

DELHI TRANSCO LTD

(A Government of NCT of Delhi Undertaking)



Bidding Documents

For

Design, Engineering, Supply, Erection, Testing & Commissioning of 220/66kV GIS Substation at Bharthal, including complete civil works & automation, along with LILO of 220kV D/C Bamnauli-DIAL Overhead Transmission Line at Bharthal, on a Turnkey Basis.



Volume – I, II & III

Tender No: T26P630001

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Volume – I

Tender No: T26P630001

VOLUME-I

CONDITIONS OF CONTRACT

CONTENTS

Section - I	Invitation for Bid (IFB)
Section - II	Instruction to Bidders (ITB)
Section - III	Bid Data Sheet (BDS)
Section - IV	Conditions of Contract (CC)
Section –V	Special Conditions of Contract (SCC)
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SECTION-I

INVITATION FOR BID **(IFB)**

DELHI TRANSCO LIMITED

(A Government of NCT of Delhi Undertaking)

INVITATION FOR BID (IFB)

(DOMESTIC COMPETITIVE BIDDING)

WEB NOTIFICATION

Tender is invited in Two-part Bid system (i.e. Technical bid and Price bid) through e- procurement portal of Delhi Govt. by **AGM(T) Material, Delhi Transco Limited, Room No. 9, Ground Floor, Maintenance Block, Old Indraprastha Power House, Near 220kV Indraprastha Substation, New Delhi-110002 (India)**, from eligible bidders who have registered with e- procurement portal of GNCTD and have obtained digital signature.

Tender Name	Design, Engineering, Supply, Erection, Testing & Commissioning of 220/66kV GIS Substation at Bharthal, including complete civil works & automation, along with LILO of 220kV D/C Bamnauli-DIAL Overhead Transmission Line at Bharthal, on a Turnkey Basis.		
Tender Enquiry No.	T26P630001		
Estimated Amount (in Rs.)	Rs. 198,01,74,776/- (Rs. One hundred ninety-eight crore one lakh seventy-four thousand seven hundred seventy-six only)		
Bid Security (BS) in Rs.	Rs. 50,00,000/- (Rupees Fifty Lakh Only)		
Tender Fee	Nil		
Bid Validity	180 days after the date of bid opening.		
Completion Period	The total completion time for the project is 30 months from the date of Notification of Award. The broad break-up of time for completion is as under:		
	Description		Duration in months from date of Notification of Award
	Taking over by the Employer upon successful completion of:		
	A)	GIS of all the voltage levels within the Substation with one Power Transformer of 220kV level along with infeed work	24 months
	B)	Remaining Power Transformers and other scope of work	30 months
		DATE	TIME
Date and Time of Start of downloading of the bidding document		-	-
Date and Time of Close of downloading of the bidding document		-	-
Date and time of Pre-Bid Conference		-	-
Date and time of start of submission of bids		-	-

Date and Time of Close of submission of bids	-	-
Date and time of opening of Techno-Commercial part of bids (Part-I)	-	-

For details please visit web site www.dtl.gov.in (unique No.....). Tender can only be submitted on e-tendering portal of Delhi Govt. website <http://govtprocurement.delhi.gov.in> or may contact office of AGM(T) Material, Delhi Transco Limited, Room No. 9, Ground Floor, Maintenance Block, Old Indraprastha Power House, Near 220kV Indraprastha Substation, New Delhi-110002 (India), Email: dgmms105@gmail.com. The Pre-Bid conference will be held at conference hall, 4th floor, Shakti Sadan, Kotla Road, New Delhi-110002. Date and time of Pre-Bid Conference.....

General requirements for invitation of bids are as under:

1.0 DELHI TRANSCO LIMITED invites tenders for the aforesaid package in Two-part Bid system (i.e. Techno-Commercial and Price bid) through e-procurement portal from eligible bidders who are registered at e-procurement portal of Delhi Govt. website i.e. <http://govtprocurement.delhi.gov.in> and have obtained digital signature.

1.1 Bidding Documents are available for downloading date and time mentioned in the web notification.

1.2 No purchase preference shall be given.

1.3 The submission of bids date and time has been mentioned in the web notification. Bids shall be received up to date and time mentioned in the web notification and Techno- Commercial Bid (Part-I) shall be opened on the same day through e-procurement portal of Delhi Govt. website i.e. <http://govtprocurement.delhi.gov.in> in the presence of Bidder's representative who chose to attend at the address given below:-

**Tender Opening Cell,
Delhi Transco Limited,
Room No. 16, Ground Floor,
Maintenance Block, Old Indraprastha Power House,
Near 220kV Indraprastha Substation,
New Delhi-110002 (India),
Email: dgmms105@gmail.com**

1.4 In case any of the above dates are declared holiday/ closing day, these shall be extended to next working day.

1.5 The complete Bidding Documents including tender drawings are available on DTL website <https://www.dtl.gov.in> and Delhi Govt. website <http://govtprocurement.delhi.gov.in>.

1.6 The Qualifying Requirements are given in the bidding document of the subject package. In addition to submission of scanned copies of mandatory documents through e-procurement portal, the bidder shall also submit (02) two copies of the bid in Book Bonded form, clearly marking each "Original Bid" and "Copy of bid" including, the signed hard copies of all relevant pre-qualification documents being submitted in support of Bid (all Forms, Annexures etc. Experience certificate, supporting documents copies, type test reports, Guaranteed Technical Particulars and any other documents required as per the bidding document etc.) at least one and half hour before the time of bid opening in the **Tender Opening Cell, Delhi Transco Limited, Room No. 16, Ground Floor, Maintenance Block, Old Indraprastha Power House, Near 220kV Indraprastha Substation, New Delhi-110002 (India)**. In the event of any discrepancy

between original and copy of the hard bid, the original shall govern. Also in the event of any discrepancy between online bidding documents and the hard copy of the bid, the online bid shall govern. **The Price Bid (Part-II) shall not be submitted in hard copy and shall only be uploaded on e-portal of Delhi Govt. website.**

- 1.7 All bids must be accompanied by Bid Security amount mentioned in the web notification as per cl. No. 23 of Section ITB, Volume-I of the bidding document. The Scanned copy of Bid Security is to be submitted with online bid; however, the Bid Security in original shall be submitted in the **Tender Opening Cell, Delhi Transco Limited Room No. 16, Ground Floor, Maintenance Block, Old Indraprastha Power House, Near 220kV Indraprastha Substation, New Delhi-110002 (India)**, at least one and half hour before the time of bid opening, failing which the bids shall be rejected.
- 1.8 The Techno- Commercial Bid (Part-I) so opened shall be evaluated and the date of opening of the Price Bid (Part-II) of the techno-commercially successful bidders shall only be communicated to all techno commercially successful bidders.
- 1.9 Delhi Transco Limited shall not be responsible for any postal delays in respect of request for issuance of bidding documents and/or dispatch of bidding documents and/or submission of bids.
- 2.0 Delhi Transco limited reserves the right to cancel/withdraw this invitation to bids without assigning any reason and shall bear no liability whatsoever consequent upon such a decision.
- 2.1 All correspondence/communication regarding the NIT shall be made to: **AGM(T) Material, Delhi Transco Limited, Room No. 9, Ground Floor, Maintenance Block, Old Indraprastha Power House, Near 220kV Indraprastha Substation, New Delhi-110002 (India), Email: dgmms105@gmail.com.**
- 2.2 Integrity Pact must be submitted alongwith the bid in physical form at the address given at para 1.7 above.
- 2.3 Under the Integrity Pact Program (IPP), Shri Umakant Lal & Shri Ashok Kumar Garg shall be the Independent External Monitor (IEM) for the subject package. Correspondence, if any, to the IEM be addressed to the following:

S.No	Name	Email id
1.	Shri Umakant Lal	Umakantlal@yahoo.co.in
2.	Shri Ashok Kumar Garg	Akgarg1654@gmail.com

AGM(T) Material

SECTION-II

INSTRUCTION TO BIDDER **(ITB)**

SECTION- II

INSTRUCTION TO BIDDERS (ITB)

A. INTRODUCTION

1.0 GENERAL INFORMATION

1.1 Delhi Transco Limited (hereinafter called ‘DTL’/ ‘Owner’/ ‘Employer’) will receive bids in respect of equipment to be furnished and erected as set-forth in the accompanying Specifications. All bids shall be prepared and submitted in accordance with these instructions.

1.2 Eligibility of bidders

Bids can be submitted by firms: -

1.2.1 From within India including company (ies) registered and incorporated in India as per Companies Act, 2013 barring foreign bidders/MNCs not registered and incorporated in India and those bidders with whom business is banned by DTL and

1.2.2 Only 'Class-I local supplier' shall be eligible to bid as per MoP order dt. **16.11.2021** read in conjunction with PPP-MII order dt. **16.09.2020** with latest amendment if any.

1.2.3 Any bidder from a country which shares a land border with India **and any bidder (including an Indian bidder) who has a Specified Transfer of Technology (ToT) arrangement with an entity from a country which shares a land border with India** will be eligible to bid only if bidder is registered with a competent authority and the registration should be valid at the time of submission of bid and at the time of acceptance of bid as per Ministry of Finance order no- **F.No.7/10/2021-PPD(1) dt 23.02.2023** and their latest amendment thereof.

2.0 QUALIFYING REQUIREMENTS OF BIDDERS

2.1 The Qualifying Requirements for the Bidders are given in **Annexure-A (BDS)** to this Volume-I of the Bidding Documents.

2.2 The above stated requirements are a minimum and the Owner reserves the right to request for any additional information and also reserves the right to reject the Proposal of any Bidder, if in the opinion of the Owner, the qualification data is incomplete or the Bidder is found not qualified to satisfactorily perform the contract.

3.0 COST OF BIDDING

3.1 The bidder shall bear all costs and expenses associated with preparation and submission of its bid including post-bid discussion, technical and other presentations etc., and the Owner will in no case be responsible or liable for those costs, regardless of the conduct or outcome of the bidding process.

B. THE BIDDING DOCUMENTS

4.0 CONTENTS OF BIDDING DOCUMENT

4.1 The goods and services required, bidding procedures and Contract terms are prescribed in the Bidding Document.

In addition to the Invitation For Bids, the Bidding Document is a compilation of the following sections:

Volume - I: Conditions of Contract

- | | | |
|------|-------------|--------------------------------------|
| i) | Section-I | Invitation For Bid (IFB) |
| ii) | Section-II | Instructions to Bidders (ITB) |
| iii) | Section-III | Bid Data Sheets (BDS) |
| iv) | Section-IV | Conditions of Contract (CC) |
| v) | Section-V | Special Conditions of Contract (SCC) |
| vi) | Section-VI | Forms and Procedures (F&P) |

Volume -II: Technical Specification

Volume -III: Bid Form, Attachments, GTP & Price Schedules

- | | |
|-------------|--|
| Section I | Bid Form |
| Section II | Attachments |
| Section III | Guaranteed Technical Particulars (GTP) |
| Section IV | Price Schedules |

5.0 UNDERSTANDING OF BID DOCUMENTS

- 5.1 A prospective Bidder is expected to examine all instructions, forms, terms, specifications and all other information in the Bid documents and fully inform himself as to all the conditions and matters which may in any way affect the scope of work or the cost thereof. Failure to furnish all information required by the Bid document or submission of a Bid not substantially responsive to the Bid document in every respect will be at the Bidder's risk and may result in the rejection of its bid.

6.0 CLARIFICATIONS ON BID DOCUMENTS

- 6.1 A prospective Bidder finding discrepancies or omissions, in specifications and document or is in doubt as to the true meaning of any part; they shall at once make a request, in writing or by electronic media (hereinafter, the term cable is deemed to include Electronic Data Interchange (EDI) or telefax) at the Employer's mailing address indicated below, to the Owner. The owner, then, will issue interpretation(s) and clarification(s) as he may think fit in writing. After receipt of such interpretation(s) and clarification(s), the Bidder may submit his bid but within the time and date as specified in the invitation for bid. All such interpretations and clarifications shall form a part of the bidding document and shall accompany the Bidder's proposal. A prospective Bidder requiring any clarification on bidding document may notify the owner in writing. The Employer will respond in writing to any request for clarification or modification of the bidding documents that it receives within 15 days after appearing in the website. Written copies of the owner's response (including an explanation of the query but without identifying its source) will be uploaded on the website as the part of bidding documents.

Address of Employer, telephone, facsimile numbers & E-mail address: (Refer BDS)

- 6.2 Verbal clarification and information given by the owner or his employee(s) or his representative (s) shall not in any way be binding on the owner.
- 6.3 The Bidder is advised to visit and examine the site, where the facilities are to be installed and its surroundings and obtain for itself on its own responsibility, all information that may be necessary, for preparing the bid and entering into a contract for supply and installation of the

facilities. The costs of visiting the site shall be at the Bidder's own expense.

- 6.4 The Bidder and any of its personnel or designated representative will be granted permission by the facilities incharge to enter upon its premises and lands for the purpose of such inspection, but only upon the express condition that the Bidder, its personnel and designated representative will release and indemnify the facilities incharge and its personnel and designated representative from and against all liability in respect thereof and will be responsible for death or personal injury, loss of or damage to property and any other loss, damage, costs and expenses incurred as a result of the inspection.
- 6.5 The Bidder's designated representative(s) is/are invited to attend pre-bid meeting, which, if convened, will take place at the venue and time stipulated in the **BDS**.

The purpose of the conference will be to clarify any issues regarding the Bidding Documents in general and the Technical Specifications in particular. The bidder is required to submit questions in writing or by cable to reach the Employer at the address indicated in **BDS**, two days before the pre-bid conference i.e. (As per web notification and relevant corrigendum)

Any modifications of the Bidding Documents which may become necessary as a result of the pre-bid conference shall be made by the Employer exclusively through an amendment pursuant to **ITB Clause 7.0** and not through the record notes of the pre-bid conference.

Non-attendance at the pre-bid conference will not be a cause for disqualification of a bidder.

7.0 AMENDMENT TO BIDDING DOCUMENT

- 7.1 At any time prior to the deadline for submission of bids, the owner may, for any reason, whether as its own initiative or in response to a clarification requested by a prospective Bidder, modify the bidding document by amendment(s).
- 7.2 Each Amendment will be posted on owners as well as on Delhi Govt. website. The owner will not be responsible for checking the website by the bidder for the same in time or otherwise. It will be considered that the information contained therein will have been taken into account by the Bidder in its bid.
- 7.3 In order to afford prospective Bidders reasonable time in which to take the amendment into account in preparing their bids, the owner may, at its discretion, extend the deadline for the submission of bids.
- 7.4 Such amendments, clarification, etc, shall be binding on the Bidders and will be given due consideration by the Bidders while they submit their bids and invariably enclose such documents as a part of the bid.

C. PREPARATION OF BIDS

8.0 Language of Bid

- 8.1 The bid prepared by the bidder and all correspondence and documents relating to the bid, exchanged by the owner and the bidder shall be written in the English language, provided that any printed literature furnished by the Bidder may be written in another language so long as accompanied by an English translation of its pertinent passages. Failure to comply with this may disqualify a bid. For purposes of interpretation of the bid, the English translation shall govern.

9.0 LOCAL CONDITIONS

- 9.1 It will be imperative on each bidder to fully inform himself of all local conditions and factors which may have any effect on the execution of the contract covered under these documents and specification. The owner shall not entertain any request for clarifications from the Bidders, regarding such local conditions.
- 9.2 It must be understood and agreed that such factors have properly been investigated and considered while submitting the proposals. No claim for financial adjustment to the contract awarded under these specifications and documents will be entertained by the owner. Neither any change in the time schedule of the contract nor any financial adjustments arising thereof shall be permitted by the owner, which are based on the lack of such clear information or its effect on the cost of the Works to the Bidder.

10.0 DOCUMENTS COMPRISING THE BID

- 10.1 The bidder shall complete the Bid form inclusive of Price Schedules, Technical Data requirements etc. furnished in the Bidding Documents, indicating for the goods to be supplied and services to be rendered, a brief description of goods and services, quantity and prices.
- 10.2 The bidder shall also submit documentary evidence to establish that the Bidder meets the Qualification Requirements (QR) as detailed in Bid data sheets (**BDS**).
- 10.3 The Bid Security shall be furnished in a separate cover in accordance with clause 23.0 of Section ITB.

Each Bidder shall submit with its bid the following Attachments:

- (a) **Attachment 1: Bid Security**
A bid security furnished in accordance with ITB Clause 23.
- (b) **Attachment 2: Power of Attorney**
A power of attorney, duly authorized by a Notary Public, indicating that the person(s) signing the bid has the authority to sign the bid and thus that the bid is binding upon the Bidder during the full period of its validity in accordance with ITB Clause 24.
- (c) **Attachment 3: Bidder's Eligibility and Qualifications**
In the absence of prequalification, documentary evidence that the Bidder is eligible to bid in accordance with ITB Cl 1.2, Section BDS and is qualified to perform the contract if its bid is accepted.

The documentary evidence of the Bidder's qualifications to perform the contract, if its bid is accepted, shall establish to the Employer's satisfaction that the Bidder has the financial, technical, production, procurement, shipping, installation and other capabilities necessary to perform the contract, and, in particular, meets the experience and other criteria outlined in the Qualification Requirement & ITB.

Qualification requirements for bidders are enclosed as **Annexure-A, Section BDS**.

(d) **Attachment 4: Subcontractors Proposed by the Bidder**

The Bidder shall include in its bid details of all major items of supply or services, that it proposes to purchase and shall give details of the name and nationality of the proposed Subcontractor, including vendors, for each of those items. Bidders are free to list more than one Subcontractor against each item of the facilities. Quoted rates and prices will be deemed to apply to whichever Subcontractor is appointed, and no adjustment of the rates and prices will be permitted.

Vendors hired by the erector or the manufacturer or the lead player, shall be selected on considerations of quality and economy and DTL reserves the right to seek information in relation to any such vendor proposed to be hired by the erector or manufacturer or lead player. Subletting of either whole or part of the contract by the contractor, hired by DTL shall not be permissible.

The Employer reserves the right to delete any proposed Subcontractor from the list prior to award of contract, and after discussion between the Employer and the Contractor, attachment-4 to the form of Contract Agreement shall be completed, listing the approved Subcontractors for each item.

(e) **Attachment 5: Commercial Deviations**

In order to facilitate evaluation of bids, deviations, if any, from the Terms & Conditions Commercial Deviations Specifications shall be listed in Attachment 5 for Techno commercial Bid.

(f) **Attachment 6: Deviation on Important condition.**

In order to facilitate evaluation of bids, deviations on Important Condition shall be listed in Attachment 6 for important condition of Bid.

(g) **Attachment 7: Technical Deviation.**

In order to facilitate evaluation of bids, deviations, if any on technical specifications shall be listed in Attachment 7 for Techno commercial Bid.

(h) **Attachment 8: Additional Information**

In order to facilitate evaluation of bids, if any additional Information on technical/commercial specifications shall be listed in Attachment 8 for Techno commercial Bid.

(i) **Attachment 9: Bought-out & Sub-Contracted Item**

(j) **Attachment 10: Work Completion Attachment**

(k) **Attachment 11: List of Special Tools & Tackles**

(l) **Attachment 12: Information regarding ex-employees of Employer in Bidder's firm.**

(m) **Attachment 13: Deleted.**

(n) **Attachment 14: Price Adjustment Data**

(o) **Attachment 15: Guarantee Declaration**

(p) **Attachment 16: Integrity Pact**

Integrity Pact (*submission of Hard Copy in 'Original'*)

The Bidder shall complete the accompanying Integrity Pact, which shall be applicable for bidding as well as contract execution, duly signed on each page by the person signing the bid and shall be returned by the Bidder in two (2) originals alongwith the Techno - Commercial Part in a separate envelope, duly superscripted with 'Integrity Pact'. "The Bidder shall submit the Integrity Pact on a non judicial stamp paper of Rs. 100/-.

The required format for Integrity Pact shall be as per Attachment 16.

If the Bidder is a partnership firm or a consortium, the Integrity Pact shall be signed by all the partners or consortium members.

Integrity Pact must be submitted in physical form at the address given at ITB 25.0 at or before the schedule time and date of opening of Techno-commercial part of the bid.

Bidder's failure to submit the Integrity Pact duly signed in Original alongwith the Bid or subsequently pursuant to ITB Sub-Clause 27.6 shall lead to outright rejection of the Bid.

Bidder shall not approach the court while representing the matters to IEMs and bidder will await their decision in the matter.

(q) **Attachment 17: Deleted**

(r) **Attachment 18: Checklist**

(Bidder shall submit the information regarding documents submitted by them in the offer as per the checklist provided in Attachment)

(s) **Attachment 19: Affidavit of Self certification regarding Local Content in line with PPP-MII order (submission of Hard Copy in 'Original'), to be submitted on a non-judicial stamp paper of Rs. 100/-.**

In line with the MOP order dt. **16.11.2021** read in conjunction with PPP-MII order dt 16.09.2020 & their latest amendments thereof, 'Class-I local supplier' shall be required to indicate percentage of local content and submit self-certification, in original, certifying that the item offered meets the local content requirement for 'Class-I local supplier' and shall also give details of the location(s) at which the local value addition is made, as prescribed in the PPP-MII Order dt. 16.09.2020 & their latest amendments thereof, on a non-judicial stamp paper of Rs. 100/-.

Any False declarations will be in breach of the Code of Integrity under Rule 175(1)(i)(h) of the General Financial Rules for which a bidder or its successors can be debarred for up to two years as per Rule 151(iii) of the General Financial Rules along with such other actions as may be permissible under law.

(t) **Attachment 20: Certificate from statutory auditor or cost auditor of the company giving the percentage of Local Content, in line with PPP-MII order and MoP Order, as applicable (submission of Hard Copy in 'Original') to be submitted on the letter head of the auditor/ cost accountant.**

In line with the MOP order dt. **16.11.2021** read in conjunction with PPP-MII order dated 16.09.2020 & their latest amendments thereof, the 'Class-I local supplier' shall submit certificate on the letter head of the auditor/cost accountant from the statutory auditor or cost auditor of the company giving the percentage of local content.

Any False declarations will be in breach of the Code of Integrity under Rule 175(1)(i)(h) of the General Financial Rules for which a bidder or its successors can be debarred for up to two years as per Rule 151(iii) of the General Financial Rules along with such other actions as may be permissible under law.

(u) Attachment 21: Undertaking for not indulging in Corrupt & Fraudulent practice

It shall be the sole responsibility of bidder to provide the information based on the documents submitted by them.

(v) Attachment 22: Certification by the Bidder as per DoE Order no- F.No.7/10/2021-PPD(1) dt 23.02.2023 in line with ITB Clause 1.2.2 (In case of a Joint Venture bid, the declaration shall be given by all partners of the Joint Venture).

Any false certificate given by a bidder whose bid is accepted will let to immediate termination and further legal action in accordance with law.

(w) Attachment 23: Details of Type test Report as per QR and in accordance with latest IEC/NIT.

11.0 SCOPE OF THE PROPOSAL

11.1 The scope of the work covered under this package shall be on the basis of a single Bidder's responsibility, completely covering all the equipment specified under the section Project, Volume-II. It will include the following: -

- a. Complete manufacture including shop testing.
- b. Providing Engineering drawing, data, operational manual, etc for the Owner's approval.
- c. Packing and transportation from the manufacturer's works to the site.
- d. Receipt, storage, preservation and conservation of equipment at the site.
- e. Pre-assembly, if any, erection, testing and commissioning of all equipment.
- f. Reliability tests and performance and guarantee tests on completion of commissioning and
- g. Furnishing of spares, if applicable.

The above scope of work is indicative and the complete scope of work is defined in section project, Volume-II of this tender document.

11.2 Bids containing deviations from critical provisions relating to (i) to (xi) below will be considered as non responsive:

- (i) Governing Laws, Clause 5, CC
- (ii) Settlement of Disputes, Clause 6, CC
- (iii) Taxes and Duties, Clause 14, CC
- (iv) Appendix 2 to the Form of Contract Agreement (Price Adjustment): Clause No. 15 ITB
- (v) Bid Security: Clause 23.0, Section ITB Volume-I, conditions of contract
- (vi) Contract Performance Guarantee: Clause 43.0, Section ITB, Volume-I, Conditions of Contract.
- (vii) Liquidated Damages & (Functional Guarantee): Clause 28 & 28.5 CC
- (viii) Defect Liability: Clause No. 27 CC
- (ix) Price Basis and Payment: Clause No.12 CC and Clause 14 Section ITB

- (x) Completion Time: Section F&P Appendix-4
- (xi) Patent Indemnity, Clause No.29, CC

However, the Bidders, wishing to propose deviations to any of the above provisions, must provide in the Commercial Deviations Attachment of Bid Form in their bid alongwith the cost of withdrawal of such deviations. If the deviation to any of these provisions is not priced, the bid will be rejected. The evaluated cost of the bid shall include, in addition to the cost described in Price schedule, the cost of withdrawal of the deviations from the above provisions to make the bid fully compliant with these provisions.

Bidders are also required to quote the price for Commercial, contractual and Technical obligations outlined in the bidding document. If a Bidder wishes to make a deviation, such deviation shall be listed in deviation Attachment of Volume-III. The Bidder shall also provide additional price, if any, for withdrawal of the deviations. If the deviation to any of these provisions is not priced, the bid will be rejected.

At the time of Award of Contract, if so desired by the owner, the Bidder shall withdraw these deviations listed in commercial deviation Attachment of Bid Form in their Bid at the cost of withdrawal stated by him in the bid. In case the Bidder does not withdraw the deviations proposed by him, if any, at the cost of withdrawal stated by him in the bid, his bid will be rejected and his bid security forfeited.

The owner's determination of a bid's responsiveness is to be based on the contents of the bid itself without recourse to extrinsic evidence.

- 11.3 Bids not covering the above entire scope of works may be treated as incomplete and hence rejected.

12.0 BID PRICE

- 12.1 The Bidder shall quote in the appropriate Attachment of Bid form lump-sum price for the entire scope of works (covered under the Bidding document) and also the unit rates of the goods and services
- 12.2 The Bid price under the contract shall be on a firm price basis, unless otherwise specified in the conditions of contract.
- 12.3 The Bidder shall also furnish the price break-up in the appropriate Attachments of bid form to indicate the following:
 - i. Ex-works price of the equipment/materials (including tools and tackles etc.)
 - ii. Charges for transportation and insurance for delivery of the equipment/ materials up to their final destinations.
 - iii. Lump-sum charges towards unloading, storage, insurance, erection, testing & commissioning, exclusive of taxes and duties as per GST.
 - iv. Price break-up for spares, if applicable, in line with clause 17.0 of this section.
 - v. Taxes and duties and any other levies legally payable on the transactions between the owner and the Bidder.
 - vi. Any other charges as per the requirement of conditions of contract/Technical specifications.

- 12.4 Bidder can effect reductions in the prices already filled up in Price Schedules by way of discounts. Bidder can offer the discount either on lump sum basis or percent basis, which can be made applicable either on the total price or one or more of the price schedule(s).

The Bidder may note that in case they choose to offer multiple discounts, all discounts shall be applicable simultaneously on the base prices of respective items on which the bidder has offered the discount(s) i.e., all the discounts shall be considered together on the Quoted Prices of such items (as quoted by the bidder without discount).

- 12.5 Examination of the bid shall be in accordance to Clause 34 of Section ITB.

13.0 ALTERNATE PROPOSALS

- 13.1 Based on their experience, capabilities, patented research, and development works etc., the bidder may, in addition to a base proposal, offer alternate proposal(s), for reasons of economy or better performance. But in all such cases, the base proposal shall be strictly in line with the requirements as stipulated in the bidding documents and only such base proposal shall be considered for the purposes of evaluation of the proposals. Should the bid by the successful bidder contain such alternate proposal then the owner at its discretion may accept the same at the time of award of contract.

14.0 PRICE BASIS AND PAYMENTS

- 14.1 The bidders shall quote in their proposals lump-sum price for the entire scope of works covered under section Project, Volume-II as required in the Bid Forms on a firm price basis unless otherwise specified in the Conditions of Contract. Bidders quoting a system of pricing other than that specified run the risk of rejection.
- 14.2 Bidder shall indicate bid prices in Indian Rupees only.

15.0 PRICE ADJUSTMENT: Refer BDS

16.0 TIME SCHEDULE

- 16.1 The basic consideration and the essence of the contract shall be strict adherence to the time schedule for performing the specified works.
- 16.2 The Owner's requirements of completion schedule for the works are mentioned in the accompanying conditions of contract.
- 16.3 The completion schedule as stated in the Conditions of Contract shall be one of the major factors in consideration of the bids.
- 16.4 The Owner reserves the right to request for a change in the work schedule during pre-award discussions with successful Bidder.
- 16.5 The Successful Bidder will be required to prepare detailed PERT network and finalize the same with the Owner as per the requirement of Clause 18.0, Section CC, Vol-I.

17.0 SPARE PARTS

- 17.1 In case where it is mandatory for the bidders to quote for certain identified spare parts, the same are included in the accompanying Technical Specifications. In such cases the item wise price breakdown of such spares on an Ex-works basis shall be indicated in the bid. The

Bidder shall further indicate item wise price break-up on FOR site basis. In respect of Taxes, the provisions of Clause 14.0 CC shall be applicable. The above prices shall not be included in the lump-sum price but indicated separately in the Attachments and shall not be subject to escalation. The prices quoted for these spares will be taken into account for evaluation. The owner, however, reserves the right to vary the quantity of any of the spare and/or to delete any items of spares altogether or add new items of spares during award/detailed engineering stage limited to a period of six (6) months from date of contract unless such period is specified otherwise in conditions of contract at the unit rate agreed to in the contract or to be agreed mutually in case unit rates are not identified in the Bid/Contract.

- 17.2 In addition, the Bidder shall provide in the form of Attachment given in Bid Forms, the complete list of recommended spare parts for three (3) years operation of the equipment covered under the Proposal. In the list of recommended spare parts, the bidder shall identify the unit-wise population of each of the items recommended and anticipated normal life of the spare. Such list will also indicate the prices on FOR destination site basis for each item. No other basis of prices will be quoted. The prices of these spare parts shall be on firm price basis and shall remain valid till 120 days after the date on which the validity of the main bid expires. The prices of the spare parts thus quoted shall not be taken into consideration for the purpose of evaluation. Other relevant terms and conditions of these documents shall also be applicable to such spare parts.
- 17.3 Spare parts list will be used by the owner to decide about the spares to be procured against his spares requirement for equipment quoted. The quantities of the spares to be procured shall be decided by the owner and the Bidder shall furnish all those spares ordered.
- 17.4 In case where no mandatory spares are indicated, the Bidder shall comply with the requirement indicated in Clause 17.2 through 17.3 above.

18.0 CONTRACT QUALITY ASSURANCE

- 18.1 The Bidder shall include in his Proposal the Quality Assurance Programme containing the overall quality management and procedures, which he proposes to follow in the performance of the works during various phases as detailed in relevant clause of the General Technical Conditions.
- 18.2 At the time of Award of Contract, the detailed Quality Assurance Programme to be followed for the execution of the contract will be mutually discussed and agreed to and such agreed Programme shall form a part of the Contract.

19.0 INSURANCE

- 19.1 The Bidder's insurance liabilities pertaining to the scope of works are detailed out in Clauses titled 'Insurance' in Conditions of Contract (CC) of this Volume- I. Bidder's attention is specifically invited to these clauses. Bid price shall include all the cost in pursuance of fulfilling all the insurance liabilities under the Contract.

20.0 MAINTENANCE TOOLS AND TACKLES

The Proposal shall include all special tools and tackles required for the operation and maintenance of the equipment in each equipment package. The Bidder shall indicate all the above items in the Proposal sheets in the form of an Attachment given there in and the description and the quantity of each item. The lump sum price to be quoted by the Bidder shall include prices of these tools and tackles. These tools and tackles shall be delivered at site along with the last consignment of equipment and in no case earlier than this, unless

otherwise specified in the Conditions of Contract and /or Technical Specifications, Volume-II.

21.0 ERECTION TOOLS & TACKLES

The Bidder, under a separate Attachment, in his Proposal shall include a list of all special equipment, tools & tackles etc. which he proposes to bring to site for the purpose of erection, handling, testing and commissioning including performance & guarantee tests of the equipment. If any such equipment is listed anywhere else in the Proposal and not specially mentioned in the above Attachment, it shall be deemed to have been included in the Bidder's proposed scope of supply.

22.0 BRAND NAMES

- 22.1 The specific reference in these specifications and documents to any Material / Equipment by brand name, make or catalogue number shall be construed as establishing standards of quality and performance and not as limiting competition. However, Bidders may offer other similar material/equipment provided they meet the specified standard, design and performance requirements. The Bidder shall furnish adequate technical information about such alternative material/equipment to enable the owner to determine its acceptability. The Owner shall be the sole judge on the acceptability or other wise of such alternative material/equipment.
- 22.2 The Bidder shall note that standards for workmanship, material and equipment and reference to brand names or catalogue numbers designated by the Owner in its Technical Specifications are intended to be descriptive only and not restrictive. The Bidder may substitute alternative standards, brand name and/or catalogue numbers in its bid, provided that it demonstrates to the Owner's satisfaction that the substitutions are substantially equivalent or superior to those designed in the Technical Specifications.

23.0 BID SECURITY

- 23.1 The Bidder shall furnish, as part of its bid, Bid Security for an amount as specified in the **BDS**. Bid security shall be valid for 60 days beyond validity of the bid.
- 23.2 The Bid Security is required to protect the Owner against the risk of Bidder's conduct, which would warrant the guarantee forfeiture, pursuant to Clause 23.7. The Bid Security shall be made payable to the Owner without any condition whatsoever.
- 23.3 The Bid Security shall be denominated in Indian Rupees only and shall be in one of the following forms:
- (a) DD/Pay Order/FD/Insurance Surety Bonds receipt in favour of Delhi Transco Limited New Delhi, payable at New Delhi, from a Scheduled Commercial Bank. The format of the Insurance Security Bond to be issued by an Insurance Company/ Scheduled Commercial Bank towards Bid Security should generally conform to the proforma enclosed under Section VI (Forms and Procedures).
- (b) E-payment from the account of the bidder. The detail of DTL's Bank account is as under:

Name	Delhi Transco Ltd.
Name of Bank with Address	SBI, Chandni Chowk Delhi.
Current Account No.	10820056547
Codes	RTGS/IFSC No: SBIN0000631 MICR No: 110002018

- (c) An irrevocable Bank Guarantee (**including e- Bank Guarantee**) issued by a Scheduled Commercial Bank in favour of Delhi Transco Limited, New Delhi & BG (Bank Guarantee) should be valid for minimum **240** days from date of opening of tender. Performa for the Bank Guarantee is enclosed as Form-2, Section Forms & Procedure to this Volume-I.
- 23.4 Any bid not secured in accordance with paras 23.1 and 23.3 above will be rejected by the Owner as non-responsive.
- 23.5 EMD/Bid Security may be returned to bidders (except L-1 bidder), after opening of price bids and recommendation of L-1 bidder for award/negotiation.
- 23.6 The successful Bidder's Bid Security will be discharged /returned upon the Bidder's executing the Contract and furnishing the Performance Security/ Guarantee pursuant to Clause 43.0 of ITB. The amount of Bid Security in whole or any part thereof is liable to be forfeited due to its non submission of performance security/guarantee or non-execution of contract.
- 23.7 The Bid Security may be forfeited:
- a) If a Bidder withdraws/modifies his bid after opening during the period of bid validity specified by the Bidder on the Bid Form;
- or**
- In case the Bidder does not withdraw the deviations proposed by him, if any, even after considering the cost of withdrawal stated by him in the bid;
- or**
- If a Bidder does not accept the corrections to its bid price pursuant to Clause 35.0, A and B, Section-ITB;
- or**
- If, as per the Qualifying Requirements the Bidder has to submit a Deed of Joint Undertaking (if any) and bidder fails to submit the same, duly attested by Notary Public of the place(s) of the respective executant (s) or registered with the Indian Embassy/ High Commission in that country, within ten days from the date of intimation of pre-award discussion.
- b) In case of a successful Bidder, if the Bidder fails within the specified time limit,
- (i) to sign the Contract, in accordance with NIT.
- or**
- (ii) to furnish the Performance Security/ Guarantee, in accordance with NIT.
- 23.8 The Scanned copy of Bid Security is to be submitted with online bid, however, the Bid Security shall be submitted in separate sealed envelope in one original and two copies in the **Tender Opening Cell (Refer BDS)** at least one and half hour before the time of bid opening. Any bid not accompanied by the required bid security in accordance with provisions of this clause will be rejected by the Owner and bid shall not be opened.
- 23.9 No interest shall be payable by the Owner on the above Bid Security.
- 23.10 Bid security is required from all the bidders except Startups, Micro and Small Enterprises (MSEs)/NSIC registered firms as notified by Department of Micro, Small and Medium Enterprises (MSME) and OEM/OES from Govt. organization/PSU.

- 23.11 Unsuccessful Bidder's Bid Security will be discharged /returned as promptly as possible after a decision with regard to finalization of the tender or after the expiry of the period of bid validity prescribed by the Owner.

24.0 PERIOD OF VALIDITY OF BIDS

- 24.1 Bids shall remain valid for 180 days after the date of bid opening prescribed by the Owner unless otherwise specified in the accompanying Conditions of Contract. A bid valid for a shorter period will be rejected by the Owner as non-responsive.
- 24.2 In exceptional circumstances e.g. expiry of bid validity, the Owner may solicit the Bidder's consent to an extension of the period of validity of the bid on same terms and conditions otherwise their bid shall not be considered. The request and the response thereto shall be made in writing (including cable or telex). The bid security provided under Clause 23.0 shall also be extended by the same period as the extension in the validity of the Bid. A bidder may refuse the request without forfeiting his bid security. A Bidder granting the request will not be required or permitted to modify its bid.

D. FORMAT OF BID

- 25.0 The on line offer complete in all respects will be submitted at e- procurement portal of Delhi Govt. website i.e. <http://govtprocurement.delhi.gov.in>. In addition to submission of scanned copies of mandatory documents through e-procurement portal, the bidder shall also submit (02) Two copies of the bid in Book Binded form, clearly marking each "Original Bid" and "Copy of bid" including, the signed hard copies of all relevant pre-qualification documents being submitted in support of Bid (all Forms, Annexures etc. Experience certificate and supporting documents copies, type test reports, Guaranteed Technical Particulars, any other documents required as per the bidding document, etc.) and un priced schedule at least one and half hour before the time of bid opening in the **Tender Opening Cell (Refer BDS) J**. In the event of any discrepancy between original and copy of the hard bid, the original shall govern. Also in the event of any discrepancy between online bidding documents and the hard copy of the bid, the online bid shall govern. **The Price Bid (Part-II) shall not be submitted in hard copy and shall only be uploaded on e-portal of Delhi Govt. website.**

- 25.1 The original and all copies of the bid shall be typed or written in indelible ink and shall be signed by the Bidder or a person or persons duly authorized to bind the Bidder to the Contract. The letter of authorization shall be indicated by written Power-of-Attorney accompanying the bid. All pages of the bid, except for un-amended printed literature, shall be initialed by the person or persons signing the bid. **All pages of the bid shall be sequentially numbered.**

All document comprising Power of Attorney, Joint Deed of Undertaking (as applicable), Affidavit of self-certification regarding Minimum Local Content under PPP-MII order dt 15.06.2017, 28.05.2018, 29.05.2019, 04.06.2020 & 16.09.2020 & their latest amendments thereof, read in conjunction with MoP Order dt. 20.12.2018, 04.04.2020, 28.07.2020, 16.11.2021 & their latest amendments thereof, Certificate from statutory auditor/cost auditor/cost accountant/chartered accountant, giving the percentage of Local Content, under PPP-MII orders and MoP Orders, if applicable shall be submitted in separate envelop.

- 25.2 The Bidders must submit the qualifying data in (2) two copies, as required in this Instruction to Bidders in a separate envelop sealed and enclosed in the envelope submitting Proposals, super scribed as under:

QUALIFYING DATA FOR: BID TITLE (Refer BDS)

25.3 The bid shall contain no interlineations, erasures or overwriting except as necessary to correct errors made by the Bidder, in which case such corrections shall be initialed by the persons or persons signing the bid.

25.4 Documents to be uploaded on e-procurement portal of Delhi Government while bidding:

The following scanned copies of documents are required to be uploaded:

- a) Bid Security
- b) GST Registration No.
- c) PAN No.
- d) EPF Registration No.
- e) Registration Certificate of the Company issued from the Competent Authority.
- f) Details of technical experience along with performance certificates as per NIT.
- g) Financial details as per NIT
- h) Bid form, attachments and annexure's as per NIT
- i) Price bid (Only Online)
- j) Other documents as per NIT

26.0 SIGNATURE OF BIDS

26.1 The bid must contain the name, residence and place of business of the person or persons making the bid and must be signed and sealed by the Bidder with his usual signature. The names of all persons signing should also be typed or printed below the signature.

26.2 Bid by a partnership must be furnished with full names of all partners and be signed with the partnership name, followed by the signature(s) and designation(s) of the authorized partner(s) or other authorized representative(s).

26.3 Bids by Corporation/Company must be signed with the legal name of the Corporation/company by the President, Managing Director or by the Secretary or other person or persons authorized to bid on behalf of such Corporation/Company in the matter.

26.4 A bid by a person who affixes to his signature the word 'President' Managing Director', 'Secretary', 'Agent' or other designation without disclosing his principal will be rejected.

26.5 Satisfactory evidence of authority of the person signing on behalf of the Bidder shall be furnished with the bid.

26.6 The Bidder's name stated on the Proposal shall be exact legal name of the firm.

26.7 Bids not conforming to the above requirements of signing may be disqualified.

27.0 SEALING AND MARKING OF BIDS

27.1 The Bidders shall seal the original and each copy of the bid in an inner and an outer envelope, duly marking the envelopes as "Original" and "Copy".

27.2 The inner and outer envelopes shall be:

a). Addressed to the Owner at the following address:

Address of Employer, telephone, facsimile numbers & E-mail address: (Refer BDS)

- b). bear the name of package, the specification number, Details of Bid Guarantee, Validity of Bid, Name of the Bidder with address and the words **“DO NOT OPEN BEFORE date and time of opening as mentioned in web notification”**, to be completed with the time and date specified in the Invitation for Bid, pursuant to ITB Sub-Clause 27.2. Other Annexure's/ Performa's / Attachments shall be enclosed in envelope on which above contents shall be super scribed. **The Price Bid (Part-II) shall not be submitted in hard copy, and shall be submitted online only however un-priced schedules shall be submitted along with techno commercial bid Part I.**
- 27.3 The inner envelope shall indicate the name and address of the Bidder to enable the bid to be returned unopened in case it is declared “late” or “rejected”.
- 27.4 If the outer envelope is not sealed and marked as required by para 27.2 above, the Owner will assume no responsibility for the bid's misplacement or premature opening or its secrecy, but this disclosure will not constitute grounds for bid rejection.
- 27.5 The Bid Security must be submitted in a separate sealed envelope on which the contents shall be super scribed.
- 27.6 The Bidder shall submit the sealed bids in Two Part System i.e. PART-I (**TECHNO-COMMERCIAL BID- ONLINE AND IN HARD COPY**) and PART-II (**PRICE BID- ONLINE ONLY**). The Integrity Pact shall be submitted in two (2) originals in separate sealed envelope alongwith bid having marking as “Integrity Pact”. The separate envelopes containing original & copies of PART-I (TECHNO-COMMERCIAL BID)”, and BID SECURITY and Integrity Pact shall then be sealed in an outer envelope.

PART-I (TECHNO-COMMERCIAL BID) - All supporting documents, Attachments, Annexures, Performa, Un-priced Schedules, Bid Form (un-priced) and Bid document **except price bid.**

PART-II (PRICE BID) - Price Schedules & Bid Form only. (**ONLINE ONLY**)

28.0 DEADLINE FOR SUBMISSION OF BIDS

- 28.1 The Bidders are required to submit the bid through e-procurement portal of Delhi Govt. website i.e. <http://govtprocurement.delhi.gov.in> not later than the time & date mentioned in the Invitation for Bid. In addition to submission of scanned copies of mandatory documents through e-procurement portal, the bidder shall also submit (02) Two copies of the bid in Book Binded form, clearly marking each “Original Bid” and “Copy of bid” including, the signed hard copies of all relevant pre-qualification documents being submitted in support of Bid (all Forms, Annexures etc. Experience certificate, supporting documents copies, type test reports, Guaranteed Technical Particulars and any other documents required as per the bidding document, etc.) at least one and half hour before the time of bid opening in the **Tender Opening Cell (Refer BDS) /**. In the event of any discrepancy between original and copy of the hard bid, the original shall govern. Also in the event of any discrepancy between online bidding documents and the hard copy of the bid, the online bid shall govern. **The Price Bid (Part-II) shall not be submitted in hard copy and shall only be uploaded on e-portal of Delhi Govt. website.** Bidders have the option of sending the hard copy of the bid by registered post or submitting the bid in person. Bids submitted by telex/telegram will not be accepted. No request from any Bidder to the Owner to collect the Proposals from airlines, cargo agents etc. shall be entertained by the Owner.

28.2 Hard Copy of the bids must be received by the Owner at the address specified under para 27.2, not later than the time & date mentioned in the Invitation for Bid. In the event of the specified date for submission of Bids, being declared a holiday for the Owner, the Bid will be received upto the appointed time on the next working day.

28.3 The Owner may, at its discretion, extend this deadline for the submission of bids by amending the Bidding Documents, in which case all rights and obligations of the Owner and Bidders previously subject to the deadline will thereafter be subject to the deadline as extended.

29.0 LATE BIDS

29.1 Any bid received by the Owner after the time & date fixed or extended for submission of bids prescribed by the Owner, will be rejected and/or returned unopened to the Bidder.

30.0 MODIFICATION AND WITHDRAWAL OF BIDS

30.1 The Bidder may modify or withdraw its bid after the bid's submission provided that written notice of the modification or withdrawal is received by the Owner prior to the deadline prescribed for submission of bids.

30.2 The Bidder's modification or withdrawal notice shall be sent by fax/e-mail but it should be followed by a signed confirmation copy by post and such signed confirmation should reach the owner/ purchaser not later than the bid submission date and the modified bid prepared, sealed, marked and dispatched in accordance with the provisions of Clause 27.0 clearly identified as such, in two inner envelopes duly marked "Bid Modifications-Original" and "Bid Modifications-Copies." The inner envelopes shall be sealed in an outer envelope, which shall be duly marked "Bid Modifications." The Bidder shall submit one (1) no. original and two (2) no. copies of the same.

Other provisions concerning the marking and dispatch of bid modifications shall be in accordance with ITB Sub-Clauses 27.2, 27.3 and 27.4.

30.3 No bid may be modified or withdrawn after the deadline for submission of bids. Withdrawal of a bid after the deadline for submission of bids will result in forfeiture of bidder's bid security.

30.4 Notice of withdrawal shall

a) be addressed to the Owner named in Clause. No. 27.2(a) of ITB.

b) bear the name of the package, tender/ specification number, and the words "Bid Withdrawal Notice"

Bid withdrawal notices received after the bid submission deadline will be ignored, and the submitted bid will be deemed to be a validly submitted bid.

31.0 INFORMATION REQUIRED WITH THE PROPOSAL

31.1 The bids must clearly indicate the name of the manufacturer, the type of model of each principal item of equipment proposed to be furnished and erected. The bid should also contain drawings and descriptive materials indicating general dimensions, materials from which the parts are manufactured, principles of operation, the extent of pre-assembly involved, major construction equipment proposed to be deployed, method of erection and the proposed erection organizational structure.

- 31.2 The above information shall be provided by the Bidder in the form of separate sheets, drawings, catalogues, etc. in (02) two copies.
- 31.3 Any bid not containing sufficient descriptive material to describe accurately the equipment proposed may be treated as incomplete and hence rejected. Such descriptive materials and drawings submitted by the Bidder will be retained by the Owner. Any major departure from these drawings and descriptive material submitted will not be permitted during the execution of the Contract without specific written permission of the Owner.
- 31.4 Oral statements made by the Bidder at any time regarding quality, quantity or arrangement of the equipment or any other matter will not be considered.
- 31.5 Standard catalogue pages and other documents of the Bidder may be used in the bid to provide additional information and data as deemed necessary by the Bidder.
- 31.6 The Bidder, along with his Proposal, shall submit a list of recommended erection equipment and materials which will be required for the purpose of erection of equipment and materials supplied under the Contract.
- 31.7 In case the 'Proposal' information contradicts specification requirements, the specification requirements will govern, unless otherwise brought out clearly in the Technical Commercial Deviations Attachment.

E. BID OPENING AND EVALUATION

32.0 OPENING OF BIDS BY OWNER

- 32.1 Two-part bids submitted by the bidders shall be opened in two phases. In the first phase, the techno commercial bid (Part-I) shall be opened and the bids of the bidders found techno commercially successful after detailed evaluation shall be opened in the second phase.

In first stage, the Owner will open the Part-I (Techno Commercial Bid) bids in the presence of Bidders' representatives (up to 2 persons) who choose to attend at the date and time for opening of bids in the Invitation to Bid or in case any extension has been given thereto, on the extended bid opening date and time notified to all the Bidders. The Bidders' representatives who are present shall sign in a register as well as proforma evidencing their attendance.

Bid Security will be checked and in case Bid Security is not found of required amount or not in acceptable mode, the offer of that particular bidder shall be considered invalid.

On the due date of opening as notified, Bidders, whose Bid Security will be found in order only their Techno Commercial offer will be opened on the date of opening.

- 32.2 Envelopes marked "**WITHDRAWAL**" shall be opened first and the name of the Bidder shall be read out. Bids for which an acceptable notice of withdrawal has been submitted pursuant to ITB clause 30.0 shall not be opened.
- 32.3 The Bidders' names, bid prices, modifications, bid withdrawals and the presence or absence of the requisite Bid Security and such other details as the Owner, at its discretion, may consider appropriate will be announced at the opening. Subsequently, all envelopes marked "**MODIFICATION**" shall be opened and the submissions therein read out in appropriate detail. No bid shall be rejected at bid opening except for late bids pursuant to ITB Clause 30.0.

Any bid not accompanied by an acceptable Bid Security shall be rejected by the Owner as being non responsive, pursuant to ITB clause 34.4. The bid guarantee of a Joint Venture must be in the name of all partners in the Joint Venture submitting the bid.

- 32.4 No electronic recording devices will be permitted during bid opening.
- 32.5 Bids not opened and read out at bid opening shall not be considered for further evaluation, irrespective of the circumstances.
- 32.6 After Tenders/Bids have been opened no alterations, shall be permitted either in the Tendered/Bid amount or in the specifications or schedule or any altering offer entertained unless and until specifically asked for.

33.0 CLARIFICATION OF BIDS

To assist in the examination, evaluation and comparison of bids the Owner may, at its discretion, ask the Bidder for a clarification of its bid. The request for clarification and the response shall be in writing and no change in the price or substance of the bid shall be sought, offered or permitted.

34.0 PRELIMINARY EXAMINATION

- 34.1 The Owner will examine the bids to determine whether they are complete, whether required sureties have been furnished, whether the documents have been properly signed and whether the bids are generally in order.
- 34.2 Prior to the detailed evaluation of PART-I (TECHNO-COMMERCIAL BID)", the Owner/Employer will determine whether each bid is of acceptable quality, is generally complete and is substantially responsive to the bidding documents. For purpose of this Clause, a substantially responsive bid is one, which conforms to all the terms and conditions of the Bidding Document without material deviations, objections, conditions or reservations. A material deviation, objection, conditionality or reservation is one (i) that affects in any substantial way the scope, quality or performance of the contract; (ii) that limits in any substantial way, inconsistent with the bidding documents, the Owner's rights or the successful Bidder's obligations under the contract; or (iii) whose rectification would unfairly affect the competitive position of other Bidders who are presenting substantially responsive bids.

The qualified bidders, whose bids are techno-commercially responsive and, who are considered to have the capacity and capability to perform the Contract based on the assessment, if carried out, price bids shall be opened.

The PART-II (PRICE BID) of only those bidders whose **TECHNO-COMMERCIAL BID** are of acceptable quality shall be opened **ONLINE ONLY**, thereafter. However technically acceptable party shall be informed for the opening of the Price Bid (Part-II).

- 34.3 A bid determined as not substantially responsive will be rejected by the Owner and may not subsequently be made responsive by the Bidder by correction of the non- conformity. The Owner's determination of a bid's responsiveness is to be based on the contents & compliance of the complete provisions of Techno-Commercial bid itself without recourse to extrinsic evidence.
- 34.4 The Owner may waive any minor informality or non-conformity or irregularity in a bid, which does not constitute a material deviation, provided such waiver does not prejudice or affect the relative ranking of any Bidder.

35A Detailed Technical & Commercial Evaluation (Part-I)

35A.1 The Owner will carry out a detailed evaluation of the Techno-Commercial (Part-I) of offer to determine whether the Technical/Commercial aspects are in accordance with the requirements set forth in the bidding documents. In order to reach such a determination, the Owner will examine and compare the technical/commercial aspects of the bids on the basis of the information supplied by the bidders, taking into account the following factors:

- (a) Overall completeness and compliance with the Techno-Commercial Specifications and Drawings; deviations from the Technical Specifications as identified in Attachment-7 to the bid; suitability of the facilities offered in relation to the environmental and climatic conditions prevailing at the site; and quality, function and operation of any process control concept included in the bid. The bid that does not meet minimum acceptable standards of completeness, consistency and detail will be rejected for non-responsiveness.
- (b) Achievement of specified performance criteria by the facilities & Qualifying Requirements as provided in **Annexure-A of BDS**. The evaluation will also take into account the Bidder's financial, technical and production capabilities.
- (c) Type, quantity and long term availability of mandatory and recommended spare parts and maintenance services.
- (d) Any other relevant factors, if any, listed in the Bid, or that the Owner deems necessary or prudent to take into consideration.
- (e) The bidder has to quote the complete scope of work for the subject package covered under the specifications as stated in the bid document. Bids covering partial scope of work will be treated incomplete and shall be rejected.
- (f) Conditional discount(s)/ rebate(s), if any, offered by the bidder shall not be taken into consideration for evaluation. It shall however, be considered in case of award.
- (g) The cost of withdrawal of deviations shall also be considered for the purpose of evaluation of Bid.

35A.2 When alternative technical proposal have been permitted and offered in Section-ITB to the bid, the Owner will make similar evaluation of the alternatives, which will be treated in the technical and commercial evaluations as if they were base bids. Where alternatives are not permitted, but have been offered in any event, they shall be ignored.

35B Evaluation of Price Bids (Part-II)

35B.1 The Owner will carry out a detailed evaluation of the Price Bids Part (Part-II) of the bidders found techno-commercially successful. The comparison will be in line with the bidding documents and on the basis of Lump sum price for the entire scope of work under the package. Based on such evaluation, L1 bidder would be decided on the basis of least evaluated cost to the Employer.

The lump sum price shall include:

- i) F.O.R. destination (site) price of equipment/materials, including mandatory spares and special tools & tackles (if any) under the package.
- ii) Charges for erection, which shall include unloading, handling, storage, insurance, erection, testing & commissioning of the complete equipment/materials under the package and all associated civil works.

The Owner's comparison will also include the costs resulting from application of the

evaluation procedures described in ITB Sub-Clause 35B.3.

DTL's evaluation of a bid, in addition to the lump sum price as above will take into account the applicable taxes, duties & levies payable/reimbursable by the Employer as per provisions of Clause 14.0 of CC, Volume I.

Discount(s)/ rebate(s) offered by the bidder shall be indicated either on lumpsum basis or percent basis. Bidder shall also indicate in his bid, the price component on which the percentage discount is to be applied. In case the price component(s) on which the percentage discount is applicable is not indicated in the bid, then the discount will be adjusted in the total bid price [i.e. proportionately on each price component], **for arriving the price of L1 bidder**. However, if lumpsum discount is offered, the same shall be adjusted in full from the ex-works price component (by proportionately reducing ex-works price of individual items), **for arriving the price of L1 bidder**.

35B.2 The Owner's evaluation of a bid will take into account, in addition to the bid prices indicated in Price Schedules, the following costs and factors that will be added to each Bidder's bid price in the evaluation using pricing information available to the Owner, in the manner and to the extent indicated in ITB Sub-Clause 35.B.3 and in the Technical Specifications:

- (a) the cost of all quantifiable deviations and omissions from the contractual and commercial conditions and the Technical Specifications as identified in Attachment-5 to 7 to the bid.
- (b) compliance with the time Attachment called for in Attachment-10 of Bid price Attachment and evidenced as needed in a milestone Attachment provided in the bid.
- (c) *Performance and Productivity of the equipments offered*

Bidder shall state the guaranteed performance or efficiency in response to Technical Specifications. Equipment offered shall have minimum performance specified in Technical Specifications to be considered responsive. Bids offering Equipments with a performance less than that of specified may be rejected.

35B.3 Pursuant to ITB Sub-Clause 35.B.2, the following evaluation methods will be followed:

- (a) *Contractual and commercial deviations*

The evaluation shall be based on the evaluated cost of fulfilling the contract in compliance with all commercial, contractual and technical obligations under this bidding document. In arriving at the evaluated cost, the price of withdrawal of deviations shown in relevant Attachment of the bid, price and other Attachments, will be used. If the deviation to any of the provisions is not priced, the bid will be rejected.

At the time of award of contract, if so desired by the Owner, the bidder will withdraw the deviations listed in relevant deviation Attachments of bid in their bid at the cost of withdrawal stated by him in the bid. In case the bidder does not withdraw the deviations proposed by him in the bid, his bid will be rejected and his Bid Security will be forfeited.

- (b) Time Attachment (Program of Performance)

The plant and equipment covered by this bidding are required to be shipped and installed, and the facilities shall have the pre-commissioning completed within the period named in the Bid

after the effective date specified in the Contract Agreement. Bidders are required to base their prices on the Time Attachment given in Attachment -10 of Bid Form to the form of Contract Agreement (Time Attachment) or, where no time Attachment is given, on the completion date(s) given in the Bid. No credit will be given for earlier completion. Bid offering completion beyond the named period is liable to be rejected.

- (c) If the vendor has quoted higher than the scheduled delivery period the bids will be treated as non-responsive.

Any adjustments in price that result from the above procedures shall be added, for purposes of comparative evaluation only, to arrive at an "Evaluated Bid Price." Bid prices quoted by Bidders shall remain unaltered.

- a) Arithmetical/computational errors will be rectified on the following basis.
- (i) If there is a discrepancy between the unit price and the total price, which is obtained by multiplying the unit price and quantity of item, or between sub-total and the total price, the unit or sub-total price shall prevail, and the total price shall be corrected.
 - (ii) Further, if there is a discrepancy between the quantity specified by DTL in the bidding document and the indicated by the bidder in his bid, the former shall be taken to arrive at the computed price.
 - (iii) In case the unit rate of an item is not quoted but the total price of the item is indicated, the same shall be taken to arrive at the computed price.
 - (iv) If there is a discrepancy between words and figures (of unit price or sub-total price if total price is not quoted), the amount in words will prevail (Not applicable in case of total quoted price, in that case arithmetically corrected computed price shall prevail).
- b) Wherever, as per the bidding documents, any shortfall in the rating and performance requirement of equipment/material/systems attracts consideration of differential price factor and the value of differential loss for evaluation, the same shall be worked out as per the methodology given in the bidding documents, for adding the same to the computed price of the bidders.
- c) The value of the differential loss will be added to the computed price of each bidder and the price quoted by the bidder for extra scope of work will be deducted, as discussed above, to arrive at the computed bid price.
- d) The computed price arrived at, as above, shall be considered for the purpose of further evaluation as well as award.

If the bidder does not accept the methodology of correction as mentioned above, its bid will be rejected and the bid security will be forfeited in accordance with ITB Clause 23.7.

36.0 DEFINITIONS AND MEANINGS

- 36.1 For the purpose of evaluation and comparison of bids, the following meanings and definitions will apply.

- a). **‘Bid Price’** shall mean the base price quoted by each Bidder in his Proposal for the completed scope of works.
- b). **‘Differential Price’** shall mean the summation of the equalizing elements of price for parameter differential or deficiencies in the equipment and services determined from the Bidder’s Proposal.
- c) **‘Cost Compensation for Deviations’** shall mean the Rupee value of deviations, which shall be provided by the Bidder with proper justification in his Bid.
- d). **‘Evaluated Bid Price’** shall be the summation of ‘Bid Price’, ‘Differential Price’ and ‘Cost Compensation for Deviations’.

36.2 Calculation of Differential Price & Cost Compensation for Deviations, if applicable:

36.2.1 The Differential Price (if applicable) to be added to the Bid Price of each during evaluation and comparison shall be derived as under:

Differential price is not applicable as per technical specification.

37.0 COMPARISON OF BIDS

37.1 Lump-sum price includes all taxes and levies covering both supply of material as well as erection, installation and commissioning. However, while submitting the invoices/bills/running bills, for making payments, bifurcation between taxable amount and applicable taxes should be enumerated on each and every invoices/bills/running bills.

37.2 For comparison purposes all the evaluated bid prices shall be in Indian Rupees as under:-

$$W = M + DP + D$$

Where,

W	=	Total Comparison Price
M	=	Bid price in Indian Rupees (Ex-works value of equipment + Components of erection cost + mandatory spares, taxes and duties and other Components, if any).
DP	=	Differential price in Indian Rupees calculated according to para 36.2.1.
D	=	Cost compensation for deviations.

37.3 All evaluated bid prices of all the Bidders shall be compared among themselves to determine the lowest evaluated bid and, as a result of this comparison; the lowest bid **will be term as L1 bidder.**

38.0 Purchase preference, Contacting the employer & Award of Contract

38.1 Purchase Preference:

38.1.1 Deleted.

38.1.2 Deleted.

38.1.3 Verification of local content:

- a. The 'Class-I local supplier' at the time of tender, bidding or solicitation in his bid in the given format, shall be required to indicate percentage of local content and provide self-certification that the item offered meets the local content requirement for 'Class-I local supplier' as the case may be. They shall also give details of the location(s) at which the local value addition is made. Further,
 - b. the 'Class-I local supplier' shall also be required to provide a certificate from the statutory auditor or cost auditor of the company (in the case of companies) or from a practicing cost accountant or practicing chartered accountant (in respect of suppliers other than companies) giving the percentage of local content.
- 38.1.4 Any False declarations will be in breach of the Code of Integrity under Rule 175(1)(i)(h) of the General Financial Rules for which a bidder or its successors can be debarred for up to two years as per Rule 151(iii) of the General Financial Rules along with such other actions as may be permissible under law.
- 38.1.5 A supplier who has been debarred by any procuring entity for violation of PPP-MII Order, dt 15.06.2017, 28.05.2018, 29.05.2019, 04.06.2020 & 16.09.2020 & there latest amendments thereof, read in conjunction with MoP Order dt. 20.12.2018, 04.04.2020, 28.07.2020, 16.11.2021 & their latest amendments thereof (mentioned above) for procurement by any other procuring entity for the duration of the debarment. The debarment for such other procuring entities shall take effect prospectively from the date on which it comes to the notice of other procurement entities.

38.2 CONTACTING THE OWNER

Bid shall be deemed to be under consideration immediately after they are opened and until such time official intimation of award/rejection is made by the Owner to the Bidders. While the bids are under consideration, Bidders and/or their representatives or other interested parties are advised to refrain from contacting by any means, the Owner and/or his employees/representatives on matters related to the bids under consideration. The owner, if necessary, will obtain clarifications on the bids by requesting for such information from any or all the Bidders, either in writing or through personal contacts as may be necessary. Bidders will not be permitted to change the substance of the bids after the bids have been opened.

38.3 Award of Contract

38.3.1 Post-Qualification

- 38.3.1 The Employer will determine to its satisfaction whether the Bidder selected as Techno-Commercially qualified & lowest bidders considered for award is qualified to satisfactorily perform the contract in terms of the qualifying requirements stipulated in the ITB 1.2 and 2.0.
- 38.3.2 The determination will take into account the Bidder's financial, technical and production capabilities, in particular its contract, work in hand, future commitments and current litigation. It will be based upon an examination of the documentary evidence of the Bidder's qualifications submitted by the Bidder in **Attachment 3** to the bid, as well as such other information as the Employer deems necessary and appropriate.
- 38.3.3 An affirmative determination will be a prerequisite for award of the contract to the Bidder. A negative determination will result in rejection of the Bidder's bid, in which event the Employer will proceed to the next bidder to make a similar determination of that Bidder's capabilities to perform satisfactorily.

39.0 AWARD CRITERIA

- 39.1 The Owner will award the Contract to the successful Bidders whose bids have been determined to be substantially responsive and **lowest bidder considered for award** provided further that the Bidders are determined to be qualified to perform the Contract satisfactorily. The owner shall be the sole judge in this regard.
- 39.2 The Employer may request the Bidder to withdraw any of the deviations listed in Attachment 05 to 07 of the winning bid, at the price shown for the deviation in Attachment 05 to 07 to the bid. Bidder would be required to comply with all other requirements of the Bidding Documents except for those deviations which are accepted by the Employer.
- 39.3 The Employer reserves the right to vary the quantity of any of the spares and/or delete any items of spares altogether at the time of Award of Contract.
- 39.4 The mode of contracting with the successful bidder will be as briefly indicated below:

In the case of successful Bidder, the award shall be made as follows:

- (i) First Contract: Supply of equipment and materials on the ex-works basis.
- (ii) Second Contract: Transportation, storage, insurance, erection, testing and commissioning etc. of equipment/ materials in respect of all the equipments supplied under the "First Contract" and any other services specified in the Contract Documents.

Both contracts will contain a cross fall breach clause specifying that breach of one will constitute breach of the other.

40.0 OWNER'S RIGHT TO ACCEPT ANY BID AND TO REJECT ANY OR ALL BIDS

- 40.1 The Owner reserves the right to accept or reject any bid, and to annul the bidding process and reject all bids at any time prior to award of contract, without thereby incurring any liability to the affected Bidder or Bidders or any obligation to inform the affected Bidder or Bidders of the grounds for the Owner's action. DELHI TRANSCO LIMITED reserves the right to waive minor deviations if they do not materially affect the capability of the Bidder to perform the contract.

41.0 NOTIFICATION OF AWARD

- 41.1 Prior to the expiration of the period of bid validity and extended validity period, if any, the Owner will notify the successful Bidder in writing by registered letter or by cable or telex or fax or e-mail, that its bid has been accepted which shall be confirmed in writing by bidder. However if confirmation is not received from the bidder the notification shall be deemed to have been accepted by the bidder after expiry of the period mentioned in the notification.
- 41.2 The notification of award will constitute the formation of the Contract.
- 41.3 Upon the successful Bidder's furnishing of Contract performance Guarantee (CPG) pursuant to Clause 43.0 the Owner will promptly notify each unsuccessful Bidder and will discharge its bid security, pursuant to Clause 23.0.

42.0 SIGNING OF CONTRACT

- 42.1 At the same time as the Owner notifies the successful Bidder that its bid has been accepted, the Owner will send the Bidder the detailed Letter of Award, incorporating all agreements between the parties.
- 42.2 Within seven (07) days of receipt of the detailed Letter of Award, the successful bidder shall sign and date the same and return it to the Owner, failing which all the terms & conditions of the Letter of Award shall be binding upon the successful bidder and it shall be treated as a binding Contract between Delhi Transco Limited and the successful bidder.
- 42.3 The Bidder will prepare the Contract Agreement as per the Performa enclosed in Section- Forms & Procedure to this Volume-I and the same will be signed within 30 (thirty) days from the date of Notification of Award.

43.0 **CONTRACT PERFORMANCE GUARANTEE**

- 43.1 Within Twenty-Eight (28) days from the issuance of the notification of award, the successful Bidder, to whom the work is awarded, shall be required to furnish a Performance Guarantee deposited in the form of Insurance Surety Bonds, Account Payee Demand Draft, Fixed Deposit Receipt from a Commercial bank, Bank Guarantee **(including e-Bank Guarantee)** from a scheduled Commercial bank or any foreign Bank or subsidiary of a foreign Bank having its branch in India with overall international corporate rating or rating of long term debt not less than A- (A minus) or equivalent by reputed rating agency, in the form attached in Section- Forms & Procedure to this Volume-I in favour of the Owner or online payment in an acceptable form.

The guarantee amount shall be equal to ten percent (10%) of the total Contract Price and it shall guarantee the faithful performance of the Contract in accordance with the terms and conditions specified in these documents and specifications.

Performance Security shall be valid upto Defect Liability Period but initially for 12 months from the date of taking over/operational acceptance. This Performance guarantee shall be renewed periodically every year upto the end of Defect Liability Period. Every renewal of the Performance guarantee shall be done by the contractor one month prior to the expiry date.

Non submission of performance security within the stipulated period will constitute a sufficient ground for the annulment of the award and forfeiture of the bid security.

44.0 **Corrupt or Fraudulent Practices**

- 44.1 DTL requires that Bidders/Suppliers/Contractors, observe the highest standard of ethics during the procurement and execution of such contracts. In pursuance of this policy, the DTL:
- (a) defines, for the purposes of this provision, the terms set forth below as follows:
 - (i) "corrupt practice" means the offering, giving, receiving or soliciting of anything of value to influence the action of a public official in the procurement process or in contract execution; and
 - (ii) "fraudulent practice" means a misrepresentation of facts in order to influence a procurement process or the execution of a contract to the detriment of the Employer/Owner, and includes collusive practice among Bidders (prior to or after bid submission) designed to establish bid prices at artificial non-competitive levels and to deprive the Borrower of the benefits of free and open competition;

- (b) will reject a proposal for award if it determines that the Bidder recommended for award has engaged in corrupt or fraudulent practices in competing for the contract in question;
- (c) will declare a firm ineligible, either indefinitely or for a stated period of time, if it at any time determines that the firm has engaged in corrupt or fraudulent practices in competing for, or in executing this contract.

44.2 Furthermore, Bidders shall be aware of the provision stated in sub-clause 42.2 of the Conditions of Contract.

44.3 Bidder shall furnish undertaking for not indulging in corrupt & fraudulent practice as per **Attachment 21**.

45 **GOODS AND SERVICE TAX**

45.1 The bidder shall comply with the provision of section 171 of the GST Act, 2017 and all the benefits accrued to him on account of any reduction in rate of tax on any supply of goods or services will be supplied to DTL under this Tender No. ***Refer BDS*** will be passed on to Delhi Transco Limited by way of commensurate reduction in the prices. In future, if anything found contrary, the bidder will be accountable for any contravention of the law and shall indemnify Delhi Transco Limited for the loss suffered on account of not passing the aforesaid benefit.

SECTION-III

BID DATA SHEETS **(BDS)**

SECTION-III

BID DATA SHEETS (BDS)

The following bid specific data for the Plant and Equipment to be procured shall amend and/or supplement the provisions in the Instruction to Bidders (ITB)

S. No.	ITB Clause Ref. No.	Bid Data Details
1.	ITB 23.8, ITB 25.0, ITB 28.1	Address for submission of Bid Documents and Bid Opening; Address in Person or by Post: Tender Opening Cell, Delhi Transco Limited, Room No. 16, Ground Floor, Maintenance Block, Old Indraprastha Power House, Near 220kV Indraprastha Substation, New Delhi-110002 (India), Email: dgmms105@gmail.com
2.	ITB 6.1, ITB 27.2	Address for submission of Bid Documents and Bid Opening; Address in Person or by Post: Tender Opening Cell, Delhi Transco Limited, Room No. 16, Ground Floor, Maintenance Block, Old Indraprastha Power House, Near 220kV Indraprastha Substation, New Delhi-110002 (India), Email: dgmms105@gmail.com
3.	ITB 6.1	Clause 6.1 of ITB stands modified as under: A prospective Bidder finding discrepancies or omissions, in specifications and document or is in doubt as to the true meaning of any part; they shall at once make a request, in writing or by electronic media (hereinafter, the term cable is deemed to include Electronic Data Interchange (EDI) or telefax) at the Employer's mailing address within ten (10) days after floating of tender. In case of any changes/modification in the bidding documents due to the above, the same shall be uploaded on the website as part of bidding document.
4.	ITB 6.5	Venue, date and time for Pre-bid Meeting: The Bidder's designated representative is invited to attend a pre-bid meeting, which will take place at the venue and time as given below: Delhi Transco Limited , Fourth Floor, Conference Room Shakti Sadan, Kotla Road New Delhi – 110002. Date :..... Time: hours (IST)

S. No.	ITB Clause Ref. No.	Bid Data Details
5.	ITB 15.0	<p>For a Completion Period extending beyond 18 months, ITB Cl. 15.0 to be followed as under:</p> <p>“Prices as quoted by the bidder shall remain fixed except Power Transformer and Civil works during the Bidder’s Performance of the Contract and not subject to variation on any account. A bid submitted with an adjustable price quotation will be treated as non-responsive and rejected.”</p> <p>Price variation shall be calculated as per Appendix-2 of Form of Contract Agreement, Section Forms & Procedures, Volume-I.</p>
6.	ITB 23.1	<p>Amount of Bid Security: In Figures: 50,00,000/- In Words: Rs. Fifty Lakh Only.</p>
7.	ITB 25.2	<p>BID TITLE: Design, Engineering, Supply, Erection, Testing & Commissioning of 220/66kV GIS Substation at Bharthal, including complete civil works & automation, along with LILO of 220kV D/C Bamnauli-DIAL Overhead Transmission Line at Bharthal, on a Turnkey Basis.</p>
8.	ITB 33.1	<p>Clause no. 33.1 of ITB: “To assist in the examination, evaluation and comparison of bids the Owner may, at its discretion, ask the Bidder for a clarification of its bid. The request for clarification and the response shall be in writing and no change in the price or substance of the bid shall be sought, offered or permitted.”</p> <p>Shall be read as: “To assist in the examination, evaluation and comparison of bids the Owner may, at its discretion, ask the Bidder for a clarification of its bid. The request for clarification and the response shall be in writing and no change in the price or substance of the bid shall be sought, offered or permitted.</p> <p>The bidder shall ensure that its original bid will be complete in all respect before submission.”</p>
9.	ITB 36, 37	<p>Differential price shall be applicable only to <u>HTLS Conductor</u>, as per the Technical Specification of HTLS Conductor.</p>
10.	ITB 41.3	<p>Upon the successful Bidder’s furnishing of Contract performance Guarantee (CPG) pursuant to Clause 43.0 the Owner will discharge its bid security, pursuant to Clause 23.0.</p>
11.	ITB 45.1	<p>Tender No.- T26P630001</p>

S. No.	ITB Clause Ref. No.	Bid Data Details
12.	ITB 46.0: New Clause	Bidders must not have been blacklisted or deregistered by any Central/State Government department or Public Sector Undertaking. Also, no work of the bidder must have been rescinded by client after award of contract during last 5 years. The bidder should submit undertaking to this effect.

Qualifying Requirements of bidders for Establishment of 220 kV GIS Turnkey Package along with 220 kV Power Transformer

Qualification of bidder will be based on meeting the minimum pass/fail criteria specified below regarding the Bidder's technical experience and financial position as demonstrated by the Bidder's responses in the corresponding Bid Schedules. Technical experience and financial resources of any proposed sub-contractor shall not be taken into account in determining the Bidder's compliance with the qualifying criteria. The bid can be submitted by an individual firm as a manufacturer or a Collaborator or an EPC Contractor or as a Joint Venture/Consortium of two or more firms (Specific requirements for Joint Ventures/Consortium are given under Para 3.0 below).

The Employer may assess the capacity and capability of the bidder, to successfully execute the scope of work covered under the package within stipulated completion period. This assessment shall inter-alia include (i) document verification; (ii) bidders work/manufacturing facilities visit; (iii) manufacturing capacity, details of works executed, works in hand, anticipated in future & the balance capacity available for present scope of works; (iv) details of plant and machinery, manufacturing and testing facilities, manpower and financial resources; (v) details of quality systems in place; (vi) past experience and performance; (vii) customer feedback; (viii) banker's feedback etc.

General Requirements

1. The bidder shall furnish documentary evidence in support of the qualifying requirement stipulated as below along with the bid.
2. All the bidders shall submit the proof of work executed by them along with the Performance Certificates in support of their qualification.
3. The bidder shall have a project manager with 15 years' experience in executing such contract of comparable nature including not less than five years as manager.
4. The bidder should have adequate after sales support facility and shall ensure availability of technical support in India so as to attend warrantee provisions under this contract.
5. For the purpose of qualifying 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, two disconnectors and three nos. of single phase CTs/ Bushing CTs.
6. In case a Bidder submits more than one bid in this bidding process, either individually or as an entity of the same parent/ group/subsidiary/ sister concern## or as a partner in a Joint Venture, all such bids shall be disqualified. However, this does not limit the participation of a Bidder in the tender as a subcontractor/sub-vendor (including that of QR item) in another bid, or of a firm as a subcontractor in more than one bid.

Qualifying Requirements of bidders for Establishment of 220 kV GIS Turnkey Package along with 220 kV Power Transformer

7. The offered GIS design should have been type tested as per relevant IEC with validity of type test reports in line with CEA guidelines.
8. The offered power transformers to be supplied in the package should have been type tested as per relevant IS/IEC standard with validity of type test reports in line with CEA guidelines.

1.0 Technical Experience

Route-1:

- 1.1 (A)** The Bidder/Manufacturer must have designed, manufactured, tested^s (as per IEC), supplied, supervised erection and commissioning of at least two (2) nos. GIS circuit breaker bays* of 220 kV or above voltage class in one (1) GIS substation or switchyard during last seven (7**) years and these bays must be in satisfactory operation[#] for at least two (2) years as on the originally scheduled date of bid opening.

OR

The Bidder/Manufacturer must have designed, manufactured, tested^s (as per IEC), supplied, erected and commissioned at least two (2) nos. GIS circuit breaker bays* of 220 kV or above voltage class in one (1) GIS substation or Switchyard during last seven (7**) years and these bays must be in satisfactory operation[#] for at least two (2) years as on the originally scheduled date of bid opening.

AND

- 1.1 (B)** The Bidder/Manufacturer must have designed, manufactured, type tested, supplied and commissioned 220kV or higher voltage class power transformer during last seven (7**) years which must be in satisfactory operation[#] for at least two (2) years as on originally scheduled date of bid opening.

OR

The bidder shall offer the Power Transformer of such Indian manufacturers who have designed, manufactured, type tested and supplied 220kV or higher voltage class Power Transformer during last seven (7**) years which must be in satisfactory operation[#] for at least two (2) years as on originally scheduled date of bid opening. The bidder or its proposed Power Transformer Manufacturer should have commissioned a 220kV or higher voltage class Power Transformer during last seven (7**) years which must be in satisfactory operation[#] for at least two (2) years as on originally scheduled date of bid opening. The bid shall include consent letter (as per format Annexure-D4) from the proposed Transformer Manufacturer.

OR

Qualifying Requirements of bidders for Establishment of 220 kV GIS Turnkey Package along with 220 kV Power Transformer

Route-2:

1.2 In case, the Bidder is not meeting the requirement stipulated in para 1.1A and 1.1B above, he shall also be considered, provided he meets the following requirements:

- a) The bidder must have established manufacturing and testing facilities in India for 220 kV or above voltage class GIS and must have manufactured at least one (1) no. 220 kV or above voltage Class GIS Circuit Breaker bay* based on the technological support of the Collaborator(s). Further the bidder must have either supplied or type tested (as per IEC) the above GIS bay* as on originally scheduled date of bid opening, provided further that the collaborator(s) of the bidder meets qualifying requirements as per para 1.1A.
- b) The bidder meets qualifying requirements as per para 1.1B mentioned above.
- c) Further the erection, testing and commissioning of GIS circuit breaker bays shall be carried out under the supervision of collaborator. A consent letter from collaborator regarding the same must be submitted along with the bid by the bidder (as per format Annexure-D3).

OR

Bidder shall propose a GIS erector as sub-contractor who has erected and commissioned at least two (2) nos. GIS circuit breaker bays of 220kV or above voltage class in one (1) 220 kV GIS substation during last seven (7**) years and these Sub-Stations/ bays must be in satisfactory operation[#] for at least two (2) years as on originally scheduled date of bid opening. The bid shall include consent letter (as per format Annexure-D1) from the proposed Erector.

d) Further, the bidder shall also submit the following along with the bid:

- i. A legally enforceable undertaking (jointly with the Collaborator(s)) to guarantee quality, timely supply, performance and warranty obligations as specified for the equipment(s);
- ii. A confirmation letter from the Collaborator(s) stating that the Collaborator(s) shall also furnish performance guarantee for an amount of 10 % of the ex-works cost of such equipment(s). This performance guarantee shall be in addition to Contract Performance Guarantee to be submitted by the bidder.
- iii. A valid collaboration agreement for technology transfer / license to design, manufacture, test and supply 220 kV or above voltage class GIS equipment in India.

OR

Route-3:

1.3 In case, the Bidder is established as Subsidiary/JVC/ Group company by its parent/principal/sister concern^{##}, he shall also be considered, provided he meets the following requirements:

Qualifying Requirements of bidders for Establishment of 220 kV GIS Turnkey Package along with 220 kV Power Transformer

- a) The bidder/manufacturer must have established manufacturing and testing facilities in India for 220 kV or above voltage class GIS and must have manufactured at least one (1) no. 220 kV or above voltage Class GIS Circuit Breaker bay* based on the technological support of the parent/principal/subsidiary/sister concern^{##} company. Further, the bidder must have either supplied or type tested (as per IEC) the above GIS bay* as on originally scheduled date of bid opening. Provided further that the parent/principal/subsidiary/sister concern^{##} company of the bidder meets qualifying requirements as per para 1.1A.
- b) The bidder meets qualifying requirements as per para 1.1B mentioned above.
- c) Further the erection, testing and commissioning of GIS circuit breaker bays shall be carried out under the supervision of parent/principal/sister concern^{##}. A consent letter from parent/principal/sister concern^{##} regarding the same must be submitted along with the bid by the bidder (as per format Annexure-D3).

OR

Bidder shall propose a GIS erector as sub-contractor who has erected and commissioned at least two (2) nos. GIS circuit breaker bays of 220 kV or above voltage class in one (1) 220kV GIS substation during last seven (7**) years and these Sub-Stations/ bays must be in satisfactory operation[#] for at least two (2) years as on originally scheduled date of bid opening. The bid shall include consent letter (as per format Annexure-D1) from the proposed Erector.

d) Further, the bidder shall also submit the following along with the bid:

- i. A legally enforceable undertaking (jointly with the parent/principal/subsidiary/ sister concern^{##} company) to guarantee quality, timely supply, performance and warranty obligations as specified for the equipment(s);
- ii. A confirmation letter from the GIS manufacturer/ GIS Collaborator/ Parent/ Principal/ Subsidiary/ JVC/ Group/sister concern^{##} company etc. as applicable that they shall also furnish performance guarantee for an amount of 10 % of the ex-works cost of such equipment(s). This performance guarantee shall be in addition to Contract Performance Guarantee to be submitted by the bidder.
- iii. A valid collaboration agreement for technology transfer / license to design, manufacture, test and supply 220 kV or above voltage class GIS equipment in India.

OR

Route-4:

EPC Contractor (Eligibility as per 1.4 below):

Qualifying Requirements of bidders for Establishment of 220 kV GIS Turnkey Package along with 220 kV Power Transformer

1.4 In Case, the bidder is not a GIS Manufacturer he shall also be considered, provided :

- (a)** The bidder must have erected and commissioned at least two (2) nos. GIS circuit breaker bays* of 220 kV or above voltage class in one (1) GIS substation or Switchyard during last seven (7**) years and these Sub-Stations/ bays must be in satisfactory operation# for at least two (2) years as on the originally scheduled date of bid opening.
- (b)** In such cases, GIS equipments should be offered from Indian manufacturers who meet the clause no. 1.1A or 1.2(a) or 1.3(a), while fulfilling all additional requirements as per respective clauses no. 1.1A or 1.2(d) or 1.3(d).
- (c)** The bidder meets qualifying requirements of Power Transformer as per para 1.1B mentioned above.

(d) Further, the bidder shall also submit the following along with the bid:

- i) The bid shall include consent letter (as per format Annexure-D2) from the proposed GIS manufacturer.
- ii) A legally enforceable undertaking (jointly with GIS manufacturer) to guarantee quality, timely supply, performance and warranty obligations as specified for the equipment(s);
- iii) A confirmation letter from the GIS manufacturer/ GIS Collaborator/ Parent/ Subsidiary/ JVC/ Group/sister concern^{##} company etc. as applicable or EPC Bidder that they shall furnish performance guarantee for an amount of two (2) % of the GIS portion (i.e. Total Price of GIS Portion including Supply, F&I, Installation and applicable tax).

This performance guarantee shall be in addition to Contract Performance Guarantee to be submitted by the bidder. In case this additional performance guarantee is provided by the EPC bidder on behalf of GIS manufacturer, the documentary proof of submission of equivalent Performance Guarantee by the GIS manufacturer to the EPC bidder shall also be submitted to purchaser/owner. The additional performance guarantee will be released after successful completion of contract performance guarantee period.

Note:

- 1. Manufacturer of GIS (Route-1) may propose a GIS erector as sub-contractor who has erected and commissioned at least two (2) nos. GIS circuit breaker bays of 220 kV or above voltage class in one (1) 220 kV GIS substation during last seven (7**) years and these Sub-Stations/ bays must be in satisfactory operation# for at least two (2) years as on originally scheduled date of bid opening. The bid shall include consent letter (as per format Annexure-D1) from the proposed Erector.
- 2. (#) Satisfactory operation means certificate issued by the Employer certifying the operation without any adverse remark.
- 3. (*) For the purpose of qualifying requirement, one no. of circuit breaker bay shall be considered as a bay used

Qualifying Requirements of bidders for Establishment of 220 kV GIS Turnkey Package along with 220 kV Power Transformer

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, two Disconnectors and three nos. of single phase CTs / Bushing CTs.

4. In case bidder is a holding company, the technical experience referred to in Route-1, 2 and 3 above as the case may be, shall be of that holding company only (i.e. excluding its subsidiary/group companies). In case bidder is a subsidiary of a holding company, the technical experience referred to in Route-1, 2 and 3 above as the case may be, shall be of that subsidiary company only (i.e. excluding its holding company).
5. (**) For the purpose of qualifying requirement, during the last seven years means that commissioning date is to be within a period of seven years as on originally scheduled date of bid opening.
6. In case bidder is qualifying through Route-2/3, type test reports of Collaborator/ Parent Company/ Subsidiary Company/ Group Company/sister concern## shall also be acceptable, for which a confirmation shall be furnished along with the bid as per format attached in the bidding documents.
7. ## Sister Concern of bidder means the company which has same parent as that of the bidder.
8. § Tested means the design of the 220 kV GIS or higher voltage class has been type tested as per IEC with validity as per CEA guidelines.
9. In case of 220 kV Power Transformers 'Type tested' means type tested as per relevant IS/IEC Standards.
10. In case of award, the commissioning of power transformer shall be carried out under the supervision of power transformer manufacturer.

2.0 FINANCIAL POSITION:

The bidder should have adequate financial capability to meet the following minimum criteria:

a) Net Worth requirement of QR

Net Worth for last three financial years should be positive. (Total Assets less Total liabilities shall be positive)

b) Minimum Average Annual Turnover (MAAT) requirement for last three years of the bidder should not be less than:

MAAT: - Rs. 118,81,04,866/- (One hundred eighteen crore eighty-one lakh four thousand eight hundred sixty-six only)

(Cost Estimate x 1.5/Completion period in years).

(For the purpose of arriving at MAAT, total income, except non-recurring income e.g. Sale of fixed assets shall be considered).

Qualifying Requirements of bidders for Establishment of 220 kV GIS Turnkey Package along with 220 kV Power Transformer

Further the completion period for calculating MAAT shall be considered as 1 year even if the Contractual Completion period is less than 1 year.

c) Liquid Asset (LA) requirement of

LA: - Rs. 19,80,17,478/- (Nineteen crore eighty lakh seventeen thousand four hundred seventy-eight only)

(Cost Estimate x 3/Completion period in months).

(For the purpose of arriving at LA, Current Assets less Inventories and prepaid expenses shall be considered i.e. LA=Current Asset-Inventories-Prepaid Expenses)

Further, the Completion Period for calculating LA shall be considered as 12 months even if the Contractual Completion period is less than 12 months.

The cost Estimate referred above shall include GST and other taxes & duties.

d) Relaxation for Start-Ups[^]/ MSEs

Start-Ups[^]/ MSEs, meeting the specified requirements at Para 2.0 (a) above in Financial Position shall also be considered qualified if they meet Eighty (80) % of the requirement specified at Para 2.0 (b) & 2.0 (c) above in Financial Position.

[^] *Start-Ups as defined by DIPP, applicable as on originally scheduled date of bid opening.*

Note:

- i) In case bidder is a holding company, the Financial Position criteria referred to in para 2.0 above shall be that of holding company only (i.e. excluding its subsidiary / group companies). In case bidder is a subsidiary of a holding company, the Financial Position criteria referred to in para 2.0 above shall be that of subsidiary company only (i.e. excluding its holding company).
- ii) In case bidder has established manufacturing facility in India and yet to complete three (3) financial years, the Net Worth and average of the turnover as per financial statement for completed financial years shall be considered for the purpose of compliance to the specified Net Worth and MAAT requirements.
- iii) In case of bidder qualifying through Route-3 but not meeting the Financial Position requirement as per note (i) read along with note (ii) above, the following shall be applicable:

In case bidder is yet to complete three (3) years from the date of commercial production of such equipment(s) but no later than five (5) years from the date of incorporation of the said company as on originally scheduled date of bid opening as above, the financial position requirement as per para 2.0 (b) & (c) of parent/principal company providing collaboration for Technological Support shall be considered.

Qualifying Requirements of bidders for Establishment of 220 kV GIS Turnkey Package along with 220 kV Power Transformer

However, once he meets the turnover requirement on their own or completes three(3) years from the date of commercial production of such equipment (s) in India but no later than five (5) years from the date of incorporation as on originally scheduled date of bid opening as above,, the financial position requirements as specified at 2.0 (b) and (c) above shall also be required to be met by such bidder on their own as per note (i) above and not based on their Parent/Principal company. Further, in case the bidder is yet to complete one (1) financial year, the Net worth requirement as per para 2.0 (a) above of Parent/Principal shall be considered.

3.0 JOINT VENTURE/CONSORTIUM BIDS:

- a) In case a bid is submitted by a JV/Consortium of two or more firms as partners, all the partners of JV/ Consortium shall meet collectively the complete requirements stipulated at para 1.0 and 2.0 (b) & (c) above.

Further, for a JV/Consortium to be qualified, the partner(s) of JV/Consortium must also meet the following minimum criteria:

- i. All the partners of the JV/Consortium shall meet individually the Financial Position criteria given at 2.0 (a) above.
- ii. The Lead Partner shall meet, not less than 40% of the minimum Financial Position^s criteria given at para 2.0 (b) & (c) above.
- iii. Each of the other partner(s) individually shall meet not less than 25% of the minimum Financial Position^s criteria given at para 2.0 (b) & (c) above.
- iv. One of the partner(s) of JV/Consortium must be an Indian GIS manufacturer of 220kV or above voltage level meeting the relevant Technical Experience criteria and the requirements of GIS stipulated under clause 1.1 or 1.2 or 1.3.

The figure of average annual turnover and liquid assets/credit facilities for each of the partners of the JV/Consortium shall be added together to determine the JV's/ Consortium compliance with the minimum qualifying criteria set out in Para 2.0 (b) & (c) above.

In case of Joint Venture/consortium, the following conditions shall also apply:

- i. In case of award, the contract agreement shall be signed by all the partners, so as to be legally binding on all partners.
- ii. All the partners of Joint Venture/consortium shall meet collectively, the technical as well as financial requirements.
- iii. The Lead Partner shall be authorized to incur liabilities and receive instructions for and on behalf of any and all partners of the Joint Venture/consortium. Thus, the lead partner shall be authorized to represent the joint venture/ consortium for the purpose of execution of the Contract. The payment shall be in the name of joint venture/ consortium. The authorization shall be evidenced by submitting a Power of Attorney signed

Qualifying Requirements of bidders for Establishment of 220 kV GIS Turnkey Package along with 220 kV Power Transformer

by legally authorized signatory of all the partners as per bidding documents.

- iv. All the partners of the joint venture/consortium shall be liable jointly and severally for the execution of the Contract in accordance with the Contract terms, and a statement of this effect shall be included in the authorization mentioned under (iii) above as well as in the Bid Form and in the Contract Form (in case of a successful bid).
- v. Agreement entered into by the Joint Venture/consortium partners shall be submitted with the bid. The change in constitution/agreement shall not be permitted at any stage after submission of bid and the JV/Consortium formed for the purpose of this project shall be valid till completion of the performance guarantee period.

Note:

- 1. (#) Satisfactory operation means certificate issued by the Employer certifying the operation without any adverse remark.
- 2. (*) For the purpose of qualifying 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, two disconnector and three nos. of single phase CTs / Bushing CTs.
- 3. (\$) In case of a JV bid involving an Indian Entity qualifying through Route-3 and its Parent/ Principal company as partner(s), the Indian Entity shall meet the applicable Financial Position criteria on its own and not based on its Parent/Principal company.
- 4. (**) For the purpose of qualifying requirement, during the last seven years means that commissioning date is to be within a period of seven years as on originally scheduled date of bid opening.

4.0 Financial & Capacity Requirements

Bidder shall be financially sound.

- i. Bidder shall submit a certificate from their Banker(s) as per format indicating various fund based/non fund based limits sanctioned to the bidder and the extent of utilization as on date. Such certificate should have been issued not earlier than three months prior to originally scheduled date of bid opening.
- ii. Bidder shall submit a monthly cash flow projection for execution of the contract having regard to implementation schedule. Bidder should indicate how funding gap in each month is proposed to be met.
- iii. Bidder shall submit the complete Annual reports together with Audited statement of accounts of the company for last three years.

In the event the Bidder (being a company registered/ incorporated outside India or otherwise) is not able to furnish the above information of its own (separate), being a subsidiary company and the accounts are being consolidated with their Group/ Holding/ Parent/sister concern^{##} company, the Bidder should submit the balance sheet, income

Qualifying Requirements of bidders for Establishment of 220 kV GIS Turnkey Package along with 220 kV Power Transformer

statement, other information as required, of its own (separate), (not of its Group/ Holding/ Parent/ sister concern^{##} company) duly certified by:

- i) Their statutory Auditor; or
- ii) A Certified Public Accountant; or
- iii) Their Company Secretary certifying that it is based on audited accounts, as the case may be.

Similarly, if the Bidder happens to be a Group / Holding /Parent company, the Bidder should submit the above information of its own (separate), exclusive of its Subsidiaries, duly certified by:

- i) Their statutory Auditor; or
- ii) A Certified Public Accountant; or
- iii) Their Company Secretary certifying that it is based on audited accounts, as the case may be.

Qualifying Requirements of bidders for Establishment of 220 kV GIS Turnkey Package along with 220 kV Power Transformer

Annexure-D1

CONSENT LETTER FROM ERECTOR TO BE FURNISHED BY THE GIS MANUFACTURER

(To be submitted on the letterhead of the company)

To

Dt....

Delhi Transco Ltd.

Shakti Sadan, Kotla Road

New Delhi-110002.

IN RESPECT OF TURNKEY PACKAGE (Name of tender)

TENDER NO.

Dear Sir,

The undersigned on behalf of M/s.....having its registered office at..... wish to confirm as under:

1. That, we shall carry out erection, testing & commissioning of GIS equipments for M/s meeting the technical specification as specified in Delhi Transco Limited said Tender No
2. That, we as a Erector meet the qualifying criteria as specified in Annexure A, BDS, Vol-I of the said Tender No.
3. That, we shall carry out erection, testing & commissioning of GIS equipments in line with the agreed Time Schedule between Delhi Transco Limited and M/S.....
4. That, documentation in respect of our qualification and experience is enclosed with this consent letter as per the requirement of Tender Specifications.

That, Undersigned is authorized to submit this consent/confirmation letter on behalf of M/s.....

(Authorization letter enclosed).

For and on behalf of M/s...

Signature...

Name...

Designation...

Seal...

Qualifying Requirements of bidders for Establishment of 220 kV GIS Turnkey Package along with 220 kV Power Transformer

Annexure-D2

CONSENT LETTER FROM GIS MANUFACTURER TO BE FURNISHED BY THE ERECTOR

(To be submitted on the letterhead of the company)

To

Dt....

Delhi Transco Ltd.
Shakti Sadan, Kotla Road
New Delhi-110002.

IN RESPECT OF TURNKEY PACKAGE (Name of tender).

TENDER NO.

Dear Sir,

The undersigned on behalf of M/s.....having its manufacturing units at and registered office at..... wish to confirm as under:

1. That, we shall supply GIS equipments to M/s meeting the technical specification as specified in Delhi Transco Limited said Tender No
2. That, we as a GIS Manufacturer meet the qualifying criteria as specified in Clause 1.1/1.2/1.3 of Annexure A, BDS, Vol-I of the said Tender No.
3. That, we shall supply the GIS equipments in line with the agreed Time Schedule between Delhi Transco Limited and M/S.....
4. That, we shall undertake supervision of erection, testing & commissioning in case of award of contract to M/s.....(To be submitted by an erector who is not having GIS experience as provided in Cl. 1.4)
5. That, documentation in respect of our qualification and experience is enclosed with this consent letter as per the requirement of Tender Specifications.

That, Undersigned is authorized to submit this consent/confirmation letter on behalf of M/s.....
(Authorization letter enclosed).

For and on behalf of M/s...

Signature...

Name...

Designation...

Seal

Qualifying Requirements of bidders for Establishment of 220 kV GIS Turnkey Package along with 220 kV Power Transformer

Annexure-D3

CONSENT LETTER FROM THE COLLABORATOR/PARENT/PRINCIPAL/SISTER CONCERN##

(To be submitted on the letterhead of the company)

To

Date....

Delhi Transco Ltd.

Shakti Sadan, Kotla Road

New Delhi-110002.

IN RESPECT OF TURNKEY PACKAGE (Name of tender)

TENDER NO.

Dear Sir,

The undersigned on behalf of M/s.....having its registered office at..... wish to confirm as under:

1. That, we shall supervise erection, testing & commissioning of GIS equipments for M/s meeting the technical specification as specified in Delhi Transco Limited said Tender No
2. That, we shall carry out supervision of erection, testing & commissioning of GIS equipments in line with the agreed Time Schedule between Delhi Transco Limited and M/s.....

That, Undersigned is authorized to submit this consent/confirmation letter on behalf of M/s.....

(Authorization letter enclosed).

For and on behalf of M/s...

Signature...

Name...

Designation...

Seal...

Qualifying Requirements of bidders for Establishment of 220 kV GIS Turnkey Package along with 220 kV Power Transformer

Annexure-D4

CONSENT LETTER FROM POWER TRANSFORMER MANUFACTURER TO BE FURNISHED BY THE BIDDER

(To be submitted on the letterhead of the company)

To

Date....

Delhi Transco Ltd.

Shakti Sadan, Kotla Road

New Delhi-110002.

IN RESPECT OF TURNKEY PACKAGE (Name of tender)

TENDER NO.

Dear Sir,

The undersigned on behalf of M/s.....having its registered office at..... wish to confirm as under:

1. That, we shall supply 220kV Power Transformer to M/s meeting the technical specification as specified in Delhi Transco Limited said Tender No
2. That, we shall supply the 220kV Power Transformer in line with the agreed Time Schedule between Delhi Transco Limited and M/s.....
3. That, we shall undertake supervision of commissioning of Power Transformer in case of award of contract to M/s.....
4. That, documentation in respect of our qualification and experience is enclosed with this consent letter as per the requirement of Tender Specifications.

That, Undersigned is authorized to submit this consent/confirmation letter on behalf of M/s.....
(Authorization letter enclosed).

For and on behalf of M/s...

Signature...

Name...

Designation...

Seal...

SECTION-IV

CONDITIONS OF CONTRACT **(CC)**

SECTION-IV

Condition of Contract (CC)

A. Contract and Interpretation:

1.0 Definitions:

1.1 The following words and expressions shall have the meanings hereby assigned to them:

"Contract" means the Contract Agreement entered into between the Employer and the Contractor, together with the Contract Documents referred to therein; they shall constitute the Contract, and the term "the Contract" shall in all such documents be construed accordingly.

"Contract Documents" means the documents listed in Article 1.1(Contract Documents) of the Form of Contract Agreement (including any amendments thereto).

"CC" means the Conditions of Contract hereof.

"Day" means calendar day of the Gregorian Calendar.

"Month" means calendar month of the Gregorian Calendar.

"Employer/Owner" means the person named as below and includes the legal successors or permitted assigns of the Employer/Owner.

**Delhi Transco Ltd.
Shakti Sadan
New Delhi-110002
Fax No. – 011-23232721,
Tel. No. -011-23230026**

"Project Manager" means the person appointed by the Employer in the manner provided in CC Sub-Clause 17.1 (Project Manager) hereof and named as such in the CC to perform the duties delegated by the Employer.

The Project Manager is: [Name, address, telephone, cable, email-id and facsimile numbers]

"Contractor" means the person(s) whose bid to perform the Contract has been accepted by the Employer and is named as such in the Contract Agreement, and includes the legal successors or permitted assigns of the Contractor.

The Contractor is: [Name, address, telephone, cable and facsimile numbers]

"Contractor's Representative" means any person nominated by the Contractor and named as such in the CC and approved by the Employer in the manner provided in CC Sub-Clause 17.2 (Contractor's Representative and Construction Manager) hereof to perform the duties delegated by the Contractor.

The Contractor's Representative is: [Name, address, telephone, cable and facsimile numbers]

"Subcontractor," including vendors, means any person to whom execution of any part of the Facilities, including preparation of any design or supply of any Plant and Equipment, is sub-contracted directly or indirectly by the Contractor, and includes its legal successors or permitted assigns.

"Contract Price" means the sum specified in Article 2.1 (Contract Price) of the Contract Agreement, subject to such additions and adjustments thereto or deductions therefrom, as may be made pursuant to the Contract.

"Facilities" means the Plant and Equipment to be supplied and installed, as well as all the Installation Services to be carried out by the Contractor under the Contract.

"Plant and Equipment" means permanent plant, equipment, machinery, apparatus, articles and things of

all kinds to be provided and incorporated in the Facilities by the Contractor under the Contract (including the spare parts to be supplied by the Contractor under CC Sub-Clause 7.3 hereof), but does not include Contractor's Equipment.

"Installation Services" means all those services ancillary to the supply of the Plant and Equipment for the Facilities, to be provided by the Contractor under the Contract; e.g., transportation and provision of marine or other similar insurance, inspection, expediting, Site preparation works (including the provision and use of Contractor's Equipment and the supply of all construction materials required), installation, testing, Pre-commissioning, commissioning, operations, maintenance, the provision of operations and maintenance manuals, training, etc.

"Contractor's Equipment" means all plant, facilities, equipment, machinery, tools, apparatus, appliances or things of every kind required in or for installation, completion and maintenance of Facilities that are to be provided by the Contractor, but does not include Plant and Equipment, or other things intended to form or forming part of the Facilities.

"Site" means the land and other places upon which the Facilities are to be installed, and such other land or places as may be specified in the Contract as forming part of the Site.

"Effective Date" means the date from which the Time for Completion shall be determined as stated in Article 3 (Effective Date for Determining Time for Completion) of the form of Contract Agreement.

"Taking Over" means the Employer's written acceptance of the Facilities under the Contract, after successful Trial – Operation for the specified period in accordance with the Contract.

"Time of completion" means the time within which completion of the Facilities as whole (or of a part of the Facilities where a separate Time for completion of such part has been prescribed) and Taking Over by the employer is to be attained in accordance with the stipulations in the SCC and the relevant provisions of the Contract.

The successful Bidder shall be required to prepare detailed Network(s) and project implementation plans & programmes and finalize the same with the Employer as per requirement specified in Technical Specifications, which shall form a part of the Contract.

Note: No credit will be given for the earlier delivery/ completion and offers with delivery/completion beyond the completion period will be treated as unresponsive.

"Completion" means that the Facilities (or a specific part thereof where specific parts are specified in the CC) have been completed operationally and structurally and put in a tight and clean condition, and that all work in respect of Pre-commissioning of the Facilities or such specific part thereof has been completed and Commissioning has been attained as per Technical Specifications followed by successful Trial – Operation, as provided in CC Clause 24.0 (Completion of Facilities) & 25.0 (Commissioning and Operational Acceptance) hereof.

"Pre-commissioning" means the testing, checking and other requirements specified in the Technical Specifications that are to be carried out by the Contractor in preparation for Commissioning as provided in CC Clause 24 (Completion of Facilities) hereof.

"Commissioning" means operations of the facilities or any part thereof to be carried out by the Contractor as provided in CC Sub-Clause 25.1 (commissioning) hereof, for the purpose of carrying out Guarantee Test(s).

"Guarantee Test(s)" means the test(s) specified in the Technical Specifications to be carried out to ascertain whether the Facilities or a specified part thereof is able to attain the Functional Guarantees specified in the Technical Specifications in accordance with the provisions of CC Sub-Clause 25.2 (Guarantee Test) hereof.

"Operational Acceptance" means the acceptance by the Employer of the Facilities (or any part of the Facilities where the Contract provides for acceptance of the Facilities in parts), which certifies the Contractor's fulfillment of the Contract in respect of Functional Guarantees of the Facilities (or the relevant part thereof) in accordance with the provisions of CC Clause 28 (Functional Guarantees) hereof and shall include deemed acceptance in accordance with CC Clause 25 (Commissioning and Operational

Acceptance) hereof.

"Defect Liability Period" means the period of validity of the warranties given by the Contractor commencing at Completion of the Facilities or a part thereof, during which the Contractor is responsible for defects with respect to the Facilities (or the relevant part thereof) as provided in CC Clause 27 (Defect Liability) hereof.

'Local content' means the amount of value added in India which shall, unless otherwise prescribed by the Nodal Ministry, be the total value of the item procured (excluding net domestic indirect taxes) minus the value of imported content in the item (including all customs duties) as a proportion of the total value, in percent.

'Class-I local supplier' means a supplier or service provider, whose goods, services or works offered for procurement, meets the minimum local content as prescribed for 'Class-I local supplier' as defined under PPP-MII Order No. P-45021/2/2017-PP (BE-II) dated 16.09.2020.

'Class-II local supplier' means a supplier or service provider, whose goods, services or works offered for procurement, meets the minimum local content as prescribed for 'Class-II local supplier' but less than that prescribed for 'Class-I local supplier' as defined under PPP-MII Order No. P-45021/2/2017-PP (BE-II) dated 16.09.2020.

'Non - Local supplier' means a supplier or service provider, whose goods, services or works offered for procurement, has local content less than or equal to 20%, as defined above or as defined under PPP-MII Order No. P-45021/2/2017-PP (BE-II) dated 16.09.2020.

'Minimum local content:' The 'local content' requirement to categorize a supplier as 'Class-I local supplier' is minimum 50%. For 'Class-II local supplier', the 'local content' requirement is minimum 20%. Nodal Ministry/ Department may prescribe only a higher percentage of minimum local content requirement to categorize a supplier as 'Class-I local supplier'/ 'Class-II local supplier'. For the items, for which Nodal Ministry Department has not prescribed higher minimum local content notification under the Order, it shall be 50% and 20% for 'Class-I local supplier'/ 'Class-II local supplier' respectively.

'L1' means the lowest tender or lowest bid or the lowest quotation received in a tender, bidding process or other procurement solicitation as adjudged in the evaluation process as per the tender or other procurement solicitation.

'Margin of purchase preference' means the maximum extent to which the price quoted by a "Class-I local supplier" may be above the L 1 for the purpose of purchase preference.

'Procuring entity' means a Ministry or department or attached or subordinate office of, or autonomous body controlled by, the Government of India and includes Government companies as defined in the Companies Act.

2. Contract Documents

- 2.1** Subject to Article 1.2 (Order of Precedence) of the Contract Agreement, all documents forming part of the Contract (and all parts thereof) are intended to be correlative, complementary and mutually explanatory. The Contract shall be read as a whole.

3. Interpretation

3.1 Language

- 3.1.1** All Contract Documents, all correspondence and communications to be given, and all other documentation to be prepared and supplied under the Contract shall be written in English, and the Contract shall be construed and interpreted in accordance with that language.

- 3.1.2** If any of the Contract Documents, correspondence or communications are prepared in any language other than the governing language under CC Sub Clause 3.1.1 above, the English translation of such documents, correspondence or communications shall prevail in matters of interpretation.

3.2 Singular and Plural

The singular shall include the plural and the plural the singular, except where the context otherwise requires.

3.3 Headings

The headings in the CC are included for ease of reference, and shall neither constitute a part of the Contract nor affect its interpretation.

3.4 Persons

Words importing persons or parties shall include firms, corporations and government entities.

3.5 Incoterms

Unless inconsistent with any provision of the Contract, the meaning of any trade term and the rights and obligations of parties there under shall be as prescribed by Incoterms.

Incoterms means international rules for interpreting trade terms published by the International Chamber of Commerce (latest edition), 38 Cours Albert 1er, 75008 Paris, France.

3.6 Entire Agreement

Subject to CC Sub-Clause 16.4 hereof, the Contract constitutes the entire agreement between the Employer and Contractor with respect to the subject matter of Contract and supersedes all communications, negotiations and agreements (whether written or oral) of parties with respect thereto made prior to the date of Contract.

3.7 Amendment

No amendment or other variation of the Contract shall be effective unless it is in writing, is dated, expressly refers to the Contract, and is signed by a duly authorized representative of each party hereto.

3.8 Independent Contractor

The Contractor shall be an independent contractor performing the Contract. The Contract does not create any agency, partnership, joint venture or other joint relationship between the parties hereto.

Subject to the provisions of the Contract, the Contractor shall be solely responsible for the manner in which the Contract is performed. All employees, representatives or Subcontractors engaged by the Contractor in connection with the performance of the Contract shall be under the complete control of the Contractor and shall not be deemed to be employees of the Employer, and nothing contained in the Contract or in any subcontract awarded by the Contractor shall be construed to create any contractual relationship between any such employees, representatives or Subcontractors and the Employer.

3.9 Joint Venture or Consortium

If the Contractor is a joint venture or consortium of two or more firms, all such firms shall be jointly and severally bound to the employer for the fulfillment of the provisions of the Contract and shall designate one of such firms to act as a leader with authority to bind the joint venture or consortium. The composition or the constitution of the joint venture or consortium shall not be altered without the prior consent of the Employer.

3.10 Non-Waiver

3.10.1 Subject to CC Sub-Clause 3.10.2 below, no relaxation, forbearance, delay or indulgence by either party in enforcing any of the terms and conditions of the Contract or the granting of time by either party to the other shall prejudice, affect or restrict the rights of that party under the Contract, nor shall any waiver by either party of any breach of Contract operate as waiver of any subsequent or continuing breach of Contract.

3.10.2 Any waiver of a party's rights, powers or remedies under the Contract must be in writing, must be dated and signed by an authorized representative of the party granting such waiver, and must specify the right and the extent to which it is being waived.

3.11 Severability

If any provision or condition of the Contract is prohibited or rendered invalid or unenforceable, such prohibition, invalidity or unenforceability shall not affect the validity or enforceability of any other provisions and conditions of the Contract.

3.12 Country of Origin

"Origin" means the place where the materials, equipment and other supplies for the Facilities are mined, grown, produced or manufactured, and from which the services are provided.

4. Notices

- 4.1** Unless otherwise stated in the Contract, all notices to be given under the Contract shall be in writing, and shall be sent by personal delivery, airmail post, special courier, cable, telegraph, telex, facsimile, email id or Electronic Data Interchange (EDI) to the address of the relevant party set out in the Special Conditions of Contract, with the following provisions.

Employer's address for notice purposes: [Name, address and telephone, cable, email-id and facsimile numbers]

Contractor's address for notice purposes: [Name, address and telephone, cable, email-id and facsimile numbers]

- 4.1.1** Any notice sent by cable, telegraph, telex, facsimile, email id or EDI shall be confirmed within two (2) days after despatch by notice sent by airmail post or special courier, except as otherwise specified in the Contract.
- 4.1.2** Any notice sent by airmail post or special courier shall be deemed (in the absence of evidence of earlier receipt) to have been delivered ten (10) days after dispatch. In proving the fact of despatch, it shall be sufficient to show that the envelope containing such notice was properly addressed, stamped and conveyed to the postal authorities or courier service for transmission by airmail or special courier.
- 4.1.3** Any notice delivered personally or sent by cable, telegraph, telex, facsimile, email id or EDI shall be deemed to have been delivered on date of its despatch.
- 4.1.4** Either party may change its postal, cable, telex, facsimile or EDI address or addressee for receipt of such notices by ten (10) days' notice to the other party in writing.
- 4.2** Notices shall be deemed to include any approvals, consents, instructions, orders and certificates to be given under the Contract.

5. Governing Law

- 5.1** The courts at New Delhi shall have the exclusive jurisdiction on all matters

This Contract/Agreement is governed by and shall be construed in accordance with the laws of India and Indian laws shall govern the validity, enforcement, and interpretation of this Contract/Agreement."

In the contracts concerning International Agreements or contracts involving international parties, the following 'Governing Law' clause shall be considered:

"This Contract/Agreement shall be governed by and construed in accordance with the laws of India and Indian laws shall govern the validity, enforcement, and interpretation of this Contract/Agreement without regard to applicable principles of conflicts of law. Each of the parties hereto irrevocably consents to the exclusive jurisdiction of Courts at New Delhi, in connection with controversy, dispute, or claim of any nature arising out of, in connection with, or in relation to the interpretation, performance, enforcement or breach of this Contract/Agreement (and any closing document executed in connection herewith), including any claim based on contract, tort or statute, which shall be resolved before the commercial courts as per Commercial Courts Act, 2015."

6. Settlement of Disputes

(Note: - Bidder shall not approach the court while representing the matters to IEMs and bidder will await their decision in the matter.)

6.1. Adjudicator

Not applicable.

6.2. Dispute Resolution

- 6.2.1** Any controversy, dispute, or claim of any nature arising out of, in connection with, or in relation to the interpretation, performance, enforcement or breach of this Contract/Agreement (and any closing document executed in connection herewith), including any claim based on contract, tort or statute, shall be resolved before the Commercial Courts as per Commercial Courts Act, 2015
The Agreement shall be subject to jurisdiction of the courts at New Delhi.

- 6.2.2** The parties irrevocably submit to the exclusive jurisdiction of Courts at New Delhi for the determination of disputes arising under this contract/agreement.”
- 6.2.3** Deleted
- 6.2.4** Deleted
- 6.2.5** Deleted
- 6.2.6** Deleted
- 6.2.7** Deleted
- 6.2.8** Deleted
- 6.2.9** Deleted
- 6.2.9.1** Deleted
- 6.2.9.2** Deleted

B. Subject Matter of Contract

7. Scope of Facilities

- 7.1.** Unless otherwise expressly limited in the Technical Specifications, the Contractor’s obligation cover the provision of all Plant and Equipment and the performance of all Installation Services required for the design, the manufacture (including procurement, quality assurance, construction, installation, associated civil works, Pre-commissioning and delivery) of the Plant and Equipment and the installation, completion, commissioning and performance testing of the facilities in accordance with the plans, procedures, specifications drawings, codes and any other documents as specified in the Technical specifications. Such specifications include, but are not limited to, the provision of supervision and engineering services the supply of labour, materials, equipment, spare parts (as specified in CC sub-clause 7.3 below) and accessories, Contractor’s Equipment; construction utilities and supplies, temporary materials, structures and facilities, transportation (including without limitation, unloading and hauling to, from and at the Site); and storage except for those supplies, works and services that will be provided or performed by the Employer, as set forth in Appendix-6 (Scope of Works and Supply by the Employer) to the Contract Agreement.
- 7.2** The Contractor shall, unless specifically excluded in the Contract, perform all such work and/or supply all such items and materials not specifically mentioned in the Contract but that can be reasonably inferred from the Contract as being required for attaining Completion of the Facilities as if such work and/or items and materials were expressly mentioned in the Contract.
- 7.3** In addition to the supply of Mandatory Spare Parts included in the Contract, the Contractor agrees to supply spare parts required for the operation and maintenance of the Facilities for the period specified in the CC. However, the identity, specifications and quantities of such spare parts and the terms and conditions relating to the supply thereof are to be agreed between the Employer and the Contractor, and the price of such spare parts shall be that given in Price Schedules, which shall be added to the Contract Price. The price of such spare parts shall include the purchase price thereof and other costs and expenses (including the Contractor's fees) relating to the supply of spare parts.
- The Contractor shall ensure the availability of spare parts for the supplied items for a minimum period of fifteen (15) years from operational acceptance by the Employer
- 7.4** The Contractor shall carry sufficient inventories to ensure an ex-stock supply of consumable spares for the plant and equipment. Other spare parts and components shall be supplied as promptly as possible, but at the most within six (6) months of placing the order and opening the letter of credit.

7.5 In the event of termination of production of spare parts:

- (i) The Contractor shall send advance notification to the Employer of the pending termination, with 2 (two) years time to permit the Employer to procure needed requirements, and
- (ii) Following such termination, the contractor shall furnish at no cost to the Employer the blueprints, drawings and specifications of the spare parts, if requested.

8. Time for Commencement and Completion

8.1 The Contractor shall commence work on the Facilities within the period specified in the CC and without prejudice to CC Sub-Clause 26.2 hereof, the Contractor shall thereafter proceed with the Facilities in accordance with the time schedule specified in Appendix 4 (Time Schedule) to the Contract Agreement.

The contractor shall commence work on the facilities from the Effective Date of Contract for determining Time for completion as specified in the contract.

8.2. The Contractor shall attain Completion of the Facilities (or of a part where a separate time for Completion of such part is specified in the Contract) within the time stated in the CC or within such extended time to which the Contractor shall be entitled under CC Clause 40 (Extension of Time for Completion) hereof.

9. Contractor's Responsibilities

9.1 The Contractor shall design, manufacture (including associated purchases and/or subcontracting), install and complete the Facilities with due care and diligence in accordance with the Contract.

9.2 The Contractor confirms that it has entered into this Contract on the basis of a proper examination of the data relating to the Facilities (including any data as to boring tests) provided by the Employer, and on the basis of information that the Contractor could have obtained from a visual inspection of the Site (if access thereto was available) and of other data readily available to it relating to the Facilities as at the date twenty-eight (28) days prior to bid submission. The Contractor acknowledges that any failure to acquaint itself with all such data and information shall not relieve its responsibility for properly estimating the difficulty or cost of successfully performing the Facilities.

9.3 The Contractor shall acquire in its name all permits, approvals and/or licenses from all local, state or national government authorities or public service undertakings in the country where the Site is located that are necessary for the performance of the Contract, including, without limitation, visas for the Contractor's and Subcontractor's personnel and entry permits for all imported Contractor's Equipment. The Contractor shall acquire all other permits, approvals and/or licenses that are not the responsibility of the Employer under CC Sub-Clause 10.3 hereof and that are necessary for the performance of the Contract.

9.4 The Contractor shall comply with all laws in force in the country where the Facilities are installed and where the Installation Services are carried out. The laws will include all national, provincial, municipal or other laws that affect the performance of the Contract and bind upon the Contractor. The Contractor shall indemnify and hold harmless the Employer from and against any and all liabilities, damages, claims, fines, penalties and expenses of whatever nature arising or resulting from the violation of such laws by the Contractor or its personnel, including the Subcontractors and their personnel, but without prejudice to CC Sub-Clause 10.1 hereof.

9.5 Any Plant, Material and Services that will be incorporated in or be required for the Facilities and other supplies shall have their origin as specified under CC Sub-Clause 3.12 (Country of Origin).

9.6 The Contractor shall permit the Employer to inspect the Contractor's accounts and records relating to the performance of the Contractor.

10. Employer's Responsibilities

10.1 The Employer shall ensure the accuracy of all information and/or data to be supplied by the Employer as described in Appendix 6 (Scope of Works and Supply by the Employer) to the Contract, except when otherwise expressly stated in the Contract.

- 10.2** The Employer shall be responsible for acquiring and providing legal and physical possession of the Site and access thereto, and for providing possession of and access to all other areas reasonably required for the proper execution of the Contract, including all requisite rights of way, as specified in Appendix 6 (Scope of Works and Supply by the Employer) to the Contract Agreement. The Employer shall give full possession of and accord all rights of access thereto on or before the date(s) specified in Appendix 6.
- 10.3** The Employer shall acquire and pay for all permits, approvals and/or licenses from all local, state or national government authorities or public service undertakings in the country where the site is located which such authorities or undertakings require the Employer to obtain them in the Employer's name, are necessary for the execution of the Contract (they include those required for the performance by both the Contractor and the Employer of their respective obligations under the Contract), including those specified in Appendix 6 (Scope of works and supply by the Employer) to the Contract Agreement.
- 10.4** If requested by the Contractor, the Employer shall use its best endeavors to assist the Contractor in obtaining in a timely and expeditious manner all permits, approvals and/or licenses necessary for the execution of the Contract from all local, state or national government authorities or public service undertakings that such authorities or undertakings require the Contractor or Subcontractors or the personnel of the Contractor or Subcontractors, as the case may be, to obtain.
- 10.5** Unless otherwise specified in the Contract or agreed upon by the Employer and the Contractor, the Employer shall provide sufficient, properly qualified operating and maintenance personnel, shall supply and make available all raw materials utilities, lubricants, chemicals, catalysts, other materials and facilities, and shall perform all works and services of whatsoever nature, to enable the Contractor to properly carry out Pre-commissioning, Commissioning and Guarantee Tests, all in accordance with the provisions of Appendix 6 (Scope of works and supply by the Employer) to the Contract Agreement at or before the time specified in the program furnished by the Contractor under CC Sub-Clause 18.2 (Program of Performance) hereof and in the manner thereupon specified or as otherwise agreed upon by the Employer and the Contractor.
- 10.6** The Employer shall be responsible for the continued operation of the facilities after Operational Acceptance, in accordance with CC 25.3
- 10.7** All costs and expenses involved in the performance of the obligations under this CC Clause 10 shall be the responsibility of the Employer, save those to be incurred by the Contractor with respect to the performance of Guarantee Tests, in accordance with CC Sub-Clause 25.2.

C. Payment

11. Contract Price

- 11.1** The Contract Price shall be as specified in Article 2 (Contract Price and Terms of Payment) of the Form of Contract Agreement.
- 11.2** The Contract Price shall be on lump sum basis. The Contract price shall be adjusted on account of variation in quantity in accordance with clause 39 CC. Further the CIF/Ex-works price component and installation price component shall also be subject to price adjustment in line with the provisions of Appendix 2 to Form of Contract Agreement
- 11.3** Subject to CC Sub-Clauses 9.2, 10.1 and 35 (Unforeseen Conditions) hereof, the Contractor shall be deemed to have satisfied itself as to the correctness and sufficiency of the Contract Price, which shall, except as otherwise provided for in the Contract, cover all its obligations under the Contract.

12. Terms of Payment

- 12.1** The Contract Price shall be paid as specified in Appendix 1 (Terms and Procedures of Payment) to the Contract Agreement. The procedures to be followed in making application for and processing payments shall be those outlined in the same Appendix 1.
- 12.2** No payment made by the Employer herein shall be deemed to constitute acceptance by the Employer of the Facilities or any part(s) thereof.
- 12.3** The currency or currencies in which payments are made to the Contractor under this Contract shall be specified in Appendix 1 (Terms and Procedures of Payment) to the Contract Agreement, subject to the

general principle that payments will be made in the currency or currencies in which the Contract Price has been stated in the Contractor's bid.

- 12.4 All payments shall be made in currency or currencies specified in the corresponding Appendix 1 (Terms and Procedures of Payment) to the Contract Agreement, pursuant to CC 12.3.

13. Securities

13.1 Issuance of Securities

The Contractor shall provide the securities specified below in favor of the Employer at the times, and in the amount, manner and form specified below.

13.2 Advance Payment Security

- 13.2.1 The Contractor shall, within twenty-eight (28) days of the notification of contract award, provide a security in an amount equal to the advance payment calculated in accordance with Appendix 1 (Terms and Procedures of Payment) to the Contract Agreement, and in the same currency or currencies with a validity of up to the date of completion of Facilities in accordance with CC clause 24.0 and it shall be kept alive till the recovery of the full amount of the advance with interest portion.

- 13.2.2 The Security shall be in the form provided in the bidding documents or in another form acceptable to the Employer. The security shall be discharged after completion of the facilities or relevant party thereof.

Procedure for effective reduction in the Advance Payment Security:

Recovery of the advance amount shall be made from each running bill proportionately. It should be clearly understood that reduction in the value of security for advance shall not in any way dilute the Contractor's responsibility and liabilities under the Contract including in respect of the Facilities for which reduction in the value of security is allowed.

13.3 Performance Security

- 13.3.1 The Bidder shall submit **performance security @ 10% of the total contract price for the performance of contract** within twenty-eight days (28 days) **from the issuance of** notifications of award. **The Material shall not be accepted without depositing performance security.**

The performance security is to be deposited in the form of Insurance Surety Bonds, Account Payee Demand Draft, Fixed Deposit Receipt from a commercial Bank, Bank Guarantee (including e- Bank Guarantee) from a commercial Bank or online payment in an acceptable form safeguarding the purchaser's interest in all respect. Performance security shall be valid up to defect liability period but initially for 12 Months from the date of taking over/operational acceptance. This performance guarantee shall be renewed periodically every year upto the end of defect liability period. Every renewal of performance guarantee shall be done by the contractor one month prior to the expiry date.

The bidder will submit an undertaking to the owner with a copy to the banker issuing the performance bank guarantee that the bidder will renew and submit the bank guarantee within thirty days before the expiry of bank guarantee failing which it shall be encashed and credited in favour of DTL automatically by the banker without waiting for any instructions from DTL.

- 13.3.2 The performance security shall be in the form of unconditional Bank Guarantee attached hereto in the Section VI - Sample Forms and Procedures.

- 13.3.3 Reduction in the security pro rata to the Contract Price of any part of the Facilities is not admissible since separate time for Completion of part of the facilities is not applicable. However, if the Defects Liability Period has been extended on any part of the Facilities pursuant to CC sub-clause 27.8 hereof, the Contractor shall issue an additional security in an amount proportionate to the Contract Price of that part. The Security shall be returned to the Contractor immediately after its expiration, provided, however, that if the Contractor pursuant to CC Sub-Clause 27.10, is liable for an extended warranty obligation, the performance security shall be extended for the period and up to the amount specified in the CC clause 27.

- 13.3.4. In case of award of the contract to a Joint Venture, the performance security and the Bank Guarantee for advance payment shall be submitted in the name of the Joint Venture and not in the name of the Lead Partner or any Partner(s) of the Joint Venture alone

- 13.3.5. No interest on Performance Security Deposit will be payable to the depositors.
- 13.3.6 Exemption from performance security deposit will not be permitted under any circumstance.

13.4 Issuing Banks

The Advance Payment Security and Performance Security are to be provided by the Contractor in the form of 'Bank Guarantee' which should be issued either:

- (a) by a reputed bank located in the country of Employer and acceptable to the Employer, or
- (b) by a foreign bank confirmed by either its correspondence bank located in the country of Employer which should be reputed and acceptable to the Employer, or
- (c) by a Public Sector Bank in the country of Employer.

All banks shall be nationalized and scheduled banks operating in India.

14. Taxes and Duties

- 14.1 Prices are to be quoted exclusive of GST and GST rate may also be indicated in the price bid and BOQ/un-priced schedule.
- 14.2 The Contractor shall be entirely responsible for payment of all taxes, duties, license fees and other such levies legally payable/incurred until delivery of the contracted supplies to the Employer. If it is statutory requirement to make deductions towards such taxes and duties or any other applicable taxes and duties, the same shall be made by the owner and a certificate for the same shall be issued to the Contractor.
- 14.3 The Contractor shall be solely responsible for its Income Tax liabilities and for taxes that may be levied on the Contractor's persons or on earnings of any of his employees and shall hold the owner indemnified and harmless against any claims that may be made against the Employer. The Employer does not take any responsibility whatsoever regarding taxes under Income Tax Act, for the Contractor or his personnel. If it is obligatory under the provisions of the Income Tax Act, deduction of Income Tax at source shall be made by the Employer.
- 14.4 In respect of transactions between the Employer and the Contractor, the Base Price is inclusive of all cost as well as duties and tax (custom duties & levies, Taxes and duties as per GST Rules) paid or payable on components, raw materials and any other items used /incorporated or to be incorporated in the Plants & Equipments and other final goods & services to be supplied by the contractor under the proposed contract. No separate claim shall be paid by the Employer for taxes and duties included in respect of these items stated herein.
- 14.5 Taxes, duties and levies as per GST Rules for the goods & Services under 'transactions' between contractor & Employer for destination site/state shall not be included in the base price. These amounts will be payable (along with subsequent statutory variation if any) on the supplies made by the Contractor, subject to submission of the documentary evidence indicating the said taxes paid by the contractor and GST credit is transferred to the Employer. But the amount of said taxes shall be limited to the tax liability on the transaction between the employer and the Contractor only. However, Employer will not bear any upward variation in GST rate due to change/disputes in classification relating to HSN/SAC code as quoted by the bidder at a later stage. Employer shall, however, deduct such taxes at source as per the rules and issue Tax Deduction at Source (TDS) Certificate to the Contractor as per the said rules. The Input Tax Credit (ITC) available, if any, under GST as per the relevant Government laws wherever applicable has been taken into account by the Contractor. Reimbursement of GST by the Employer shall be at the rate applicable on the HSN/SAC of the goods/ services supplied by the Contractor to the Employer as mutually agreed upon. The payment of GST on advance payment shall be against Invoice/Debit Note containing particulars specified under the GST Act and related Rules, Notifications, etc as notified by the Government in this regard. In the event that the Contractor fails to provide the invoice in the form and manner prescribed under the GST Act and Rules, the Employer shall not be liable to make any payment against such invoice. GST payment against Advance payment shall be against a proforma invoice. Further, the Contractor shall, within 7 days from the date of receipt of Advance, furnish an Advance Receipt Voucher to the Employer, as prescribed under the GST Law.
- 14.6 The Contractor shall comply with all tax laws in force in India. The Contractor shall indemnify and hold harmless the Employer from and against any and all liabilities, interest, damages, claims, fines, penalties and expenses of whatever nature arising or resulting from the violation of such tax laws by the Contractor or its personnel, including the Subcontractors and their personnel.

14.7 DELETED

- 14.8 For payment in respect of dispatches made directly from Contractor's works, Tax invoices raised by the Contractor shall be accepted as documentary evidence and for payment of GST. The amount of GST as stated in Tax invoice will be paid only after the GST credit is transferred to the Employer. However, the employer from time to time may also verify the payment / deposit of various taxes by the contractor, which the later has already claimed and charged in the previous invoices from the employer against the aforesaid transactions between employer and the contractor.
- 14.9 In Case the Taxes, Duties and Levies as per GST Rules on transaction between Employer and the Contractor is covered under the Reverse Charge provision full Tax has to be stated / mentioned in the quoted prices/ bid. However, where the Reverse Charge Mechanism Provisions are applicable, DTL shall not pay the applicable tax amount to the contractor and will deposit directly to the Government treasury. To facilitate the bidders, Employer has indicated HSN/SAC code and rate of GST against each item in the price schedule. It shall entirely be the responsibility of the bidder to check the HSN/SAC code and rate of GST given against each item. The bidder may either confirm the HSN and rate of GST or if the bidder opts to classify the item in question under a different HSN/ SAC code or opts to indicate a different rate of GST, bidder may indicate the same in the columns provided. The bidder shall solely be responsible for HSN/SAC classification and the rate of GST of each item. Employer's liability for the reimbursement of GST shall be GST applicable at the rate as confirmed/ deemed confirmed in the bid and as accepted by the employer. The Input Tax Credit (ITC) available, if any, under the GST law as per the relevant Govt. policies wherever applicable shall be taken into account by the bidder while quoting bid price.
- 14.10 For the purpose of the Contract, it is agreed that the Contract Price specified in Article-2 (Contract Price and Terms of Payment) of the Contract Agreement is based on the taxes inclusive of duties, levies and charges prevailing at the date seven (07) days prior to the last date of bid submission. If any rates of Tax including service tax are increased or decreased or, a new Tax is introduced, or/an existing Tax is abolished in the course of the performance of the Contract, which was or will be assessed on the Contractor in connection with performance of the Contract, an equitable adjustment of the Contract price shall be made to take into account any such change by addition to the Contract price or deduction therefrom, as the case may be (changes in law & regulations) hereof. However, these adjustments would be applicable to all transactions between the employer and the Contractor for which the taxes and duties are reimbursable by the Employer as per the Contract. These adjustments shall not be applicable on procurement of raw materials, intermediary components etc by the Contractor.
- 14.11 In respect of raw materials, intermediary components etc forming part of base price of goods & services supplied under the contract, neither the employer nor the Contractor shall be entitled to any claim arising due to increase or decrease in the rate of Tax, introduction of a new Tax or abolition of an existing Tax in the course of the performance of the Contract. However, Employer will not bear any upward variation in GST rate due to change/disputes in classification relating to HSN/SAC code as quoted by the bidder at a later stage.

D. Intellectual Property

15. Copyright

- 15.1 The copy right in all drawings, documents and other materials containing data and information furnished to the Employer by the Contractor herein shall remain vested in the Contractor or, if they are furnished to the Employer directly or through the Contractor by any third party, including supplies of materials, the copyright in such materials shall remain vested in such third party.

The Employer shall however be free to reproduce all drawings, document and other material furnished to the Employer for all purpose of the Contract including, if required, for operation and maintenance.

16. Confidential Information

- 16.1 The Employer and the Contractor shall keep confidential and shall not, without the written consent of the other party hereto, divulge to any third party any documents, data or other information furnished directly or indirectly by the other party hereto in connection with the Contract, whether such information has been furnished prior to, during or following termination of the Contract. Notwithstanding the above, the Contractor may furnish to its Subcontractor(s) such documents, data and other information it receives from the Employer to the extent required for the Subcontractor(s) to perform its work under the Contract, in which event the Contractor shall obtain from such Subcontractor(s) an undertaking of confidentiality similar to that imposed on the Contractor under this CC Clause.16.
- 16.2 The Employer shall not use such documents, data and other information received from the Contractor for any purpose other than the operation and maintenance of the Facilities. Similarly, the Contractor shall not use such documents, data and other information received from the Employer for any purpose other than the

design, procurement of Plant and Equipment, construction or such other work and services as are required for the performance of the Contract.

- 16.3** The obligation of a party under CC Sub-Clauses 16.1 and 16.2 above, however, shall not apply to that information which

(a) now or hereafter enters the public domain through no fault of that party

(b) can be proven to have been possessed by that party at the time of disclosure and which was not previously obtained, directly or indirectly, from the other party hereto

(c) otherwise lawfully becomes available to that party from a third party that has no obligation of confidentiality

- 16.4** The above provisions of this CC Clause 16 shall not in any way modify any undertaking of confidentiality given by either of the parties hereto prior to the date of the Contract in respect of the Facilities or any part thereof.

- 16.5** The provisions of this CC Clause 16 shall survive termination, for whatever reason, of the Contract.

E. Execution of the Facilities

17. Representatives

- 17.1** If the Project Manager is not named in the Contract, then within fourteen (14) days of the Effective Date, the Employer shall appoint and notify the Contractor in writing of the name of Project manager. The Employer may from time to time appoint some other person as the Project manager in place of the person previously so appointed, and shall give a notice of the name of such other person to the Contractor without delay. The Employer shall take all reasonable care to see that no such appointment is made at such a time or in such a manner as to impede the progress of work on the Facilities. The Project Manager shall represent and act for the employer at all times during the currency of the Contract. All notices, instructions, orders, certificates, approvals and all other communications under the Contract shall be given by the Project Manager, except as herein otherwise provided.

All notices, instructions, information and other communications given by the Contractor to the employer under the Contract shall be given to the Project Manager, except as herein otherwise provided.

17.2 Contractor's Representative & Construction Manager

- 17.2.1** If the Contractor's Representative is not named in the Contract, then within fourteen (14) days of the Effective Date, the Contractor shall appoint the Contractor's Representative and shall request the Employer in writing to approve the person so appointed. If the Employer makes no objection to the appointment within fourteen (14) days, the Contractor's Representative shall be deemed to have been approved. If the Employer objects to the appointment within fourteen (14) days giving the reason therefore, then the Contractor shall appoint a replacement within fourteen (14) days of such objection, and the foregoing provisions of this CC Sub-Clause 17.2.1 shall apply thereto.

- 17.2.2** The Contractor's Representative shall represent and act for the Contractor at all times during the currency of the Contract and shall give to the Project Manager all the Contractor's notices, instructions, information and all other communications under the Contract.

All notices, instructions, information and all other communications given by the Employer or the Project Manager to the Contractor under the Contract shall be given to the Contractor's Representative or, in its absence, its deputy, except as herein otherwise provided.

The Contractor shall not revoke the appointment of the Contractor's Representative without the Employer's prior written consent, which shall not be unreasonably withheld. If the Employer consents thereto, the Contractor shall appoint some other person as the Contractor's Representative, pursuant to the procedure set out in CC Sub-Clause 17.2.1.

- 17.2.3** The Contractor's Representative may, subject to the approval of the Employer (which shall not be unreasonably withheld), at any time delegate to any person any of the powers, functions and authorities vested in him or her. Any such delegation may be revoked at any time. Any such delegation or revocation shall be subject to a prior notice signed by the Contractor's Representative, and shall specify the powers, functions and authorities thereby delegated or revoked. No such delegation or revocation shall take effect unless and until a copy thereof has been delivered to the Employer and the Project Manager

Any act or exercise by any person of powers, functions and authorities so delegated to him or her in

accordance with this CC Sub-Clause 17.2.3 shall be deemed to be an act or exercise by the Contractor's Representative.

17.2.3.1 Notwithstanding anything stated in CC sub-Clause 17.1 and 17.2.1 above, for the purpose of execution of Contract, the Employer and the Contractor shall finalize and agree to a Contract Co-ordination Procedure and all the communication under the Contract shall be in accordance with such Contract Coordination Procedure.

17.2.4 From the commencement of installation of the Facilities at the site until Operational Acceptance, the Contractor's Representative shall appoint a suitable person as the construction manager, (hereinafter referred to as "the Construction Manager"). The Construction Manager shall supervise all work done at the site by the Contractor and shall be present at the site through-out normal working hours, except when on leave, sick or absent for reasons connected with the proper performance of the Contract. Whenever the Construction Manager is absent from the Site, a suitable person shall be appointed to act as his or her deputy.

17.2.5 The Employer may by notice to the Contractor object to any representative or person employed by the Contractor in the execution of the Contract who, in the reasonable opinion of the Employer, may behave inappropriately, may be incompetent or negligent, or may commit a serious breach of the Site regulations provided under CC Sub-Clause 22.3. The Employer shall provide evidence of the same, whereupon the Contractor shall remove such person from the Facilities.

17.2.6 If any representative or person employed by the Contractor is removed in accordance with CC Sub-Clause 17.2.5, the Contractor shall, where required, promptly appoint a replacement.

18. Work Program

18.1 Contractor's Organization

The Contractor shall supply to the Employer and the Project Manager a chart showing the proposed organization to be established by the Contractor for carrying out work on the Facilities. The chart shall include the identities of the key personnel together with the curricula vitae of such key personnel to be employed within twenty-one (21) days of the Effective Date. The Contractor shall promptly inform the Employer and the Project Manager in writing of any revision or alteration of such an organization chart.

18.2 Program of Performance

The form of the program of performance of the Contract shall be in the form of the Critical Path Method (CPM), the PERT network, or other internationally used programs.

Within twenty-eight (28) days after the date of Notification of Award, the Contractor shall prepare and submit to the Project Manager a detailed program of performance of the Contract, made in the form specified in the CC and showing the sequence in which it proposes to design, manufacture, transport, assemble, install and pre-commission the Facilities, as well as the date by which the Contractor reasonably requires that the Employer shall have fulfilled its obligations under the Contract so as to enable the Contractor to execute the Contract in accordance with the program and to achieve completion, commissioning and Acceptance of the Facilities in accordance with the Contract. The program so submitted by the Contractor shall accord with the Time Schedule included in appendix-4 (Time Schedule) to the Contract Agreement and any other dates and periods specified in the Contract. The Contractor shall update and revise the program as and when appropriate or when required by the Project Manager, but without modification in the Times for Completion given in the CC and any extension granted in accordance with CC Clause 40, and shall submit all such revisions to the Project Manager.

18.3 Progress Report

The Contractor shall monitor progress of all the activities specified in the program referred to in CC Sub-Clause 18.2 (Program of Performance) above, and supply a progress report to the Project Manager every month.

The progress report shall be in a form acceptable to the Project Manager and shall indicate: (a) percentage completion achieved compared with the planned percentage completion for each activity; and (b) where any activity is behind the program, giving comments and likely consequences and stating the corrective action being taken.

18.4 Progress of Performance

If at any time the Contractor's actual progress falls behind the program referred to in CC Sub-Clause 18.2 (Program of Performance), or it becomes apparent that it will so fall behind, the Contractor shall, at the request of the Employer or the Project Manager, prepare and submit to the Project Manager a revised program, taking into account the prevailing circumstances, and shall notify the Project Manager of the steps being taken to expedite progress so as to attain Completion of the Facilities within the Time for Completion under CC Sub Clause 8.2 (Time for Commencement and Completion), any extension thereof entitled under CC Sub-Clause 40.1 (Extension of Time for Completion), or any extended period as may otherwise be agreed upon between the Employer and the Contractor.

18.5 Work Procedures

The Contract shall be executed in accordance with the Contract Documents and the procedures given in the section on Sample Forms and Procedures of the Contract Documents.

The Contractor may execute the Contract in accordance with its own standard project execution plans and procedures to the extent that they do not conflict with the provisions contained in the Contract.

19. Subcontracting

19.1 Appendix 5 (List of Approved Subcontractors) to the Contract Agreement specifies major items of supply or services and a list of approved Subcontractors against each item, including vendors. Insofar as no Subcontractors are listed against any such item, the Contractor shall prepare a list of Subcontractors for such item for inclusion in such list. The Contractor may from time to time propose any addition to or deletion from any such list. The Contractor shall submit any such list or any modification thereto to the Employer for its approval in sufficient time so as not to impede the progress of work on the Facilities. Such approval by the Employer for any of the Subcontractors shall not relieve the Contractor from any of its obligations, duties or responsibilities under the Contract.

19.2 The Contractor shall select and employ its Subcontractors for such major items from those listed in the lists referred to in CC Sub-Clause 19.1.

19.3 For items or parts of the Facilities not specified in Appendix 5 (List of Approved Subcontractors) to the Contract Agreement, the Contractor may employ such Subcontractors as it may select, at its discretion.

20. Design and Engineering

20.1 Specifications and Drawings

20.1.1 The Contractor shall execute the basic and detailed design and the engineering work in compliance with the provisions of the Contract, or where not so specified, in accordance with good engineering practice.

The Contractor shall be responsible for any discrepancies, errors or omissions in the specifications, drawings and other technical documents that it has prepared, whether such specifications, drawings and other documents have been approved by the Project Manager or not, provided that such discrepancies, errors or omissions are not because of inaccurate information furnished in writing to the Contractor by or on behalf of the Employer.

20.1.2 The Contractor shall be entitled to disclaim responsibility for any design, data, drawing, specification or other document, or any modification thereof provided or designated by or on behalf of the Employer, by giving a notice of such disclaimer to the Project Manager.

20.2 Codes and Standards

Wherever references are made in the Contract to codes and standards in accordance with which the Contract shall be executed, the edition or the revised version of such codes and standards current at the date twenty-eight (28) days prior to date of bid submission shall apply unless otherwise specified. During Contract execution, any changes in such codes and standards shall be applied after approval by the Employer and shall be treated in accordance with CC Clause 39.3 (Changes Originating from Contractor).

20.3 Approval/Review of Technical Documents by Project Manager

20.3.1 The Contractor shall prepare (or cause its subcontractors to prepare) and furnish to the Project Manager the documents listed in Appendix-7 (List of Documents for Approval or Review) to the Contract Agreement for its approval or review as specified and as in accordance with the requirements of CC sub-Clause 18.2 (Program of Performance).

Any part of the Facilities covered by or related to the documents to be approved by the Project Manager shall be executed only after the Project Manager's approval thereof.

CC sub-Clause 20.3.2 through 20.3.7 shall apply to those documents requiring the Project Manager's approval, but not to those furnished to the Project Manager for its review only.

20.3.2 Within twenty-one (21) days after receipt by the Project Manager of any document requiring the Project Manager's approval in accordance with CC Sub-Clause 20.3.1, the Project Manager shall either return one copy thereof to the Contractor with its approval endorsed thereon or shall notify the Contractor in writing of its disapproval thereof and the reasons therefore and the modifications that the Project Manager proposes.

20.3.3 The Project Manager shall not disapprove any document, except on the grounds that the document does not comply with some specified provision of the Contract or that it is contrary to good engineering practice.

20.3.4 If the Project Manager disapproves the document, the Contractor shall modify the document and resubmit it for the Project Manager's approval in accordance with CC sub-Clause 20.3.2. If the Project Manager approves the documents subject to modification(s), the Contractor shall make the required modifications the document shall be deemed to have been approved.

The procedure, for submission of the documents by the Contractor and their approval by the Project Manager shall be discussed and finalized with the Contractor.

20.3.5 Deleted

20.3.6 The Project Manager's approval, with or without modification of the document furnished by the Contractor, shall not relieve the Contractor of any responsibility or liability imposed upon it by any provisions of the Contract except to the extent that any subsequent failure results from modifications required by the Project Manager.

20.3.7 The Contractor shall not depart from any approved document unless the Contractor has first submitted to the Project Manager an amended document and obtained the Project Manager's approval thereof, pursuant to the provisions of this CC Sub-Clause 20.3. If the Project Manager requests any change in any already approved document and/or in any document based thereon, the provisions of CC Clause 39 (Change in the Facilities) shall apply to such request.

21. Procurement

21.1 Plant and Equipment

Subject to CC Sub-Clause 18.2, the Contractor shall manufacture or procure and transport all the Plant and Equipment in an expeditious and orderly manner to the Site.

21.2 Employer-Supplied Plant, Equipment, and Materials

If Appendix 6 (Scope of Works and Supply by the Employer) to the Contract Agreement provides that the Employer shall furnish any specific items of machinery, equipment or materials to the Contractor, the following provisions shall apply:

21.2.1 The Employer shall, at its own risk and expense, transport each item to the place on or near the Site as agreed upon by the parties and make such item available to the Contractor at the time specified in the program furnished by the Contractor, pursuant to CC Sub-Clause 18.2 (Program of Performance), unless otherwise mutually agreed.

21.2.2 Upon receipt of such item, the Contractor shall inspect the same visually and notify the Project Manager of any detected shortage, defect or default. The Employer shall immediately remedy any shortage, defect or default, or the Contractor shall, if practicable and possible, at the request of the Employer, remedy such shortage, defect or default at the Employer's cost and expense. After inspection, such item shall fall under the care, custody and control of the Contractor. The provision of this CC Sub-21.2.2 shall apply to any item supplied to remedy any such shortage or default or to substitute for any defective item, or shall apply to defective items that have been repaired.

21.2.3 The foregoing responsibilities of the Contractor and its obligations of care, custody and control shall not relieve the Employer of liability for any undetected shortage, defect or default, nor place the Contractor under any liability for any such shortage, defect or default whether under CC Clause 27 (Defect Liability) or under any other provision of Contract.

21.3 Transportation

21.3.1 The Contractor shall at its own risk and expense transport all the Plant and Equipment and the Contractor's Equipment to the Site by the mode of transport that the Contractor judges most suitable under all the circumstances.

21.3.2 Unless otherwise provided in the Contract, the Contractor shall be entitled to select any safe mode of transport operated by any person to carry the Plant and Equipment and the Contractor's Equipment.

21.3.3 Upon despatch of each shipment of the Plant and Equipment and the Contractor's Equipment, the Contractor shall notify the Employer by telex, cable, facsimile or Electronic Data Interchange (EDI) of the description of the Plant and Equipment and of the Contractor's Equipment, the point and means of despatch, and the estimated time and point of arrival in the country where the Site is located, if applicable, and at the Site. The Contractor shall furnish the Employer with relevant shipping documents to be agreed upon between the parties.

21.3.4 The Contractor shall be responsible for obtaining, if necessary, approvals from the authorities for transportation of the Plant and Equipment and the Contractor's Equipment to the Site. The Employer shall use its best endeavors in a timely and expeditious manner to assist the Contractor in obtaining such approvals, if requested by the Contractor. The Contractor shall indemnify and hold harmless the Employer from and against any claim for damage to roads, bridges or any other traffic facilities that may be caused by the transport of the Plant and Equipment and the Contractor's Equipment to the Site.

21.4 Customs Clearance

The Contractor shall, at its own expense, handle all imported Plant and Equipment and Contractor's Equipment at the point(s) of import and shall handle any formalities for customs clearance including liabilities for port charges if any, subject to the Employer's obligations under CC sub-Clause 14.4, provided that if applicable laws or regulations require any application or act to be made by or in the name of the employer, the employer shall take all necessary steps to comply with such laws or regulations. In the event of delays in customs clearance due to the fault of the employer, the Contractor shall be entitled to an extension in the Time for Completion, pursuant to CC Clause 40.

21.5 Delivery and Documents

21.5.1 For Imported Goods

Upon shipment, the Contractor shall notify the Employer and the Insurance company by cable or telex of the full details of the shipment including Contract number, description of goods, quantity, the vessel, the bill of lading/Airway Bill number and date, port of loading, date of shipment, port of discharge, etc. The Contractor shall mail the following documents to the Employer, with a copy to the Insurance Company:

- 1) Copies of the Contractor's invoice showing Contract Agreement reference, goods description, quantity, unit price, total amount;
- 2) Original (3/3) and six copies of the negotiable, clean on-board bill of lading/Air way Bill marked freight prepaid and six copies of non-negotiable bill of lading / Airway Bill;
- 3) Copies of packing list identifying contents of each package (6 copies);
- 4) Original insurance policy certification (3 copies);
- 5) Manufacture's / Contractor's guarantee certificate of Quality;
- 6) Material Inspection & Clearance Certificate (MICC) for dispatch, issued by the Employer's representative and the Contractor's factory inspection report, test certificates (3 copies); and
- 7) Certificate of origin.

The above documents shall be air mailed/faxed by the Contractor to reach the Employer within one week from date of shipment to enable the Employer to make progressive payment to the Contractor and also

make necessary arrangement for payment of custom duties etc. The Contractor will be responsible for any consequent expenses due to delay in furnishing the above documentation.

21.5.2 For Domestic Goods

Upon shipment, the Contractor shall notify the employer and the Insurance Company by cable or telex of the full details of the dispatch including Contract number, description of goods, quantity, R/R or L/R number and date, place of loading, date of dispatch etc. The Contractor shall mail the following documents to the Employer, with a copy to Insurance Company:

- 1) Copies of the Contractor's invoice showing Contract Agreement reference, goods description, quantity, unit price, total amount (6 copies);
- 2) Copies of packing list identifying contents of each package (6 Copies);
- 3) Railway receipt / Receipted LR;
- 4) Manufacturer's / Contractor's guarantee certificate of Quality.
- 5) Material Inspection & Clearance Certificate (MICC) for dispatch issued by the Employer's representative and the Contractor's factory inspection report & test certificate (3 copies) and insurance certificate (3 copies); and
- 6) Certificate of origin.

21.6 Packing

21.6.1 The Contractor shall provide such packing of the Goods as it is required to prevent their damage or deterioration during transit to their final destination as indicated in the Contract. The packing shall be sufficient to withstand, without limitation, rough handling during transit and exposure to extreme temperatures, salt and precipitation during transit and open storage. Packing case size and weights shall take into consideration, where appropriate, the remoteness of the goods final destination and the absence of heavy handling facilities at all points in transit.

21.6.2 The packing, marking and documentation within and outside the packages shall comply strictly with such special requirements as shall be expressly provided for in the Contract and, subject to any subsequent instruction ordered by the Employer consistent with the requirements of the Contract.

21.7 Indemnity Bond

For the equipment/material to be provided by the Contractor, it will be the responsibility of the Contractor to take delivery, unload and store the material at Site and execute an Indemnity Bond in favour of the Employer against loss, damage and any risks involved for the full value of the material and obtain authorization letter from Employer as per proforma given at Section-VI. This Indemnity Bond shall be furnished by the Contractor before commencement of the supplies and shall be valid till the scheduled date of Operational Acceptance of the equipment by the Employer

22. Installation

22.1 Setting Out/Supervision/Labour

22.1.1 Bench Mark: The Contractor shall be responsible for the true and proper setting-out of the Facilities in relation to bench marks, reference marks and lines provided to it in writing by or on behalf of the Employer.

If, at any time during the progress of installation of the Facilities, any error shall appear in the position, level or alignment of the Facilities, the Contractor shall forthwith notify the Project Manager of such error and, at its own expense, immediately rectify such error to the reasonable satisfaction of the Project Manager. If such error is based on incorrect data provided in writing by or on behalf of the Employer, the expense of rectifying the same shall be borne by the Employer.

22.1.2 Contractor's Supervision:

The Contractor shall give or provide all necessary superintendence during the installation of the Facilities, and the Construction Manager or its deputy shall be constantly on the Site to provide full-time superintendence of the installation. The Contractor shall provide and employ only technical personnel who

are skilled and experienced in their respective callings and supervisory staff who are competent to adequately supervise the work at hand.

22.1.3 Labour:

(a) The Contractor shall provide and employ on the Site in the installation of the Facilities such skilled, semi-skilled and unskilled labour as is necessary for the proper and timely execution of the Contract. The Contractor is encouraged to use local labour that has the necessary skills.

(b) Unless otherwise provided in the Contract, the Contractor shall be responsible for the recruitment, transportation, accommodation and catering of all labour, local or expatriate, required for the execution of the Contract and for all payments in connection therewith.

(c) The Contractor shall be responsible for obtaining all necessary permit(s) and/or visa(s) from the appropriate authorities for the entry of all labour and personnel to be employed on the Site into the country where the Site is located.

(d) The Contractor shall at its own expense provide the means of repatriation to all of its and its Subcontractor's personnel employed on the Contract at the Site to their various home countries. It shall also provide suitable temporary maintenance of all such persons from the cessation of their employment on the Contract to the date programmed for their departure. In the event that the Contractor defaults in providing such means of transportation and temporary maintenance, the Employer may provide the same to such personnel and recover the cost of doing so from the Contractor.

(e) The Contractor shall at all times during the progress of the Contract use its best endeavors to prevent any unlawful, riotous or disorderly conduct or behavior by or amongst its employees and the labour of its Subcontractors.

(f) The Contractor shall, in all dealings with its labour and the labour of its Subcontractors currently employed on or connected with the Contract, pay due regard to all recognized festivals, official holidays, religious or other customs and all local laws and regulations pertaining to the employment of labour.

22.2 Contractor's Equipment

22.2.1 All Contractors' Equipment brought by the Contractor onto the Site shall be deemed to be intended to be used exclusively for the execution of the Contract. The Contractor shall not remove the same from the Site without the Project Manager's consent that such Contractor's Equipment is no longer required for the execution of the Contract.

22.2.2 Unless otherwise specified in the Contract, upon completion of the Facilities, the Contractor shall remove from the Site all Equipment brought by the Contractor onto the Site and any surplus materials remaining thereon.

22.2.3 The Employer will, if requested, use its best endeavors to assist the Contractor in obtaining any local, state or national government permission required by the Contractor for the export of the Contractor's Equipment imported by the Contractor for use in the execution of the Contract that is no longer required for the execution of the Contract.

22.3 Site Regulations and Safety

The Employer and the Contractor shall establish Site regulations setting out the rules to be observed in the execution of the Contract at the Site and shall comply therewith. The Contractor shall prepare and submit to the Employer, with a copy to the Project Manager, proposed Site regulations for the Employer's approval, which approval shall not be unreasonably withheld.

Such Site regulations shall include, but shall not be limited to, rules in respect of security, safety of the Facilities, gate control, sanitation, medical care, and fire prevention.

22.3.1 Compliance with Labour Regulations

22.3.1.1 During continuance of the contract, the Contractor and his sub-contractors shall abide at all times by all applicable existing labour enactments and rules made there under, regulations notifications and bye laws of the State or Central Government or local authority and any other labour law (including rules),

regulations, bye laws that may be passed or notification that may be issued under any labour law in future either by the State or the Central Government or the local authority. The employees of the Contractor and the Sub-contractor in no case shall be treated as the employees of the Employer at any point of time.

22.3.1.2 The Contractor shall keep the employer indemnified against any action by the competent authority on account of contravention of any of the provisions of any Act or rules made there under, regulations or notifications including amendments.

22.3.1.3 If the Employer is caused to pay under any law as principal employer such amounts as may be necessary to cause or as observe, or for non observance of the provisions stipulated in the notifications / byelaws / Acts / Rules / regulations including amendments, if any, on the part of the Contractor, the Employer shall have the right to deduct any money due to the Contractor under this contract or any other contract with employer including his amount of performance security for adjusting the aforesaid payment. The Employer shall also have right to recover from the Contractor any sum required or estimated to be required for making good the loss or damage suffered by the Employer.

22.3.1.4 Some major laws along with their latest amendments applicable to establishments engaged in building and other construction works:

- a) Workmen Compensation Act 1923: The Act provides for compensation in case of injury by accident arising out of and during the course of employment.
- b) Payment of Gratuity Act 1972: Gratuity is payable to an employee under the Act on satisfaction of certain conditions on separation if an employee has completed 5 years service or more or on death the rate of 15 days wages for every completed year of service. The Act is applicable to all establishments employing 10 or more employees.
- c) Employee P.F. and Miscellaneous Provision Act 1952: The Act provides for monthly contribution by the employer plus workers @ 10% or 8.33%. The benefits under the Act are:
 - 1) Pension or family pension on retirement or death, as the case may be.
 - 2) Deposit linked insurance on death in harness of the worker.
 - 3) Payment of P.F. accumulation on retirement/death etc.
- d) Maternity Benefit Act 1951: The Act provides for leave and some other benefits to women employees in case of confinement or miscarriage etc.
- e) Contract Labour (Regulation & Abolition) Act 1970: The Act provides for certain welfare measures to be provided by the Contractor to contract labour and in case the Contractor fails to provide, the same are required to be provided, by the Principal Employer by law. The Principal Employer is required to take Certification of Registration and the Contractor is required to take license from the designated Officer. The Act is applicable to the establishments or Contractor of Principal Employer if they employ 20 or more labour contract labour.
- f) Minimum Wages Act 1948: The Employer is supposed to pay not less than the Minimum Wages fixed by appropriate Government as per provision of the Act if the employment is a scheduled employment. Construction of Buildings, Roads, Runways are scheduled employments.
- g) Payment of Wages Act 1936: It lays down as to by what date the wages are to paid, when it will be paid and what deductions can be made from the wages of the workers.
- h) Equal Remuneration Act 1979: The Act provides for payment of equal wages for work of equal nature to Male and Female workers and for not making discrimination against Female employees in the matters of transfers, training and promotions etc.
- i) Payment of Bonus Act 1965: The Act is applicable to all establishments employing 20 or more employees. The Act provides for payments of annual bonus subject to a minimum of 8.33% of wages and maximum of 20% of wages to employees drawing Rs.3500/- per month or less. The bonus is to be paid to employees getting Rs.2500/- per month or above upto Rs.3500/- per month shall be worked out by taking wages as Rs.2500/-per month only. The Act does not apply to certain establishments. The newly set-up establishments are exempted for five years in certain circumstances. Some of the State Governments have reduced the employment size from 20 to 10 for the purpose of applicability of this Act.

- j) Industrial Dispute Act 1947: The Act lays down the machinery the procedure for resolution of Industrial disputes, in what situations a strike or lock out becomes illegal and what are the requirements for laying off or retrenching the employees or closing down the establishment.
- k) Industrial Employment (Standing Orders) Act 1946: It is applicable to all establishments employing 100 or more workmen (employment size reduced by some of the States and Central Government to 50). The Act provides for laying down rules governing the conditions of employment by the Employer on matters provided in the Act and get the same certified by the designated Authority.
- l) Trade Unions Act 1926: The Act lays down the procedure for registration of trade unions of workmen and employers. The Trade Unions registered under the Act have been given certain immunities from civil and criminal liabilities.
- m) Child Labour (Prohibition & Regulation) Act 1986: The Act prohibits employment of children below 14 years of age in certain occupations and processes and provides for regulation of employment of children in all other occupations and processes. Employment of Child Labour is prohibited in Building and Construction Industry.
- n) Inter-State Migrant workmen's (Regulation of Employment & Conditions of Service) Act 1979: The Act is applicable to an establishment which employs 5 or more inter-state migrant workmen through an intermediary (who has recruited workmen in one state for employment in the establishment situated in another state). The Inter-State migrant workmen, in an establishment to which this Act becomes applicable, are required to be provided certain facilities such as housing, medical aid, traveling expenses from home upto the establishment and back, etc.
- o) The Building and Other Construction workers (Regulation of Employment and Conditions of Service) Act 1996 and the Cess Act of 1996: All the establishments who carry on any building or other construction work and employ 10 or more workers are covered under this Act. All such establishments are required to pay cess at the rate not exceeding 2% of the cost of construction as may be modified by the Government. The Employer of the establishment is required to provide safety measures at the Building or construction work and other welfare measures, such as Canteens, First-Aid facilities, Ambulance, Housing accommodations for workers near the work place etc. The Employer to whom the Act applies has to obtain a registration certificate from the Registering Officer appointed by the government.
- p) Factories Act 1948: The Act lays down the procedure for approval of plans before setting up a factory, health and safety provisions, welfare provisions, working hours, annual earned leave and rendering information regarding accidents or dangerous occurrences to designated authorities. It is applicable to premises employing 10 persons or more with aid of power or 20 or more persons without the aid of power engaged in manufacturing process.

22.3.2 Protection of Environment

The Contractor shall take all reasonable steps to protect the environment on and off the Site and to avoid damage or nuisance to persons or to property of the public or others resulting from pollution noise or other causes arising as consequence of his methods of operation.

During continuance of the Contract, the Contractor and his Sub-contractors shall abide at all times by all existing enactments on environmental protection and rules made there under, regulations, notifications and bye-laws of the State or Central Government, or local authorities and any other law, bye-law, regulations that may be passed or Notification that may be issued in this respect in future by the State or Central Government or the local authority.

Salient features of some of the major laws that are applicable are given below:

The Water (Prevention and Control of Pollution) Act, 1974, This provides for the prevention and control of water pollution and the maintaining and restoring of wholesomeness of water. 'Pollution' means such contamination of water or such alteration of the physical, chemical or biological properties of water or such discharge of any sewage or trade effluent or of any other liquid, gaseous or solid substance into water (whether directly or indirectly) as may, or is likely to, create a nuisance or render such water harmful or injurious to public health or safety, or to domestic, commercial, industrial, agricultural or other legitimate uses, or to the life and health of animals or plants or of aquatic organisms.

The Air (Prevention and Control of Pollution) Act, 1981, This provides for prevention, control and abatement of air pollution. 'Air Pollution' means the presence in the atmosphere of any 'air pollutant',

which means any solid, liquid or gaseous substance (including noise) present in the atmosphere in such concentration as may be or tend to be injurious to human beings or other living creatures or plants or property or environment.

The Environment (Protection) Act, 1986, This provides for the protection and improvement of environment and for matters connected therewith and the prevention of hazards to human beings, other living creatures, plants and property. 'Environment' includes water, air and land and the inter-relationship which exists among and between water, air and land, and human beings, other living creatures, plants, micro-organism and property.

The Public Liability Insurance Act, 1991: This provides for public liability insurance for the purpose of providing immediate relief to the persons affected by accident occurring while handling hazardous substances and or matters connected herewith or incidental thereto. Hazardous substance means any substance or preparation which is defined as hazardous substance under Environment (Protection) Act, 1986, and exceeding such quantity as be specified by notification by the Central Government.

22.4 Opportunities for Other Contractors

22.4.1 The Contractor shall, upon written request from the Employer or the Project Manager, give all reasonable opportunities for carrying out the work to any other contractors employed by the Employer on or near the Site.

22.4.2 If the Contractor, upon written request from the Employer or the Project Manager, makes available to other contractors any roads or ways the maintenance for which the Contractor is responsible, permits the use by such other contractors of the Contractor's Equipment, or provides any other service of whatsoever nature for such other contractors, the Employer shall fully compensate the Contractor for any loss or damage caused or occasioned by such other contractors in respect of any such use or service, and shall pay to the Contractor reasonable remuneration for the use of such equipment or the provision of such services.

22.4.3 The Contractor shall also so arrange to perform its work as to minimize, to the extent possible, interference with the work of other contractors. The Project Manager shall determine the resolution of any difference or conflict that may arise between the Contractor and other contractors and the workers of the Employer in regard to their work.

22.4.4 The Contractor shall notify the Project Manager promptly of any defects in the other contractors' work that come to its notice, and that could affect the Contractor's work. The Project Manager shall determine the corrective measures, if any, required to rectify the situation after inspection of the Facilities. Decisions made by the Project Manager shall be binding on the Contractor.

22.5 Emergency Work

If, by reason of an emergency arising in connection with and during the execution of the Contract, any protective or remedial work is necessary as a matter of urgency to prevent damage to the Facilities, the Contractor shall immediately carry out such work.

If the Contractor is unable or unwilling to do such work immediately, the Employer may do or cause such work to be done as the Employer may determine is necessary in order to prevent damage to the Facilities. In such event the Employer shall, as soon as practicable after the occurrence of any such emergency, notify the Contractor in writing of such emergency, the work done and the reasons therefore. If the work done or caused to be done by the Employer is work that the Contractor was liable to do at its own expense under the Contract, the reasonable costs incurred by the Employer in connection therewith shall be paid by the Contractor to the Employer. Otherwise, the cost of such remedial work shall be borne by the Employer.

22.6 Site Clearance

22.6.1 Site Clearance in Course of Performance: In the course of carrying out the Contract, the Contractor shall keep the Site reasonably free from all unnecessary obstruction, store or remove any surplus materials, clear away any wreckage, rubbish or temporary works from the Site, and remove any Contractor's Equipment no longer required for execution of the Contract.

22.6.2 Clearance of Site after Completion: After Completion of all parts of the Facilities, the Contractor shall clear away and remove all wreckage, rubbish and debris of any kind from the Site, and shall leave the Site and Facilities clean and safe.

22.7 Watching and Lighting

The Contractor shall provide and maintain at its own expense all lighting, fencing, and watching when and where necessary for the proper execution and the protection of the Facilities, or for the safety of the owners and occupiers of adjacent property and for the safety of the public.

22.8 Work at Night and on Holidays

22.8.1 Unless otherwise provided in the Contract, no work shall be carried out during the night and on public holidays of the country where the Site is located without prior written consent of the Employer, except where work is necessary or required to ensure safety of the Facilities or for the protection of life, or to prevent loss or damage to property, when the Contractor shall immediately advise the Project Manager, provided that provisions of this CC Sub-Clause 22.8.1 shall not apply to any work which is customarily carried out by rotary or double-shifts

22.8.2 Notwithstanding CC Sub-Clauses 22.8.1 or 22.1.3, if and when the Contractor considers it necessary to carry out work at night or on public holidays so as to meet the Time for Completion and requests the Employer's consent thereto, the Employer shall not unreasonably withhold such consent.

23. Test and Inspection

23.1 The Contractor shall at its own expense carry out at the place of manufacture and/or on the Site all such tests and/or inspections of the Plant and Equipment and any part of the Facilities as are specified in the Contract.

23.2 The Employer and the Project Manager or their designated representatives shall be entitled to attend the aforesaid test and/or inspection, provided that the Employer shall bear all costs and expenses incurred in connection with such attendance including, but not limited to, all traveling and board and lodging expenses.

23.3 Whenever the Contractor is ready to carry out any such test and/or inspection, the Contractor shall give a reasonable advance notice of such test and/or inspection and of the place and time thereof to the Project Manager. The Contractor shall obtain from any relevant third party or manufacturer any necessary permission or consent to enable the Employer and the Project Manager (or their designated representatives) to attend the test and/or inspection. For notification of testing, four weeks shall be deemed as reasonable advance notice.

23.4 The Contractor shall provide the Project Manager with a certified report of the results of any such test and/or inspection.

If the Employer or Project Manager (or their designated representatives) fails to attend the test and/or inspection, or if it is agreed between the parties that such persons shall not do so, then the Contractor may proceed with the test and/or inspection in the absence of such persons, and may provide the Project Manager with a certified report of the results thereof.

23.5 The Project Manager may require the Contractor to carry out any test and/or inspection not required by the Contract, provided that the Contractor's reasonable costs and expenses incurred in the carrying out of such test and/or inspection shall be added to the Contract Price. Further, if such test and/or inspection impedes the progress of work on the Facilities and/or the Contractor's performance of its other obligations under the Contract, due allowance will be made in respect of the Time for Completion and the other obligations so affected.

23.6 If any Plant and Equipment or any part of the Facilities fails to pass any test and/or inspection, the Contractor shall either rectify or replace such Plant and Equipment or part of the Facilities and shall repeat the test and/or inspection upon giving a notice under CC Sub-Clause 23.3. If the inspection is not materialized due to the reasons attributable to contractor then all the expenses including to & fro airfare and TA, DA shall be to the account of the contractor.

23.7 Deleted

23.8 The Contractor shall afford the Employer and the Project Manager, at the Employer's expense, access at any reasonable time to any place where the Plant and Equipment are being manufactured or the Facilities are being installed, in order to inspect the progress and the manner of manufacture or installation, provided that the Project Manager shall give the Contractor a reasonable prior notice.

- 23.9** The Contractor agrees that neither the execution of a test and/or inspection of Plant and Equipment or any part of the Facilities, nor the attendance by the Employer or the Project Manager, nor the issue of any test certificate pursuant to CC Sub-Clause 23.4, shall release the Contractor from any other responsibilities under the Contract.
- 23.10** No part of the Facilities or foundations shall be covered up on the Site without the Contractor carrying out any test and/or inspection required under the Contract. The Contractor shall give a reasonable notice to the Project Manager whenever any such part of the Facilities or foundations are ready or about to be ready for test and/or inspection; such test and/or inspection and notice thereof shall be subject to the requirements of the Contract.
- 23.11** The Contractor shall uncover any part of the Facilities or foundations, or shall make openings in or through the same as the Project Manager may from time to time require at the Site, and shall reinstate and make good such part or parts.

If any part of the Facilities or foundations have been covered up at the Site after compliance with the requirement of CC Sub-Clause 23.10 and are found to be executed in accordance with the Contract, the expenses of uncovering, making openings in or through, reinstating, and making good the same shall be borne by the Employer, and the Time for Completion shall be reasonably adjusted to the extent that the Contractor has thereby been delayed or impeded in the performance of any of its obligations under the Contract.

24. Completion of the Facilities

- 24.1** As soon as the Facilities or any part thereof has, in the opinion of the Contractor, been completed operationally and structurally and put in a tight and clean condition as specified in the Technical Specifications, excluding minor items not materially affecting the operation or safety of the Facilities, the Contractor shall so notify the Employer in writing.
- 24.2** Within seven (7) days after receipt of the notice from the Contractor under CC Sub-Clause 24.1, the Employer shall supply the operating and maintenance personnel specified in Appendix 6 (Scope of Works and Supply by the Employer) to the Contract Agreement for Pre-commissioning of the Facilities or any part thereof.
- Pursuant to Appendix 6 (Scope of Works and Supply by the Employer) to the Contract Agreement, the Employer shall also provide, within the said seven (7) day period, the raw materials, utilities, lubricants, chemicals, catalysts, facilities, services and other matters required for Pre-commissioning of the Facilities or any part thereof.
- 24.3** As soon as reasonably practicable after the operating and maintenance personnel have been supplied by the Employer and the raw materials, utilities, lubricants, chemicals, catalysts, facilities, services and other matters if so specified in Appendix-6 (scope of works and supply by the Employer) have been provided by the Employer in accordance with CC Sub-Clause 24.2, the Contractor shall commence Pre-commissioning of the Facilities or the relevant part thereof in preparation for Commissioning.
- 24.4** As soon as all works in respect of Pre-commissioning are completed and in the opinion of the Contractor, the facilities or any part thereof is ready for commissioning, the contractor shall commence Commissioning as per procedures stipulated in Technical Specification and as soon as Commissioning is satisfactorily completed, the Contractor shall so notify the Project Manager in writing. (Also refer CC 25.2.3)
- 24.5** The Project Manager shall, within fourteen (14) days after receipt of the Contractor's notice under CC Sub-Clause 24.4, either issue a Completion Certificate in the form specified in the Forms and Procedures section in the bidding documents, stating that the Facilities or that part thereof have reached Completion as at the date of the Contractor's notice under CC Sub-Clause 24.4, or notify the Contractor in writing of any defects and/or deficiencies.

If the Project Manager notifies the Contractor of any defects and/or deficiencies, the Contractor shall then correct such defects and/or deficiencies, and shall repeat the procedure described in CC Sub-Clause 24.4.

If the Project Manager is satisfied that the Facilities or that part thereof have reached Completion, the Project Manager shall, within seven (7) days after receipt of the Contractor's repeated notice, issue a Completion Certificate stating that the Facilities or that part thereof have reached Completion as at the date

of the Contractor's repeated notice

If the Project Manager is not so satisfied, then it shall notify the Contractor in writing of any defects and/or deficiencies within seven (7) days after receipt of the Contractor's repeated notice, and the above procedure shall be repeated.

24.6 If the Project Manager fails to issue the Completion Certificate and fails to inform the Contractor of any defects and/or deficiencies within fourteen (14) days after receipt of the Contractor's notice under CC Sub-Clause 24.4 or within seven (7) days after receipt of the Contractor's repeated notice under CC Sub-Clause 24.5, or if the Employer makes use of the Facilities or part thereof, then the Facilities or that part thereof shall be deemed to have reached Completion as of the date of the Contractor's notice or repeated notice, or as of the Employer's use of the Facilities, as the case may be.

24.7 As soon as possible after Completion, the Contractor shall complete all outstanding minor items so that the Facilities are fully in accordance with the requirements of the Contract, failing which the Employer will undertake such completion and deduct the costs thereof from any monies owing to the Contractor.

25. Commissioning and Operational Acceptance

25.1 Commissioning

25.1.1 Commissioning of the Facilities or any part thereof shall be completed by the Contractor as per procedures detailed in Technical Specifications.

If any Plant and Equipment or any part of the Facilities fails during Commissioning, the Contractor shall either rectify (if fault is minor) or replace such Plant and Equipment or part of the Facilities.

25.1.2 The Employer shall unless otherwise specified in Technical Specifications supply the operating and maintenance personnel and all raw material, utilities, lubricants, chemicals, catalysts, facilities, service and other matters required for Commissioning.

25.1.3 Trial – Operation

25.1.3.1 Trial – Operation of the Facilities or any part thereof shall be commenced by the Contractor immediately after the Commissioning is completed pursuant to CC Sub-Clause 25.1.1

25.1.3.2 Trial – Operation of the Facilities or any part thereof shall be completed by the Contractor for the period specified in Technical Specification (or for a continuous period of 24 hours where such period is not specified in Technical Specification) and as per procedures detailed in Technical Specifications.

25.1.3.3 At any time after the events set out in CC Sub-Clause 25.1.3.2 have occurred, the Contractor may give a notice to the Project Manager requesting the issue of a Taking Over Certificate in the form provided in the Bidding Documents or in another form acceptable to the Employer in respect of the Facilities or the part thereof specified in such notice as on the date of such notice.

25.1.3.4 The Project Manager shall within twenty-one (21) days after receipt of the Contractor's notice, issue an Taking Over Certificate.

25.1.4 Taking Over

25.1.4.1 Upon successful Trial – Operation of the Facilities or any part thereof, pursuant to CC Sub-Clause 25.1.3, the Project Manager shall issue to the Contractor a Taking Over Certificate as a proof of the acceptance of the Facilities or any part thereof. Such certificate shall not relieve the Contractor of any of his obligations which otherwise survive, by the terms and conditions of Contract after issue of such certificate.

25.1.4.2 If within twenty one (21) days after receipt of the Contractor's notice, the Project Manager fails to issue the Taking Over Certificate or fails to inform the Contractor in writing of the justifiable reasons why the Project Manager has not issued the Taking Over Certificate, the Facilities or the relevant part thereof shall be deemed to have been Taken Over as at the date of the Contractor's said notice.

25.1.4.3 Upon Taking Over of the Facilities or any part thereof, the Employer shall be responsible for the care and custody of the Facilities or the relevant part thereof, together with the risk of loss or damage thereto, and shall thereafter take over the Facilities or the relevant part thereof.

25.2 Guarantee Test

25.2.1 The Guarantee Test (and repeats thereof) shall be conducted by the Contractor after successful trial-operation of the Facilities or the relevant part thereof to ascertain whether the Facilities or the relevant part can attain the Functional Guarantees specified in the Contract Documents. The Contractor's and Project Manager's advisory personnel shall attend the Guarantee Test. The Employer shall promptly provide the Contractor with such information as the Contractor may reasonably require in relation to the conduct and results of the Guarantee Test (and any repeats thereof).

25.2.2 If for reasons not attributable to the Contractor, the Guarantee Test of the Facilities or the relevant part thereof cannot be successfully completed within the period from the date of Completion specified in the CC or any other period agreed upon by the Employer and the Contractor, the Contractor shall be deemed to have fulfilled its obligations with respect to the Functional Guarantees, and CC Sub-Clauses 28.2 and 28.3 shall not apply.

The Guarantee Test of the Facilities shall be successfully completed within twenty-six weeks from the date of Completion.

25.2.3 Completion- Guarantee test- acceptance

In the event that the Contractor is unable to proceed with the Pre-commissioning of the Facilities pursuant to Sub-Clause 24.3, or with the Guarantee Test pursuant to Sub-Clause 25.2, for reasons attributable to the Employer either on account of non-availability of other facilities under the responsibilities of other contractor(s), or for reasons beyond the Employer's control, the provisions leading to "deemed" completion of activities such as Completion of the Facilities, pursuant to CC Sub-Clause 24.6, Operational Acceptance, pursuant to CC Sub-Clause 25.3.4, Contractor's obligations regarding Defect Liability Period, pursuant to CC Sub Clause 27.2, Functional Guarantee, pursuant to CC Clause 28, Care of Facilities, pursuant to CC Clause 32, and Suspension, pursuant to CC Sub-Clause 41.1, shall not apply. In this case, the following provisions shall apply.

25.2.3.1 When the Contractor is notified by the Project Manager that he will be unable to proceed with the activities and obligations pursuant to above Sub-Clause CC 25.2.3, the Contractor shall be entitled to the following:

- a) the Time of Completion shall be extended for the period of suspension without imposition of liquidated damages pursuant to CC Sub-Clause 26.2.
- b) payments due to the Contractor in accordance with the provisions specified in Appendix I (terms and Procedures of Payment) to the Contract Agreement, which would have not been payable in normal circumstances due to non-completion of the subject activities, shall be released to the Contractor against submission of a security in the form of a bank guarantee of equivalent amount acceptable to the Employer, and which shall become null and void when the Contractor will have complied with its obligations regarding these payments, subject to the provisions of Sub-Clause CC 25.2.3.2 below.
- c) the expenses toward the above security and extension of other securities under the Contract, of which validity need to be extended, shall be reimbursed to the Contractor by the Employer.
- d) the additional charges toward the care of the Facilities pursuant to CC Sub-Clause 32.1 shall be reimbursed to the Contractor by the Employer for the period between the notification mentioned above and the notification mentioned in Sub-Clause CC 25.2.3.3 below. The provisions of CC sub-Clause 33.2 shall apply to the Facilities during the same period.

25.2.3.2 In the event that the period of suspension under Sub-Clause CC 25.2.3 actually exceeds one hundred eighty (180) days, the Employer and the Contractor shall mutually agree to any additional compensation payable to the Contractor.

25.2.3.3 When the Contractor is notified by the Project Manager that the Facilities are ready for Pre-commissioning, the Contractor shall proceed without delay in performing all activities and obligations under the Contract.

25.3 Operational Acceptance

25.3.1 Subject to CC Sub-Clause 25.4 (Partial Acceptance) below, Operational Acceptance shall occur in respect of the Facilities or any part thereof when

- (a) the Guarantee Test has been successfully completed and the Functional Guarantees are met; or
 - (b) the Guarantee Test has not been successfully completed or has not been carried out for reasons not attributable to the Contractor within the period from the date of Completion specified in the CC or any other agreed upon period as specified in CC Sub-Clause 25.2.2 above but successful completion of the facilities has been achieved; or
 - (c) the Contractor has paid the liquidated damages specified in CC Sub Clause 28.3 hereof; and
 - (c) any minor items mentioned in CC Sub-Clause 24.7 hereof relevant to the Facilities or that part thereof have been completed.
 - (e) as built drawings, and operating and maintenance manuals and CD's etc. as per Technical Specifications of the Bidding Documents are furnished.
- 25.3.2** At any time after any of the events set out in CC Sub-Clause 25.3.1 have occurred, the Contractor may give a notice to the Project Manager requesting the issue of an Operational Acceptance Certificate in the form provided in the Bidding Documents or in another form acceptable to the Employer in respect of the Facilities or the part thereof specified in such notice as at the date of such notice.
- 25.3.3** The Project Manager shall, after consultation with the Employer, and within twenty-one (21) days after receipt of the Contractor's notice, issue an Operational Acceptance Certificate.
- 25.3.4** If within twenty one (21) days after receipt of the Contractor's notice, the Project Manager fails to issue the Operational Acceptance Certificate or fails to inform the Contractor in writing of the justifiable reasons why the Project Manager has not issued the Operational Acceptance Certificate, the Facilities or the relevant part thereof shall be deemed to have been accepted as at the date of the Contractor's said notice.
- 25.4 Partial Acceptance**
- 25.4.1** If the Contract specifies that Completion and Commissioning shall be carried out in respect of parts of the Facilities, the provisions relating to Completion and Commissioning including the Guarantee Test shall apply to each such part of the Facilities individually, and the Operational Acceptance Certificate shall be issued accordingly for each such part of the Facilities.
- 25.4.2** If a part of the Facilities comprises facilities such as buildings, for which no Commissioning or Guarantee Test is required, then the Project Manager shall issue the Operational Acceptance Certificate for such facility when it attains Completion, provided that the Contractor shall thereafter complete any outstanding minor items that are listed in the Operational Acceptance Certificate.

F. Guarantees and Liabilities

26. Completion Time Guarantee

- 26.1** The Contractor guarantees that it shall attain Completion of the Facilities (or a part for which a separate time for completion is specified in the CC) within the Time for Completion specified in the CC pursuant to CC Sub-Clause 8.2, or within such extended time to which the Contractor shall be entitled under CC Clause 40 (Extension of Time for Completion) hereof.
- 26.2** If the Contractor fails to comply with the Time for Completion in accordance with Clause CC 26 for the whole of the facilities, (or a part for which a separate time for completion is agreed) then the Contractor shall pay to the Employer a sum equivalent to 0.05% (zero point zero five percent) of the Contract Price for the whole of the facilities, (or a part for which a separate time for completion is agreed) as liquidated damages for such default and not as a penalty, without prejudice to the Employer's other remedies under the Contract, for each day which shall elapse between the relevant Time for Completion pursuant to Clause 26.1 above and the date stated in **Taking Over Certificate** of the whole of the Works (or a part for which a separate time for completion is agreed) subject to the limit of five percent (5%) of Contract Price for the whole of the facilities, (or a part for which a separate time for completion is agreed).

The parties agree that the sum specified above is not a penalty but a genuine pre-estimate of the loss/damage which will be suffered by the Employer for default on the part of the Contractor and said amount will be payable without proof of actual loss or damage caused by such default.

The Employer may, without prejudice to any other method of recovery, deduct the amount of such damages from any monies due or to become due to the Contractor. The payment or deduction of such damages shall not relieve the Contractor from his obligation to complete the Works, or from any other of his obligations and liabilities under the Contract.

Note:-If the supply of any equipment or execution of any work does not affect the Taking Over of the whole of the Works (or a part for which a separate time for completion is agreed or), then the Liquidated Damages (LD) towards such delayed supply or work shall be levied in proportion to their Cost with maximum limit of 05% of their Cost.

26.3 No bonus will be given for earlier Completion of the Facilities or part thereof.

27. Defect Liability

27.1 The Contractor warrants that the Facilities or any part thereof shall be free from defects in the design, engineering, materials and workmanship of the Plant and Equipment supplied and of the work executed.

27.2 The Defect Liability Period shall 60 months for major equipment such as Gas Insulated Switchgear (GIS) bay including Gas insulated bus duct (GIB), Power/Auto Transformers, Reactors, all AIS bay equipment, Mono Pole/Lattice towers and Power cables including its end terminations & straight through joints (of 400KV, 220KV, 66KV, 33KV levels) and 18 months for all other items from the date of Commissioning/Completion of the facilities.

If during the Defect Liability Period any defect should be found in the design, engineering, materials and workmanship of the Plant and Equipment supplied or of the work executed by the Contractor, the Contractor shall promptly in consultation and agreement with the Employer regarding appropriate remedying of the defects, and at its cost, repair, replace or otherwise make good (as the Contractor shall, at its discretion, determine) such defect as well as any damage to the Facilities caused by such defect.

27.3 The Contractor's obligations under this CC Clause 27 shall not apply to

(a) any materials that are supplied by the Employer under CC Sub-Clause 21.2 (Employer-Supplied Plant, Equipment and Materials), are normally consumed in operation, or have a normal life shorter than the Defect Liability Period stated herein.

(b) any designs, specifications or other data designed, supplied or specified by or on behalf of the Employer or any matters for which the Contractor has disclaimed responsibility herein.

(c) any other materials supplied or any other work executed by or on behalf of the Employer, except for the work executed by the Employer under CC Sub-Clause 27.7.

27.4 The Employer shall give the Contractor a notice stating the nature of any such defect together with all available evidence thereof, promptly following the discovery thereof. The Employer shall afford all reasonable opportunity for the Contractor to inspect any such defect.

27.5 The Employer shall afford the Contractor all necessary access to the Facilities and the Site to enable the Contractor to perform its obligations under this CC Clause 27. The Contractor may, with the consent of the Employer, remove from the Site any Plant and Equipment or any part of the Facilities that are defective if the nature of the defect, and/or any damage to the Facilities caused by the defect, is such that repairs cannot be expeditiously carried out at the Site.

27.6 If the repair, replacement or making good is of such a character that it may affect the efficiency of the Facilities or any part thereof, the Employer may give to the Contractor a notice requiring that tests of the defective part of the Facilities shall be made by the Contractor immediately upon completion of such remedial work, whereupon the Contractor shall carry out such tests.

If such part fails the tests, the Contractor shall carry out further repair, replacement or making good (as the case may be) until that part of the Facilities passes such tests.

The tests in character shall in any case be not less than what has already been agreed by the employer and the Contractor for the original equipment/part of the Facilities.

27.7 If the Contractor fails to commence the work necessary to remedy such defect or any damage to the Facilities caused by such defect within a reasonable time (which shall in no event be considered to be less

than fifteen (15) days), the Employer may, following notice to the Contractor, proceed to do such work, and the reasonable costs incurred by the Employer in connection therewith shall be paid to the Employer by the Contractor or may be deducted by the Employer from any amount due the Contractor or claimed under the Performance Security

- 27.8** If the facilities or any part thereof cannot be used by reason of such defect and/or making good of such defect, the Defect Liability Period of the Facilities or such part, as the case may be, shall be extended by a period equal to the period during which the Facilities or such part cannot be used by the Employer because of any of the aforesaid reasons.

Upon correction of the defects in the Facilities or any part thereof by repair/ replacement, such repair/replacement shall have the Defect Liability Period extended by a period of twenty-four (24) months for major equipment as mentioned at 27.2 above and 6 months for all other items from the time such replacement/repair of the facilities or any part thereof, subject to the condition that the overall period of Defect Liability shall not be less than Sixty (60) months and more than Eighty-four (84) months for major equipment as mentioned at 27.2 above and shall not be less than eighteen (18) months and more than twenty-four (24) months for all other items from the date of issuance of respective Commissioning/Completion.

- 27.8.1** At the end of Defect Liability Period, the Contractor's liability ceases except for latent defects. The Contractor's liability for latent defects warranty shall be limited to period of five (5) years from the end of Defect Liability Period. For the purpose of this clause, the latent defects shall be the defects inherently lying within the material or arising out of design deficiency, which do not manifest themselves during the Defect Liability Period defined in this CC Clause 27, but later.

- 27.9** Except as provided in CC Clauses 27 and 33 (Loss of or Damage to Property/ Accident or Injury to Workers/Indemnification), the Contractor shall be under no liability whatsoever and howsoever arising, and whether under the Contract or at law, in respect of defects in the Facilities or any part thereof, the Plant and Equipment, design or engineering or work executed that appear after operational acceptance or any part thereof, except where such defects are the result of the gross negligence, fraud, criminal or willful action of the Contractor.

- 27.10** In addition, the Contractor shall also provide an extended warranty for any such component of the Facilities and during the period of time as may be specified in the CC. Such obligation shall be in addition to the defect liability specified under CC Sub-Clause 27.2.

28. Functional Guarantee

- 28.1** The Contractor guarantees that during the Guarantee Test, the Facilities and all parts thereof shall attain the Functional Guarantees specified in Appendix 8 (Functional Guarantees) to the Contract Agreement, subject to and upon the conditions therein specified.

- 28.2** If, for reasons attributable to the Contractor, the minimum level of the Functional Guarantees specified in Appendix 8 (Functional Guarantees) to the Contract Agreement are not met either in whole or in part, the Contractor shall at its cost and expense make such changes, modifications and/or additions to the Plant or any part thereof as may be necessary to meet at least the minimum level of such Guarantees. The Contractor shall notify the Employer upon completion of the necessary changes, modifications and/or additions, and shall request the Employer to repeat the Guarantee Test until the minimum level of the Guarantees has been met. If the Contractor eventually fails to meet the minimum level of Functional Guarantees, the Employer may consider termination of the Contract pursuant to CC Sub-Clause 42.2 and recover the payments already made to the Contractor.

- 28.3** If, for reasons attributable to the Contractor, the Functional Guarantees specified in Appendix 8 (Functional Guarantees) to the Contract Agreement are not attained either in whole or in part, but the minimum level of the Functional Guarantees specified in Appendix 8 (Functional Guarantees) to the Contract Agreement is met, the Contractor shall, at the Employer's option, either

- (a) make such changes, modifications and/or additions to the Facilities or any part thereof that are necessary to attain the Functional Guarantees at its cost and expense within a mutually agreed time and shall request the Employer to repeat the Guarantee Test, or

- (b) pay liquidated damages to the Employer in respect of the failure to meet the Functional Guarantees in accordance with the provisions in Appendix 8 (Functional Guarantees) to the Contract Agreement.

28.4 In case the Employer exercises its option to accept the equipment after levy of liquidated damages, the payment of liquidated damages under CC sub clause 28.3, upto the limitation of liability specified in the Appendix-8 (Functional Guarantees) to the Contract Agreement, shall completely satisfy the Contractor's guarantees under CC Sub clause 28.3, and the Contractor shall have not further liability whatsoever to the Employer in respect thereof. Upon the payment of such liquidated damages by the Contractor, the Project Manager shall issue the Operational Acceptance Certificate for the Facilities or any part thereof in respect of which the liquidated damages have been so paid.

28.5 Functional Guarantees, Liquidated Damages for Non-Performance

28.5.1 The bidder shall guarantee that the equipment offered shall meet the rating and performance requirements stipulated for various equipment covered in this specification. The bidder shall also furnish a declaration in the manner prescribed and included in the relevant schedule of Bid Form & Price Schedules for guarantees, which shall attract levy of liquidated damages for non-performance.

28.5.2 If the guarantees are not established at factory tests in case of power transformer, ~~shunt reactor~~ & auxiliary transformer as defined in the relevant technical specifications then the Employer at his discretion may reject or accept the equipment in line with relevant technical specifications.

29. Patent Indemnity

29.1 The Contractor shall, subject to the Employer's compliance with CC Sub Clause 29.2, indemnify and hold harmless the Employer and its employees and officers from and against any and all suits, actions or administrative proceedings, claims, demands, losses, damages, costs, and expenses of whatsoever nature, including attorney's fees and expenses, which the Employer may suffer as a result of any infringement or alleged infringement of any patent, utility model, registered design, trademark, copyright or other intellectual property right registered or otherwise existing at the date of the Contract by reason of: (a) the installation of the Facilities by the Contractor or the use of the Facilities in the country where the Site is located; and (b) the sale of the products produced by the Facilities in any country.

Such indemnity shall not cover any use of the Facilities or any part thereof other than for the purpose indicated by or to be reasonably inferred from the Contract, any infringement resulting from the use of the Facilities or any part thereof, or any products produced thereby in association or combination with any other equipment, plant or materials not supplied by the Contractor, pursuant to the Contract Agreement.

29.2 If any proceedings are brought or any claim is made against the Employer arising out of the matters referred to in CC Sub-Clause 29.1, the Employer shall promptly give the Contractor a notice thereof, and the Contractor may at its own expense and in the Employer's name conduct such proceedings or claim and any negotiations for the settlement of any such proceedings or claim.

If the Contractor fails to notify the Employer within twenty-eight (28) days after receipt of such notice that it intends to conduct any such proceedings or claim, then the Employer shall be free to conduct the same on its own behalf. Unless the Contractor has so failed to notify the Employer within the twenty-eight (28) day period, the Employer shall make no admission that may be prejudicial to the defense of any such proceedings or claim.

The Employer shall, at the Contractor's request, afford all available assistance to the Contractor in conducting such proceedings or claim, and shall be reimbursed by the Contractor for all reasonable expenses incurred in so doing.

29.3 The Employer shall indemnify and hold harmless the Contractor and its employees, officers and Subcontractors from and against any and all suits, actions or administrative proceedings, claims, demands, losses, damages, costs, and expenses of whatsoever nature, including attorney's fees and expenses, which the Contractor may suffer as a result of any infringement or alleged infringement of any patent, utility model, registered design, trademark, copyright or other intellectual property right registered or otherwise existing at the date of the Contract arising out of or in connection with any design, data, drawing, specification, or other documents or materials provided or designed by or on behalf of the Employer.

30. Limitation of Liability

30.1 Except in cases of criminal negligence or willful misconduct,

- (a) the Contractor shall not be liable to the Employer, whether in contract, tort, or otherwise, for any indirect or consequential loss or damage, loss of use, loss of production, or loss of profits or interest costs, provided that this exclusion shall not apply to any obligation of the Contractor to pay liquidated damages to the Employer and
- (b) the aggregate liability of the Contractor to the Employer, whether under the Contract, in tort or otherwise, shall not exceed the total Contract Price, provided that this limitation shall not apply to the cost of repairing or replacing defective equipment, or to any obligation of the Contractor to indemnify the Employer with respect to patent infringement.

G. Risk Distribution

31. Transfer of Ownership

31.1 Ownership of the plant and equipment (including spare parts) to be imported into the country where the site is located shall be transferred to the Employer upon loading on to the mode of transport to be used to convey the Plant and Equipment from the country of origin to that country and upon endorsement of the dispatch documents in favour of Employer.

31.2 Ownership of the Plant and Equipment (including spare parts) procured in the country where the site is located, shall be transferred to the Employer upon loading on to the mode of transport to be used to carry the Plant and Equipment from the works to the site and upon endorsement of the dispatch documents in favour of Employer.

31.3 Ownership of the Contractor's Equipment used by the Contractor and its Subcontractors in connection with the Contract shall remain with the Contractor or its Subcontractors.

31.4 Ownership of any Plant and Equipment in excess of the requirements for the Facilities shall revert to the Contractor upon Completion of the Facilities or at such earlier time when the Employer and the Contractor agree that the Plant and Equipment in question are no longer required for the Facilities provided quantity of any Plant and Equipment specifically stipulated in the Contract shall be the property of the Employer whether or not incorporated in the Facilities.

31.5 Notwithstanding the transfer of ownership of the Plant and Equipment, the responsibility for care and custody thereof together with the risk of loss or damage thereto shall remain with the Contractor pursuant to CC Clause 32 (Care of Facilities) hereof until Completion of the Facilities or the part thereof in which such Plant and Equipment are incorporated.

32. Care of Facilities

32.1 The Contractor shall be responsible for the care and custody of the Facilities or any part thereof until the date of Completion of the Facilities pursuant to CC Clause 24 (Completion of the Facilities) or, where the Contract provides for Completion of the Facilities in parts, until the date of Completion of the relevant part, and shall make good at its own cost any loss or damage that may occur to the Facilities or the relevant part thereof from any cause whatsoever during such period. The Contractor shall also be responsible for any loss or damage to the Facilities caused by the Contractor or its Subcontractors in the course of any work carried out, pursuant to CC Clause 27 (Defect Liability). Notwithstanding the foregoing, the Contractor shall not be liable for any loss or damage to the Facilities or that part thereof caused by reason of any of the matters specified or referred to in paragraphs (a), (b) and (c) of CC Sub Clauses 32.2 and 38.1.

32.2 If any loss or damage occurs to the Facilities or any part thereof or to the Contractor's temporary facilities by reason of

- (a) (insofar as they relate to the country where the Site is located) nuclear reaction, nuclear radiation, radioactive contamination, pressure wave caused by aircraft or other aerial objects, or any other occurrences that an experienced contractor could not reasonably foresee, or if reasonably foreseeable could not reasonably make provision for or insure against, insofar as such risks are not normally insurable on the insurance market and are mentioned in the general exclusions of the

policy of insurance, including War Risks and Political Risks, taken out under CC Clause 34 (Insurance) hereof

- (b) any use or occupation by the Employer or any third party (other than a Subcontractor) authorized by the Employer of any part of the Facilities
- (c) any use of or reliance upon any design, data or specification provided or designated by or on behalf of the Employer, or any such matter for which the Contractor has disclaimed responsibility herein, The Employer shall pay to the Contractor all sums payable in respect of the Facilities executed, notwithstanding that the same be lost, destroyed or damaged, and will pay to the Contractor the replacement value of all temporary facilities and all parts thereof lost, destroyed or damaged. If the Employer requests the Contractor in writing to make good any loss or damage to the Facilities thereby occasioned, the Contractor shall make good the same at the cost of the Employer in accordance with CC Clause 39 (Change in the Facilities). If the Employer does not request the Contractor in writing to make good any loss or damage to the Facilities thereby occasioned, the Employer shall either request a change in accordance with CC Clause 39 (Change in the Facilities), excluding the performance of that part of the Facilities thereby lost, destroyed or damaged, or, where the loss or damage affects a substantial part of the Facilities, the Employer shall terminate the Contract pursuant to CC Sub-Clause 42.1 (Termination for Employer's Convenience) hereof, except that the Contractor shall have no entitlement to profit under paragraph (e) of CC Sub Clause 42.1.3 in respect of any unexecuted Facilities as at the date of termination.

32.3 The Contractor shall be liable for any loss of or damage to any Contractor's Equipment, or any other property of the Contractor used or intended to be used for purposes of the Facilities, except (i) as mentioned in CC Sub-Clause 32.2 (with respect to the Contractor's temporary facilities), and (ii) where such loss or damage arises by reason of any of the matters specified in CC Sub-Clauses 32.2 (b) and (c) and 38.1.

32.4 With respect to any loss or damage caused to the Facilities or any part thereof or to the Contractor's Equipment by reason of any of the matters specified in CC Sub-Clause 38.1, the provisions of CC Sub-Clause 38.3 shall apply.

33. Loss of or Damage to Property; Accident or Injury to Workers; Indemnification

33.1 Subject to CC Sub-Clause 33.3, the Contractor shall indemnify and hold harmless the Employer and its employees and officers from and against any and all suits, actions or administrative proceedings, claims, demands, losses, damages, costs, and expenses of whatsoever nature, including attorney's fees and expenses, in respect of the death or injury of any person or loss of or damage to any property (other than the Facilities whether accepted or not), arising in connection with the supply and installation of the Facilities and by reason of the negligence of the Contractor or its Subcontractors, or their employees, officers or agents, except any injury, death or property damage caused by the negligence of the Employer, its contractors, employees, officers or agents.

33.2 If any proceedings are brought or any claim is made against the Employer that might subject the Contractor to liability under CC Sub-Clause 33.1, the Employer shall promptly give the Contractor a notice thereof and the Contractor may at its own expense and in the Employer's name conduct such proceedings or claim and any negotiations for the settlement of any such proceedings or claim.

If the Contractor fails to notify the Employer within twenty-eight (28) days after receipt of such notice that it intends to conduct any such proceedings or claim, then the Employer shall be free to conduct the same on its own behalf. Unless the Contractor has so failed to notify the Employer within the twenty-eight (28) day period, the Employer shall make no admission that may be prejudicial to the defense of any such proceedings or claim.

The Employer shall, at the Contractor's request, afford all available assistance to the Contractor in conducting such proceedings or claim, and shall be reimbursed by the Contractor for all reasonable expenses incurred in so doing.

33.3 The Employer shall indemnify and hold harmless the Contractor and its employees, officers and Subcontractors from any liability for loss of or damage to property of the Employer, other than the Facilities not yet taken over, that is caused by fire, explosion or any other perils, in excess of the amount recoverable from insurances procured under CC Clause 34 (Insurance), provided that such fire, explosion or other perils were not caused by any act or failure of the Contractor.

33.4 The party entitled to the benefit of an indemnity under this CC Clause 33 shall take all reasonable measures to mitigate any loss or damage which has occurred. If the party fails to take such measures, the other party's liabilities shall be correspondingly reduced.

34. Insurance

34.1 To the extent specified in Appendix 3 (Insurance Requirements) to the Contract Agreement, the Contractor shall at its expense take out and maintain in effect, or cause to be taken out and maintained in effect, during the performance of the Contract, the insurances set forth below in the sums and with the deductibles and other conditions specified in the said Appendix. The identity of the insurers and the form of the policies shall be subject to the approval of the Employer, who should not unreasonably withhold such approval. .

(a) Transit / Marine insurance: During supply of materials for Supply/ Supply portion of Contract

Covering loss or damage occurring while in transit from the manufacturer's or Contractor's or Subcontractor's works or stores until arrival at the Site, to the Plant and Equipment (including spare parts thereof) and to the Contractor's Equipment. Concerned supplier/Contractor shall take such policy and ensure its validity upto 90 days of receipt of Plant and Equipment (including spare parts thereof) at employer's store or store of the contractor's as the case may be. Evidence of such policy shall be furnished by contractor along with dispatch documents.

(b) Storage Cum Erection (SCE)/Installation Insurance: All Risks Coverage

Covering physical loss or damage to all the equipment, material and facilities being supplied, under the contract, from point of receipt at site including handling, storage, erection, testing etc till Completion of the Facilities, with an extended maintenance coverage for the Contractor's liability in respect of any loss or damage occurring during the Defect Liability Period while the Contractor is on the Site for the purpose of performing its obligations during the Defect Liability Period. Concerned Erector /Contractor shall take such policy.

(c) Materials/Plants/ Equipments supplied By Employer

Covering physical loss or damage to all the equipment, material and facilities being supplied for erection or use, under the contract, from point of receipt at site including handling, storage, erection, testing etc till Completion of the Facilities.

(d) Third Party Liability Insurance

Covering bodily injury or death suffered by third parties (including the Employer's personnel) and loss of or damage to property occurring in connection with the supply and installation of the Facilities.

(e) Automobile Liability Insurance

The contractor shall ensure that all the vehicles deployed by the contractor or its sub-contractors (whether or not owned by them) in connection with the supply and installation of the facilities in the project are duly insured as per RTA act. Further the contractor or its subcontractors may also take comprehensive policy (own damage plus third party liability) of each individual vehicles deployed in the project on their own discretion in their own name to protect their own interest.

(f) Workers' Compensation

In accordance with the statutory requirements applicable in any country where the Contract or any part thereof is executed.

(g) Contractor' plant and Machinery (CPM) insurance

The Employer (including without limitation any consultant, servant, agent or employee of the Employer) shall not in any circumstances be liable to the Contractor for any loss of or damage to any of the Contractor's Equipment or for any losses, liabilities, costs, claims, actions or demands which the Contractor may incur or which may be made against it as a result of or in connection with any such loss or damage. In this regard the vendor will submit an undertaking to DTL.

(h) Other Insurances

Such other insurances as may be specifically agreed upon by the parties hereto as listed in the said

Appendix 3.

- 34.2 All the insurance policies pertaining to Storage Cum Erection /Installation & all Risk Coverage except transit insurance shall be taken in the name of DTL unless otherwise specified. All such policy shall indicate DTL as beneficiary and DTL shall be named as co-insured under all other insurance policies taken out by the Contractor pursuant to CC Sub-Clause 34.1, except for the Third Party Liability, Workers' Compensation Insurance, and the Contractor's Subcontractors shall be named as co-insured under all insurance policies taken out by the Contractor pursuant to CC Sub-Clause 34.1 except for the Transit / Marine insurance During Transport, Workers' Compensation Insurance. All insurer's rights of subrogation against such co-insured for losses or claims arising out of the performance of the Contract shall be waived under such policies.
- 34.3 The Contractor shall, in accordance with the provisions of Appendix 3 (Insurance Requirements) to the Contract Agreement, deliver to the Employer certificates of insurance (or copies of the insurance policies) as evidence that the required policies are in full force and effect. The certificates shall provide that no less than twenty-one (21) days' notice shall be given to the Employer by insurers prior to cancellation or material modification of a policy
- 34.4 The Contractor shall ensure that, where applicable, its Subcontractor(s) shall take out and maintain in effect adequate insurance policies for their personnel and vehicles and for work executed by them under the Contract, unless such Subcontractors are covered by the policies taken out by the Contractor.
- 34.5 The Employer shall at its expense take out and maintain in effect during the performance of the Contract those insurances specified in Appendix 3 (Insurance Requirements) to the Contract Agreement, in the sums and with the deductibles and other conditions specified in the said Appendix. The Contractor and the Contractor's Subcontractors shall be named as co-insureds under all such policies. All insurers' rights of subrogation against such co-insureds for losses or claims arising out of the performance of the Contract shall be waived under such policies. The Employer shall deliver to the Contractor satisfactory evidence that the required insurances are in full force and effect. The policies shall provide that not less than twenty-one (21) days' notice shall be given to the Contractor by all insurers prior to any cancellation or material modification of the policies. If so requested by the Contractor, the Employer shall provide copies of the policies taken out by the Employer under this CC Sub-Clause 34.5.
- 34.6 If the Contractor fails to take out and/or maintain in effect the insurances referred to in CC Sub-Clause 34.1, the Employer may take out and maintain in effect any such insurances and may from time to time deduct from any amount due to the Contractor under the Contract any premium that the Employer shall have paid to the insurer, or may otherwise recover such amount as a debt due from the Contractor. If the Employer fails to take out and/or maintain in effect the insurances referred to in CC 34.5, the Contractor may take out and maintain in effect any such insurances and may from time to time deduct from any amount due to the Employer under the Contract any premium that the Contractor shall have paid to the insurer, or may otherwise recover such amount as a debt due from the Employer. If the Contractor fails to or is unable to take out and maintain in effect any such insurances, the Contractor shall nevertheless have no liability or responsibility towards the Employer, and the Contractor shall have full recourse against the Employer for any and all liabilities of the Employer herein. .
- 34.7 Unless otherwise provided in the Contract, the Contractor shall prepare, lodge, pursue and conduct and settle all and any claims made under the policies effected by it pursuant to this CC Clause 34, with the insurance company in case of theft, pilferage, fire etc under information to employer and the monies payable by any insurers under all the insurance except Third Party Liability Insurance, Workers' Compensation Insurance, shall be paid to the joint account of the Employer and the Contractor and such amounts paid shall be apportioned between the Employer and the Contractor in accordance with the respective responsibilities under the Contract. The Employer shall give to the Contractor all such reasonable assistance as may be required by the Contractor. With respect to insurance claims in which the Employer's interest is involved, the Contractor shall not give any release or make any compromise with the insurer without the prior written consent of the Employer. With respect to insurance claims in which the Contractor's interest is involved, the Employer shall not give any release or make any compromise with the insurer without the prior written consent of the Contractor. The Contractor shall replace the lost/ damaged plants/materials/ equipments/ works/ foundations or Employer supplied items promptly irrespective of the settlement of claims by the underwriter.

35. Unforeseen Conditions

- 35.1 If, during the execution of the Contract, the Contractor shall encounter on the Site any physical conditions (other than climatic conditions) or artificial obstructions that could not have been reasonably foreseen prior to the date of the Contract Agreement by an experienced contractor on the basis of reasonable examination

of the data relating to the Facilities (including any data as to boring tests) provided by the Employer, and on the basis of information that it could have obtained from a visual inspection of the Site (if access thereto was available) or other data readily available to it relating to the Facilities, and if the Contractor determines that it will in consequence of such conditions or obstructions incur additional cost and expense or require additional time to perform its obligations under the Contract that would not have been required if such physical conditions or artificial obstructions had not been encountered, the Contractor shall promptly, and before performing additional work or using additional Plant and Equipment or Contractor's Equipment, notify the Project Manager in writing of

- (a) the physical conditions or artificial obstructions on the Site that could not have been reasonably foreseen
- (b) the additional work and/or Plant and Equipment and/ or Contractor's Equipment required, including the steps which the Contractor will or proposes to take to overcome such conditions or obstructions
- (c) the extent of the anticipated delay
- (d) the additional cost and expense that the Contractor is likely to incur.

On receiving any notice from the Contractor under this CC Sub-Clause 35.1, the Project Manager shall promptly consult with the Employer and Contractor and decide upon the actions to be taken to overcome the physical conditions or artificial obstructions encountered. Following such consultations, the Project Manager shall instruct the Contractor, with a copy to the Employer, of the actions to be taken.

35.2 Any reasonable additional cost and expense incurred by the Contractor in following the instructions from the Project Manager to overcome such physical conditions or artificial obstructions referred to in CC Sub-Clause 35.1 shall be paid by the Employer to the Contractor as an addition to the Contract Price.

35.3 If the Contractor is delayed or impeded in the performance of the Contract because of any such physical conditions or artificial obstructions referred to in CC Sub-Clause 35.1, the Time for Completion shall be extended in accordance with CC Clause 40 (Extension of Time for Completion).

36. Change in Laws and Regulations

36.1 If, after the date twenty-eight (28) days prior to the date of Bid submission, in the country where the Site is located, any law, regulation, ordinance, order or by-law having the force of law is enacted, promulgated, abrogated or changed (which shall be deemed to include any change in interpretation or application by the competent authorities) that subsequently affects the costs and expenses of the Contractor and/or the Time for Completion, the Contract Price shall be correspondingly increased or decreased, and/or the Time for Completion shall be reasonably adjusted to the extent that the Contractor has thereby been affected in the performance of any of its obligations under the Contract. However, these adjustments would be restricted to direct transactions between the Employer and the Contractor and not on procurement of raw materials, intermediary components etc. by the Contractor. Further, no adjustment of the Contract Price shall be made on account of variation in deemed export benefits. Notwithstanding the foregoing, such additional or reduced costs shall not be separately paid or credited if the same has already been accounted for in the price adjustment provisions where applicable, in accordance with the Appendix 2 to the Contract Agreement.

37. Force Majeure

37.1 "Force Majeure" shall mean any event beyond the reasonable control of the Employer or of the Contractor, as the case may be, and which is unavoidable notwithstanding the reasonable care of the party affected, and shall include, without limitation, the following:

- (a) war, hostilities or warlike operations (whether a state of war be declared or not), invasion, act of foreign enemy and civil war
- (b) rebellion, revolution, insurrection, mutiny, usurpation of civil or military government, conspiracy, riot, civil commotion and terrorist acts
- (c) confiscation, nationalization, mobilization, commandeering or requisition by or under the order of any government or de jure or de facto authority or ruler or any other act or failure to act of any local state or national government authority
- (d) strike, sabotage, lockout, embargo, import restriction, port congestion, lack of usual means of public

transportation and communication, industrial dispute, shipwreck, shortage or restriction of power supply, epidemics, quarantine and plague

(e) earthquake, landslide, volcanic activity, fire, flood or inundation, tidal wave, typhoon or cyclone, hurricane, storm, lightning, or other inclement weather condition, nuclear and pressure waves or other natural or physical disaster

(f) shortage of labour, materials or utilities where caused by circumstances that are themselves Force Majeure.

37.2 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 fourteen (14) days after the occurrence of such event.

37.3 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 in accordance with CC Clause 40 (Extension of Time for Completion).

37.4 The party or parties affected by the event of Force Majeure shall use reasonable efforts to mitigate the effect thereof upon its or their performance of the Contract and to fulfill its or their obligations under the Contract, but without prejudice to either party's right to terminate the Contract under CC Sub Clauses 37.6 and 38.5.

37.5 No delay or nonperformance by either party hereto caused by the occurrence of any event of Force Majeure shall

(a) constitute a default or breach of the Contract

(b) (subject to CC Sub-Clauses 32.2, 38.3 and 38.4) give rise to any claim for damages or additional cost or expense occasioned thereby if and to the extent that such delay or nonperformance is caused by the occurrence of an event of Force Majeure.

37.6. If the performance of the Contract is substantially prevented, hindered or delayed for a single period of more than sixty (60) days or an aggregate period of more than one hundred and twenty (120) days on account of one or more events of Force Majeure during the currency of the Contract, the parties will attempt to develop a mutually satisfactory solution, failing which the dispute will be resolved in accordance with CC Clause.6.

37.7. Notwithstanding CC Sub-Clause 37.5, Force Majeure shall not apply to any obligation of the Employer to make payments to the Contractor herein.

38. War Risks

38.1 "War Risks" shall mean any event specified in paragraphs (a) and (b) of CC Sub-Clause 37.1 and any explosion or impact of any mine, bomb, shell, grenade or other projectile, missile, munitions or explosive of war, occurring or existing in or near the country (or countries) where the Site is located.

38.2 Notwithstanding anything contained in the Contract, the Contractor shall have no liability whatsoever for or with respect to

(a) destruction of or damage to Facilities, Plant & Equipment, or any part thereof

(b) destruction of or damage to property of the Employer or any third party

(c) injury or loss of life if such destruction, damage, injury or loss of life is caused by any War Risks, and the Employer shall indemnify and hold the Contractor harmless from and against any and all claims, liabilities, actions, lawsuits, damages, costs, charges or expenses arising in consequence of or in connection with the same.

38.3 If the Facilities or any Plant and Equipment or Contractor's Equipment or any other property of the Contractor used or intended to be used for the purposes of the Facilities shall sustain destruction or damage by reason of any War Risks, the Employer shall pay the Contractor for

(a) any part of the Facilities or the Plant and Equipment so destroyed or damaged (to the extent not already paid for by the Employer)

(b) replacing or making good any Contractor's Equipment or other property of the Contractor so destroyed or damaged,

(c) replacing or making good any such destruction or damage to the Facilities or the Plant and Equipment or any part thereof so far as may be required by the Employer, and as may be necessary for completion of the facilities.

If the Employer does not require the Contractor to replace or make good any such destruction or damage to the Facilities, the Employer shall either request a change in accordance with CC Clause 39 (Change in the Facilities), excluding the performance of that part of the Facilities thereby destroyed or damaged or, where the loss, destruction or damage affects a substantial part of the Facilities, shall terminate the Contract, pursuant to CC Sub-Clause 42.1 (Termination for Employer's Convenience).

38.4 Notwithstanding anything contained in the Contract, the Employer shall pay the Contractor for any increased costs or incidentals to the execution of the Contract that are in any way attributable to, consequent on, resulting from, or in any way connected with any War Risks, provided that the Contractor shall as soon as practicable notify the Employer in writing of any such increased cost.

38.5 If during the performance of the Contract any war risks shall occur that financially or otherwise materially affect the execution of the Contract by the Contractor with due and proper consideration given to the safety of its and its Subcontractors personal engaged in the work on the facilities, provided, however, that if the execution of the work on the facilities becomes impossible or is substantially prevented for a single period of more than sixty (60) days or an aggregate period of more the one hundred and twenty (120) days on account of any war Risks, the parties will attempt to develop a mutually satisfactory solution, failing which the dispatch will be resolved in accordance with CC Clause.6.

38.6 In the event of termination pursuant to CC Sub Clause. 38.3, the rights and obligation of the employer and the Contractor shall be as specified in CC Sub- Clause 42.1.2 and 42.1.3, except that the Contractor shall have no entitlement to profit under paragraph (e) of CC Sub Clause 42.13 in respect of any unexecuted facilities as of the date of termination.

H. Change in Contract Elements

39. Change in the Facilities

39.1 Introducing a Change

39.1.1 Subject to CC Sub-Clauses 39.2.5 and 39.2.7, the Employer shall have the right to propose, and subsequently require, that the Project Manager order the Contractor from time to time during the performance of the Contract to make any change, modification, addition or deletion to, in or from the Facilities (hereinafter called "Change"), provided that such Change falls within the general scope of the Facilities and does not constitute unrelated work and that it is technically practicable, taking into account both the state of advancement of the Facilities and the technical compatibility of the Change envisaged with the nature of the Facilities as specified in the Contract.

39.1.2 The Contractor may from time to time during its performance of the Contract propose to the Employer (with a copy to the Project Manager) any Change that the Contractor considers necessary or desirable to improve the quality, efficiency or safety of the Facilities. The Employer may at its discretion approve or reject any Change proposed by the Contractor, provided that the Employer shall approve any Change proposed by the Contractor to ensure the safety of the Facilities.

39.1.3 Notwithstanding CC Sub-Clauses 39.1.1 and 39.1.2, no change made necessary because of any default of the Contractor in the performance of its obligations under the Contract shall be deemed to be a Change, and such change shall not result in any adjustment of the Contract Price or the Time for Completion.

39.1.4 The procedure on how to proceed with and execute Changes is specified in CC Sub-Clauses 39.2 and 39.3, and further details and sample forms are provided in the Sample Forms and Procedures section in the bidding documents.

39.2 Changes Originating from Employer

- 39.2.1** If the Employer proposes a Change pursuant to CC Sub-Clause 39.1.1, it shall send to the Contractor a "Request for Change Proposal," requiring the Contractor to prepare and furnish to the Project Manager as soon as reasonably practicable a "Change Proposal," which shall include the following:
- (a) brief description of the Change
 - (b) effect on the Time for Completion
 - (c) estimated cost of the Change
 - (d) effect on Functional Guarantees (if any)
 - (e) effect on any other provisions of the Contract.
- 39.2.2** Prior to preparing and submitting the "Change Proposal," the Contractor shall submit to the Project Manager an "Estimate for Change Proposal," which shall be an estimate of the cost of preparing and submitting the Change Proposal. Upon receipt of the Contractor's Estimate for Change Proposal, the Employer shall do one of the following:
- (a) accept the Contractor's estimate with instructions to the Contractor to proceed with the preparation of the Change Proposal
 - (b) advise the Contractor of any part of its Estimate for Change Proposal that is unacceptable and request the Contractor to review its estimate
 - (c) advise the Contractor that the Employer does not intend to proceed with the Change.
- 39.2.3** Upon receipt of the Employer's instruction to proceed under CC Sub-Clause 39.2.2 (a), the Contractor shall, with proper expedition, proceed with the preparation of the Change Proposal, in accordance with CC Sub-Clause 39.2.1.
- 39.2.4** The pricing of any Change shall, as far as practicable, be calculated in accordance with the rates and prices included in the Contract. If such rates and prices are inequitable, the parties thereto shall agree on specific rates for the valuation of the Change.
- 39.2.5** If before or during the preparation of the change proposal it becomes apparent that the aggregate effect of compliance therewith and with all other change orders that have already become binding upon the contractor under this CC Clause 39 would be to increase or decrease the contractor price as originally set forth in Article- 2 (Contract price and Terms of payment) of the contract agreement by more than fifteen (15) percent, the Contractor may give a written notice of objection there to prior to furnish the change proposal as aforesaid. If the employer accept the contractors objection, the employer and the contractor shall agree on specific rates for valuation of the change.
- The Contractor failure to so object shall neither affect its right to object to any subsequent requested change or change orders herein, nor affect its right to taken into account, when making such subsequent objection, the percentage increase or decrease in the contract price that any change not objected to by the contractor represents.
- 39.2.6** If rates and prices of any change are not available in the contract, the parties thereto shall agree on specific rates for the valuation of the change. Upon receipt of the change proposal, the employer and the contractor shall mutually agree upon all matters therein contained. With in fourteen (14) days after such agreement, the employer shall, if it intends to proceed with change, issue the contractor with a change order.
- If the employer is unable to reach a decision with in fourteen (14) days, it shall notify the contractor with details of when the contractor can expect a decision.
- If the employer decides not to proceed with the change for whatever reason, it shall, with in the said period of fourteen (14) days, notify the contractor accordingly. Under such circumstances, the contractor shall be entitled to reimbursement of all costs reasonably incurred by it in the preparation of the change proposal, provided that these do not exceed the amount given by the Contractor in its estimate for change proposal submitted in accordance with CC Sub – Clause 39.2.2.
- 39.2.7** If the Employer and the Contractor cannot reach agreement on the price for the Change, an equitable adjustment to the Time for Completion, or any other matters identified in the Change Proposal, the Employer may nevertheless instruct the Contractor to proceed with the Change by issue of a "Pending Agreement Change Order."

Upon receipt of a Pending Agreement Change Order, the Contractor shall immediately proceed with

effecting the Changes covered by such Order. The parties shall thereafter attempt to reach agreement on the outstanding issues under the Change Proposal.

If the parties cannot reach agreement within sixty (60) days from the date of issue of the Pending Agreement Change Order, then the matter may be taken up as per the CC Sub-Clause 6.2.

39.3 Changes Originating from Contractor

39.3.1 If the Contractor proposes a Change pursuant to CC Sub-Clause 39.1.2, the Contractor shall submit to the Project Manager a written "Application for Change Proposal," giving reasons for the proposed Change and including the information specified in CC Sub-Clause 39.2.1.

Upon receipt of the Application for Change Proposal, the parties shall follow the procedures outlined in CC Sub-Clauses 39.2.6 and 39.2.7. However, should the Employer choose not to proceed, the Contractor shall not be entitled to recover the costs of preparing the Application for Change Proposal.

39.4 The scope of work under the package(s) shall be as per the Technical Specification, Vol- II of bidding Documents. The quantity variation applicable for the existing scope shall be generally as per the following.

- a) The employer reserves the right to increase or decrease the quantity of different items of the specified good and services to the extent of fifteen percent (15%) of the contract prices, by way of suitable amendment to the contract, without any change in unit rate/price and/ or other terms and conditions of the contract. However, the quantities of individual items of goods and services may vary up to any extent.
- b) The contract price for (i) items for which quantities have been indicated as lumpsum / lot/ set (ii) items for which quantities were to be estimated by the bidder, including additional items (falling under (i) and /or (ii) considered necessary by the bidder for successful completion of the works as per TS and indicated by him in his bid, shall remain constant unless there is change made in the scope of work by the employer. The quantities and unit prices (a) subsequently arrived while approving the bill of quantities (BOQ)/ billing breakup of lumpsum/lot/set quantities and/ or (b) quantities estimated by the bidder /contractor shall be for on account payment purpose only. In case additional quantities, over and above the quantities in BOQ/ billing break up and/or estimated by the bidder/contractor are required for the successful completion of the scope of work as per technical specification, the contractor shall execute additional quantities of these items for which no additional payments shall be made over and above the lumpsum contract price.
- c)

In case quantities of these items supplied at site are in excess of that required for successful completion of scope of work, such additional quantities shall be property of the contractor and contractor shall be allowed to take back the same from the site for which no deduction from the lumpsum contract price shall be made. Further in case actual requirement of quantities for successful completion of scope of work is less than the quantities identified in the approved BOQ/ billing break up and/or estimated by the bidder/ contractor, the lumpsum contract price shall remain unchanged and no deduction shall be made from the lumpsum price due to such reduction of quantities. It shall be the responsibility of the bidder to pay all statutory taxes, duties and levies to the concerned authority's surplus material which would otherwise have been, lawfully payable. The bidder shall submit an indemnity bond to keep the employer harmless from any liability, before release to such material to the bidder by the employer.

- c) The quantity variation from the existing scope shall be notified to the contractor within the validity of contract.

40. Extension of Time for Completion

40.1 The Time(s) for Completion specified in the CC shall be extended if the Contractor is delayed or impeded in the performance of any of its obligations under the Contract by reason of any of the following:

- (a) any Change in the Facilities as provided in CC Clause 39 (Change in the Facilities)

(b) any occurrence of Force Majeure as provided in CC Clause 37 (Force Majeure), unforeseen conditions as provided in CC Clause 35 (Unforeseen Conditions), or other occurrence of any of the matters specified or referred to in paragraphs (a), (b) and (c) of CC Sub-Clause 32.2

(c) any suspension order given by the Employer under CC Clause 41 (Suspension) hereof or reduction in the rate of progress pursuant to CC Sub-Clause 41.2 or

(d) any changes in laws and regulations as provided in CC Clause 36 (Change in Laws and Regulations) or

(e) any default or breach of the Contract by the Employer, specifically including failure to supply the items listed in Appendix 6 (Scope of Works and Supply by the Employer) to the Contract Agreement, or any activity, act or omission of any other contractors employed by the Employer or

(f) any other matter specifically mentioned in the Contract;

by such period as shall be fair and reasonable in all the circumstances and as shall fairly reflect the delay or impediment sustained by the Contractor.

40.2 Except where otherwise specifically provided in the Contract, the Contractor shall submit to the Project Manager a notice of a claim for an extension of the Time for Completion, together with particulars of the event or circumstance justifying such extension as soon as reasonably practicable after the commencement of such event or circumstance. As soon as reasonably practicable after receipt of such notice and supporting particulars of the claim, the Employer and the Contractor shall agree upon the period of such extension. In the event that the Contractor does not accept the Employer's estimate of a fair and reasonable time extension, the Contractor may take up the matter as per CC Sub-Clause 6.2.

40.3 The Contractor shall at all times use its reasonable efforts to minimize any delay in the performance of its obligations under the Contract.

41. Suspension

41.1 The Employer may request the Project Manager, by notice to the Contractor, to order the Contractor to suspend performance of any or all of its obligations under the Contract. Such notice shall specify the obligation of which performance is to be suspended, the effective date of the suspension and the reasons thereof. The Contractor shall thereupon suspend performance of such obligation (except those obligations necessary for the care or preservation of the Facilities) until ordered in writing to resume such performance by the Project Manager.

If, by virtue of a suspension order given by the Project Manager, other than by reason of the Contractor's default or breach of the Contract, the Contractor's performance of any of its obligations is suspended for an aggregate period of more than ninety (90) days, then at any time thereafter and provided that at that time such performance is still suspended, the Contractor may give a notice to the Project Manager requiring that the Employer shall, within twenty-eight (28) days of receipt of the notice, order the resumption of such performance or request and subsequently order a change in accordance with CC Clause 39 (Change in the Facilities), excluding the performance of the suspended obligations from the Contract.

If the Employer fails to do so within such period, the Contractor may, by a further notice to the Project Manager, elect to treat the suspension, where it affects a part only of the Facilities, as a deletion of such part in accordance with CC Clause 39 (Change in the Facilities) or, where it affects the whole of the Facilities, as termination of the Contract under CC Sub-Clause 42.1 (Termination for Employer's Convenience).

41.2 In case,

(a) the Employer has failed to pay the Contractor any sum due under the Contract within the specified period, has failed to approve any invoice or supporting documents without just cause pursuant to Appendix 1 (Terms and Procedures of Payment) to the Contract Agreement, or commits a substantial breach of the Contract, the Contractor may give a notice to the Employer that requires payment of such sum, with interest thereon as stipulated in CC Sub-Clause 12.3, requires approval of such invoice or supporting documents, or specifies the breach and requires the Employer to remedy the same, as the case may be. If the Employer fails to pay such sum together with such interest, fails to approve such invoice or supporting documents or give its reasons for withholding such approval, or fails to remedy the breach or take steps to remedy the breach within fourteen (14) days after receipt of the Contractor's notice

or

(b) the Contractor is unable to carry out any of its obligations under the Contract for any reason attributable to the Employer, including but not limited to the Employer's failure to provide possession

of or access to the Site or other areas in accordance with CC Sub-Clause 10.2, or failure to obtain any governmental permit necessary for the execution and/or completion of the Facilities; then the Contractor may by fourteen (14) days' notice to the Employer suspend performance of all or any of its obligations under the Contract, or reduce the rate of progress.

41.3 If the Contractor's performance of its obligations is suspended or the rate of progress is reduced pursuant to this CC Clause 41, then the Time for Completion shall be extended in accordance with CC Sub-Clause 40.1, and any and all additional costs or expenses incurred by the Contractor as a result of such suspension or reduction shall be paid by the Employer to the Contractor in addition to the Contract Price, except in the case of suspension order or reduction in the rate of progress by reason of the Contractor's default or breach of the Contract.

41.4 During the period of suspension, the Contractor shall not remove from the Site any Plant and Equipment, any part of the Facilities or any Contractor's Equipment, without the prior written consent of the Employer.

42. Termination

42.1 Termination for Employer's Convenience

42.1.1 The Employer may at any time terminate the Contract for any reason by giving the Contractor a notice of termination that refers to this CC Sub-Clause 42.1.

42.1.2 Upon receipt of the notice of termination under CC Sub-Clause 42.1.1, the Contractor shall either immediately or upon the date specified in the notice of termination

- (a) cease all further work, except for such work as the Employer may specify in the notice of termination for the sole purpose of protecting that part of the Facilities already executed, or any work required to leave the Site in a clean and safe condition
- (b) terminate all subcontracts, except those to be assigned to the Employer pursuant to paragraph (d)(ii) below
- (c) remove all Contractor's Equipment from the Site, repatriate the Contractor's and its Subcontractors' personnel from the Site, remove from the Site any wreckage, rubbish and debris of any kind, and leave the whole of the Site in a clean and safe condition
- (d) In addition, the Contractor, subject to the payment specified in CC Sub Clause 42.1.3, shall
 - (i) deliver to the Employer the parts of the Facilities executed by the Contractor up to the date of termination.
 - (ii) to the extent legally possible, assign to the Employer all right, title and benefit of the Contractor to the Facilities and to the Plant and Equipment as at the date of termination, and, as may be required by the Employer, in any subcontracts concluded between the Contractor and its Subcontractors
 - (iii) deliver to the Employer all non-proprietary drawings, specifications and other documents prepared by the Contractor or its Subcontractors as at the date of termination in connection with the Facilities.

42.1.3 In the event of termination of the Contract under CC Sub-Clause 42.1.1, the Employer shall pay to the Contractor the following amounts:

- a. The Contract Price, properly attributable to the parts of the Facilities executed by the Contractor as on the date of termination
- b. The costs reasonably incurred by the Contractor in the removal of the Contractor's Equipment from the Site and in the repatriation of the Contractor's and its Subcontractors' personnel
- c. The amounts to be paid by the Contractor to its Subcontractors in connection with the termination of any subcontracts, including any cancellation charges
- d. Costs incurred by the Contractor in protecting the Facilities and leaving the Site in a clean and safe

condition pursuant to paragraph (a) of CC Sub-Clause 42.1.2

- e. The cost of satisfying all other obligations, commitments and claims that the Contractor may in good faith have undertaken with third parties in connection with the Contract and that are not covered by paragraphs (a) through (d) above.

42.2 Termination for Contractor's Default

42.2.1 The Employer, without prejudice to any other rights or remedies it may possess, may terminate the Contract forthwith in the following circumstances by giving a notice of termination and its reasons therefore to the Contractor, referring to this CC Sub-Clause 42.2 and Performance security (CPG) will be forfeited:

- (a) if the Contractor becomes bankrupt or insolvent, has a receiving order issued against it, compounds with its creditors, or, if the Contractor is a corporation, a resolution is passed or order is made for its winding up (other than a voluntary liquidation for the purposes of amalgamation or reconstruction), a receiver is appointed over any part of its undertaking or assets, or if the Contractor takes or suffers any other analogous action in consequence of debt.
- (b) if the Contractor assigns or transfers the Contract or any right or interest therein in violation of the provision of CC Clause 43 (Assignment).
- (c) if the Contractor, in the judgment of the Employer has engaged in corrupt or fraudulent practices in competing for or in executing the Contract.

For the purpose of this sub-clause:

"corrupt practice" means the offering, giving, receiving or soliciting of any thing of value to influence the action of a public official in the procurement process or in contract execution.

"fraudulent practice" means a misrepresentation of facts in order to influence a procurement process or the execution of a contract to the detriment of the Employer, and includes collusive practice among Bidders (prior to or after bid submission) designed to establish bid prices at artificial non-competitive levels and to deprive the Employer of the benefits of free and open competition".

42.2.2 If the Contractor

- (a) has abandoned or repudiated the Contract
- (b) has without valid reason failed to commence work on the Facilities promptly or has suspended (other than pursuant to CC Sub-Clause 41.2) the progress of Contract performance for more than twenty-eight (28) days after receiving a written instruction from the Employer to proceed
- (c) persistently fails to execute the Contract in accordance with the Contract or persistently neglects to carry out its obligations under the Contract without just cause
- (d) refuses or is unable to provide sufficient materials, services or labour to execute and complete the Facilities in the manner specified in the program furnished under CC Clause 18.2 (Program of Performance) at rates of progress that give reasonable assurance to the Employer that the Contractor can attain Completion of the Facilities by the Time for Completion as extended.

then the Employer may, without prejudice to any other rights it may possess under the Contract, give a notice to the Contractor stating the nature of the default and requiring the Contractor to remedy the same. If the Contractor fails to remedy or to take steps to remedy the same within fourteen (14) days of its receipt of such notice, then the Employer may terminate the Contract forthwith by giving a notice of termination to the Contractor that refers to this CC Sub Clause 42.2

42.2.3 Upon receipt of the notice of termination under CC Sub-Clauses 42.2.1 or 42.2.2, the Contractor shall, either immediately or upon such date as is specified in the notice of termination,

- (a) cease all further work, except for such work as the Employer may specify in the notice of termination for the sole purpose of protecting that part of the Facilities already executed, or any work required to leave

the Site in a clean and safe condition

(b) terminate all subcontracts, except those to be assigned to the Employer pursuant to paragraph (d) below

(c) deliver to the Employer the parts of the Facilities executed by the Contractor up to the date of termination

(d) to the extent legally possible, assign to the Employer all right, title and benefit of the Contractor to the Works and to the Plant and Equipment as at the date of termination, and, as may be required by the Employer, in any subcontracts concluded between the Contractor and its Subcontractors

(e) deliver to the Employer all drawings, specifications and other documents prepared by the Contractor or its Subcontractors as at the date of termination in connection with the Facilities.

42.2.4 The Employer may enter upon the Site, expel the Contractor, and complete the Facilities itself or by employing any third party. The Employer may, to the exclusion of any right of the Contractor over the same, take over and use with the payment of a fair rental rate to the Contractor, with all the maintenance costs to the account of the Employer and with an indemnification by the Employer for all liability including damage or injury to persons arising out of the Employer's use of such equipment, any Contractor's Equipment owned by the Contractor and on the Site in connection with the Facilities for such reasonable period as the Employer considers expedient for the supply and installation of the Facilities

Upon completion of the Facilities or at such earlier date as the Employer thinks appropriate, the Employer shall give notice to the Contractor that such Contractor's Equipment will be returned to the Contractor at or near the Site and shall return such Contractor's Equipment to the Contractor in accordance with such notice. The Contractor shall thereafter without delay and at its cost remove or arrange removal of the same from the Site.

42.2.5 Subject to CC Sub-Clause 42.2.6, the Contractor shall be entitled to be paid the Contract Price attributable to the Facilities executed as at the date of termination, the value of any unused or partially used Plant and Equipment on the Site, and the costs, if any, incurred in protecting the Facilities and in leaving the Site in a clean and safe condition pursuant to paragraph (a) of CC SubClause 42.2.3. Any sums due to the Employer from the Contractor accruing prior to the date of termination shall be deducted from the amount to be paid to the Contractor under this Contract.

42.2.6 If the Employer completes the Facilities, the cost of completing the Facilities by the Employer shall be determined. If the sum that the Contractor is entitled to be paid, pursuant to CC SubClause 42.2.5, plus the reasonable costs incurred by the Employer in completing the Facilities, exceeds the Contract Price, the Contractor shall be liable for such excess.

If such excess is greater than the sums due to the Contractor under CC SubClause 42.2.5, the Contractor shall pay the balance to the Employer, and if such excess is less than the sums due to the Contractor under CC Sub-Clause 42.2.5, the Employer shall pay the balance to the Contractor.

The Employer and the Contractor shall agree, in writing, on the computation described above and the manner in which any sums shall be paid.

42.3 Termination by Contractor

42.3.1 If

(a) The Employer has failed to pay the Contractor any sum due under the Contract within the specified period, has failed to approve any invoice or supporting documents without just cause pursuant to Appendix 1 (Terms and Procedures of Payment) of the Contract Agreement, or commits a substantial breach of the Contract, the Contractor may give a notice to the Employer that requires payment of such sum, with interest thereon as stipulated in CC Sub-Clause 12.3, requires approval of such invoice or supporting documents, or specifies the breach and requires the Employer to remedy the same, as the case may be. If the Employer fails to pay such sum together with such interest, fails to approve such invoice or supporting documents or give its reasons for withholding such approval, fails to remedy the breach or take steps to remedy the breach within fourteen (14) days after receipt of the Contractor's notice, or

(b) The contractor is unable to carry out any of its obligations under the contract for any reason attributable to the employer, including but not limited to the employer's failure to provide possession of or access to the site or other areas or failure to obtain any governmental permit necessary for the execution and/or

completion of the Facilities, which the employer is required to obtain as per provision of the contract as per relevant applicable laws of the country.

then the Contractor may give a notice to the Employer thereof, and if the Employer has failed to pay the outstanding sum, to approve the invoice or supporting documents, to give its reasons for withholding such approval, or to remedy the breach within twenty-eight (28) days of such notice, or if the Contractor is still unable to carry out any of its obligations under the Contract for any reason attributable to the Employer within twenty-eight (28) days of the said notice, the Contractor may by a further notice to the Employer referring to this CC Sub-Clause 42.3.1, forthwith terminate the Contract.

42.3.2 The Contractor may terminate the Contract forthwith by giving a notice to the Employer to that effect, referring to this CC Sub-Clause 42.3.2, if the Employer becomes bankrupt or insolvent, has a receiving order issued against it, compounds with its creditors, or, being a corporation, if a resolution is passed or order is made for its winding up (other than a voluntary liquidation for the purposes of amalgamation or reconstruction), a receiver is appointed over any part of its undertaking or assets, or if the Employer takes or suffers any other analogous action in consequence of debt.

42.3.3 If the Contract is terminated under CC Sub-Clauses 42.3.1 or 42.3.2, then the Contractor shall immediately

(a) cease all further work, except for such work as may be necessary for the purpose of protecting that part of the Facilities already executed, or any work required to leave the Site in a clean and safe condition

(b) terminate all subcontracts, except those to be assigned to the Employer pursuant to paragraph (d)(ii) below

(c) remove all Contractor's Equipment from the Site and repatriate the Contractor's and its Subcontractor's personnel from the Site

(d) In addition, the Contractor, subject to the payment specified in CC Sub-Clause 42.3.4, shall

(i) deliver to the Employer the parts of the Facilities executed by the Contractor up to the date of termination

(ii) to the extent legally possible, assign to the Employer all right, title and benefit of the Contractor to the Facilities and to the Plant and Equipment as on the date of termination, and, as may be required by the Employer, in any subcontracts concluded between the Contractor and its Subcontractors

(iii) deliver to the Employer all drawings, specifications and other documents prepared by the Contractor or its Subcontractors as on the date of termination in connection with the Facilities.

42.3.4 If the Contract is terminated under CC Sub-Clauses 42.3.1 or 42.3.2, the Employer shall pay to the Contractor all payments specified in CC Sub-Clause 42.1.3, and reasonable compensation for all loss or damage sustained by the Contractor arising out of, in connection with or in consequence of such termination.

42.3.5 Termination by the Contractor pursuant to this CC Sub-Clause 42.3 is without prejudice to any other rights or remedies of the Contractor that may be exercised in lieu of or in addition to rights conferred by CC Sub-Clause 42.3.

42.4 In this CC Clause 42, the expression "Facilities executed" shall include all work executed, Installation Services provided, and Plant and Equipment acquired (or subject to a legally binding obligation to purchase) by the Contractor and used or intended to be used for the purpose of the Facilities, up to and including the date of termination.

42.5 In this CC Clause 42, in calculating any monies due from the Employer to the Contractor, account shall be taken of any sum previously paid by the Employer to the Contractor under the Contract, including any advance payment paid pursuant to Appendix 1 (Terms and Procedures of Payment) to the Contract Agreement.

43. Assignment

43.1 Neither the Employer nor the Contractor shall, without the express prior written consent of the other (which consent shall not be unreasonably withheld), assign to any third party the Contract or any part thereof, or any right, benefit, obligation or interest therein or thereunder, except that the Contractor shall be entitled to assign either absolutely or by way of charge any monies due and payable to it or that may become due and payable to it under the Contract.

44 Construction of the contract

44.1 The contracts to be entered into with the successful bidder shall be as under.

For Domestic Bidder:

--- “First contract” for Ex-works supply and CIF supply, if any of all equipment and materials including mandatory spares identifying separately the CIF and Ex-works components of the supply.

---- “Second Contract” for providing all services i.e. inland transportation for delivery at site, unloading, storage handling at site, installation, testing and commissioning including performance testing in respect of all the equipments supplied under “First contract” and any other services specified in the contract documents.

44.2 The award of two (2) separate contracts shall not in any way dilute the responsibility of the contractor for the successful completion of the facility as per specification and breach in one contract shall automatically be construed as a breach of the other contract which will confer a right on the employer to terminate the other contract also at the risk and the cost of the contractor.

44.3 Deleted

44.4 Deleted

44.5 In case of two contracts entered into as above or where the employer hands over his equipment to the contractor for executing the contract then the contractor shall at the time of taking delivery of equipment through bill of lading or other dispatch documents, furnish trust receipt for plant, equipment and materials and also execute an Indemnity bond in favour of the employer in the form acceptable to the employer for keeping the equipment in safe custody and to utilize the same exclusively for the purpose of the said Contract. Samples of Performa for the Trust receipt and Indemnity bond are enclosed under Section VI (Sample forms and procedures). The employer shall also issue separate authorization letter to the Contractor to enable him to take physical delivery of plant, equipment and materials from the employer as per Performa enclosed under Section VI (sample forms and procedures).

44.6 The Contract will be signed in two original and the contractor shall be provided with one signed original and the other signed original will be retained by the employer.

44.7 The contractor shall provide free of cost to the employer all the engineering data, drawing and descriptive materials submitted with the bid, in at least two (2) copies to form a part of the contract immediately after notification of Award.

44.8 Subsequent to signing of the contract, the contractor at his own cost shall provide the employer with at least fifteen (15) true copies of contract agreement within thirty (30) days after signing of the contract.

45. Specific Requirement

The bidder 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 clearance from Electrical Inspector (Govt. of NCT of Delhi) 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. However the necessary fee of the Inspector shall be reimbursed by DTL.

46. DTL not to be made party in case of dispute between Contractor and Sub contractor Vendor.

47. BLACK-LISTING OF FIRMS/ BANNING OF BUSINESS

DTL may decide to black-list firms or ban business with them, for specified time, based on facts and circumstances of the particular case generally on the following grounds:

- i. Corrupt or Fraudulent practices resorted to by Contractor including mis-representation of facts.
- ii. Willful indulgence by the Contractor in supplying sub-standard material irrespective of whether pre-dispatch inspection conducted by DTL or not.
- iii. Repeated use of delaying tactic in fulfilling contractual obligations willfully.
- iv. Established litigant nature of the contractor to derive undue benefit.
- v. Poor performance in one or more contracts.

SECTION-V

SPECIAL CONDITIONS OF **CONTRACT** **(SCC)**

SECTION-V

SPECIAL CONDITIONS OF CONTRACT (SCC)

The following bid specific data for the Plant and Equipment to be procured shall amend and/or supplement the provisions in the Conditions of Contract (CC)

Sl. No.	CC Clause Ref. No.	Amendment/Supplement to CC												
1.	CC 1.1& Appendix -4 of Section-F&P	<p style="text-align: center;"><u>Time/Project Completion Schedule</u></p> <p>The total completion time for the project is 30 months from the date of Notification of Award. The broad break-up of time for completion is as under:</p> <table><tr><th colspan="2">Description</th><th>Duration in months from date of Notification of Award</th></tr><tr><td colspan="2">Taking over by the Employer upon successful completion of:</td><td></td></tr><tr><td>A)</td><td>GIS of all the voltage levels within the Substation with one Power Transformer of 220kV level along with infeed work</td><td>24 months</td></tr><tr><td>B)</td><td>Remaining Power Transformers and other scope of work</td><td>30 months</td></tr></table>	Description		Duration in months from date of Notification of Award	Taking over by the Employer upon successful completion of:			A)	GIS of all the voltage levels within the Substation with one Power Transformer of 220kV level along with infeed work	24 months	B)	Remaining Power Transformers and other scope of work	30 months
Description		Duration in months from date of Notification of Award												
Taking over by the Employer upon successful completion of:														
A)	GIS of all the voltage levels within the Substation with one Power Transformer of 220kV level along with infeed work	24 months												
B)	Remaining Power Transformers and other scope of work	30 months												
2.	CC 42.2.1	<p>“The Employer, without prejudice to any other rights or remedies it may possess, may terminate the Contract forthwith in the following circumstances by giving a notice of termination and its reasons therefore to the Contractor, referring to this CC Sub-Clause 42.2”</p> <p>may be read as</p> <p>“The Employer, without prejudice to any other rights or remedies it may possess, may terminate the Contract forthwith in the following circumstances by giving a notice of termination and its reasons therefore to the Contractor, referring to this CC Sub-Clause 42.2 and Performance security (CPG) will be forfeited.”</p>												

Sl. No.	CC Clause Ref. No.	Amendment/Supplement to CC
3.	CC Clause 19.1	<p>Supplementing CC Clause 19.1 with the following:-</p> <p>Further, the Contractor shall not subcontract any work to a subcontractor/sub vendor from such countries which shares a land border with India unless such subcontractor/sub vendor fulfils all requirement in regard to 'Bidder from a country which shares a land border with India as per ITB clause 1.2.2 & 1.2.3.</p>
4.	New Clause	<p>Sub-Vendor/Sub-contractor Approval</p> <p>(a) For non-QR supply item if the sub-vendor/ sub-contractor was approved in DTL during last 7 years or if the sub-vendor/sub-contractor is the enlisted vendor of PGCIL as per latest compendium, then that sub-vendor/sub-contractor shall be considered as deemed approved and no letter of approval or its project specific extension is required to be issued in such cases. The contractor can submit the valid type test report and engineering drawings of offered equipment/items directly to the D & E Deptt. for its acceptance/approval along with supporting document of earlier approval of sub-vendor/sub-contractor DTL or vendor enlistment of PGCIL.</p> <p>(b) For QR supply item if the sub-vendor/sub-contractor is the enlisted vendor of PGCIL as per latest compendium, then that sub-vendor/sub-contractor shall be required to submit only the documents in support of meeting the QR.</p> <p>(c) For non- QR supply items, if the proposed sub-vendor/sub-contractor is not covered in Cl. No.-04 (a) above, the Contractor shall be required to furnish details/ documents in support of his claim viz. Plant & Machinery, Testing Facilities, Sources of raw material, manpower, type test reports (an undertaking may be furnished by the contractor to submit the valid type test reports to D&E along with drawing approval) etc.</p> <p>(d) For QR related supply items, if the sub-vendor/sub-contractor proposed is not covered in Cl. No.-04 (b) above, the Contractor shall be required to furnish details/ documents in support of his claim viz. Qualifying requirement (QR), Plant & Machinery, Testing Facilities, Sources of raw material, manpower, type test reports (an undertaking may be furnished by the contractor to submit the valid type test reports to D&E along with drawing approval) etc.</p> <p>(e) For the off-the-shelf items (which are not custom made and are readily available in the market like LED, luminaries, other lighting equipment, AC etc.) no type test will be sought.</p>

Sl. No.	CC Clause Ref. No.	Amendment/Supplement to CC
5.	New Clause	The performance certificate for satisfactory operation of major equipments (GIS bay, Gas insulated bus duct, AIS bay equipments, Auto/Power transformer, Reactor, NIFPES, Mono Pole/Lattice towers, Power cable of 33kV and above, C&R panel, SAS) shall also be required like the QR items even if they are supplied as non-QR items.
6.	New Clause	In addition to the routine inspections carried out, DTL shall organize the quality assurance inspection of materials as well as field/site works through a third-party agency or through an officer deputed for this purpose from QA&I department, during the execution of work & at the time of completion of work, for which the contractor shall provide full access and all necessary support. Such third party inspection shall be part of Material Quality Assurance Plan (MQAP) and Field Quality Plan (FOP), as the case may be.
7.	New Clause	For items/equipment whose Technical Specifications, if not explicitly included in this Tender Document, the successful Bidder shall supply such items/equipment in conformity with the relevant applicable standards and overall project requirements. The successful Bidder shall comply with the latest Technical Specifications provided by the Employer/Owner during the detailed engineering stage.

----- End of Section-V (SCC) -----

SECTION-VI

FORMS AND PROCEDURES **(F&P)**

1. BID FORM

Please Refer Volume III

2(a) BANK GUARANTEE FOR BID SECURITY

Ref ...

Bank Guarantee No.....

Date

To

Dear Sir,

In accordance with your invitation for Bid under your Specification No.....M/s.....
.....having its Registered Office
.....(hereinafter called the "Bidder") wish to participate in the said Bid for and you, as a special favour, have agreed to accept Bank Bid Guarantee for an amount of Rs.....(Rupees.....only) valid upto on behalf of the Bidder in lieu of Bid deposit required to be made by the Bidder, as a condition precedent for participation in the said Bid.

We, having our Registered Office at guarantee and undertake to pay immediately on demand by Delhi Transco Limited the amount of Rs...../- (Rupees.....Only) without any reservation, protest, demur and recourse. Any such demand made by said 'Owner' i.e. Delhi Transco Limited or its authorized representative shall be conclusive and binding on us irrespective of any dispute or difference raised by the bidder.

This guarantee shall remain valid upto If any further extension of this guarantee is required, the same shall be extended to such required period on receiving instructions from M/s.....on whose behalf this guarantee is issued.

In witness whereof the Scheduled Bank, through its authorized Officer, has set its hand and stamp on this day ofat.....

Designation with Bank (Scheduled) Stamp

Name: _____

Phone No. _____

Domain e-mail Id _____

Official address _____

	WITNESS 1	WITNESS 2
Signatue		
Name		
Address		

2(b) BID SECURITY FORM (For Insurance Surety Bond)

(To be stamped in accordance with Stamp Act of India)

Insurance Surety Bond No.:

Date:

NIT No.

Amount of Bond:.....

To,

_____ Name of the Employer

_____ Address of Employer

WHEREAS Delhi Transco Ltd. incorporated under the Companies Act, 1956, having its registered office at [.....] and one of its offices at _____ (hereinafter called '**DTL**' or '**Employer**' which expression shall unless repugnant to the context or meaning thereof include all its successors, administrators, executors and assignees) has floated a Tender No. _____ and M/s _____ having Head/Registered office at _____ (hereinafter called the '**Bidder**' which expression shall unless repugnant to the context or meaning thereof mean and include all its successors, administrators, executors and permitted assignees) have submitted a bid bearing Reference No. and Bidder having agreed to furnish , as a condition precedent for participation in the said tender, an unconditional and irrevocable Insurance surety Bond of Indian Rupees (in figures) _____ (Indian Rupees (in words) _____ only) for the due performance of Bidder's obligations as contained in the terms of the Notice Inviting Tender (NIT) and other terms and conditions contained in the Bidding documents supplied by DTL which amount is liable to be forfeited on the happening of any contingencies mentioned in said documents.

KNOW ALL PERSONS by these present that WE *(insert name & address of the Insurer)* having its Registered/Head Office at*(insert address of registered office of the Insurer)*..... (hereinafter called "**the Insurer** " which expression shall include its successors, administrators, executors, and assigns), a company registered with the Insurance Regulatory and Development Authority of India (IRDAI), are bound, guarantee and undertake to pay immediately on first demand by*(insert name of Employer)* (hereinafter called "the Employer") in the sum of*(insert amount of Bid Security in figures & words)*..... in aggregate at any time without any demur and recourse, and without Employer having to substantiate the demand. Any such demand made by Employer shall be conclusive and binding on the Insurer and the Insurer shall immediately remit the amount to Employer in the manner provided below irrespective of any dispute or difference raised by the Bidder.

THE GUARANTEE

The Surety, at the request of the Bidder, irrevocably, unconditionally and without reservation, guarantee the due and faithful fulfilment and compliance of the terms and conditions of NIT/Tender Documents by the Bidder including but not limited to non-withdrawal of bid, acceptance of the contract and provide required bonds if selected and unconditionally and irrevocably undertake to pay forthwith to the Employer upon its mere first written demand, and without any demur, reservation, recourse, contest or protest, and without any reference to the Bidder, such sum or sums up to an aggregate sum of the Surety Bond Amount as the Employer shall claim without the Employer being required to prove or to show grounds or reasons for its demand and/or for the sum specified therein.

In order to give effect to this Surety Bond, the Employer shall be entitled to act as if the Surety Insurer were the principal debtor and any change in the constitution of the Bidder and/or the Surety Insurer, whether by their absorption with any other body or corporation or otherwise, shall not in any way or manner affect the liability or obligation of the Surety Insurer under this Surety Bond.

It shall not be necessary, and the Surety Insurer hereby waives any necessity, for the Employer to proceed against the Bidder before presenting to the Surety Insurer its demand under this Surety Bond.

The Surety Insurer confirms that this Insurance Surety Bond has been issued with observance of appropriate laws of the country of issue i.e. India.

The Surety Insurer also agree that this Insurance Surety Bond shall be irrevocable and governed and construed in accordance with Indian Laws and subject to exclusive jurisdiction of Indian Courts of the place from where NIT has been invited.

This Insurance Surety Bond shall be irrevocable and shall remain in force upto _____ which includes [.....] days after the period of bid validity and any demand/claim in respect thereof should reach the Insurer (through email or registered post or speed post or courier) on or before _____ (*Indicate date of expiry of claim period which includes minimum one month period from the date of expiry of this Insurance surety Bond*).

Notwithstanding anything contained hereinabove, our liability under this Insurance Surety Bond is limited to Indian Rs (in figures) _____ (Indian Rupees (in words) _____ only) and this Insurance Surety Bond shall remain in force until (*indicate the date of expiry of Insurance Surety Bond*).....

All Claims of DTL (beneficiary) against this Insurance Surety Bond, shall be remitted by the(Insurer's name to be inserted) to the following account of DTL only through electronic transfer of funds, unless otherwise specifically communicated by DTL.

Any claim under this Insurance Surety Bond must be received by Insurer on or before _____ (*Indicate date of expiry of claim period which includes minimum one month period from the date of expiry of this Insurance Surety Bond*). If no such claim has been

received by us on or before the said date, the rights of Employer under this Insurance Surety Bond will cease. However, if such a claim has been received by Surety on or before the said date, all the rights of Employer under this Insurance Surety Bond shall be valid and shall not cease until Insurer has satisfied that claim.

Sealed with the Common Seal of the said **Insurer** this day of 20....

THE CONDITIONS for forfeiture of Insurance Surety Bond includes but is not limited to the following:

- (1) If the Bidder withdraws its bid during the period of bid validity specified by the Bidder in the Bid Form; or
- (2) In case the Bidder does not withdraw the deviations proposed by him, if any, at the cost of withdrawal stated by him in the bid and/or accept the withdrawals/rectifications pursuant to the declaration/confirmation made by him in Attachment – Declaration of the Bid; or
- (3) If the Bidder does not accept the corrections to arithmetical errors identified during preliminary evaluation of his bid pursuant to ITB Clause 35B; or
- (4) If, as per the requirement of Qualification Requirements the Bidder is required to submit a Deed of Joint Undertaking and he fails to submit the same, duly attested by Notary Public of the place(s) of the respective executants (s) or registered with the Indian Embassy/High Commission in that Country, within ten days from the date of intimation of post – bid discussion; or
- (5) In the case of a successful Bidder, if the Bidder fails within the specified time limit
 - (i) To sign the Contract Agreement, in accordance with ITB Clause 42, or
 - (ii) To furnish the required performance security, in accordance with ITB Clause 43. or
- (6) In any other case specifically provided for in ITB.

WE undertake to pay to the Employer up to the above amount upon receipt of its first written demand, without the Employer having to substantiate its demand, provided that in its demand the Employer will note that the amount claimed by it is due to it, owing to the occurrence of any default as per NIT Documents including of the above-named CONDITIONS or their combination, and specifying the occurred condition or conditions.

A letter from the Employer, under the hand of an officer-in-charge of Project/Work, that the Bidder has committed default shall be conclusive, final and binding on the Surety Insurer. The Surety Insurer further agrees that the Employer shall be the sole judge as to whether the Bidder is in default and its decision that the Bidder is in default shall be final and binding on the Surety Insurer, notwithstanding any differences between the Employer and the Bidder, or any dispute between them pending before any Court, Tribunal, Arbitrators or any other Employer or body, or by the discharge of the Bidder for any reason whatsoever.

Any notice by way of request, demand or otherwise hereunder may be sent by post or email addressed to the Surety Insurer (as provided in this Surety Bond) at its above referred branch, which shall be deemed to have been duly authorized to receive such notice and to effect payment thereof forthwith, and if sent by post it shall be deemed to have been given at that time when it ought to have been delivered in due course of post and in proving such notice, when given by post, it shall be sufficient to prove that the envelope containing the notice was posted and a certificate signed by an officer of the Employer that the envelope was so posted shall be conclusive. When the demand/notice is send vide email, it shall be deemed to have been given at that time of email, provided the email is sent and is not undelivered.

This guarantee will remain in full force up to and including (*insert date in line with ITB Clause []*)....., and any demand in respect thereof must reach the **Insurer** not later than the above date.

Notwithstanding anything contained herein:

1. Our liability under this **Insurance Surety Bond** shall not exceed _____ (*value in figures*) _____ [*value in words*] _____.
2. This **Insurance Surety Bond** shall be valid upto _____ (*validity date*) _____.
3. We are liable to pay the guaranteed amount or any part thereof under this **Insurance Surety Bond** only & only if we receive a written claim or demand on or before _____ (*validity date*) _____.

For and on behalf of the **Insurer**

[*Signature of the authorised signatory(ies)*]

Signature _____

Name _____

Designation _____

Code No. _____

Contact Number(s): Tel. _____

Mobile _____

Fax Number _____

email _____

Common Seal _____

Witness:

Signature _____

Name _____

Address _____

Contact Number(s): Tel. _____

Mobile _____

email _____

Note:

1. In case the bid is submitted by a Joint Venture, the bid security shall be in the name of the Joint Venture and not in the name of the Lead Partner or any other Partner(s) of the Joint Venture.
2. **The Insurance Surety Bond shall be from an Insurer as per guidelines issued by Insurance Regulatory and Development Authority of India (IRDAI) as amended from time to time.**
3. **The Employer shall be the Creditor, the Bidder shall be the Principal debtor and the Insurance company/Insurer shall be the Surety in respect of the Insurance Surety Bond to be issued by the Insurer.**
4. **The Insurance Surety Bond should be on Non-Judicial stamp paper/e-stamp paper of appropriate value as per Stamp Act prevailing in the state(s) where the Insurance Surety Bond is submitted or is to be acted upon or the rate prevailing in State where the Insurance Surety Bond is executed, whichever is higher. The Stamp Paper/e-stamp paper shall be purchased in the name of Bidder/Insurer issuing the Insurance Surety Bond.**
5. **While getting the Insurance Surety Bond issued, Bidders are required to ensure compliance to the points mentioned in Form of Insurance Surety Bond.**
6. **The Insurance Surety Bond should contain the name, designation and code number of the Authorised Signatory signing the Insurance Surety Bond.**
7. **The Address, telephone number, email ID and other details of the head office of the Insurance Company as well as issuing branch should be mentioned on the covering letter of issuing branch.**
8. **Matter to be mentioned in covering letter to be submitted by vendor along with insurance surety bond:**

S.No.	Particulars	Details
1.	Insurance Surety Bond No	
2.	Date of execution of Insurance Surety Bond	
3.	Expiry date of Insurance Surety bond	
4.	Expiry date of claim period of Insurance Surety	
5.	Vendor Name / Vendor Code	Name:
		Code:
6.	Insurance Surety Bond Amount	
7.	Tender No	
8.	Nature of Insurance Surety Bond	
9.	Insurer Details	Insurer Name :
		Address :
		Email Id :

		Phone No :
--	--	------------

3(a) FORM OF NOTIFICATION BY THE EMPLOYER TO THE BIDDER FOR FORFEITURE OF BID GUARANTEE AMOUNT

M/s.....

Ref.: Your proposal against our IFB

No.....

Forfeiture of Bid Guarantee amount.

Dear Sirs,

Whereas you have furnished as a part of your proposal the Bid Guarantee in the form of irrevocable and confirmed Letter of Credit No.....
 .dated..... opened byfor a sum of..... ..

(Bank's name)

.....payable to.....

.....Name of the Employer) on demand without any reservation, demur or protest,
 contest and recourse at.....(Name and place of Bank).

In terms of the aforesaid Bid Guarantee, we do hereby forfeit the Guarantee amount.

For..... (Name of the Employer)

(AUTHORISED SIGNATORY)

N.B. The Letter of Credit should not stipulate any other proforma of notification different from this format. No change whatsoever in the said proforma is acceptable to the Employer.

3(b) FORM FOR FORFEITURE OF INSURANCE SURETY BOND (BID SECURITY)

To: *(insert Name and Address of the Insurer)*

Ref.: Forfeiture of Bid Security Amount against **Insurance Surety Bond** No.

dated for Bid Security , issued by you on behalf of M/s.....

..... *(insert name of the Bidder)* against fulfilment of conditions in Tender bearing no.issued on(dated) for (work).

Dear Sir/Madam,

Please refer to the subject Insurance Surety Bond executed by you in our favour for.....as Bid Security for the bid submitted by M/s.*(insert name of the*

Bidder) against *(insert name of the Package)* ; Specification No.

As per the terms of the said guarantee, the **Insurer** has guaranteed and undertaken to pay immediately on demand by the Employer the amount of without any reservation, protest, demur and recourse. Further, any demand made by the Employer shall be conclusive and binding on the **Insurer** irrespective of any dispute or difference raised by the Bidder.

In terms of the said guarantee, we hereby submit our claim/demand through this letter for remittance of Bid Security amount to *(insert name of the Employer)* owing to the occurrence of the condition(s) referred in the Insurance Surety Bond read with Tender Documents. The Surety **Insurer** is requested to immediately (but not later than [*date or period*]) remit the full guaranteed sum towards proceeds of the bid security in the form of Demand Draft in favour of '.... *(insert name of the Employer)*', payable at*(insert place of the Employer)*....'.

Thanking you,

For.....(Name of the Employer)

(AUTHORISED SIGNATORY)

Copy to:

.....*(Registered Office of the Insurer)*....

3(c) FORM OF SIGHT DRAFT

Drawn under L.C.

No.....dated.....of.....
.....
(Name of Bank that opened the L.C.)

At sight promptly pay to
(Name of the Bank at which L.C. is negotiable)

or order sum of.....(for payment to the Employer) for value received.
(Amount of L.C.)

For.....(Name of the Employer)

(AUTHORISED SIGNATORY)

To,

(Name and Address of the Bank which opened L.C.)

**4(a) FORM OF ‘NOTIFICATION OF AWARD’ OF CONTRACT FOR SUPPLY
OF PLANT AND EQUIPMENT**

NOTE: INSTRUCTIONS INDICATED IN ITALICS IN THIS NOTIFICATION OF AWARD ARE TO BE TAKEN CARE OF BY THE ISSUING AUTHORITY.

Ref. No. :

Date :

.....(Contractor's Name & Address).....

Attn : Mr.....

Sub : Notification of Award of Contract for Supply of.....
(Package Name) as per Specification No.....

Dear Sir,

1.0 This has reference to the following:

- (i) Our Invitation for Bids (IFB) No. dated
- (ii) Bidding Documents for the subject package issued to you vide our letter no. dated.....comprising the following :

..... **(List out all the Sections/Volumes of the Bidding Documents along with Tender Drawings etc. as issued to the bidder)**

Errata/Amendment No..... to..... (Name of Section/Volume of the Bidding Documents to which Errata/Amendment pertains)..... issued to you vide our letter no..... dated.....

(Applicable only if any Errata/Amendment to the Bidding Documents has been issued subsequently)

- (iii) Clarifications furnished to you on the Bidding Documents vide our letter no.....datedbased on the query raised by you/one of the prospective bidders. (Use as applicable)

(Applicable only if any clarification to the Bidding Documents has been issued subsequently)

(INCLUDE AS FURTHER SUB-PARAGRAPHS ANY OTHER CORRESPONDENCE MADE TO THE BIDDER AFTER ISSUANCE OF BIDDING DOCUMENTS UP TO BID OPENING)

- (iv) Your Proposal for the subject package submitted vide your letter No.

..... dated.....and its modification vide letter no.....dated (Delete if not applicable).

- (v) Our Fax message/letter No.dated..... regarding extension of validity of bid and that of the Bank Guarantee towards Bid Security.

(Applicable only if any extension has been sought subsequently)

(INCLUDE AS FURTHER SUB-PARAGRAPHS ANY OTHER CORRESPONDENCE MADE TO OR BY THE BIDDER AFTER BID OPENING)

- (vi) Our Fax message/letter No.....dated..... inviting you for post bid discussions.

- (vii) Post bid discussions and meetings we had with you from.....to resulting into the following Minutes of Meeting enclosed herein with this Notification of award:

(a) Minutes of Meeting regarding Commercial issues (APPENDIX -)

(b) Minutes of Meeting on Technical issues (APPENDIX -)

(c) Minutes of Meeting regarding Work Schedule (APPENDIX -)

(d) Minutes of Meeting regarding Quality Assurance Aspects (APPENDIX-)

- 2.0 We confirm having accepted your proposal submitted vide letter no. datedand its modification vide letter no.....dated (Delete if not applicable) read in conjunction with all the specifications, terms & conditions of the Bidding Documents, Your subsequent letters (Use if relevant) and agreed Minutes of Meeting referred to in para 1.0 above and award on you the Contract for the work of(Indicate brief Scope of Work).....of(Name of Package) for(Name of project)as per Specification No. :(hereinafter referred to as the 'First Contract').

- 3.0 We have also notified you vide our Notification of Award No..... dated for award of another Contract on you for the work of (Indicate brief scope of work of the Second Contract) of the equipment/materials to be supplied by you under this 'First Contract' including Performance and Guarantee test for complete(Name of Package)..... for(Name of Project)..... as per Specification No.....(hereinafter referred to as the 'Second Contract'). You shall also be fully responsible for the works to be executed under the 'Second Contract' and it is expressly understood and agreed by you that any breach under the 'Second Contract' shall automatically be deemed as a breach of this 'First Contract' and vice-versa and any such breach or occurrence or default giving us a right to terminate the 'Second Contract' and/or recover damages thereunder, shall give us an absolute right to terminate this Contract and/or recover damages under this 'First Contract' as well and vice-versa. However, such breach or default or occurrence in the

'Second Contract' shall not automatically relieve you of any of your responsibility/obligations under this 'First Contract'. It is also expressly understood and agreed by you that the equipment/materials to be supplied by you under this 'First Contract' when installed and commissioned under the 'Second Contract' shall give satisfactory performance in accordance with the provisions of the Contract.

4.0 The total Contract Price for the entire scope of work under the Contract shall be(Specify the amount and currency)..... as per the following break up:

- (i) Ex-manufacturing works/place
.....
of dispatch price (both in India)/ CIF/CIP port of entry price
(Use as Applicable)
for Main Equipment
 - (ii) Ex-manufacturing works/place
.....
of dispatch price (both in India)/ CIF/CIP port of entry price
(Use as Applicable)
for Mandatory Spares
 - (iii) Type test charges
.....
(Delete if not applicable)
- TOTAL (i + ii + iii)
(..... (Specify the total amount in words).....)

5.0 You shall prepare and finalize the Contract Documents for signing of the formal Contract Agreement and shall enter into the Contract Agreement with us, as per the proforma enclosed with the Bidding Documents, on non-judicial stamp paper of appropriate value within.....(Specify).....days from the date of this Notification of Award.

6.0 This Notification of Award is being issued to you in duplicate. We request you to return its duplicate copy duly signed and stamped on each page including all the enclosed Appendices, by the authorized signatory of your company as a proof of your acknowledgement and confirmation.

Please take the necessary action to commence the work and confirm action.

Yours faithfully,
for and on behalf of
(Name of the Employer)

(Authorized Signatory)

Encl. : As above.

**4(b) FORM OF 'NOTIFICATION OF AWARD' OF CONTRACT FOR
INSTALLATION OF PLANT AND EQUIPMENT**

NOTE:INSTRUCTIONS INDICATED IN ITALICS IN THIS NOTIFICATION OF
AWARD ARE TO BE TAKEN CARE OF BY THE ISSUING AUTHORITY.

Ref. No. :

Date :

...(Contractor's Name & Address)...

Attn : Mr.....

Sub : Notification of Award of Contract for Installation, testing and commissioning of
..... (Package Name) as per Specification No.

Dear Sir,

1.0 This has reference to the following:

- (i) Our Invitation for Bids (IFB) No. dated
- (ii) Bidding Documents for the subject package issued to you vide our letter no.
dated..... comprising the following:

.....(List out all the Sections/Volumes of the Bidding Documents
along with Tender Drawings etc. as issued to the
bidder)..... Errata/Amendment No.....
to..... (Name of Section/Volume of the Bidding Documents to which
Errata/Amendment pertains)issued to you vide our letter no.
dated.....

(Applicable only if any Errata/Amendment to the Bidding Documents has been issued
subsequently)

- (iii) Clarifications furnished to you on the Bidding Documents vide our letter no.....
dated based on the query raised by you/one of the prospective bidders
(Use as applicable).

(Applicable only if any clarification to the Bidding Documents has been issued
subsequently)

(INCLUDE AS FURTHER SUB-PARAGRAPHS ANY OTHER
CORRESPONDENCE MADE TO THE BIDDER AFTER ISSUANCE OF
BIDDING DOCUMENTS UP TO BID OPENING)

- (iv) Your Proposal for the subject package submitted vide your letter No.
dated..... and its modification vide letter no.

.....dated..... (Delete if not applicable).

- (v) Our Fax message/letter no. Dated..... regarding extension of validity of bid and that of the Bank Guarantee towards Bid Security.

(Applicable only if any extension has been sought subsequently)

(INCLUDE AS FURTHER SUB-PARAGRAPHS ANY OTHER CORRESPONDENCE MADE TO OR BY THE BIDDER AFTER BID OPENING)

- (vi) Our Fax message/letter no. Dated inviting you for post bid discussions.

- (vii) Post bid discussions and meetings we had with you fromto resulting into the following Minutes of Meeting enclosed herein with this Notification of Award:

(a) Minutes of Meeting regarding Commercial issues (APPENDIX -)

(b) Minutes of Meeting on Technical issues (APPENDIX -)

(c) Minutes of Meeting regarding Work Schedule (APPENDIX -)

(d) Minutes of Meeting regarding Quality Assurance Aspects (APPENDIX -)

- 2.0 We confirm having accepted your proposal submitted vide letter no.dated..... and its modification vide letter no. dated(Delete if not applicable) read in conjunction with all the specifications, terms & conditions of the Bidding Documents, Your subsequent letters (Use if relevant) and agreed Minutes of Meeting referred to in para 1.0 above and award on you the Contract for the work of(Indicate brief Scope of Work)..... of (Name of Package) for(Name of project)..... as per Specification No.:(hereinafter referred to as the 'Second Contract').

- 3.0 We have also notified you vide our Notification of Award No. dated..... for award of another Contract on you for the work of (Indicate brief scope of work of the First Contract)..... of the equipment/ materials to be supplied by you under the 'First Contract' including Performance and Guarantee Test for complete(Name of Package)..... for(Name of Project)as per Specification No.....(hereinafter referred to as the 'First Contract'). You shall also be fully responsible for the works to be executed under the 'First Contract' and it is expressly understood and agreed by you that any breach under the 'First Contract' shall automatically be deemed as a breach of this 'Second Contract' and vice-versa and any such breach or occurrence or default giving us a right to terminate the 'First Contract' and/or recover damages there-under, shall give us an absolute right to terminate this Contract and/or recover damages under this 'Second Contract' as well and vice-versa. However, such breach or default or occurrence in the 'First Contract' shall not automatically relieve you of any of your responsibility/obligations under this 'Second Contract'. It is also expressly understood and agreed by you that the

equipment/materials to be supplied by you under the 'First Contract' when erected and commissioned under this 'Second Contract' shall give satisfactory performance in accordance with the provisions of the Contract.

4.0 The total Contract Price for the entire scope of work under the Contract shall be (Specify the amount and currency)..... as per the following break up:

- (i) Inland transportation and inland transit insurance charges including port clearance, port handling and port charges (Delete if not applicable) for Main Equipment:
- (ii) Inland transportation and inland transit insurance charges including port clearance, port handling and port charges (Delete if not applicable) for Mandatory Spares:
- (iii) Unloading and handling at site, storage, erection, testing and commissioning including performance testing and insurance covering all the activities:

TOTAL (i + ii + iii)

.....(Specify the total amount in words)

5.0 You shall prepare and finalize the Contract Documents for signing of the formal Contract Agreement and shall enter into the Contract Agreement with us, as per the proforma enclosed with the Bidding Documents, on non-judicial stamp paper of appropriate value within (Specify)..... days from the date of this Notification of Award.

6.0 This Notification of Award is being issued to you in duplicate. We request you to return its duplicate copy duly signed and stamped on each page including all the enclosed Appendices, by the authorized signatory of your company as a proof of your acknowledgement and confirmation.

Please take the necessary action to commence the work and confirm action.

Yours faithfully,
for and on behalf of

(Name of the Employer)

(Authorized Signatory)

5. FORM OF CONTRACT AGREEMENT

THIS CONTRACT AGREEMENT is made the day of, 20.....

BETWEEN

(1)a corporation incorporated under the laws
(Name of Employer)
ofand having its principal place of business
(law of country of Employer)
at.....(Address of Employer) (hereinafter called "the Employer")

and

(2), a corporation incorporated under the laws of
(Name of Contractor)
..... and having its principal place of business
(Country of Contractor)
at (Address of Contractor) (hereinafter called "the Contractor")

WHEREAS the Employer desires to engage the Contractor to design, manufacture, test, deliver, install, complete and commission certain Facilities, viz.

..... ("the Facilities") and the
(List of Facilities)

Contractor has agreed to such engagement upon and subject to the terms and conditions hereinafter appearing.

NOW IT IS HEREBY AGREED as follows:

Article 1. Contract Documents

1.1 Contract Documents (Reference CC Clause 2)

The following documents shall constitute the Contract between the Employer and the Contractor, and each shall be read and construed as an integral part of the Contract:

- (1) This Contract Agreement and the Appendices hereto
- (2) Notification of Award.
- (3) Conditions of Contract & SCC
- (4) Technical Specifications and Drawings
- (5) The Bid and Price Schedules submitted by the Contractor
- (6) Procedures (as listed)
- (7) Any other documents shall be added here

1.2 Order of Precedence (Reference CC Clause 2)

In the event of any ambiguity or conflict between the Contract Documents listed above, the order of precedence shall be the order in which the Contract Documents are listed in Article 1.1 (Contract Documents) above.

1.3 Definitions (Reference CC Clause 1)

- 1.3.1 Capitalized words and phrases used herein shall have the same meanings as are ascribed to them in the Conditions of Contract.

Article 2. Contract Price and Terms of Payment

2.1 Contract Price (Reference CC Clause 11)

The Employer hereby agrees to pay to the Contractor the Contract Price in consideration of the performance by the Contractor of its obligations hereunder. The Contract Price shall be the aggregate of:

.....

.....

(amount in words)

(.....)

(amount in figures in INR)

or such other sums as may be determined in accordance with the terms and conditions of the Contract.

2.2 Terms of Payment (Reference CC Clause 12)

The terms and procedures of payment according to which the Employer will reimburse the Contractor are given in Appendix 1 (Terms and Procedures of Payment) hereto.

Article 3. Effective Date for Determining Time for Completion

3.1 Effective Date (Reference CC Clause 1)

The Time of Completion of Facilities shall be determined from the date of the Notification of Award provided all of the following conditions have been fulfilled within a period of two (2) months from the date of said Notification of Award:

- (a) This Contract Agreement has been duly executed for and on behalf of the Employer and the Contractor;
- (b) The Contractor has submitted to the Employer the Performance Security and the Advance Payment Guarantee;
- (c) The Employer has paid the Contractor the Advance Payment.

Each party shall use its best efforts to fulfill the above conditions for which it is responsible as soon as practicable.

- 3.2** If the Conditions listed under 3.1 are not fulfilled within two (2) months from date of Notification of Award because of reasons attributable to the Employer, the contract would become effective only from the date of fulfillment of the above conditions and, the parties shall discuss and agree on an equitable adjustment to the Contract Price and the time for completion and/or other relevant conditions of the Contract. The Contractor shall not however, benefit (in reckoning the Time for Completion) on account of its delay in providing the Performance Security or the Bank Guarantee for advance payment beyond the period provided in the Contract.

Article 4. It is expressly understood and agreed by and between the Contractor and the Employer that the Employer is entering into this Agreement solely on its own behalf and not on behalf of any other person or entity. In particular it is expressly understood and agreed that the Government of India (GoI) is not a party to this Agreement and has no liabilities, obligations or rights hereunder. It is expressly understood and agreed that the Employer is an independent legal entity with power and authority to enter into contracts solely on its own behalf under the applicable laws of India and the general principals of Contract Law.

The Contractor expressly agrees, acknowledges and understands that the Employer is not an Agent, Representative or Delegate of the GoI. It is further understood and agreed that the GoI is not and shall not be liable for any acts, omissions, commissions, breaches or other wrongs arising out of the Contract. Accordingly, the Contractor expressly waives, releases and foregoes any and all actions or claims, including cross claims, impleader claims or counter claims against the GoI arising out of this Contract and covenants not to sue the GoI as to any manner, claim, cause of action or thing whatsoever arising of or under this Agreement.

Article 5. Appendices

The Appendices listed in the attached List of Appendices shall be deemed to form an integral part of this Contract Agreement.

Reference in the Contract to any Appendix shall mean the Appendices attached hereto, and the Contract shall be read and construed accordingly.

Article 6. Deleted

Article 7. Notwithstanding the award of contract under two separate contracts, any breach under one contract shall be deemed to be a breach of the other contract(s).

IN WITNESS WHEREOF the Employer and the Contractor have caused this Agreement to be duly executed by their duly authorized representatives the day and year first above written.

Signed by for and
on behalf of the Employer

Signed by for and
on behalf of the Contractor

Signature

Signature

Title

Title

in the presence of

in the presence of

CONTRACT AGREEMENT

dated the day of 20.....

BETWEEN

("the Employer")

and

("the Contractor")

(Separate Contract Agreements shall be executed by the Employer and the Contractor in accordance with the Construction of the Contract stipulated at clause 44 of CC. The forms of Contract would be similar except for necessary changes required to suit the individual Contracts).

APPENDICES

Appendix 1	Terms and Procedures of Payment
Appendix 2	Price Adjustment
Appendix 3	Insurance Requirements
Appendix 4	Time Schedule
Appendix 5	List of Approved Subcontractors
Appendix 6	Scope of Works and Supply by the Employer
Appendix 7	List of Document for Approval or Review
Appendix 8	Functional Guarantees
Appendix 9	Integrity Pact (<i>to be appended at the Stage of Contract Award.</i>)

1.0 TERMS AND PROCEDURES OF PAYMENT

The payment to the Contractor under the Contract will be made by the Owner in line with Clause 12.0, Section-CC, Conditions of Contract, Volume-I of the Bidding Documents and as per the guidelines and conditions specified hereunder, on the basis of the Price Break-up given in the section on price schedules. Payments will be made in Indian currency i.e. INR. The Contractor may make applications for payment in respect of part deliveries as work proceeds.

In addition to the Conditions stipulated under Clause 12.0, Section-CC, Conditions of Contract, the following terms & Conditions will apply.

All payments made during the Contract will be on account payment only.

1.1 Supply Portion

- a) Advance Payment
10% (Ten percent) of the Ex-works price component (inclusive of mandatory spares) of the Contract price shall be paid as *interest bearing advance after signing the Contract Agreement and on submission of:
 - i) Unconditional acknowledgement of LOA by the contractor
 - ii) Contractor's detailed invoice
 - iii) Unconditional and irrevocable Advance Bank Guarantee** for 110% of the advance amount
 - iv) Performance Security
 - v) Detailed BAR CHART and its approval by DTL
 - vi) Execution of Contract Agreement.

Note:

*This payment is an optional payment. The Contractor has the option of taking the interest bearing initial advance or otherwise. In case, the Contractor opts for this interest bearing initial advance, the same shall be paid to the Contractor on fulfillment of above conditions and an interest on monthly outstanding amount will be charged at the rate of SBI MCLR at the time of disbursement of advance. The Interest shall be calculated from the date of interest amount paid and charged till the date of posting of Invoice by Finance department. The monthly outstanding amount for the purpose of calculating the interest shall be worked out at the end of each calendar month considering proportionate adjustment of advance against dispatch payment. In case, the Contractor opts not to take interest bearing advance as above, it would be mandatory for him to submit the documents listed at S. No.(i), (iv) and (v) and (vi) above within thirty (30)days of issuance of LOA.

**The bank guarantee(s) for advance shall be kept valid till 90 days after issuance of Operational Acceptance Certificate. Recovery of the advance amount shall be made from each running bill proportionately.

b) Progressive Payment

- i) Sixty percent (60%) ^{##} of the CIF / Ex-works price component (inclusive of mandatory spares) of each item (as identified in the price schedule) shipped shall be paid through irrevocable Letter of Credit (L/C) established in favour of the Contractor and on submission of documents specified in CC Clause 21.0.

^{##} In case, the Contractor opts not to take interest bearing initial advance then this payment shall be 70% instead of 60%.

- ii) Further Twenty percent (20%) of the CIF / Ex-Works price (exclusive of mandatory spares) of each item shipped shall be paid after receipt and storage of material at site and on physical verification by the Employer.
- iii) For mandatory spares, balance Thirty percent (30%) of the CIF / Ex-Works Price of each item shipped shall be paid after receipt and storage of material at site and on physical verification by the Employer.

c) Final Payment

Balance 10% (Ten percent) of the Ex-works price component of Main Equipment/Materials (excluding Mandatory Spares) shall be paid as per the following:

- i. 5% (Five percent) on Successful completion of erection, testing and commissioning of individual bays. For other than bay items, this payment shall be released upon respective commissioning/completion.
- ii. 5% (Five percent) on proof of submission of required number of reproducible, O&M Manuals, approved drawings, data sheets, test report, pamphlets and manuals of mandatory spares, maintenance & testing equipment and on successful completion of erection, testing and commissioning of all bays and issuance of Taking Over Certificate.

However, in case of delay, which is not attributable to contractor, in testing and commissioning & issuance of taking over certificate by Employer beyond six (6) months from the date of receipt of equipment at site, the last 10% of Ex-Works price of respective equipment shall be paid after issuance of a certificate by Employer's representative that the equipment have been received in good condition and on submission of a bank guarantee of equivalent amount, which shall be kept valid initially for a period of twelve (12) months or until three (3) months after the expected date of commissioning (in case it is possible to anticipate the same), whichever is earlier, provided all other conditions as per above are complied with by the Contractor. If the commissioning does not take place within the validity period of BG, the validity of BG shall be extended from time to time. The bank guarantee shall, however, be released within one month of successful commissioning of the respective equipment by the Employer.

1.2 DELETED

1.3 TRANSPORTATION & INSURANCE CHARGES

Hundred Percent (100%) of transportation and insurance charges shall be paid to the Contractor pro-rata to the value of the equipment received at site and on production of invoices by the Contractor. The aggregate of all such pro-rata payments shall, however, not exceed the total amount quoted by the bidder in his proposal and incorporated in the Contract.

1.4 ERECTION PRICE COMPONENT (INCLUDING CHARGES FOR CIVIL WORKS)

a) Advance

Ten Percent (10%) of the total Contract Price for services viz. installation (including civil works) component except transportation & insurance shall be paid as * interest bearing initial advance on establishment of Contractor's Site office and submission of a bank guarantee* of 110% of the advance amount valid till 90 days after issuance of Operational Acceptance Certificate.

*This payment is an optional payment. The Contractor has the option of taking the interest bearing advance or otherwise.

In case, the Contractor opts for this interest bearing advance, the same shall be paid to the Contractor on fulfillment of above conditions and an interest on monthly outstanding amount will be charged at the rate of SBI MCLR at the time of disbursement of advance. The monthly outstanding amount for the purpose of calculating the interest shall be worked out at the end of each calendar month against the progressive payment for the work done.

In case, the Contractor opts not to take interest bearing advance as above, it would be mandatory for him to submit the documents listed at S. No.(i), (iv),(v) and (vi) of 1.1 (a) above within thirty (30) days of issuance of LOA.

b) Progressive Payment

Eighty Percent (80%) of the total installation (including civil works) component of the Contract price (In case the contractor opts to take interest bearing advance as above) or Ninety Percent (90%) of the total installation (including civil works) component of the Contract price (In case the contractor opts not to take interest bearing advance as above) shall be paid progressively monthly on pro-rata basis on certification by Employer's representative.

c) Final Payment

Final 10% payment of the total installation (including civil works) shall be made as follow:

- a) 5% (Five percent) of the Installation price component shall be paid on commissioning of individual bay and
- b) balance 5% (Five percent) on proof of submission of required number of

reproducible, O&M Manuals, approved drawings, data sheets, test report, pamphlets and manuals of mandatory spares, maintenance & testing equipment and on successful completion of erection, testing and commissioning of all bays and issuance of Taking Over Certificate.

1.5 Deleted

- 1.6 “Commissioning” for the purpose of payments shall mean satisfactory completion of all supplies, erection, inspection, commissioning checks and successful completion of all site tests and continuous energisation of the equipment/ materials at rated voltage at site as per the Contract and to the satisfaction/ approval of DTL. The contractor will clear the sites and the balance materials, if any, will be shifted to proper place as per instruction of the Site Engineer. The necessary “No Dues Certificates” for electricity and water will required to be submitted, if any, from local agency(s)/ authority(s).

1.7 Taxes & Duties

Taxes & Duties in respect of transaction between Employer and the Contractor as applicable for destination site/state on all items of supply including bought-out finished items (as identified in the Contract), which shall be dispatched directly from the sub-vendor’s works to the Employer’s site will be paid after each shipment against documentary evidence. This payment shall be released by Employer directly to the Contractor against invoices to be submitted by the Contractor.

1.8 MODE OF PAYMENT

Payments shall be made by DTL within Thirty (30) days of receipt of Complete GST compliance tax invoices and supported by the requisite documents and fulfillment of stipulated conditions, if any. All the payment shall be released to the Contractor directly through ECS. For this the contractor shall have to provide their Bank Account No., Bank Name, RTGS / MICR / IFSC and other details to our AM(F)SB / AM(F)Works, IInd Floor, pre-fabricated building, Rajghat Power House, New Delhi - 110002.

Payment of GST component shall be made only if vendor deposited the GST and the credit for the same reflected in the form GSTR3 (Monthly Return) of the GST network and in case of dis- allowance of credit in GSTR3, the amount shall be recovered from vendor with the penalty as per the provision stipulated in GST Act/Law.

PRICE ADJUSTMENT

1. Price adjustment for Power Transformer/ Reactor.

The price variation as per latest IEEMA (Indian Electrical & Electronics Manufacturers Association) formula shall be applicable for power transformer/~~Reactor~~ as given below:

**PRICE VARIATION CLAUSE FOR POWER TRANSFORMERS AND REACTOR
COMPLETE WITH ALL ACCESSORIES AND COMPONENTS
(of voltage above 33 kV and up to 400kV)
of supplied against domestic contracts**

This price variation clause is applicable for Transformers and ~~Reactors~~ of voltage above 33 kV and up to 400 KV supplied against domestic contracts. A separate price variation clause IEEMA/PVC/PWR TRF_Up to 400 KV/DE/2021 has been evolved for above types of Transformers and Reactors supplied against export/deemed export contracts.

The price quoted/confirmed is based on the input cost of raw materials/components and labour cost as on the date of quotation and the same is deemed to be related to prices of raw materials and all India average consumer price index number for industrial workers as specified in the price variation clause given below. In case of any variation in these prices and index numbers, the price payable shall be subject to adjustment, up or down in accordance with the following formula:

$$P = \frac{P_0}{100} \left(6 + 32 \frac{C}{C_0} + 27 \frac{ES}{ES_0} + 12 \frac{IS}{IS_0} + 4 \frac{IM}{IM_0} + 9 \frac{TO}{TO_0} + 10 \frac{W}{W_0} \right)$$

Wherein,

P = Price payable as adjusted in accordance with the above formula.

P₀ = Price quoted/confirmed.

C₀ = Price of CC copper rods (refer notes)
This price is as applicable for the month, **ONE** month prior to the date of tendering.

ES₀ = Price of CRGO Electrical Steel Lamination (refer note)
This price is as applicable for the month, **ONE** months prior to the date of tendering.

IS₀ = Average price of steel Plates 10 mm thick (refer notes)
This price is as applicable for the month, **ONE** month prior to the date of tendering.

IM₀ = Price of Insulating Materials (refer notes)
This price is as applicable for the month, **ONE** months prior to the date of tendering.

TO₀ = Price of Transformer Oil (refer notes)
This price is as applicable for the month, **ONE** month prior to the date of tendering.

W₀ = All India average consumer price index number for industrial workers, as published by the Labour Bureau, Ministry of Labour, Govt. of India (Base: 2016 = 100).
This index number is as applicable for the month, **THREE** months prior to the date of tendering.

For example, if date of tendering (i.e. last stipulated date of receipt of tender including extensions) falls in December 2021, applicable prices of Copper Rods (Co), Steel Plates 10 mm thick (ISo), CRGO Electrical Steel Laminations (ESo) and Insulating material (IMo) and Transformer Oil (TOo) should be as on 1st November 2021 and all India average consumer price index no. (Wo) should be for the month of 1st September 2021.

The above prices and indices are as published by IEEMA vide circular reference number IEEMA(PVC)/PWR_DIST_TRF (R-1)/_/ **ONE** month prior to the date of tendering.

C = Price of CC copper rods (refer notes)
This price is as applicable for the month, **TWO** months prior to the date of delivery.

ES = Price of CRGO Electrical Steel Lamination (refer note)
This price is as applicable for the month, **TWO** months prior to the date of delivery.

IS = Average price of Steel Plates 10 mm thick (refer notes)
This price is as applicable for the month, **TWO** months prior to the date of delivery.

IM = Price of Insulating Materials (refer notes).
This price is as applicable for the month, **TWO** months prior to the date of delivery.

TO = Price of Transformer Oil (refer notes).
This price is as applicable for the month, **ONE** month prior to the date of delivery.

W = All India average consumer price index number for industrial workers, as published by the Labour Bureau, Ministry of Labour, Govt. of India (Base: 2016 = 100).
This index number is as applicable for the month, **THREE** months prior to the date of delivery.

For example, if date of delivery in terms of clause given below falls in December 2022, applicable prices of Copper Rods (C), Insulating material (IM), CRGO Electrical Steel Lamination (ES), Plates 10 mm thick (IS) should be as on 1st October 2022 and Transformer Oil (TO) should be 1st November 2022 and all India average consumer price index no. (W) should be for the month of September 2022.

The date of delivery is the date on which the transformer is notified as being ready for inspection/dispatch (in the absence of such notification, the date of manufacturer's dispatch note is to be considered as the date of delivery) or the contracted delivery date (including any agreed extension thereto), whichever is earlier.

Note: All prices are exclusive of GST and exclusive of any other central, state or local taxes etc.

(a) The details of prices are as under.

1. Price of 8 mm CC copper rod (in Rs./MT) is ex-works price as quoted by the primary producer.
2. The price of CRGO is the price of CRGO Electrical Steel Lamination in Rs./MT suitable for Transformers of voltage above 33 kV and up to 400 kV
3. Price of Steel is the average retail price of steel plates 10 mm thick as published by Joint Plant Committee (JPC) in Rs./MT
4. The price of Insulating materials (in Rs./Kg) of pre-compressed pressboards of size 10 mm thick, 3200 mm x 4100 mm is the average C&F price in free currency per MT converted into Indian Rupees with applicable exchange rates prevailing as on 1st working day of the month as quoted by primary suppliers. This price is the landed cost, inclusive of applicable customs duty only but exclusive of countervailing duty.
5. The price of Transformer Oil (in Rs./K.Ltr) is the average price on ex-refinery basis as quoted by primary producers for supply in drums.

(b) Some purchasers are purchasing oil immersed Transformers from manufacturers without first filling of oil. Oil for first filling is procured and filled by the purchasers. For such supplies PVC formula, excluding Oil will apply as under:

$$P = \frac{P_o}{91} \left(6 + 32 \frac{C}{C_o} + 27 \frac{ES}{ES_o} + 12 \frac{IS}{IS_o} + 4 \frac{IM}{IM_o} + 10 \frac{W}{W_o} \right)$$

Where description of P, P_o, C, ES, IS, IM, W etc. remains same as mentioned earlier

Note:

- No price increase shall be allowed beyond the original delivery date unless specifically stated in the Time Extension Letter, if any, issued by the Employer. The Employer will, however, be entitled to any decrease in the Contract Price which may be caused due to lower price adjustment amount in case of delivery of Goods beyond the original delivery date. Therefore, in case of delivery of Goods beyond the original delivery date, the liability of the Employer shall be limited to the lower of the price adjustment amount which may work out either on schedule date or actual date of delivery of Goods.
- If the Price Adjustment amount works out to be positive, the same is payable to the Contractor by the Employer and if it works out to be negative, the same is to be recovered by the Employer from the Contractor.

2. Price adjustment for “Civil Works”

The cost of Civil Works as per approved indices of CPWD due to increase/decrease in price of cement and steel reinforcement bars after receipt of tender as given below:

CLAUSE: PAYMENT DUE TO INCREASE/DECREASE IN PRICES OF CEMENT AND STEEL REINFORCEMENT BARS AFTER RECEIPT OF TENDER.

If after submission of the tender, the price of cement and/or steel reinforcement bars incorporated in the works (not being a material supplied from the Engineer-in Charge's stores in accordance with relevant contract clause thereof) increase(s) beyond the price(s) prevailing at the time of the last stipulated date for receipt of tenders (including extensions, if any) for the work, then the amount of the contract shall accordingly be varied and provided further that any such increase shall not be payable if such increase has become operative after the stipulated date of completion of work in question.

If after submission of the tender, the prices of cement and/or steel reinforcement bars incorporated in the works (not being a material stipulated from the Engineers-in-Charge's stores in accordance with the relevant contract clause thereof) is decreased. DTL shall in respect of these materials incorporated in the works (not being materials supplied from the Engineers-in-Charge's stores in accordance with the relevant contract clause thereof) be entitled to deduct from the dues of the contractor such amount as shall be equivalent to the difference between the prices of cement and/or steel reinforcement bars as prevailed at the time of last stipulated date for receipt of tenders including extensions if any for the work and the prices of these materials on the coming into force of such base price of cement and/or steel reinforcement bars issued under authority of Director General (Works) CPWD.

The increase/decrease in prices shall be determined by the All India Wholesale Price Indices for Cement and Steel (bars and rods) as published by Economic Advisor to Government of India, Ministry of Commerce and Industry and base price for cement and/or steel reinforcement bars as issued under authority of Director General (Works), CPWD as valid on the last stipulated date of receipt of tender, including extension if any and for the period under consideration.

The amount of the contract shall accordingly be varied for cement and/or steel reinforcement bars and will be worked out as per the formula given below:

- a) Adjustment for component of 'Cement'

$$V_C = P_C \times Q_C \times \frac{CI - CI_0}{CI_0}$$

Where,

V_C = Variation in cement cost i.e. increase or the amount in rupees to be paid or recovered.

P_C = Base price of cement as issued under authority of DG(W), CPWD valid at the

time of the last stipulated date of receipt of tender including extensions, if any.

Q_c = Quantity of cement used in the works since previous bill.

CI₀ = All India Wholesale Price Index for cement as published by the Economic Advisor to Government of India, Ministry of Industry and Commerce & issued by DG (W) CPWD as valid on the last stipulated date of receipt of tenders including extensions, if any.

CI = All India Wholesale Price Index for cement for period under consideration as published by Economic advisor to Government of India, Ministry of Industry and Commerce & issued by DG (W) CPWD.

b) Adjustment for component of 'Steel'

$$V_s = P_s \times Q_s \times \frac{SI - SI_0}{SI_0}$$

Where,

V_s = Variation in cost of steel reinforcement bars i.e. increase or decrease in the amount in rupees to be paid or recovered.

P_s = Base price of steel reinforcement bars as issued under authority of DG(W), CPWD at the time of the last stipulated date of receipt of tender including extensions, if any.

Q_s = Quantity of steel paid either by way of secured advance or used in the works since previous bill (whichever is earlier).

SI₀ = All India Wholesale Price Index for Steel (bars & rods) for the period under consideration as published by Economic Advisor to Government of India, Ministry of Industry and Commerce & issued by DG (W) CPWD as valid on the last stipulated date of receipt of tenders including extensions, if any.

SI = All India Wholesale Price Index for steel (bars & rods) for the period under consideration as published by Economic advisor to Government of India, Ministry of Industry and Commerce & issued by DG (W) CPWD.

Note:

- No price increase shall be allowed beyond the original delivery date unless specifically stated in the Time Extension Letter, if any, issued by the Employer. The Employer will, however, be entitled to any decrease in the Contract Price which may be caused due to lower price adjustment amount in case of delivery of Goods beyond the original delivery date. Therefore, in case of delivery of Goods beyond the original delivery date, the

liability of the Employer shall be limited to the lower of the price adjustment amount which may work out either on schedule date or actual date of delivery of Goods.

- If the Price Adjustment amount works out to be positive, the same is payable to the Contractor by the Employer and if it works out to be negative, the same is to be recovered by the Employer from the Contractor.

INSURANCE REQUIREMENTS

Insurances to be taken out by the Contractor

In accordance with the provisions of CC Clause 34, the Contractor shall at its expense take out and maintain in effect, or cause to be taken out and maintained in effect, during the performance of the Contract, the insurances set forth below in the sums and with the deductibles and other conditions specified. The identity of the insurers and the form of the policies shall be subject to the approval of the Employer, such approval not to be unreasonably withheld.

(a) Transit / Marine insurance During supply of materials for supply/ Supply portion of Contract

covering loss or damage occurring, whilst in transit from the Contractor's or manufacturer's works or stores until arrival at the Site, to the Facilities (including spare parts therefore) and to the Construction Equipment to be provided by the Contractor or its Subcontractors.

(i) For Imported Plant/ Equipment/ Materials

Amount	Deductible limits	Parties Insured	From	To
125%* of the (CIF value)	NIL	Contractor & Employer	Warehouse	Warehouse + 90 Days

***Price variation @ 10 % per Annum of CIF cost shall be taken subject to a maximum of 30% or specified otherwise, whichever is lower.**

(ii) For Domestic Plant/ Equipment/ Materials

Amount	Deductible limits	Parties Insured	From	To
110%* of the (FOR value)	NIL	Contractor & Employer	Warehouse	Warehouse + 90 Days

***Price variation @ 10 % per Annum of CIF cost shall be taken subject to a maximum of 30% or specified otherwise, whichever is lower.**

(b) Storage Cum Erection (SCE)/ Installation Insurance: All Risks Coverage

Covering physical loss or damage to all the equipment, material and facilities being supplied, under the contract, from point of receipt at site to Completion of the Facilities/ commissioning including handling, storage, erection, testing etc. with an extended maintenance coverage for the Contractor's liability in respect of any loss or

damage occurring during the Defect Liability Period while the Contractor is on the Site for the purpose of performing its obligations during the Defect Liability Period.

Amount	Deductible limits	Parties Insured	From	To
105% of the (Contract Price)	NIL	Contractor / Sub-contractor & Employer	Receipt at site	Upto Defect Liability period.

(c) Materials/Plants/ Equipments supplied By Employer As per (a) Above

(d) Third Party Liability Insurance

covering bodily injury or death suffered by third parties (including the Employer's personnel) and loss of or damage to property (including the Employer's property and any parts of the Facilities which have been accepted by the Employer) occurring in connection with the supply and installation of the Facilities.

Amount	Deductible limits	Parties Insured	From	To
Rs. 0.5 million per person per occasion	NIL	Contractor / Sub-contractor	Commencement of work	Upto Defect Liability period

(e) Automobile Liability Insurance

The contractor shall ensure that all the vehicles deployed by the contractor or its sub-contractors (whether or not owned by them) in connection with the supply and installation of the facilities in the project are duly insured as per RTA act. Further the contractor or its subcontractors may also take comprehensive policy (own damage plus third party liability) of each individual vehicles deployed in the project on their own discretion in their own name to protect their own interest.

(f) Worker's Compensation

in accordance with the statutory requirements applicable in any country where the Facilities or any part thereof is executed.

(g) Contractor' plant and Machinery (CPM) insurance

The Employer (including without limitation any consultant, servant, agent or employee of the Employer) shall not in any circumstances be liable to the Contractor for any loss of or damage to any of the Contractor's Equipment or for any losses, liabilities, costs, claims, actions or demands which the Contractor may incur or which may be made against it as a result of or in connection with any such loss or damage.

In this regard the vendor will submit an undertaking to DTL.

(h) Other Insurances

The Contractor is also required to take out and maintain at its own cost the following insurances:

Amount	Deductible limits	Parties Insured	From	To
	NIL	Contractor / Sub-contractor & Employer	Receipt at site	Upto Defect Liability period

The Employer shall be named as co-insured under all insurance policies taken out by the Contractor pursuant to CC Sub-Clause 34.1, except for the Third Party Liability, Worker's Compensation Insurance, and the Contractor's Subcontractors shall be named as co-insured under all insurance policies taken out by the Contractor pursuant to CC Sub Clause 34.1 above except for the **Transit / Marine insurance**, Worker's Compensation Insurance, and all insurer's rights of subrogation against such co-insured for losses or claims arising out of the performance of the Contract shall be waived under such policies.

Insurances to be taken out by the Employer

The Employer shall at its expense take out and maintain in effect during the performance of the Contract the following insurances.

Details:...

Amount	Deductible limits	Parties Insured	From	To
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----- NIL -----

TIME SCHEDULE

1. The Project Completion Schedule shall be as follows:

Sl. No.	Activities	Duration in months from the effective date of Contract
1.	Taking Over by the employer upon successful completion of: Design, Engineering, Supply, Erection, Testing & Commissioning of 220/66kV GIS Substation at Bharthal, including complete civil works & automation, along with LILO of 220kV D/C Bamnauli-DIAL Overhead Transmission Line at Bharthal, on a Turnkey Basis.	As Per SCC

- 1.1 The bidder shall include in his proposal his programme for furnishing and installation of the equipment including related civil work covered under this package. The programme shall be in the form of a master network plan (MNW) and shall identify the various activities like design, engineering, manufacturing, supply, installation, factory testing, transportation to site, site testing and commissioning guarantee test and operational acceptance etc. of the entire project work. The network plan shall confirm to the above completion schedule. No credit will be given for earlier completion.

This master network will be discussed and agreed before Award in line with above, engineering drawing and data submission schedule shall also be discussed and finalized before Award. Liquidated damages for delay in successful completion of taking over at rates specified in Clause 26.2 of CC shall be applicable beyond the date specified above.

- 1.2 The employer reserves the right to request minor changes in the work schedule at the time of Award of Contracts to the successful Bidder.
- 1.3 The successful Bidder shall be required to prepare detailed Network(s) and project implementation plans & programs and finalize the same with the Employer as per the requirement specified in Technical Specifications, which shall form a part of the Contract.

APPENDIX 5

LIST OF APPROVED SUBCONTRACTORS

Prior to award of Contract, the following details shall be completed indicating those subcontractors proposed by the Bidder by Attachment to its bid that are approved by the Employer for engagement by the Contractor during the performance of the contract.

The following Subcontractors are approved for carrying out the item of the facilities indicated. Where more than one Subcontractor is listed, the Contractor is free to choose between them, but it must notify the Employer of its choice in good time prior to appointing any selected Subcontractor. In accordance with CC Sub-Clause 19.1, the Contractor is free to submit proposals for Subcontractors for additional items from time to time. No Subcontractors shall be placed with any such Subcontractors for additional items until the Subcontractors have been approved in writing by the Employer and their names have been added to this list of Approved Subcontractors.

Item of Facilities	Approved Subcontractors	Nationality

SCOPE OF WORKS AND SUPPLY BY THE EMPLOYER

The following personnel, facilities, works and supplies will be provided/ supplied by the Employer, and the provisions of CC 10, 20, 21 and 24 as well as Employer responsibilities stated in technical specifications shall apply as appropriate.

All personnel, facilities, works and supplies will be provided by the Employer in good time so as not to delay the performance of the Contractor in accordance with the approved Time Schedule and Program of Performance pursuant to CC Sub-Clause 18.2.

Unless otherwise indicated, *all personnel, facilities, works and supplies* will be provided free of charge to the Contractor.

Personnel

Charge to Contractor – None

NIL

Facilities

Charge to Contractor - None except as noted

1. Permission will be arranged by the Employer for full site and facilities access as required for site surveys and for the installation, connection and testing of complete equipment and systems. Such permission shall be requested by the Contractor one month prior to the Scheduled need for such access, consistent with the Contractors "Project Implementation Plan", Subsequent to approval of such "Plan" by Employer.

Electricity and Water

Charge to Contractor - as noted

The Contractor shall be entitled to use for the purposes of the facilities such supplies of electricity and water as may be available on the Site and shall provide any apparatus necessary for such use. The Contractor shall pay the Employer at the applicable tariff plus Employer's overheads, if any, for such use. Where such supplies are not available, the Contractor shall make his own arrangement for provision of any supplies he may require.

Works

Charge to Contractor - None

-----NIL-----

Supplies

Charge to Contractor - None

-----NIL-----

LIST OF DOCUMENTS FOR APPROVAL OR REVIEW

Pursuant to CC Sub-Clause 20.3.1, the Contractor shall prepare or cause its Subcontractor to prepare, and present to the Project Manager in accordance with the requirements of CC Sub-Clause 18.2 (Program of Performance), the following documents for:

A. Approval

- 1.
- 2.
- 3.

B. Review

- 1.
- 2.
- 3.

Note :

Bidder shall furnish the exhaustive list, which shall be discussed and finalized for incorporation into the Contract Agreement.

FUNCTIONAL GUARANTEES

GUARANTEES, LIQUIDATED DAMAGES FOR NON-PERFORMANCE

1. The equipment offered shall meet the rating and performance requirements stipulated in Technical Specification for various equipment or indicated in Data requirement.
2. In particular, **Power Transformer and Reactor** offered under this contract shall meet the maximum loss limit requirement as stipulated in technical specifications. Penalties shall be levied on the manufacturer/contractor (as the case may be) if losses measured during routine test are found to be within +2% tolerance of the losses specified in technical specifications, beyond which the transformer shall be liable for rejection. No benefit shall be given for supply of transformer with losses (measured during routine tests) less than the losses specified in technical specifications.
3. In particular, **LT Transformer** offered under this contract shall meet the maximum loss limit requirement as stipulated in technical specifications. The losses shall be firm and no positive tolerance shall be allowed. No benefit shall be given for supply of LT transformer, with losses (measured during routine tests) less than the losses specified in Technical specification.
4. **HTLS Conductor**
 - a. The ratings and performance figures of the below mentioned equipment are guaranteed by you.

S.No.	Item	Guaranteed AC Resistance (R_{ac}) in Ohm per km at temperature corresponding to the Rate of Liquidated Damages in Indian Rupees continuous current of operating 1200 A under normal condition	Rate of Liquidated Damages in Indian Rupees (applicable for Average Ohmic Loss)
1.	HTLS Conductor		Rs. 1,52,600/- (Rupees One Lakh Fifty-Two Thousand Six Hundred only)

- b. If the aforementioned guarantees are not established at factory tests, then the Employer at his discretion may reject or accept the equipment after assessing the liquidated damages as per table above against the Contract and such amounts shall be deducted from the Contract Price or otherwise recovered from the Contractor.

6(a) PROFORMA OF BANK GUARANTEE FOR PERFORMANCE SECURITY

Bank Guarantee No.....

Date

To,

To

[Name and address of the Employer]

- 1) In consideration of the Delhi Transco Limited (hereinafter called “The Undertaking”) having agreed to accept from M/s..... (hereinafter called the said contractor(s) from the demand, under the terms & conditions of an agreement dated..... between Delhi Transco Limited & M/s..... for supply of..... Nos..... in respect of NOA No..... dated..... (hereinafter called the agreement) security deposit for the due fulfillment of the said contract of the terms & conditions contained in the said agreement on production of Bank Guarantee for Rs..... (Rupees.....). We (Name of Bank with address) (hereinafter referred to as “The Bank”) do hereby undertake to pay to the undertaking amount not exceeding Rs..... (Rupees.....) against any loss or damage caused to or suffered or would be caused to the said contractor of any of the terms & conditions in the said agreement. As 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..... (Rupees.....).
- 2) We (Name of Bank with address) do hereby undertake to pay the amount due and payable under this guarantee without any demur, merely on a demand for the undertaking stating that the amount claimed due by a way of loss or damage caused to or would be caused to suffered by the undertaking by reason of any breach, by the said contractor(s) or any of the terms & conditions contained in the said agreement. 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..... (Rupees.....).
- 3) We (Name of Bank with address), further agree that the guarantee herein contained shall remain in full force and effect during the period that would be taken for performance of the said agreement and that it shall continue to be enforceable till all the dues of the undertaking by virtue of the said agreement have been fully paid and its claims satisfied or discharged of till (Date of validity) the undertaking certifies that the terms & conditions of the said agreement have been fully and properly carried out by the said contractor(s) and accordingly guarantee is made on us in writing on or before the (Date of validity).
- 4) We (Name of Bank with address), further agree with the undertaking that the undertaking shall have the fullest liberty without our consent and without effecting in any manner our obligations hereunder to vary any of the agreement or to enforce any of the performance by the said contractor and to forebear or enforce any of the terms & conditions relating to the said or any such variation, or extension being warrantee to the said contract(s) for any forbearance, act or omission on the part of the undertaking or any indulgence by the

Undertaking to the 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.

- 5) We, (Name of Bank with address), lastly undertake not to revoke this guarantee during its currency except with the previous consent of the Undertaking in writing and to extend the period of guarantee, if required for any reason.
- 6) “Notwithstanding anything contained herein above, our liability under this guarantee is restricted to Rs..... (Rupees.....) and the guarantee shall remain in force upto (date of validity) unless a demand or claim in writing is presented on the bank within (date of validity). The Bank shall be relieved and discharged from all liabilities there under”

Dated the..... Day of200

For (Name of Bank)

(BRANCH MANAGER)

WITNESS

1.....

6(b) PERFORMANCE SECURITY FORM (For Insurance Surety Bond)

(To be stamped in accordance with Stamp Act of India)

Insurance Surety Bond No.:

Date:

Name of Contract.....

NOA/Contract No. and date:

Amount of Bond:

To,

_____ *Name of the Owner*

_____ *Address of Owner*

1. PARTIES

This Bond is executed by [**Insurance Company Name**] ("Surety"), a company registered with the Insurance Regulatory and Development Authority of India (IRDAI), having its registered office at [**Address**], in favor of **Delhi Transco Limited** ("Obligee" or "Owner") for the performance of obligations by [**Contractor**] ("Principal"), [Address].

2. CONTRACT

The Principal has entered into a Contract with the Obligee dated [**Date**] for [**Brief description of project/work**] ("Contract") pursuant to the Tender ID [.....] and RFP/NIT Document issued in respect of the Project/work and other related documents including without limitation the contract Agreement.

3. GUARANTEE

The Principal and Surety are firmly bound to the Obligee in the sum of [**Amount in words and figures**] i.e., [.....] percent (___%) of the Contract Price until valid upto defect liability period but initially for 12 months from the date of taking over/operational acceptance. i.e., upto and inclusive of (dd/mm/yy) (referred to as "**Surety Bond Amount**"), for which payment, the Principal and Surety bind themselves, their heirs, executors, administrators, and successors, jointly and severally.

The Surety, at the request of the Contractor, irrevocably, unconditionally and without reservation, guarantee the due and faithful fulfilment and compliance of the terms and conditions of Contract by the Contractor during the [**Construction Period/Operation and Maintenance Period**] and unconditionally and irrevocably undertake to pay forthwith to the Obligee upon its mere first written demand, and without any demur, reservation, recourse, contest or protest, and without any reference to the Contractor, such sum or sums up to an aggregate sum of the Surety Bond Amount as the Obligee shall claim without the Obligee being required to prove or to show grounds or reasons for its demand and/or for the sum specified therein.

In order to give effect to this Surety Bond, the Obligee shall be entitled to act as if the Surety Insurer were the principal debtor and any change in the constitution

of the Contractor and/or the Surety Insurer, whether by their absorption with any other body or corporation or otherwise, shall not in any way or manner affect the liability or obligation of the Surety Insurer under this Surety Bond.

It shall not be necessary, and the Surety Insurer hereby waives any necessity, for the Obligee to proceed against the Contractor before presenting to the Surety Insurer its demand under this Surety Bond.

This Surety Bond is in addition to and not in substitution of any other Surety Bond or security now or which may hereafter be held by the Owner in respect of or relating to the Contract or for the fulfillment, compliance and/ or performance of all or any of the obligations of the Contractor under the Contract.

4. MECHANISM

A letter from the Owner, under the hand of an officer-in-charge of Project/Work, that the Contractor has committed default in the due and faithful performance of all or any of its obligations under and in accordance with the Contract shall be conclusive, final and binding on the Surety Insurer. The Surety Insurer further agrees that the Owner shall be the sole judge as to whether the Contractor is in default in due and faithful performance of its obligations during and under the Contract and its decision that the Contractor is in default shall be final and binding on the Surety Insurer, notwithstanding any differences between the Owner and the Contractor, or any dispute between them pending before any Court, Tribunal, Arbitrators or any other Owner or body, or by the discharge of the Contractor for any reason whatsoever.

Any notice by way of request, demand or otherwise hereunder may be sent by post or email addressed to the Surety Insurer (as provided in this Surety Bond) at its above referred branch, which shall be deemed to have been duly authorized to receive such notice and to effect payment thereof forthwith, and if sent by post it shall be deemed to have been given at that time when it ought to have been delivered in due course of post and in proving such notice, when given by post, it shall be sufficient to prove that the envelope containing the notice was posted and a certificate signed by an officer of the Owner that the envelope was so posted shall be conclusive. When the demand/notice is sent by email, it shall be deemed to have been given at that time of email, provided the email is sent and is not undelivered.

5. AMENDMENT

The Owner shall have the liberty, without affecting in any manner the liability of the Surety Insurer under this Surety Bond, to vary at any time, the terms and conditions of the Contract or to extend the time or period for the compliance with, fulfillment and/ or performance of all or any of the obligations of the Contractor contained in the Contract or to postpone for any time, and from time to time, any of the rights and powers exercisable by the Owner against the Contractor, and either to enforce or forbear from enforcing any of the terms and conditions contained in the Contract and/or the securities available to the Owner, and the Surety Insurer shall not be released from its liability and obligation under these presents by any exercise by the Owner of the liberty with reference to the matters aforesaid or by reason of time being given to the Contractor or any other forbearance, indulgence, act or omission on the part of

the Owner or of any other matter or thing whatsoever which under any law relating to sureties and guarantors would but for this provision have the effect of releasing the Surety Insurer from its liability and obligation under this Surety Bond and the Surety Insurer hereby waives all of its rights under any such law.

6. PERIOD

This Surety Bond shall come into force with immediate effect and shall remain in force and effect **upto defect liability period but initially for 12 months from the date of taking over/operational acceptance** i.e. upto and inclusive of (dd/mm/yy) and shall be extended from time to time for such period (not exceeding one year), as may be desired by M/s. (Contractor) on whose behalf this Surety Bond has been given.

Notwithstanding anything contained hereinbefore, the liability of the Surety Insurer under this Surety Bond is restricted to the Surety Bond Amount and this Surety Bond will remain in force for the period specified and Surety Insurer's liability under this **Insurance Surety Bond** shall become null and void immediately upon its expiry, whether it is returned or not, and no claim may be made hereunder after such expiry or after the aggregate of the sums paid by us to you shall equal the sums guaranteed hereunder, whichever is the earlier.

7. WARRANTIES

The Surety Insurer undertakes not to revoke this Surety Bond during its currency, except with the previous express consent of the Owner in writing, and declares and warrants that it has the power to issue this Surety Bond and the undersigned has full powers to do so on behalf of the Surety Insurer.

No action, event or condition which by any applicable law should operate to discharge Surety Insurer from liability hereunder shall have any effect and Surety Insurer hereby waive any right Surety Insurer may have to apply such law so that in all respects our liability hereunder shall be irrevocable and, except as stated herein, unconditional in all respects.

The Insurer confirms that this Insurance Surety Bond has been issued with observance of appropriate laws of the country of issue i.e. India.

8. LAW

The Insurer also agree that this Insurance Surety Bond shall be irrevocable and governed and construed in accordance with Indian Laws and subject to exclusive jurisdiction of Courts in New Delhi of the place from where NIT has been invited.

9. MODE OF PAYMENT

All Claims of DTL (beneficiary) against this Insurance Surety Bond, shall be remitted by the(Insurer's name to be inserted) to the following account of DTL only through electronic transfer of funds, unless otherwise specifically communicated by DTL.

All notices to be given under shall be given by registered (airmail) posts to the addressee at the address herein set out or as otherwise advised by and between the parties hereto.

Notwithstanding anything contained herein:

1. Our liability under this **Insurance Surety Bond** shall not exceed _____
(value in figures)_____ [_____ (value in words)_____].

2. This **Insurance Surety Bond** shall be valid upto _____(validity date)_____.

3. We are liable to pay the guaranteed amount or any part thereof under this **Insurance Surety Bond** only & only if we receive a written claim or demand on or before _____ (validity date) _____.

For and on behalf of the **Insurer**

[Signature of the authorised signatory(ies)]

Signature_____

Name_____

Designation_____

Code No. _____

Contact Number(s): Tel. _____

Mobile _____

Fax Number _____

email _____

Address_____

Common Seal of the Insurer

Witness:

Signature_____

Name_____

Address_____

Contact Number(s): Tel._____

Mobile_____

email _____

Note:

1. The Insurance Surety Bond should be on Non-Judicial stamp paper/e-stamp paper of appropriate value as per Stamp Act prevailing in the state(s) where the Insurance Surety Bond is submitted or is to be acted upon or the rate prevailing in State where the Insurance Surety Bond is executed, whichever is higher. The Stamp Paper/e-stamp paper shall be purchased in the name of Bidder/Insurer issuing the Insurance Surety Bond.
2. The Insurance Surety Bond shall be signed on all the pages by the Insurer Authorities and should invariably be witnessed.
3. The Insurance Surety Bond shall be from an Insurer as per guidelines issued by Insurance Regulatory and Development Authority of India (IRDAI) as amended from time to time.
4. The Employer shall be the Creditor, the Bidder shall be the Principal debtor and the Insurance company/Insurer shall be the Surety in respect of the Insurance Surety Bond to be issued by the Insurer.
5. While getting the Insurance Surety Bond issued, Contractors/ Suppliers are required to ensure compliance to the points mentioned in Form of Insurance Surety Bond.
6. The Insurance Surety Bond should contain the name, designation and code number of the Authorised Signatory signing the Insurance Surety Bond.
7. The Address, telephone number, email ID and other details of the head office of the Insurance Company as well as issuing branch should be mentioned on the covering letter of issuing branch.
8. Matter to be mentioned in covering letter to be submitted by vendor along with insurance surety bond:

S.No.	Particulars	Details
10.	Insurance Surety Bond No	
11.	Date of execution of Insurance Surety Bond	
12.	Expiry date of Insurance Surety bond	
13.	Expiry date of claim period of Insurance Surety	

14.	Vendor Name / Vendor Code	Name:
		Code:
15.	Insurance Surety Bond Amount	
16.	Tender No	
17.	Nature of Insurance Surety Bond	
18.	Insurer Details	Insurer Name :
		Address :
		Email Id :
		Phone No :

7. BANK GUARANTEE FORM FOR ADVANCE PAYMENT

Date.....

Contract No.....

[Name of Contract]

To: [Name and address of the Employer]

Dear Ladies and/or Gentlemen,

We refer to the Contract ("the Contract") signed on..... between you and..... ("the Contractor") concerning design, execution and completion of (Brief description of the Facilities)

Whereas, in accordance with the terms of the said Contract, the Employer has agreed to pay or cause to be paid to the Contractor an Advance Payment in the amount of Indian Rupees (INR).....

(Amount in words)

.....(.....)
(Amount in figures in INR)

By this letter we, the undersigned,, a Bank (or company) organized under the laws of and having its registered/principal office at..... do hereby jointly and severally with the Contractor irrevocably guarantee repayment of the said amounts upon the first demand of the Employer without cavil or argument in the event that the Contractor fails to commence or fulfill its obligations under the terms of the said Contract, and in the event of such failure, refuses to repay all or part (as the case may be) of the said advance payment to the Employer.

Provided always that the Bank's obligation shall be limited to an amount equal to the outstanding balance of the advance payment, taking into account such amounts, which have been repaid by the Contractor from time to time in accordance with the terms of payment of the said Contract as evidenced by appropriate payment certificates.

This Guarantee shall remain in full force from the date upon which the said advance payment is received by the Contractor until the date upon which the Contractor has fully repaid the amount so advanced to the Employer in accordance with the terms of the Contract. At the time at which the outstanding amount is NIL, this Guarantee shall become null and void, whether the original is returned to us or not.

Any claims to be made under this Guarantee must be received by the Bank during its period of validity, i.e. upto 90 (ninety) days after the date of operational acceptance by the Employer i.e. on or before.....(year, month, date).

Yours truly,
For and on behalf of the Bank

[*Signature of the authorised signatory(ies)*]

Signature _____

Name _____

Designation _____

POA Number _____

Contact Number(s): Tel. _____ Mobile _____

Fax Number _____

email _____

Common Seal of the Bank _____

Witness:

Signature _____

Name _____

Address _____

Contact Number(s): Tel. _____ Mobile _____

email _____

Note :

1. The non-judicial stamp papers of appropriate value shall be purchased in the name of bank who issues the 'Bank Guarantee'.
2. Advance Bank Guarantee is to be provided by the successful bidder in the form of a bank guarantee which should be issued either:
 - (a) by a reputed bank located in the country of Employer and acceptable to the Employer, or
 - (b) by a foreign bank confirmed by either its correspondent bank located in the country of Employer which should be reputed and acceptable to the Employer, or
 - (c) by a Public Sector Bank in the country of Employer.

All banks shall be nationalized and scheduled banks operating in India.

8. FORM OF COMPLETION CERTIFICATE

Date.....

Name of Contract.....

Contract No.....

To:

(Name and address of the Contractor)

Dear Ladies and/or Gentlemen,

Pursuant to CC 24 (Completion of the Facilities) of the Conditions of the Contract entered into between yourselves and the Employer dated relating to the

(Brief description of the Facilities)

we hereby notify you that the following part(s) of the Facilities was (were) complete on the date specified below, and that, in accordance with the terms of the Contract, the Employer hereby takes over the said part(s) of the Facilities, together with the responsibility for care and custody and the risk of loss thereof on the date mentioned below :

1. Description of the Facilities or part thereof
2. Date of Completion :.....

However, you are required to complete the outstanding items listed in the attachment hereto as soon as practicable.

This letter does not relieve you of your obligation to complete the execution of the Facilities in accordance with the Contract nor of your obligations during the Defects Liability Period.

Very truly yours,

Title
(Project Manager)

9. FORM OF OPERATIONAL ACCEPTANCE CERTIFICATE

Date.....

Name of Contract.....

Contract No.....

To:

(Name and address of the Contractor)

Dear Ladies and/or Gentlemen,

Pursuant to CC 25.3 (Operational Acceptance) of the Conditions of the Contract entered into between yourselves and the Employer dated.....
relating to the
(Brief description of the facilities)

we hereby notify you that the Functional Guarantees of the following part(s) of the Facilities were satisfactorily attained on the date specified below.

1. Description of the Facilities or part thereof
2. Date of Operational Acceptance :

This letter does not relieve you of your obligation to complete the execution of the Facilities in accordance with the Contract nor of your obligations during the Defects Liability Period.

Very truly yours,

Title
(Project Manager)

10. CHANGE ORDER PROCEDURE

Contract No.

CONTENTS

1. GENERAL

2. CHANGE ORDER LOG

3. REFERENCE FOR CHANGES

1. ANNEXURES

ANNEX 1	Request for Change Proposal
ANNEX 2	Estimates for Change Proposal
ANNEX 3	Acceptance of Estimates
ANNEX 4	Change Proposal
ANNEX 5	Change Order
ANNEX 6	Pending Agreement Change Order
ANNEX 7	Application for Change Proposal
ANNEX 8	Change Order Log

CHANGE ORDER PROCEDURE

1. General

This section provides samples of procedures and forms for implementing changes in the Facilities during the performance of the Contract in accordance with CC 39 (Change in Facilities) of the Conditions of Contract.

2. Change Order Log

The Contractor shall keep an up-to-date change Order Log to show the current status of Requests for Change and Changes authorized or pending as Annex-8 Entries of the Changes in the Change Order Log shall be made to ensure that the log is up-to-date. The Contractor shall attach a copy of the current Change Order Log in the monthly progress report to be submitted to the Employer.

3. References for Changes

- (i) Request for Changes as referred to in CC Clause 39 shall be serially numbered CR-X-nnn.
- (ii) Estimate for Change Proposal as referred to in CC Clause 39 shall be serially numbered CN-X-nnn.
- (iii) Acceptance of Estimate as referred to in CC Clause 39 shall be serially Numbered CA-X-nnn.
- (iv) Change Proposal as referred to in CC Clause 39 shall be serially numbered CP-X-nnn.
- (v) Change Order as referred to in CC Clause 39 shall be serially numbered CO-X-nnn.

Notes :

- (a) Requests for Change issued from the Employer's Home Office and the site representatives of the Employer shall have the following respective references:

Home Office	CR-H-nnn
Site	CR-S-nnn

- (b) The above number "nnn" is the same for Request for Change, Estimate for Change Proposal Acceptance of Estimate, Change Proposal Change Order.

REQUEST FOR CHANGE PROPOSAL

.....
(Employer's Letterhead)
.....

To : (Contractor's Name and Address)

Date :

.....
.....
.....

Attention : (Name and Title)

.....
.....

(Contract Name).....

(Contract No.).....

.....
.....

Dear Ladies and/ or Gentlemen :

With reference to the captioned Contract, you are requested to prepare and submit a Change Proposal for the Change noted below in accordance with the following instructions withindays of the date of this letter. (or on before[date])

1. Title of Change :.....

2. Change Request No..... (Rev.....)

3. Originator of Change:

Employer (Name).....

Contractor (by Application for Change Proposal No.....*)

* Refer to ANNEX 7.

4. Brief Description of Change :

.....
.....
.....

5. Facilities and/ or Item No. of equipment related to the requested Change :

.....
.....
.....

6. Reference drawings and /or technical documents for the request of Change :
Drawings No. / Document No. **Description**

.....
.....
.....

7. Detailed conditions or special requirements on the requested Change :

.....
.....
.....

8. **General Terms and Conditions :**

- (1) Please submit your estimate to us showing what effect the requested Change will have on the Contract Price.
- (2) Your estimate shall include your claim for the additional time, if any for completion of the requested Change.
- (3) If you have any opinion negative to the adoption of the requested Change in connection with the conformability to the other provisions of the Contract on the safety of the Plant or Facilities Please inform us of your opinion in your proposal of revised provisions.
- (4) Any increase or decrease in the work of the Contractor relating to the services of its personnel shall be calculated.
- (5) You shall not proceed with the execution of the work for the requested Change Until we have accepted and confirmed the amount and nature in writing

.....
(Employer's Name)

(Signature)
.....

(Name of signatory)
.....

(Title of signatory)

ESTIMATE FOR CHANGE PROPOSAL

.....
(Contractor's Letterhead)
.....

To : (Employer's Name and Address) Date :

Attention : (Name and Title)
.....

Contract Name.....

Contract Number.....

Dear Ladies and /or Gentlemen:

With reference to your Request for Change Proposal, we are pleased to notify you of the approximate cost of preparing the below-referenced Change Proposal in accordance with CC Sub-Clause 39.2.1 of the Conditions of Contract. We acknowledge that your agreement to the cost of preparing the Change Proposal, in accordance with CC Sub-Clause 39.2.2, is required before estimating the Cost for Change work.

1. Title of Change
2. Change Request No.....(Rev.....)
3. Brief Description of Change :
.....
.....
4. Scheduled Impact of Change :
.....
.....
5. Cost for Preparation of Change Proposal (in the currencies of the Contract)
.....
.....

(a)	Engineering	(Amount)
(i)	Engineer _____ hrs x _____ rate/hr =	_____
(ii)	Draftsperson _____ hrs x _____ rate/hr =	_____
	Sub-total _____ hrs	_____
	Total Engineering Cost	_____

(b) Other Cost _____
Total Cost (a) + (b) _____

.....
(Contractor's Name)

.....
(Signature)

.....
(Name of Signatory)

(Title of signatory)

ACCEPTANCE OF ESTIMATES

.....
(Employer's Letterhead)
.....

To : (Contractor's Name and Address) Date :

Attention : (Name and Title).....
.....

Contract Name :
Contract Number.....

Dear Ladies and /or Gentlemen :

We hereby accept your Estimate for Change Proposal and agree that you should proceed with the preparation of the Change Proposal.

1. Title of Change :

2. Change Request No. (Rev)

3. Estimate for Change Proposal No. (Rev)

4. Acceptance of Estimate No..... (Rev)

5. Brief Description of Change :
.....
.....

6. Other Terms and Conditions In the event that we decide not to order the Change accepted, you shall be entitled to compensation for the cost of preparation of Change Proposal described in your estimate for Change Proposal mentioned in para. 3 above in accordance with CC Clause 39.0 of the Conditions of Contract.

.....
(Employer's Name)

.....
(Signature)

.....
(Name and Title of signatory)

CHANGE PROPOSAL

.....
(Contractor's Letterhead)
.....

To : (Employer's Name and Address)

Date :

.....
.....
.....
Attention : (Name and Title)
.....
.....

(Contract Name)

(Contract No.)

.....
.....
Dear Ladies and / or Gentlemen

In response to your Request for Change Proposal No.we hereby submit our proposal as follows :

1. Title of Change : (Name)

2. Change Request No.(Rev

3. Originator of Change : Employer (Name)
Contractor (Name)

4. Brief Description of Change :

.....
.....

5. Reasons for Change :

.....
.....

6. Facilities and/ or Item No. of equipment related to the requested Change :

.....
.....

7. Reference drawings and/ or technical documents for the requested Change :

Drawing No. / Document No.

Description

.....
.....

.....
.....

8. Estimate of increase / decrease / (in the currencies of the contract to the Contract Price resulting from Change Proposal

(Amount)

- (a) Direct Material
- (b) Major construction equipment
- (c) Direct field labour (Total hrs)
- (d) Subcontracts
- (e) Indirect material and labour
- (f) Site supervision
- (g) Head office technical staff salaries

Process engineer	hrs @	rate/hr	_____
Project engineer	hrs @	rate/hr	_____
Equipment engineer	hrs @	rate/hr	_____
Procurement	hrs @	rate/hr	_____
Draftsperson	hrs @	rate/hr	_____
Total _____ hrs @			_____

- (h) Extraordinary costs (computer, travel, etc.) _____
- (i) Fee for general administration _____ % of Items _____
- (j) Taxes and customs duties _____

Total lump sum cost of Change Proposal
[sum of Items (a) to (j)] _____

Cost to prepare Estimate for Change Proposal
(amount payable if Change is not accepted) _____

9. Additional time for Completion required due to Change Proposal :
10. Effect on the other Functional Guarantees.
11. Effect on the other terms and Conditions of the Contract.
12. Validity of this Proposal : Withindays after receipt of this Proposal by the Employer.
13. Other Terms and Conditions of this Change Proposal:

- (a) You are requested to notify us of your acceptance, comments or rejection of this detailed Change Proposal within.....days from your receipt of this Proposal.
- (b) The amount of any increase and/ or decrease shall be taken into account In the adjustment of the Contract Price.
- (c) Contractor's cost for preparation of this Change Proposal :

(Note) This cost shall be reimbursed by the Employer in case of Employer's withdrawal or rejection of this Change Proposal without default of the Contractor in accordance with CC Clause 39.0 of the Conditions of Contract.

.....
(Contractor's Name)

.....
(Signature)

.....
(Name of signatory)

.....
(Title of signatory)

.....
(Contractor's Name)

.....
(Signature)

.....
(Name of signatory)

.....
(Title of signatory)

PENDING AGREEMENT CHANGE ORDER

(Contractor's Letterhead)

To : (Employer's Name and Address)

Date :

Attention : (Name and Title)

(Contract Name)

(Contract No.)

Dear Ladies and / or Gentlemen :

We instruct you to carry out the work in the Change Order detailed below in accordance with CC 39.0 of the Conditions of Contract.

1. Title of Change : (Name)
2. Employer Request for Change Proposal No.....(Rev) Dated.....
3. Contractor's Change Proposal No.....(Rev.....) Dated.....
4. Brief Description of Change :

5. Facilities and/ or Item No. of equipment related to the requested Change :

- | | |
|----------------------------|---|
| 6. | Reference drawings and/ or technical documents for the requested Change |
| Drawing No. / Document No. | Description |

7. Adjustment of time for completion :
8. Other change in the Contract terms :
9. Other terms and Conditions :

(Contractor's Name)

(Signature)

(Name of signatory)

(Title of signatory)

APPLICATION FOR CHANGE PROPOSAL

.....
(Contractor's Letterhead)
.....

To : (Employer's Name and Address)

Date :

.....
.....
.....

Attention : (Name and Title)

.....
.....

(Contract Name)

(Contract No.)

.....
.....

Dear Ladies and / or Gentlemen :

We hereby propose that the below mentioned work be treated as a Change in the Facilities.

1. Title of Change :
(Name)
2. Application for Change Proposal No.....(Rev)
Dated
3. Brief Description of Change :
.....
.....
4. Reasons for Change :
.....
.....
5. Order of Magnitude Estimation (in the currencies of the Contract).
.....
.....
6. Scheduled Impact of Change :
.....
.....
7. Effect on Functional Guarantee. If any :
.....
.....
8. Appendix

.....
.....

.....
(Contractor's Name)

(Signature)

.....
(Name of signatory)

.....
(Title of signatory)

CHANGE ORDER LOG

.....
 (Contractor's Letterhead)

To : (Employer's Name and Address)

Date :

.....

Attention : (Name and Title)

.....

(Contract Name)

(Contract No.)

.....

Dear Ladies and / or Gentlemen :

(Contract Name).....

(Contract No.....

.....

We hereby furnish the up-to date change order log to show the current status of request for changes and authorized or pending.

S1. No.	Employer's Request for change proposal revision	Contractor application for change including revision	Contractor's Change proposal including revision	Change order No. including revision	Pending proposal No.	Remarks*
------------	---	--	---	--	-----------------------------	----------

.....
 (Contractor's Name)
 (Signature)

.....
 (Name of signatory)

.....

Title of Signatory

Note :

- (i) *In case Employer has authorized to carryout the work pending agreement change order, the details of such authorization shall be furnished.
- (ii) The contractor shall attach a copy of the current change order log in the monthly progress report to be submitted to the Employer every month.

11. FORM OF INDEMNITY BOND TO BE EXECUTED BY THE CONTRACTOR FOR THE EQUIPMENT HANDED OVER IN ONE LOT BY DELHI TRANSCO LTD. FOR PERFORMANCE OF ITS CONTRACT

INDEMNITY BOND

THIS INDEMNITY BOND is made this day of..... 200..... by..... a Company registered under the Companies Act, 1956/ Partnership firm/ proprietary concern having its Registered Office at.....(hereinafter called as 'Contractor' or "Obligor" which expression shall include its successors and permitted assigns) in favour of DELHI TRANSCO LTD, a Company incorporated under the Companies Act, 1956 having its Registered Office at Shakti Sadan, Kotla Road, New Delhi-110002.

WHEREAS DELHI TRANSCO LTD. has awarded to the Contractor a contract forvide its Notification of Award/ Contract No..... datedand its Amendment No.....(applicable when amendments have been issued) (hereinafter called the "Contract") in terms of which DTL is required to hand over various Equipments to the Contractor for execution of the Contract.

And WHEREAS by virtue of Clause No.....of the said Contract, the Contractor is required to execute an Indemnity Bond in favour of DTL for the Equipment handed over to it by DTL for the purpose of performance of the Contract/ Erection portion of the contract (hereinafter called the "Equipment")

AND THEREFORE, This Indemnity Bond witnesseth as follows:

1. That in consideration of various Equipments as mentioned in the Contract, valued at (amount in words.....) handed over to the Contractor for the purpose of performance of the Contract, the Contractor hereby undertakes to indemnify and shall keep DTL indemnified, for the full value of the Equipment. The Contractor hereby acknowledges receipt of the Equipments as per dispatch title documents handed over to the Contractor duly endorsed in their favour and detailed in the Schedule appended hereto. It is expressly understood by the Contractor that handing over of the dispatch title documents in respect of the said equipments duly endorsed by DTL in favour of the contractor shall be construed as handing over of the equipment purported to be covered by such title documents and the contractor shall hold such equipment in trust as a Trustee for and on behalf of DTL.
2. That the contractor is obliged and shall remain absolutely responsible for the safe transit/protection and custody of the equipment of DTL project Site against all risks whatsoever till the equipment are duly used/erected in accordance with the terms of the contract and the plant/package duly erected and commissioned in accordance with the terms of the contract, is taken over by DTL. The contractor undertakes to keep DTL harmless against any loss or damage that may be caused to the equipments.
3. The contractor undertakes that the equipment shall be used exclusively for the performance/execution of the contract strictly in accordance with its terms and conditions and no part of the equipment shall be utilized for any other work or purpose whatsoever. It is clearly understood by the contractor that non observance of

the obligations under this indemnity bond by the contractor shall inter-alia constitute a criminal breach of trust on the part of the contractor for all intents and purpose including legal/penal consequences.

4. That DTL is and shall remain the exclusive owner of the equipment free from all encumbrances, charges or liens of any kind, whatsoever. The equipment shall be all times be open to inspection and checking by the employer or employer's representative in this regard. Further DTL shall always be free at all times to take possession of the equipment in whatever form the equipment may be, if in its opinion, the equipments are likely to be endangered, mis-utilised or intended for use other than those specified in the contract, by any acts of omission or commission on the part of the contractor or any other person or on account of any reason whatsoever and the contractor binds himself and undertakes to comply with the directions of demand of DTL to return the equipment without any demur or reservation.
5. That this indemnity Bond is irrevocable. If at any time any loss or damage occurs to the Equipment or the same or any part thereof is mis-utilised in any manner whatsoever, then the Contractor hereby agrees that the decision of the Employer's Representative as to assessment of loss or damage to the Equipment shall be final and binding on the Contractor. The Contractor binds itself and undertakes to replace the lost and /or damaged Equipment at its own cost and/ or shall pay the amount of loss to DTL without any demur, reservation or protest. This is without prejudice to any other right or remedy that may be available to DTL against the Contractor under the Contract and under this Indemnity Bond.
6. NOW THE CONDITION of this Bond is that if the Contractor shall duly and punctually comply with the terms and conditions of this Bond to the satisfaction of DTL, THEN. The above Bond shall be void, but otherwise, it shall remain in full force and virtue.

IN WITNESS, the Contractor has hereunto set its hand through its authorized representative under the common seal of the Company, the day, month and year first above mentioned.

SCHEDULE

Particulars of the Equipment	Quantity	Particulars of Despatch title Documents	Value of the Equipment	Signature of Attorney in Handed token of receipt
		RR/ GR No. Date of lading & Carrier		

For and on behalf of

M/s.....

WITNESS

- | | | | |
|----|----|----------------|---------------------------|
| 1. | 1. | Signature..... | Signature..... |
| | 2. | Name..... | Name..... |
| | 3. | Address..... | Address..... |
| | | | Authorized representative |
| 2. | 1. | Signature..... | |
| | 2. | Name..... | (Common Seal) |
| | | | (In case of Company) |
| | 3. | Address..... | |

Indemnity Bonds are to be executed by the authorized person and (i) in case of contracting Company under common seal of the Company or (ii) having the power of attorney issued under common seal of the company with authority to execute Indemnity Bonds, (iii) in case of (ii), the original Power of Attorney if it is General Power of Attorney and such documents should be attached to Indemnity Bond.

12. FORM OF INDEMNITY BOND TO BE EXECUTED BY THE CONTRACTOR FOR THE EQUIPMENT HANDED OVER IN INSTALLMENTS BY DELHI TRANSCO LTD FOR PERFORMANCE OF ITS CONTRACT

INDEMNITY BOND

THIS INDEMNITY BOND is made thisday of200.....by.....a Company registered under the Companies Act, 1956/ Partnership firm/ proprietary concern having its Registered Office at(hereinafter called as 'Contractor' or 'Obligor' which expression shall include its successors and permitted assigns) in favor of DELHI TRANSCO LTD a Company incorporated under the Companies Act, 1956 having its Registered Office at Shakti Sadan, Kotla Marg, New Delhi-110002

WHEREAS DTL has awarded to the Contractor a Contractor forvide Its Notification of Award/Contract No.datedand Amendment No. (applicable when amendments have been issued) (hereinafter called the "Contract") in terms of which DTL is required to handover various Equipments to the Contractor for execution of the Contract.

AND WHEREAS by virtue of Clause No.....of the said Contract, the Contractor is Required to execute an Indemnity Bond in favour of DTL for the Equipment handed over to it by DTL for the purpose of performance of the contract/ Erection portion of the Contract (hereinafter called the "Equipment".)

NOW THEREFORE, This Indemnity Bond witnessed as follows:

1. That in consideration of various Equipments as mentioned in the Contract, valued at (amount in words) to be handed over to the Contractor in installments from time to time for the purpose of performance of the contract, the Contractor hereby undertakes to indemnify and shall keep DTL indemnified, for the full value of Equipment. The Contractor hereby acknowledges receipt of the initial installment of the equipment per details in the schedule appended hereto. Further, the Contractor agrees to acknowledge receipt of the subsequent installments of the Equipment as required by DTL in the form of Schedules consecutively numbered which shall be attached to this Indemnity bond so as to form integral parts of this Bond It is expressly understood by the Contractor shall be construed as handing over the Equipment purported to be covered by such title documents and the Contractor shall hold Equipments in trust as a Trustee for and on behalf of DTL
2. That the contractor is obliged and shall remain absolutely responsible for the safe transit/protection and custody of the equipment of DTL project Site against all risks whatsoever till the equipment are duly used/erected in accordance with the terms of the contract and the plant/package duly erected and commissioned in accordance with the terms of the contract, is taken over by DTL. The contractor undertakes to keep DTL harmless against any loss or damage that may be caused to the equipments.
3. The contractor undertakes that the equipment shall be used exclusively for the performance/execution of the contract strictly in accordance with its terms and

conditions and no part of the equipment shall be utilized for any other work or purpose whatsoever. It is clearly understood by the contractor that non observance of the obligations under this indemnity bond by the contractor shall inter-alia constitute a criminal breach of trust on the part of the contractor for all intents and purpose including legal/penal consequences.

4. That DTL is and shall remain the exclusive owner of the equipment free from all encumbrances, charges or liens of any kind, whatsoever. The equipment shall be all times be open to inspection and checking by the employer or employer's representative in this regard. Further DTL shall always be free at all times to take possession of the equipment in whatever form the equipment may be, if in its opinion, the equipments are likely to be endangered, mis-utilised or intended for use other than those specified in the contract, by any acts of omission or commission on the part of the contractor or any other person or on account of any reason whatsoever and the contractor binds himself and undertakes to comply with the directions of demand of DTL to return the equipment without any demur or reservation.
5. That this indemnity Bond is irrevocable. If at any time any loss or damage occurs to the Equipment or the same or any part thereof is mis-utilised in any manner whatsoever, then the Contractor hereby agrees that the decision of the Employer's Representative as to assessment of loss or damage to the Equipment shall be final and binding on the Contractor. The Contractor binds itself and undertakes to replace the lost and /or damaged Equipment at its own cost and/ or shall pay the amount of loss to DTL without any demur, reservation or protest. This is without prejudice to any other right or remedy that may be available to DTL against the Contractor under the Contract and under this Indemnity Bond.
6. NOW THE CONDITION of this Bond is that if the Contractor shall duly and punctually comply with the terms and conditions of this Bond to the satisfaction of DTL, then, the above Bond shall be void, but otherwise, it shall remain in full force and virtue.

IN WITNESS, the Contractor has hereunto set its hand through its authorized representative under the common seal of the Company, the day, month and year first above mentioned.

SCHEDULE No. 1

Particulars of the Equipment	Quantity	Particulars of Despatch title Documents	Value of the Equipment	Signature of Attorney in Handed token of receipt
		RR/ GR No. Date of lading & Carrier		

For and on behalf of

M/s.....

WITNESS

1. 1. Signature..... Signature.....

2. Name..... Name.....

3. Address..... Address.....

Authorized representative

2. 1. Signature.....

2. Name.....

(Common Seal)
(In case of Company)

3. Address.....

Indemnity Bonds are to be executed by the authorized person and (i) in case of contracting Company under common seal of the Company or (ii) having the power of attorney issued under common seal of the company with authority to execute Indemnity Bonds, (iii) in case of (ii), the original Power of Attorney if it is General Power of Attorney and such documents should be attached to Indemnity Bond.

13. FORM OF AUTHORIZATION LETTER: DELHI TRANSCO LIMITED.

REF. No.

DATE:

TO,

M/s.....

.....

.....

REF: Contract No..... dated for..... awarded
by Delhi Transco limited.

Dear Sir,

Kindly refer to Contract No. Dated for You are hereby authorized on behalf of Delhi Transco Limited, having its registered office at Delhi Transco Limited, Shakti Sadan, Kotla Road New Delhi-110002 and its project atto take physical delivery of materials/equipments covered under Dispatch Document/Consignment Note No.....dated..... and as detailed in the enclosed schedule for the sole purpose of successful performance of the aforesaid contract and for no other purpose, whatsoever.

(Signature of Project Authority)**

Designation

Date

Encl: As above

** To be signed not below the rank of Manager.

- Mention LR/RR No.

14. FORM OF TRUST RECEIPT FOR PLANT, EQUIPMENT AND MATERIALS RECEIVED

We M/s (Contractor's Name)_____ having our Principal place of business at _____ having been awarded a Contract No. _____ dated _____ for (Contract Name) by (Name of Employer) _____.

We do hereby acknowledge the receipt of the Plant, Equipment and Materials as are fully described and mentioned under Documents of Title/RR/LR etc and in the schedule annexed here to, which shall form an integral part of this receipt as "Trustee" of _____ (Name of Employer). The aforesaid materials etc. so received by us shall be exclusively used in the successful performance of the aforesaid contract and for no other purpose whatsoever. We undertake not to create any charge, lien or encumbrance over the aforesaid materials etc, in favour of any other person /institution (s) / Banks.

For M/s _____
(Contractor's Name)

Dated: _____

Place: _____

(AUTHORISED SIGNATORY)

SEAL OF COMPANY

15(a) FORM OF EXTENSION OF BANK GUARANTEE

Ref. No.....

Dated.....

**Delhi Transco Limited,
Shakti Sadan, Kotla Road
New Delhi 110002.
India**

Dear Sirs,

Sub: - Extension of Bank Guarantee No. for..... favoring
yourself expiring on On account of
M/s..... in respect of Contract No..... dated
..... (hereinafter called original Bank Guarantee).

At the request of M/s We Bank branch office
at..... Having its Head Office at do hereby extend our liability
under the above mentioned Guarantee No..... dated for a
further period of Years/Month from Expire on
Except as provided above, all other terms and conditions of the original Bank Guarantee
No..... dated..... shall remain unaltered and binding.

Please treat this as an integral part of the original Guarantee to which it would be attached.

Yours Faithfully,

For.....

Manager. Agent/Accountant

Power of attorney No.....

Dated

SEAL OF BANK

Note : The non. Judicial stamp paper of appropriate value shall be purchased in the name of
the bank who has issued the bank Guarantee.

15(b) FORM FOR CONDITIONAL CLAIM PENDING EXTENSION IN INSURANCE SURETY BOND

To: *(insert Name and Address of the Insurer)*

Ref.: Conditional Claim against Insurance Surety Bond No. dated
for valid up to issued by you on behalf of M/s.
..... *(insert name of the Bidder)*

Dear Sirs,

Please refer to the subject **Insurance Surety Bond** executed by you in our favour on behalf of M/s. *(insert name of the Bidder)*, who have submitted this Insurance Surety Bond to us towards Bid Security against *(insert name of the Package)* ; Specification No.

We, *(insert name of the Employer)* do hereby request you to lodge our claim/demand against the subject **Insurance Surety Bond** for full guaranteed sum. Kindly note that this claim/ demand against the subject **Insurance Surety Bond** is without any further notice in case the amendment to **Insurance Surety Bond No.** dated extending its validity upto is not got arranged by *(insert name of the Bidder)* in our favour and are not received by us upto

In such an event you are requested to remit the full guaranteed amount in terms of the subject guarantee in its letter and spirit and proceeds of this **Insurance Surety Bond** shall be forwarded to us in form of demand draft in favour of '.... *(insert name of the Employer)*', payable at*(insert place of the Employer)*....'.

This is without prejudice to our right under this guarantee and under the law.

Thanking you,

For(Name of the Employer)....
(AUTHORISED SIGNATORY)

Copy to:

(insert Name and Address of the Bidder)

- You are requested to do the needful so that the amendment to the subject **Insurance Surety Bond** extending the validity up to is received by us by.....

16. FORM OF POWER OF ATTORNEY FOR JOINT VENTURE/CONSORTIUM

(On Non-judicial Stamp paper of Appropriate Value to be purchased in the name of joint venture/ Consortium)

KNOW ALL MEN BY THESE PRESENTS THAT WE, the partners whose details are given hereunder have formed a Joint venture/ Consortium under the laws of And having our Registered Office(S) / Head Office (s) at (hereinafter called the Joint venture/ Consortium which expression shall unless repugnant to the context or meaning thereof, include its successors, administrators and assigns) acting through M/sbeing the partner in-charge do hereby constitute, nominate and appoint M/s a Company incorporated under the laws ofand having its registered / Head Office at as our duly constituted lawful Attorney (hereinafter called “ Attorney” or “ Authorized Representative” or “ Partner In- charge”) to exercise all or any of the powers for and on behalf of the joint venture/ Consortium in regard to Specification No..... Package the bids for which have been invited by Delhi Transco Limited, Shakti Sadan Building, Kotla Road, New Delhi, India (hereinafter called the “ Employer”) to undertaking the following acts :

- i) To submit proposal and participate in the aforesaid Bid Specification of the Employer on behalf of the “Joint venture/ Consortium”.
- ii) To negotiate with the employer the terms and conditions for award of the Contract pursuant to the aforesaid Bid and to sign the Contract with the Employer for and on behalf of the ‘JOINT VENTURE/ CONSORTIUM’.
- iii) To do any other act or submit any document related to the above.
- iv) To receive, accept and execute the Contract for and on behalf of the “Joint venture/ Consortium”.

It is clearly understood that the partner In-charge (Lead Partner) shall ensure performance of the Contract(s) and if one or more partner fail to perform their respective portions of the Contract(s), the same shall be deemed to be default by all the partners.

It is expressly understood that this Power of Attorney shall remain valid binding and irrevocable till completion of the Defect Liability Period in terms of the Contract.

The joint venture/ Consortium hereby agrees and undertakes to ratify and confirm all and whatsoever the said Attorney/ Authorized Representatives/Partner in- charge quotes in the bid, negotiates And signs the Contract with Employer and / or proposes to act on behalf of the Joint venture/ Consortium by virtue of this Power of Attorney and the same shall bind the joint venture/ Consortium as if done by itself.

In WITNESS THEREOF the partners Constituting the joint venture/ Consortium as aforesaid have executed these present on this day of Under the Common Seal(s) of their Companies.

for and on behalf of the
Partners of joint venture/ Consortium

.....
.....

The Common Seal of the above Partners of the Joint venture/ Consortium:

The Common Seal has been affixed the unto in the presence of:

WITNESS

1. Signature.....
Name.....
Designation
Occupation.....

2. Signature.....
Name.....
Designation
Occupation.....

17. FORM OF JOINT VENTURE/ CONSORTIUM AGREEMENT

(On non-judicial stamp paper of appropriate value to be purchased in the name of joint venture/ Consortium)

PERFORMA OF JOINT VENTURE/ CONSORTIUM AGREEMENT BETWEEN AND FOR BID SPECIFICATION NO..... OF DELHI TRANSCO LIMITED

THIS joint venture/ Consortium agreement executed on this day of Two thousand..... between M/s a company incorporated under the laws of and having its registered office at.....(hereinafter called the “Lead partner” which expression shall include its successors executors and permitted assigns), M/s a company incorporated under the laws of and having its registered office at.....(hereinafter called “the partner” which expression shall include its successors executors and permitted assigns) and M/s a company incorporated under the laws of and having its registered office at.....(hereinafter called “the partner” which expression shall include its successors, executors and permitted assigns) for the purpose of making a bid and entering into a contract (in case of award) against the specification No..... for.....(Name of the Package)under.....(Name of the project)of Delhi Transco limited ,a company incorporated under the Companies Act of 1956 having its registered Shakti Sadan, Kotla Road New Delhi-110002, India (hereinafter caller the; “Employer”)

Whereas the employer invited bids as per the above mentioned Specification for the design, engineering, manufacture, supply, installation, testing and commissioning of equipment/materials stipulated in the bidding documents for.....(Name of the Package)under.....(Name the project)

AND WHEREAS Annexure-A, section-CC (qualification of the bidder) forming part of the bidding documents, stipulates that a joint venture/ Consortium of two or more qualified firms as partners, meeting the joint venture/ Consortium fulfills all other requirements under Annexure-A, Section CC (qualification of the bidder) and in such a case, the BID FROM shall be signed by all the partners so as to legally bind all the partners of the Joint venture/ Consortium, who will be jointly and severally liable to perform the contract and all obligations hereunder.

The above clause further states that the joint venture/ Consortium agreement shall be attached to the bid and the contract performance guarantee will be as per the format enclosed with the bidding document without any restriction or liability for either party.

AND WHEREAS the bid has been submitted to the Employer vide proposal No..... dated.....by Lead partner based on the joint venture/ Consortium agreement between all the partners under these present and the bid in accordance with the requirements of Annexure-A, section CC (Qualification of the Bidders), has been signed by all the partners.

NOW THIS INDENTURE WITNESS AS UNDER:

In consideration of the above premises and agreements all the partners to this joint venture/ Consortium do hereby now agree as follow:

1. In consideration of the award of the contract by the Employer to the joint venture/ Consortium partners, we, the partners to the joint venture/ Consortium agreement do hereby agree that M/s shall act as lead partner and further declare and confirm that we shall joint and severally be bound unto the Employer for the successful performance of the Contract and shall be fully responsible for the design, engineering, manufacture, supply, and successful performance of the equipments in accordance with the Contract.
2. In case of any breach of the said Contract by the Lead Partner or other partner(s) of the joint venture/ Consortium agreement, the partner(s) do hereby agree to be fully responsible for the successful performance of the contract and carry out all the obligations and responsible under the Contract in accordance with the requirements of the Contract.
3. Further if the Employer suffers any loss or damage on account of any breach in the Contract or any shortfall in the performance of the equipment in meeting the performance guaranteed as per the specification in terms if the Contract, the partner(s) of these present undertake to promptly make good such loss or damages caused to the Employer, on its demand without any demur. It shall not be necessary or obligatory for the Employer to proceed against Lead Partner to these presents before proceeding against or dealing with the other Partner(s).
4. The financial liability of the partner of this joint venture/ Consortium agreement to the Employer, with respect to any of the claims arising out of the performance or non-performance of the obligations set forth in the said joint venture/ Consortium agreement, read in conjunction with the relevant conditions of the Contract shall, however, not be limited in any way so as to restrict or limit the liabilities of any of the partners of the joint venture/ Consortium agreement.
5. It is expressly understood and agreed between the partners to the joint venture/ Consortium agreement that the responsibilities and obligations of each of the partners shall be as delineated in Appendix-I (* To be incorporated suitably by the partners) to this agreement. It is further agreed by the partners that the above sharing of responsibilities and obligations shall not in any way be a limitation of joint and servable responsibilities of the partners under this Contract.
6. This joint venture/ Consortium agreement shall be constructed and interpreted in accordance with the laws of India and the courts of New Delhi shall have the exclusive jurisdiction in all matters arising there under.
7. In case of an award of a Contract, we the partners to the joint venture/ Consortium agreement do hereby agree that we shall be jointly and severe ally responsible for furnishing a contract performance security from a bank in favour of the Employer in the currency of the Contract.
8. It is further agreed that the venture agreement shall be irrevocable and shall from an integral part of the Contract, and shall continue to be enforceable till the Employer

discharges the same. It shall be effective from the date first mentioned above for all purpose and intents.

IN WITNESS WHEREOF, the partners to the joint venture/ Consortium agreement have through their authorized representatives executed these present and affixed Common Seals of their companies, on the day, month and year first mentioned above.

- | | | |
|----|---|--|
| 1. | Common Seal of | For Lead partner |
| | has been affixed in my/our | (Signature of authorized representative) |
| | presence pursuant to the | Name..... |
| | Board of Director's resolution dated... | Designation..... |
| | Signature..... | Common Seal of the company |
| | Name..... | |
| | Designation..... | |
| 2. | Common Seal of | For partner |
| | has been affixed in my/our | (Signature of authorized representative) |
| | presence pursuant to the | Name..... |
| | Board of Director's resolution dated... | Designation..... |
| | Signature..... | Common Seal of the company |
| | Name..... | |
| | Designation..... | |

WITNESSES:

- | | |
|----|--------------------|
| 1 | |
| | (Signature) |
| | Name..... |
| | |
| | (Official address) |
| 2. | |
| | (Signature) |
| | Name..... |
| | |
| | (Official address) |

**18. PROFORMA OF JOINT UNDERTAKING BY THE COLLABORATOR/
PARENT COMPANY/ GROUP COMPANY/ SUBSIDIARY
COMPANY/PRINCIPAL/ SISTER CONCERN ALONGWITH THE
BIDDER/MANUFACTURER**

(On non-judicial stamp paper of appropriate value)

THIS DEED OF UNDERTAKING executed this day of Two Thousand and..... by M/s..... a company incorporated under the laws ofand having its registered office at.....(hereinafter called the “Collaborator/Parent Company/ Group Company/ Subsidiary Company /Principal/sister concern” which expression shall include its successors, administrators, executors and permitted assigns) and M/s.....a company incorporated under the laws of and having its registered office at..... (hereinafter called the “Bidder/Manufacturer” which expression shall include its successors, administrators, executors and permitted assigns) in favour of Delhi Transco Limited, having its Registered office at Shakti Sadan, Kotla Marg, New Delhi.(herein after called the “Employer” which expression shall include its successors, executors and permitted assigns)

WHEREAS the “Employer” invited Bid as per Specification No. for the execution of(Insert name of the Project).....

AND WHEREAS Clause No., Sectionof, Vol.-forming part of the Bidding Documents inter-alia stipulates that the Bidder and/or Manufacturer alongwith its collaborator/parent company/ group company/ subsidiary company/principal/sister concern must fulfill the Qualifying Requirements for the *..... and be jointly and severally bound and responsible for the successful performance of the *.....offered in the event the bid submitted by the bidder is accepted by the Employer resulting in Contract.

AND WHEREAS the bidder has submitted its bid to the Employer vide Proposal No.datedbased on the collaboration /association of the collaborator/parent company/principal/sister concern with the Bidder/Manufacturer.

NOW THEREFORE THIS UNDERTAKING WITNESSTH as under.

- 1.0 In consideration of the award of Contract by the Employer to the Bidder (herein after referred to as the “Contract”) we, the collaborator/parent company/ group company/ subsidiary company/principal/sister concern and the Bidder/Contractor and /or manufacturer do hereby declare that we shall be jointly and severally bound unto the DELHI TRANSCO LIMITED , for the guarantee quality, timely supply ,successful performance and warranty obligations of the * and shall be fully responsible for the design, manufacturer , testing, supply on FOR destination delivery at site basis and supervision of unloading at site, storage, erection, testing & commissioning and successful performance of the *in accordance with the Contract Specifications.
- 2.0 Without in any way affecting the generality and total responsibility in terms of deed of Undertaking, the Collaborator in particular hereby agrees to depute their technical experts from time to time to the Bidder/Contractor’s/Manufacture’s Works/ Owner’s project site as mutually considered necessary by the Owner, bidder/Contractor, Manufacturer and the collaborator to ensure proper design, engineering, manufacturer, testing ,supply on for destination delivery at site basis and supervision of unloading at site , storage, erection, testing and commissioning and successful performance of the collaborator shall advise the manufacturer/ contractor suitable modifications of designs and implement necessary corrective measures to discharge the obligations under the contract.

- 3.0 This deed of undertaking shall be construed and interpreted in accordance with the laws of India and the Courts in New Delhi shall have exclusive jurisdiction in all matters arising under the undertaking.
- 4.0 As a security, the bidder shall apart from the contractor's performance guarantee furnish a contract performance guarantee from its Bank in favour of the Employer on a form acceptable to the Employer. The value of such guarantee shall be equivalent to 10% of price of such equipments manufactured in India as identified in the contract awarded by the Employer to the bidder/contractor and it shall be part of guarantee towards the faithful performance/ compliance of this deed of undertaking in terms of the contract. The guarantee shall be unconditional, irrevocable and valid for the entire period of the contract, namely till the end of the defect liability period of Project under the contract. The bank guarantee amount shall be payable to the Employer on demand without any reservation or demur. This shall be in addition to the contract performance guarantee furnished by the contractor.
- 5.0 We the collaborator/parent company/ group company/ subsidiary company/principal/sister concern and bidder/contractor and /or manufacturer agree that this undertaking shall be irrevocable and shall form an integral part of the contract and further agree that this undertaking shall continue to be enforceable till the Employer discharges it. It shall become operative from the effective date of contract.

IN WITNESS WHEREOF the collaborator/parent company/ group company/subsidiary company/principal/sister concern and bidder/contractor and /or manufacturer, have through their Authorized Representatives executed these present and affixed common seals of their respective Companies, on the day, month and year first above mentioned.

WITNESSES:

For Collaborator/parent company/ group company/
subsidiary company/principal/sister concern

1.-----

Signature of Authorized Representative

(Signature)

(Name in Block Letter)

Name-----

(Office Address)

Common seal of Company -----

2.-----

Signature of Authorized Representative

(Signature)

(Name in Block Letter)

Name-----

(Office Address)

Common seal of Company-----

-

For Manufacturer

3.-----

Signature of Authorized Representative

(Signature)

(Name in Block Letter)

Name-----

(Office Address)

Common seal of Company-----

Note:

- (i) This deed of Joint undertaking duly certified by the Company Secretary shall be submitted along with the bid. Further, the deed of Joint Undertaking attested by Notary Public of the place(s) of the respective executants (s) or registered with the Indian Embassy/ High Commission in the country shall be submitted by the bidder before opening of price bid. In case the bidder fails to submit the deed of Joint Undertaking as mentioned above, the bidders bid guarantee may be forfeited.
- (ii) In the event the bidder is a Manufacturer and the collaboration is between collaborator and the Bidder, then the Joint deed of Undertaking shall be continued accordingly.
- (iii) *The name(s) of equipment for which Joint deed of undertaking is to be submitted is to be inserted.
- (iv) The manufacturer may be having ongoing collaboration agreement or had collaboration agreement in the past with the collaborator.

19. FORM OF TAKING OVER CERTIFICATE

Date.....

Name of Contract.....

Contract No.....

To:

(Name and address of the Contractor)

Dear Ladies and/or Gentlemen,

Pursuant to CC 24 & 25 of the Conditions of the Contract entered into between yourselves and the Employer datedrelating to the
(Brief description of the Facilities)

we hereby notify you that the following part(s) of the Facilities was (were) complete on the date specified below, and that, in accordance with the terms of the Contract, the Employer hereby takes over the said part(s) of the Facilities, together with the responsibility for care and custody and the risk of loss thereof on the date mentioned below:

1. Description of the Facilities or part thereof... ..
2. Date of Completion...

However, you are required to complete the outstanding items listed in the attachment hereto as soon as practicable.

This letter does not relieve you of your obligation to complete the execution of the Facilities in accordance with the Contract nor of your obligations during the Defects Liability Period.

Very truly yours,

Title
(Project Manager)

DELHI TRANSCO LTD

(A Government of NCT of Delhi Undertaking)



Bidding Documents

For

Design, Engineering, Supply, Erection, Testing & Commissioning of 220/66kV GIS Substation at Bharthal, including complete civil works & automation, along with LILO of 220kV D/C Bamnauli-DIAL Overhead Transmission Line at Bharthal, on a Turnkey Basis.



VOLUME – II **TECHNICAL SPECIFICATIONS**

Tender No: T26P630001

VOLUME-II
TECHNICAL SPECIFICATIONS

SECTION I	:	PROJECT
SECTION II	:	GAS INSULATED SWITCHGEAR (GIS)
SECTION III	:	GENERAL TECHNICAL REQUIREMENTS (GTR)
SECTION IV	:	SPECIAL EQUIPMENTS
SECTION V	:	FIRE PROTECTION SYSTEM
SECTION VI	:	LT SWITCHGEAR
SECTION VII	:	BATTERY & BATTERY CHARGER
SECTION VIII	:	LIGHTING SYSTEM
SECTION IX	:	LT TRANSFORMER
SECTION X	:	DIESEL GENERATOR
SECTION XI	:	SWITCHYARD
SECTION XII	:	CIVIL WORKS
SECTION XIII	:	SUBSTATION AUTOMATION
SECTION XIV	:	C & R PANEL
SECTION XV	:	POWER & CONTROL CABLE
SECTION XVI	:	VISUAL MONITORING
SECTION XVII	:	FIBRE OPTIC TERMINAL EQUIPMENT (FOTE)
SECTION XVIII	:	LIGHTNING ARRESTOR
SECTION XIX	:	OPTICAL GROUND WIRE (OPGW)
SECTION XX	:	TRANSFORMER
SECTION XXI	:	NITROGEN INJECTION FIRE PREVENTION CUM EXTINGUISHING SYSTEM (NIFPES)
SECTION XXII	:	33kV & 66kV XLPE CABLE
SECTION XXIII	:	MONOPOLE STEEL TOWERS
SECTION XXIV	:	HTLS CONDUCTOR AND ASSOCIATED H/W FITTINGS & ACCESSORIES
SECTION XXV	:	POLYMER INSULATORS

SECTION-I

PROJECT

SECTION: I

PROJECT

1.0 GENERAL

Preamble:

- 1.1 Delhi Transco Ltd. hereinafter termed as DTL or Owner/Purchaser is a company incorporated under Company Act 2013, fully owned by the Govt. of NCT of Delhi.
- 1.2 Delhi Transco Ltd. (DTL) is a State Transmission Utility (STU) and responsible for Bulk Power Transmission of Electrical Energy in National Capital Delhi.
- 1.3 Delhi Transco Ltd. (DTL) proposes to establish 220/66kV GIS Substation at Bharthal, Delhi, India, under this contract.

2.0 INTENT OF SPECIFICATION:

- 2.1 Design, Engineering, Supply, Erection, Testing, and Commissioning of a 220/66kV GIS Substation at Bharthal, New Delhi, with an installed transformation capacity of 480 MVA (3 x 160 MVA), including complete civil works & automation, along with LILO (Line-In Line-Out) of 220kV D/C Bamnauli-DIAL Overhead Transmission Line at Bharthal, on a turnkey basis, with provision for future addition of one (01) No. 160 MVA Transformer and (one) 01 No. 50 MVAR Reactor.
- 2.2 The supply will include all supporting structures, auxiliary equipments, mechanical linkages, hydraulic piping (if applicable) for control devices with pumps, SF6 gas piping, auxiliary circuits wiring, interlocking devices, current and voltage transformers, cable end boxes and SF6 bus ducts.
- 2.3 It is the intent of this specification to describe primary features, materials, and design & performance requirements, and to establish minimum standards for the work.
- 2.4 The specification is not intended to specify the complete details of the various practices of manufactures/bidders, but to specify the requirements with regard to performance, durability, and satisfactory operation under the specified site conditions.

3.0 SCOPE OF WORK

The scope of work broadly covers the following:

- i. 220kV GIS having double bus bar arrangement with 15 Nos. of 220kV GIS Bays (4 Nos. transformer bays + 1 No. reactor bay + 6 Nos. feeder bays + 2 Nos. bus couplers + 2 Nos. bus sections).
- ii. 66kV GIS having double bus bar arrangement with 26 Nos. of 66kV GIS Bays (4 Nos. transformer I/Cs + 18 Nos. feeder bays + 2 Nos. bus couplers + 2 Nos. bus sections).
- iii. The connection of 03 (three) transformers and 04 (four) feeder bays with 220kV GIS will be through SF6 GIS Bus Duct (GIB) & SF6-to-air bushings. Further, 02 (two) nos. 220kV GIS spare feeder bays, 01 (one) reactor bay, and 01 (one) transformer bay shall have suitable arrangement for indoor termination. The conventional outdoor-type Lightning Arresters (LAs) are required for 03 (three) nos. 160 MVA transformers and 04 (four) nos. 220kV O/H feeder bays.

- iv. Construction of 220kV GIS building and 66kV GIS cum Control Building, Store building, etc. with required auxiliary supply, equipment, accessories and amenities.
- v. Complete connection of 66kV GIS with 66kV Incomers through 66kV XLPE cable (Double Run x Single Core x 1200 Sq.mm., Copper) and 66kV GIS feeders upto H-pole arrangement through 66kV XLPE cable (Single Run x Single Core x 1200 Sq.mm., Copper), including proper cable end termination. Further, all 66kV H-pole arrangements shall have 66kV LA & 66kV BPI (Bus Post Insulator).
- vi. Complete substation automation system including hardware and software for remote control room, relay and protection system along with associated equipment and kiosks for bays. The contractor shall provide FOTE equipment along with teleprotection cards, Ethernet switches, etc. (for remote end substation also). The remote end substations are 400kV S/Stn. Bamnauli, 220kV S/Stn. DIAL, 01 No. future substation, and proposed Centralized Control Centre at Maharani Bagh.
- vii. Complete Civil works as per the tentative layout/design requirement, including internal roads, drains, necessary buildings, etc., and other electrical & mechanical auxiliary systems on turnkey basis.
- viii. Further, if any services of OEM of existing system are required for completion of work, the same shall be in the scope of Contractor.
- ix. Bidder shall also ensure GIS compatibility for line feeder/cable termination and provide the ancillary equipment required for the same.
- x. Any other equipment/material/services required for completion of work.
- xi. In addition to the above work, the following space provision shall also be made:
 - a) Provision of minimum 03 nos. future bays with adopter in the building for future 220kV bays.
 - b) Provision of minimum 05 nos. future bays with adopter in the building for future 66kV feeders.
- xii. 220kV Infeed arrangement

The 220kV in-feed at Bharthal has been envisaged from LILO of 220kV O/H D/C Bamnauli-DIAL Transmission Line after diversion of existing 220kV Overhead Transmission Line Towers P-2 to P-4 as per layout (**Annexure XVI**). It is mentioned that P-2 & P-4 are already erected, therefore, only Tower No. P-3 is to be erected between P-2 & P-4 as per layout (**Annexure XVI**) for in-feed to 220kV Substation Bharthal by LILO of 220kV D/C O/H Bamnauli-DIAL Transmission Line.

The scope of work broadly covers the following:

- 1) Design, Engineering, Supply, Erection, Testing, and Commissioning of 01 No. D/C, D-Type BXA, 28 mtr, 220kV Monopole along with conductor and all accessories, etc., including stringing and de-stringing of the existing line for LILO of the O/H D/C 220kV Bamnauli-DIAL Transmission Line at 220kV Substation Bharthal. Further, if any services of OEM of existing system are required for completion of the work, the same shall also be in the scope of Contractor.

- 2) SETC of the gantry along with all accessories and associated works, etc., for termination of LILO of O/H D/C 220kV Bamnauli-DIAL Transmission Line at 220kV Substation Bharthal.
- 3) All other works required for completion of the job as per site requirement, not limited to the above.

I. 220kV SYSTEM:

The new 245kV SF₆ Gas Insulated Switchgear (GIS) shall have double bus bar arrangement as per Technical Specifications (TS), with provision for the following bays:

S.No.	Bay type	Number of bay(s)
01	Transformer bays	04
02	Reactor bay	01
03	Feeder bays	06
04	Bus Coupler bays	02
05	Bus Sectionalizer bays	02
06	Total	15

There shall be a provision for a minimum of three (03) future bays with adopter in the GIS building for future 220kV bays.

The requirement-wise details of equipment for each 220kV GIS module, as per the tentative Single Line Diagram (SLD) enclosed at **Annexure-II(A)** for 220/66 kV GIS Substation at Bharthal, are detailed below:

(A) Double bus bar arrangement, 245kV, 2500A, 3-phase/ three 1-phase (isolated) units, SF₆ Gas Insulated, metal enclosed bus bars, each bus comprising of:

Each set in the GIS Bus-bar module consists of two (2) busbars, and each busbar contains the following:

- i. Bus bars enclosures running along the length of the switch gear to interconnect each of the circuit breaker bay modules in double main bus system.
- ii. Three, 1-Phase, 3 core, voltage transformers/PTs.
- iii. One, 3-phase, single pole, group operated isolator/disconnector switch with one 3-phase, single pole, group operated safety grounding switch, complete with manual and motor driven operating mechanisms.
- iv. GIS duct with gas monitoring devices, barriers, pressure switches, UHF based partial discharge measurement sensors, etc. as required.
- v. Local control cubicle (if required).

(B) 245kV, 2500A, Bus Coupler Bay Module, each comprising of:

- i. One, 2500 A, 3-phase, SF₆ gas insulated circuit breaker, complete with operating mechanism.
- ii. Three, 1-phase, 5-core, multi ratio, current transformers.
- iii. Two, 3-phase, single pole, group operated isolator switches, 2500A, complete with manual and motor driven operating mechanisms.
- iv. Two, 3-phase, single pole, group operated safety grounding switches, complete with

manual and motor driven operating mechanisms.

- v. GIS duct with gas monitoring devices, barriers, pressure switches, UHF based partial discharge measurement sensors, etc. as required.
- vi. Local Control Cubicle.

(C) 245kV, 2500A, Transformer Bay Module for 160MVA, 220/66/11kV Power Transformer Bay, each comprising of:

- i. One, 245kV, 1600 A, 3-phase, SF₆ gas insulated circuit breaker, complete with operating mechanism.
- ii. Three, 1-phase, 5-core, multi ratio, current transformers.
- iii. Three, 3-phase, single pole, group operated isolator switches, 1600A, complete with manual and motor driven operating mechanisms.
- iv. Three, 3-phase, single pole, group operated safety grounding switches, complete with manual and motor driven operating mechanisms.
- v. Gas insulated terminal connection for connecting three (03) Nos. 160MVA Transformers with 220kV GIS through SF₆-to-air bushings, including SF₆ GIS duct, etc., to complete transformer bay module. Further, considering the provision for future addition of one (01) no. 160 MVA transformer, one (01) GIS transformer bay shall have suitable arrangement for indoor termination.
- vi. GIS Bus duct with gas monitoring device, barriers, pressure switch, UHF based partial discharge measurement sensors, etc. as required.
- vii. Local control cubicle.

(D) 245kV, 2500A, Reactor Bay Module for 50MVAR Shunt Reactor Bay, each comprising of:

- i. One, 245kV, 1600 A, 3-phase, SF₆ gas insulated circuit breaker, complete with operating mechanism.
- ii. Three, 1-phase, 5-core, multi ratio, current transformers.
- iii. Three, 3-phase, single pole, group operated isolator switches, 1600A, complete with manual and motor driven operating mechanisms.
- iv. Three, 3-phase, single pole, group operated safety grounding switches, complete with manual and motor driven operating mechanisms.
- v. Considering the provision for future addition of one (01) no. 50MVAR Shunt Reactor, one (01) GIS Reactor Bay shall have suitable arrangement for indoor termination.
- vi. GIS Bus duct with gas monitoring device, barriers, pressure switch, UHF based partial discharge measurement sensors, etc. as required.
- vii. Local control cubicle.

(E) 245kV, 1600A, GIS Feeder Bay Module, each comprising of:

- i. One, 1600 A, 3-phase, SF₆ gas insulated circuit breaker, complete with operating mechanism.
- ii. Three, 1-phase, 5-core, multi ratio, current transformers.
- iii. Three, 3-phase, single pole, group operated isolator switches, 1600A, complete with

- manual and motor driven operating mechanisms.
- iv. Two, 3-phase, single pole, group operated safety grounding switches, complete with manual and motor driven operating mechanisms.
- v. One, 3-phase, single pole, high speed fault making grounding switch, complete with group operated manual and motor driven operating mechanisms.
- vi. Three, 3-core, 1-phase, voltage transformers/PTs with one, 3-phase, single pole, group operated isolator switch, complete with manual and motor driven operating mechanisms.
- vii. Three, 1-phase, surge arresters.
- viii. Gas insulated terminal connection for connecting four (04) nos. feeders with 220kV GIS through SF₆-to-air bushings, including SF₆ GIS duct, etc., to complete the feeder bay module. Further, two (02) nos. 220kV GIS spare feeder bays shall have suitable arrangement for indoor termination.
- ix. GIS duct with gas monitoring device, barriers, pressure switch, UHF based partial discharge measurement sensors, etc. as required.
- x. Local control cubicle.

(F) 245kV, 2500A, Bus Sectionalizer Bay Module, each comprising of:

- i. One, 2500 A, 3-phase, SF₆ gas insulated circuit breaker, complete with operating mechanism.
- ii. Three, 1-phase, 5-core, multi ratio, current transformers on one side of the circuit breaker.
- iii. Three, 1-phase, 5-core, multi ratio, current transformers on the other side of the circuit breaker.
- iv. Two, 3- phase, single pole, group operated isolator switches, 2500A, complete with manual and motor driven operating mechanisms.
- v. Two 3-phase, single pole, group operated safety grounding switches, complete with manual and motor driven operating mechanisms.
- vi. GIS duct with gas monitoring devices, barriers, pressure switches, UHF based partial discharge measurement sensors, etc. as required.
- vii. Local Control Cubicle (if required).

(G) 245kV, 1600A, SF₆ Gas Insulated Bus Duct (GIB) for feeder/transformer bay modules outside GIS hall with support structure (along with Gas monitoring devices, barriers, pressure switches, UHF based partial discharge measurement sensors etc., as required), and 245kV, 1600 A, 1-phase, SF₆ to air bushings (alongwith support structure) for connecting 220kV GIS with the respective gantry/AIS equipment. Further, 02 (two) nos. 220kV GIS spare feeder bays, 01 (one) reactor bay, and 01 (one) transformer bay shall have suitable arrangement for indoor termination.

(H) The connection of 03 (three) transformers and 04 (four) feeder bays with 220kV GIS will be through SF₆ GIS Bus Duct (GIB) & SF₆-to-air bushings.

- (I) The scope of work also includes**
- a. 216kV, 10kA, conventional outdoor (O/D) single phase Lightning Arresters (LA) with surge/discharge counter, milli-ampere meter and suitable terminal connectors, etc.,
 - b. Steel for support structure for double support gantry, 220kV O/D surge arrester,

etc.,

- c. ACSR Zebra Conductor along with fittings, and 4" IPS Al. tube, etc.

- (J) The Switchgear shall be complete with all necessary terminal boxes, SF₆ gas filling, interconnecting power and control wiring, grounding connections, gas monitoring equipment and piping, support structures and UHF based partial discharge measurement sensors, etc.

II. **66kV SYSTEM:**

The new 72.5kV SF₆ Gas Insulated Switchgear (GIS) shall have double bus bar arrangement as per Technical Specifications (TS), with provision for the following bays:-

S. No.	Bay type	Number of bay(s)
01	Transformer I/C bays	04
02	Feeder bays	18
03	Bus-coupler bays	02
04	Bus Sectionalizer bays	02
05	Total	26

There shall be a provision for a minimum of five (05) future bays with adopter in the GIS building for future 66kV feeders.

The requirement-wise details of equipment for each 66kV GIS module, as per the tentative Single Line Diagram (SLD) enclosed at **Annexure-II(A)** for 220/66 kV GIS Substation at Bharthal, are detailed below:

(A) Double Bus Bar arrangement, 72.5kV, 3000A, 3-phase or 1-phase encapsulated unit, SF₆ Gas Insulated, metal enclosed bus bars, each bus comprising of:

Each set in the GIS Bus-bar module consists of two (2) busbars, and each busbar contains the following:

- Bus bar enclosures running along the length of the switchgear to interconnect each of the circuit breaker bay modules in double main bus system.
- Three, 1-phase, 3-core, voltage transformers/PTs.
- One, 3-phase, single pole, group operated isolator/disconnector switch with one 3-phase, single pole, group operated safety grounding switch, complete with manual and motor driven operating mechanisms.
- Gas monitoring device, barriers, pressure switch, UHF based partial discharge measurement sensors etc. as required.
- Grounding, support structures and platforms.
- Local control cubicle.

(B) 72.5kV, 2500A, GIS Bus Coupler Bay module, each comprising of:

- One, 2500 A, 3-phase, SF₆ gas insulated Circuit Breaker, complete with operating mechanism.
- Three, 1-phase, 3-core, current transformers.
- Two, 3-phase, single pole, group operated isolator/disconnector switches each with 3-phase, single pole, group operated earthing switch, complete with manual and motor driven operating mechanisms.
- Gas monitoring device, barriers, pressure switch, UHF based partial discharge

- measurement sensors etc. as required.
- e. Local control cubicle.

(C) 72.5kV, 2500A, bays for Incomer from 160 MVA, 220/66/11kV Power Transformer, each comprising of:

- a. One, 2500A, 3-phase, SF₆ gas insulated circuit breaker, complete with operating mechanism for incomer bay from 220/66/11kV Power Transformer.
- b. Three, 1-phase, 4-core, current transformers.
- c. One, 2500A, 3-phase, single pole, group operated isolator/disconnector without earthing switch, complete with manual and motor driven operating mechanisms.
- d. One, 2500A, 3-phase, single pole, group operated isolator/disconnector with one, 3-phase, single pole, group operated earthing switch, complete with manual and motor driven operating mechanisms.
- e. One, 2500A, 3-phase, single pole, group operated isolator/disconnector with one normal & one high speed fault make, 3-phase, single pole, group operated earthing switch, complete with manual and motor driven operating mechanisms.
- f. Three, 1-phase, surge arresters.
- g. Gas insulated terminal connection (cable housing) for connecting 66kV side of three (03) nos. 160 MVA Transformers to 66kV GIS through 66kV XLPE Power Cables (Double Run, Single Core, 1200 sq.mm., Copper), complete with cable end boxes, cable termination enclosures, and all associated accessories, to complete the transformer incomer bay module. Further, considering the provision for future addition of one (01) no. 160 MVA transformer, one (01) GIS incomer/transformer bay module shall have suitable arrangement for indoor termination.
- h. Gas monitoring device, barriers, pressure switch, UHF based partial discharge measurement sensors etc. as required.
- i. Local control cubicle.

(D) Outgoing 72.5kV Line Feeder Circuit Breaker Bay modules, each comprising of:

- a. One, 2000A, 3-phase, SF₆ gas insulated circuit breaker, complete with operating mechanism for outgoing feeder.
- b. Three, 1-phase, 3-core, current transformers.
- c. One, 2000 A, 3-phase, single pole, group operated isolator/disconnector without earthing switch, complete with manual and motor driven operating mechanisms.
- d. One, 2000A, 3-phase, single pole, group operated isolator/disconnector with one 3-phase, single pole, group operated earthing switch, complete with manual and motor driven operating mechanisms.
- e. One, 2000 A, 3-phase, single pole, group operated isolator with one normal & one high speed fault make, 3-phase, single pole, group operated earthing switch, complete with manual and motor driven operating mechanisms.
- f. Three, 3-core, 1-phase, voltage transformers/PTs with one, 3-phase, single pole, group operated isolator/disconnector switch, complete with manual and motor driven operating mechanisms.
- g. Three, 1-phase, surge arresters.
- h. Gas insulated terminal connection for connecting 66kV feeder bays to 66kV GIS through 66kV XLPE Power Cables (Single Run, Single Core, 1200 sq.mm., Copper), complete with cable end boxes, cable termination enclosures, and all associated accessories, to complete the feeder bay module.
- i. Gas monitoring device, barriers, pressure switch, UHF based partial discharge measurement sensors etc. as required.
- j. Local control cubicle.

(E) 72.5kV, 2500A, Bus Sectionalizer Bay module, each comprising of:

- a. One, 2500 A, 3-phase, SF6 gas insulated Circuit Breaker, complete with operating mechanism.
- b. Three, 1-phase, 3-core, current transformers on one side of the circuit breaker.
- c. Three, 1-phase, 3-core, current transformers on the other side of the circuit breaker.
- d. Two, 3-phase, single pole, group operated isolator/disconnector switches each with 3-phase, single pole, group operated earthing switch complete with manual and motor driven operating mechanisms.
- e. Gas monitoring device, barriers, pressure switch, UHF based partial discharge measurement sensors etc. as required.
- f. Local control cubicle.

(F) The scope of work also covers complete connection of 66kV GIS with 03 Nos. 160MVA Power Transformer through single phase SF₆/XLPE cable terminations. For making connection between GIS and transformer, 66kV XLPE Power Cable (Double Run x Single Core x 1200 Sq.mm., Copper) shall be used, including indoor & outdoor termination and connection with 66kV bushings of transformer through Al/Cu bus-bar. The outdoor type 60kV, 10kA, single phase Lightning Arresters (LAs) with discharge counter, milli-ampere meter, 66kV Bus Post Insulator (BPI) with Corona Ring, and suitable terminal connectors etc. shall also be in the scope of work.

(G) The scope of work also covers the termination of 66kV GIS feeder bays on an H-pole outdoor arrangement using a 66kV XLPE Cable (Single Run × Single Core × 1200 sq. mm, Copper), including both indoor and outdoor terminations, H-pole installation, LA, BPI, and other associated equipment for outgoing feeder termination on the H-pole. Furthermore, all 66kV H-pole arrangements shall include 66kV LA & 66kV BPI.

(H) The scope of work also covers steel for support structure for 66kV O/D surge arrester, 66kV BPI, 66kV H Pole, tertiary support structure, etc.

III. The scope also includes the supply, erection, testing, and commissioning of three (3) 220/66/11kV, 160MVA Power Transformers with bushings and all accessories, and first filling of oil with 10% spare quantity of oil, Nitrogen Injection Fire Prevention & Extinguishing System (NIFPES), oil storage tank as per specification, Neutral CTs, RTCC panel, terminal connectors, control cables, and power cables. The RTCC panel shall be installed inside the DTL control room or as per the approved drawing/requirement of the site in-charge.

IV. Complete Sub-Station Automation System based on IEC 61850 including hardware and software for remote control station, relay and protection system along with associated equipment and kiosk for following bays (bay as defined in technical specification, section: sub-station automation):

- 220kV: 15 Bays + 2 Bus Bar Protection Bays + provision of minimum 03 nos. future bays with adopter, and
- 66kV: 26 Bays + provision of minimum 05 nos. future bays with adopter.

The sub-station should have the provision to be controlled from a remote location and mode of communication shall be optical fiber for all voltage levels. Bidder shall provide FOTE equipments alongwith Tele-protection cards for remote end sub-station also. FO cable inside the substation and FODB alongwith patch chord at local and remote ends for successful operation are in contractor's scope. FOTE for both ends shall also have provision for eight command tele-protection and two current differential protection

interfaces. The protection requirement shall be fulfilled by the contractor for successful commissioning. Location details to be made available during detailed engineering. Suitable Converters/provision shall be made by Contractors for commissioning of FOTE system and only 220V Battery System shall be used.

- V.** Control & Relay Panels for the following bays, with complete automation with local SCADA system:
- a. 220kV Feeder Bays : 06 Nos.
 - b. 220kV Transformer Bays : 04 Nos.
 - c. 220kV Reactor Bays : 01 No.
 - d. 220kV Bus Coupler Bays : 02 Nos.
 - e. 220kV Bus Section Bays : 02 Nos.
 - f. 220kV Bus Bar Protection Panels : 02 Nos.
 - g. 66kV Feeder Bays : 18 Nos.
 - h. 66kV Transformer Incomer Bays : 04 Nos.
 - i. 66kV Bus Coupler Bays : 02 Nos.
 - j. 66kV Bus-section Bays : 02 Nos.
- VI.** Time Synchronization Equipment and other common equipments pertaining to Relay & Protection System.
- VII.** Remote HMI alongwith monitor for DTL control room, and inverter of suitable capacity for the station HMI & peripheral devices i.e. printer, etc.
- VIII.** The following Testing & Maintenance equipment under the Automation & SCADA system has been considered:
- a. Optical Time Domain Reflected Meter,
 - b. Fibre Splicing machine,
 - c. Test Plug for testing & isolation of relay for testing, and
 - d. Manufacture's specific maintenance tool.
- IX.** Complete Relay and Protection system.
- X.** Air Conditioning System (VRV/VRF) for:
- a. 220kV Relay & Protection Panels Room,
 - b. 66kV Relay & Protection Panels Room,
 - c. Control Room Building,
 - d. Battery Room, and
 - e. Office Space, Lab, Conference Hall, etc.
- XI.** Ventilation system for 220kV GIS hall & 66kV GIS hall.
- XII.** Two (02) Nos., 1000KVA, 11kV/0.433kV LT, three phase Transformer having 170kVp BIL on the 11kV side, including bushings, accessories, and first filling of oil.
- XIII.** Tertiary loading equipment for one 160 MVA transformer, such as:
- a. 33kV, O/D type isolator with earth switch,
 - b. 33kV, O/D type CT,
 - c. 33kV, O/D type Circuit Breaker,
 - d. Control & Relay Protection scheme,

- e. 11kV, O/D type Potential Transformer,
 - f. 11kV Surge Arrester,
 - g. 33 kV XLPE Power Cable with termination kit (2 Run x 3C x 400 Sq.mm, Copper)
- XIV.** 11kV switchgear, 3-panel board (1 Incomer, 1 Outgoing, and 1 Bus Coupler), alongwith associated Control & Relay system, 11kV Cables, etc. for loading 1000KVA Auxiliary Transformer, which shall be connected to the DISCOM supply.
- XV.** LT switchgear.
- XVI.** 220V, 600 AH Battery & 220V, 600 AH, Battery Charger system .
- XVII.** 250KVA, 440V, Generator Set along with control panel.
- XVIII.** 1.1kV grade Power & Control cables along with complete accessories.
- XIX.** EOT crane for a) 220kV GIS room with complete accessories, b) 66kV GIS room with complete accessories, and c) store room.
- XX.** Fire Detection, Alarm & Protection for 220kV GIS building, Control Room Building, 66kV GIS Building, Store, etc. (Portable type fire extinguishers system) (refer “Annexure-V”).
- XXI.** Heat/Smoke Fire Detection system.
- XXII.** Complete lighting and illumination of the installation. This shall include illumination for 220kV & 66kV GIS Buildings, Control Room, Control Room Building, store, etc. including the switchyard/street lighting system (High Mast lighting System). The specification for control room GIS building illumination shall be as per “Annexure-IV”.
- XXIII.** 40mm MS rod for the main earthmat for 220kV & 66kV GIS systems, and lightning mast/GS shield wire (Measurement of resistivity is in the scope of contractor).
- XXIV.** Provision of CCTV cameras for complete supervision of 220kV & 66kV GIS hall, main entrance gate of the substation, LT switchgear room, battery bank room, and outdoor areas for monitoring of transformers and switchyard equipment from the control room as well as from a remote location other than the substation. The cameras should be installed in such a way that the complete substation is visible remotely for unmanned operation. Provision for online viewing of cameras from a remote substation shall be made by the contractor.
- XXV.** Design, Engineering, Supply, Erection, Testing, and Commissioning of 01 No. Double Circuit (D/C), D-Type BXA, 28 mtr, 220kV Monopole, along with HTLS conductor and all associated accessories such as OPGW, long rod polymer insulators, hardware fittings, clamps, tower accessories, etc., including stringing and de-stringing of the existing line for LILO of the overhead D/C 220kV Bamnauli-DIAL Transmission Line at 220kV Substation Bharthal.
- XXVI.** SETC of gantry structures along with all accessories and associated works, etc. for termination of the LILO of overhead D/C 220kV Bamnauli-DIAL Transmission Line at 220kV Substation Bharthal.
- XXVII.** All dismantled materials shall be safely transported to the Mehrauli Store, and scrap materials shall be transported to the Rampura store or any other designated DTL location, as per site requirements and instructions of the Engineer-in-Charge.

- XXVIII.** Bidder shall arrange suitable provision for testing of 220kV & 66kV cables after isolation from the main GIS. Provision for space for termination of cable/ Overhead line shall be kept during designing stage.
- XXIX.** Special equipment for testing and maintenance.
- XXX.** Testing & Maintenance equipment for GIS, and Mandatory Spares.
- XXXI.** 11kV protection IEDs shall have integration with SCADA. ACDB, DCDB, DG Set and battery charger system shall be communicable and integrated with SCADA.
- XXXII.** The work to be done under this specification comprises the provision of all labour, plant, equipment and material and the performance of all work necessary for the complete installation and commissioning of switchyard. It is hereby required that the contractor should provide 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.
- XXXIII.** The scope of work shall cover in complete conformity with the specifications, the following: -
- A single line schematic of 220 & 66kV SF6 gas insulated switchgear is enclosed with the specification (**Annexure-II(A)**). In case any additional equipment is required, the same should be included in the scope of the supply and the offer should be complete and comprehensive. In addition, all necessary platforms, supports, ladders and catwalks etc. for operation & maintenance work shall also be supplied. A tentative layout of the switchyard is enclosed with this specification (**Annexure-II(B)**). Bidder may adopt similar arrangement or optimize the same further without affecting any of the functional requirements specified.
- XXXIV.** Any other equipment/material/services required for the completion of work.
- XXXV.** The watch and ward of the complete site shall be in the scope of bidder.
- XXXVI.** The bidder's scope shall also include provision of the purchaser's site office and stores, along with adequate illumination and air-conditioning.
- XXXVII.** The location of the transformer site may undergo change within Delhi, if required by the Employer.
- XXXVIII.** If any services of the OEM of the existing system are required for the completion of the work, the same shall also be in the scope of the Contractor.
- XXXIX.** **Civil works** - The scope of work shall include, but not be limited to, the following:-
- A. Foundations for**
1. 160 MVA, 220/66/11kV, Power Transformers with accessories, NCT, soak pit and sump well, etc.
 2. 220kV LA.
 3. 220kV SF6/Air Bushings.
 4. 66kV LA.
 5. 66kV BPI.

6. 1000 KVA, 11/0.433kV LT Transformer.
7. 250 KVA DG Set.
8. 66kV H-pole arrangement with LA & BPI.
9. Tertiary Loading Equipment.
10. Switchyard/Street light system (High Mast lighting System).
- B.** RCC in foundation including earth work in excavating disposal of surplus earth PCC, RCC reinforcement steel, for structures and equipment.
- C.** Cable Trench including all types of crossings.
- D.** Site surfacing (gravelling) & Anti weed Treatment including yard development.
- E.** Roads (including all crossings), road in front of ICTs with connecting rail.
- F.** Storm Water drainage, Rain water harvesting, Water conservation management & waste management.
- G.** Main Gates and Switchyard Fencing along with gates.
- H. Buildings (including foundations)**
 1. 220kV GIS Building as per design requirement.
 2. 66kV GIS building as per design requirement.
 3. Store room as per design requirement.
 4. Pumphouse along with pump etc.
 5. Security Room, Site offices and Parking Shed.
- I.** Transformer RCC fire walls.
- J.** RCC frame Boundary wall with brick panneling including gates for complete substation.
- K.** Land filling with good earth including watering, compacting etc. as per standard CPWD specifications of work.
- L.** Horticulture work including landscaping and Plantation as per design requirement.
- M.** Furniture of Reputed make for complete Control Room Building including control room, office space, conference hall etc.
- N.** Soil Investigation.
- O.** Demolition/Dismantling of existing fencing/structures, clearing of vegetation/tree, ground preparation, recovery of material with scrap value and Petty work as per site condition etc. (if any).
- P.** Petty work required for completion of job, if any.

Any other work required for the functional requirement of establishment of the substation.

- 3.1** Before proceeding with the construction work of the substation, the Contractor shall fully familiarize itself with the site conditions and general arrangements & scheme etc. Though the Purchaser shall endeavor to provide the information, it shall not be binding on the Purchaser to provide the same.

The bidders are advised to visit the substation site(s) and acquaint themselves with the topography, infrastructure, and also the design philosophy. The Bidder shall be fully responsible for providing all equipment, materials, systems, 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 shall be supplied by the Contractor. Cement and steel shall also 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.

- 3.2** The Contractor shall also be responsible for overall co-ordination with internal/external agencies, project management, training of the Purchaser's manpower, and for loading,

unloading, handling, and movement to the final destination for successful erection, testing, and commissioning of the substation/switchyard/extension work at the sub-station.

3.3 Design of the substation and its associated electrical & mechanical auxiliaries systems includes preparation of single line diagrams and electrical layouts for extension area, erection key diagrams, electrical and physical clearance diagrams, design calculations for Earth mat, control and protection schematics, wiring and termination schedules, civil designs (as applicable) and drawings, design of fire fighting system and air conditioning system, indoor/outdoor lighting/illumination, and other relevant drawings & documents required for engineering of all facilities under the scope of this contract.

3.4 The Bidder shall keep the provision of service bays for increasing the length of the GIS room to meet future requirements, while keeping the width of the building same. The GIS building size shall be finalized after considering the requirement of a minimum of three (03) nos. 220kV GIS future bays and a minimum of five (05) nos. 66kV GIS future bays with adaptor.

3.5 Specific Exclusions

The following items of work are specifically excluded from the scope of the specifications for substation:

- i. Road outside Boundary Wall.
- ii. Scope of solar panel.

3.6 Any other items not specifically mentioned in the specification, but which are required for erection, testing, commissioning, and satisfactory operation of the substation, shall be deemed to be included in the scope of the specification unless specifically excluded.

3.7 The purchaser has standardized its technical specifications for various equipments and works for different voltage levels. Items which are not applicable to the scope of this package, as per the Schedule of Quantities described in the Bid Price Schedule (BPS), shall not be referred to in the technical specifications.

3.8 Water-based firefighting and a reservoir are not envisaged.

A pump and pump house are required for evacuation of surface/rain water or water logging in the substation premises, primarily for water accumulated in trenches/drains/cellars. Moreover, the pump will also function for regulating water to the water harvesting system.

4.0 PHYSICAL AND OTHER PARAMETERS

4.1 Location of the Substation - The location of the substation is indicated below:

Name of Substation	Name of State	Nearest Railway station	Railway Head
Bharthal	Delhi Region	New Delhi	Northern Railways

4.2 Meteorological data

The meteorological data of the substation shall be handed over to successful bidder. However, for design purposes, ambient temperature and altitude shall be considered as 50 degrees centigrade and less than 1000 mtr. above MSL, respectively.

4.3 Soil Data

The bidder shall be responsible for carrying out the required tests and should fully satisfy himself about the nature of soil expected to be encountered prior to the submission of bid. Any variation of soil data during detailed engineering or construction stage shall not constitute a valid reason in affecting the terms and conditions of the bid.

5.0 SCHEDULE OF QUANTITIES

The requirement of various items/equipments and civil works are indicated in Bid price Schedules.

All equipments/items and civil works for which quantities have been given in the price schedule 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 the letter of award.

Wherever the quantities of items/works are not indicated, 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.

The quantities of the mandatory spares are given in the price schedules, and the detailed bill of quantities of the mandatory spares, with break-up, is provided in ‘**Annexure-I**’.

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 Purchaser.

6.0 BASIC REFERENCE DRAWINGS

- 6.1 A new 220/66kV Gas Insulated Switchgear (GIS) sub-station is to be established at Bharthal. The Single Line Diagram (SLD) and layout arrangements are enclosed with the bid documents, which shall be further engineered by the bidder.

The drawings enclosed in “**Annexure-II**” shall give the basic scheme, layout of the substation, substation building, associated services, etc. In case of any discrepancy between the drawings and text of specification, the requirements of the text shall prevail in general.

- 6.2 The auxiliary transformers of rating 1000 KVA shall be used to feed the substation auxiliaries:

1000 KVA, 11/0.433 kV (170kVp - BIL) auxiliary transformer shall be connected through overhead conductor to the tertiary of any one of the 160 MVA power transformers and shall be located near the power transformer. These auxiliary transformers should not be used for construction purpose.

7.0 ORDER OF PRECEDENCE OF DIFFERENT SECTIONS OF TECHNICAL SPECIFICATION

In case of any discrepancy between Section: Project, Bill of Material, GTP, equipment Technical Specification, Single Line Diagram, Section: Project shall prevail over all other sections, and the order of precedence shall be as follows:

Section-I, Vol-II: Section Project
Section-IV, Vol-III: Price Schedules
Section-II to Section XXV, Vol-II
Single line Diagram
Layout

For the purpose of present scope of work, the order of precedence between various sections of Volume-II (Technical Specification) shall be as under and they should be read in conjunction with each other:

- 1) Section-I: Project
- 2) Section-II: Gas Insulated Switchgear (GIS)
- 3) Section-III: General Technical Requirement (GTR)
- 4) Section-IV: Special Equipments
- 5) Section-V: Fire Protection System
- 6) Section-VI: LT Switchgear
- 7) Section-VII: Battery and Battery Charger
- 8) Section-VIII: Lighting System
- 9) Section-IX: LT Transformer
- 10) Section-X: Diesel Generator Set
- 11) Section-XI: Switchyard Erection
- 12) Section-XII: Civil Works
- 13) Section-XIII: Substation Automation System
- 14) Section-XIV: Control and Relay Panels
- 15) Section-XV: Power and Control Cables
- 16) Section-XVI: Visual Monitoring
- 17) Section-XVII: Fiber Optic Terminal Equipment (FOTE)
- 18) Section-XVIII: Lightning Arrestor (LA)
- 19) Section-XIX: Optical Ground Wire (OPGW)
- 20) Section-XX: Power Transformer
- 21) Section-XXI: Nitrogen Injection Fire Prevention Cum Extinguishing System (NIFPES)
- 22) Section-XXII: 33kV & 66kV XLPE Cable
- 23) Section-XXIII: Monopole Steel Towers
- 24) Section-XXIV: HTLS Conductor and associated H/W Fittings & Accessories
- 25) Section-XXV: Polymer Insulators

In case of any discrepancy between Section-PROJECT, Section- GTR, and other technical specifications on the 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 MANDATORY SPARES

Mandatory Spares shall be included in the bid proposal by the bidder. Prices of these spares shall be given by the Bidder in the relevant price schedule and shall be considered for evaluation of bid. It shall not be binding on the Purchaser to procure all of these mandatory spares.

The bidder is clarified that no mandatory spares shall be used during 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.

9.0 SPECIAL TOOLS AND TACKLES

The bidder shall include in its proposal the deployment of all special tools and tackles required for erection, testing, commissioning, and maintenance of equipment. However, a list of all such devices should be indicated in the relevant price schedule. In addition to this, the Contractor shall also furnish a list of special tools and tackles for the various equipment in a manner to be referred by the Purchaser during the operation of these equipment.

10.0 FACILITIES TO BE ARRANGED BY THE CONTRACTOR

- 10.1 For construction purpose, the Contractor shall arrange suitable electricity supply from the Distribution Utility at the Contractor's own cost, and in case of failure of power due to any unavoidable circumstances, the contractor shall make necessary arrangements, such as diesel generator sets, etc., at the Contractor's own cost so that the 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.
- 10.2 The contractor shall make its own arrangement for water supply at its 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.

11.0 TERTIARY WINDING (TRANSFORMER)

The tertiary winding shall be suitable for connection to LT transformer for auxiliary supply. The details of equipment associated with loading tertiary winding are enclosed as “**Annexure-III**”.

12.0 SPECIFIC REQUIREMENT

12.1 Training of Owner's Personnel:

The successful tenderer shall also arrange the training of owner's/purchaser's engineers at the manufacturer's works/facility from where the equipment is being supplied for 120 man days in Design, Manufacturing, and Testing of equipment being supplied. To & fro air fare including boarding and lodging shall be borne by the owner/purchaser and no separate charges for training shall be paid.

- 12.2 The equipment to be supplied for 220kV and 66 kV systems shall be suitable for system fault current of 50 kA and 31.5 kA for 1 second respectively as specified elsewhere in the specification.
- 12.3 The contractor shall install the panels (i.e. Bay level units, bay mimic, relay & protection panels, etc.) in an enclosure for 220kV & 66kV systems in respective GIS hall. The enclosure shall be air-conditioned, and the air-conditioning requirements shall be as detailed in the respective section.
- 12.4 Control, monitoring and protections (over current and open delta protections) for Auxiliary transformer and associated equipments shall be from auxiliary BCU to be provided as per section Sub-Station Automation.
- 12.5 The specification of ACSR Zebra Conductor is enclosed as “**Annexure-VI**”.

- 12.6 As extension of 220kV and 66kV GIS is envisaged in future, the Contractor shall ensure submission of complete design details, including cross-sections, gas pressure, and all other relevant parameters, during detailed engineering, to enable seamless design and integration of adapters for future extension of GIS.
- 12.7 The bidder 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 Purchaser.
- 12.8 In Section-GTR and other Technical Specifications, the word 'Employer' and/or 'Owner' may be read as 'Purchaser'.
- 12.9 The Contractor shall ensure adequate minimum clearances in and around the GIS hall to facilitate safe operation, maintenance activities, and free movement of equipment and personnel.
- 12.10 Provision of separate /different trenches for power cable and control cable are to be made as far as possible.
- 12.11 The bidder shall submit all the applicable type test reports of the equipment in line with latest editions of relevant IS/IEC standards. The validity of the type test reports shall be as per the latest CEA guidelines. The type test reports shall be submitted along with the bid.
- In case any applicable type test has not been conducted, the Bidder shall carry out the same at its own cost, without any impact on the completion schedule of the project/tender. In case the item/equipment is not listed in the CEA guidelines, the validity of the respective items/equipments shall be as per the Technical Specifications (TS).
- 12.12 The Technical Specifications (TS) for Air conditioning system (VRV/VRF) & Ventilation System is to be taken as per the latest CPWD manual on general specifications for Heating, Ventilation and Air Conditioning (HVAC) works.
- 12.13 The Specification for Full Face Mask with Dual Cartridges is enclosed as **"Annexure-IX"**.
- 12.14 The Technical Specifications of Neutral Current Transformer is enclosed as **"Annexure-X"**.
- 12.15 The Technical Specifications of the Clamp-on meter, Fibre Splicing Machine, and Optical Time Domain Reflected Meter (OTDR) are enclosed as **"Annexure-XI"**, **"Annexure-XII"**, and **"Annexure-XIII"**, respectively.
- 12.16 The Technical Specifications of Tower Accessories are enclosed as **"Annexure-XIV"**.
- 12.17 The Technical Specifications of 11kV, 500MVA Switchgear panel are enclosed as **"Annexure-XV"**.
- 12.18 The General Technical Requirements for 66kV Bus Post Insulator (BPI), 11kV Surge Arrester, and 11kV PT have been incorporated in Volume II, Section 3: GTR.
- 12.19 Use of call before you Dig application if applicable (CBuD APP) of Department of

Telecommunication (GoI) and other concerned Departments.

13.0 PRE-APPROVED SUB-VENDOR LIST

The list of pre-approved sub-vendors is attached as **Annexure-II(E)**. The list is not exhaustive and its purely indicative. It is also not mandatory for the bidders and the bidder is free to opt their own sub-vendors.

MANDATORY SPARES FOR GAS INSULATED SWITCHGEAR (GIS)

	220kV & 66kV GIS Spares	Quantity (for each voltage class)
1.	Cable end termination connection & enclosure, compatible with the main Circuit	1 set (1-ph)
2.	SF6 gas Pressure Relief Devices, 03Nos. of each type	2 sets
3.	SF6 Pressure gauge cum switch OR Density monitors cum switch as applicable (3 no. of each type)	1 set complete for 1 bay + bus bar, Bus duct. + CB
4.	Coupling device with pressure gauge for connecting Gas handling plant including GIS & Cylinder both	2 sets
5.	Rubber Gaskets, "O" Rings and Seals for SF6 gas of each type	1 set
6.	Molecular filter for SF6 gas with filter bags	20% of total quantity
7.	All types of Control Valves for SF6 gas of each type	1 set
8.	SF ₆ gas	20% of total quantity
	Covers along with all accessories necessary to close a compartment in case of dismantling of any part of the Enclosure to ensure the sealing of this compartment.	
9.	For 3 Phase Enclosure	2 Nos.
10.	For Single phase enclosure	3 Nos.
11.	Bus Support insulator of each type for 3 phase/single phase enclosure.	5% of installed/ used population
12.	SF6 to air bushing of each type rating including fixing arrangement	3 No.
	220kV SF6 CIRCUIT BREAKER	
13.	Circuit Breaker pole complete of each type & rating complete with interrupter, main circuit, enclosure and Marshalling Box with operating mechanism	3 Nos.
14.	Fixed, moving and arcing contacts including insulating nozzles 3 Nos. of each type/rating of CB	1 set (3 No.)
15.	Rubber gaskets, 'O' rings and seals for SF6 gas of each type	1 set
16.	Trip coil assembly with resistor as applicable, 3 Nos. of each rating of CB	2 sets
17.	Closing coil assembly with resistor as applicable, 3 Nos. of each rating of CB	2 sets
18.	Corona rings/cover if applicable	1 set
19.	Relays, Power contactors, push buttons, timers & MCBs etc of each type & rating	1 set
20.	Closing valve assembly, 3 Nos. of each type	2 sets
21.	Trip valve assembly, 3 Nos. of each type	2 sets
22.	Auxiliary switch assembly, 3 Nos. of each type	1 set
23.	Operation Counter, 3 Nos. of each type	1 set
24.	Rupture disc, 3 Nos. of each type	1 set

25.	Spring operated closing mechanism, 1 Nos. of each type, if applicable	1 set
	For Hydraulic Operated Mechanism, if applicable	
26.	Hydraulic operating mechanism with drive motor, 3 Nos. of each type	1 Set
27.	Hydraulic filter, 3 Nos. of each type	1 Set
28.	Hose pipe, 3 Nos. of each type	1 Set
29.	N2 Accumulator, 3 Nos. of each type	1 Set
30.	Pressure transducer, 3 Nos. of each type	1 Set
31.	Valves 3 Nos. of each type	1 Set
32.	Pipe length (copper & steel) 3 Nos. of each size & type	1 Set
33.	Pressure switches 3 Nos. of each type	1 Set
34.	Pressure gauge with coupling device, 3 Nos. of each type	1 Set
35.	Hydraulic oil	20% of total qty. used
36.	Pressure Relief Device, 3 Nos. of each type	2 Sets
	66kV SF6 CIRCUIT BREAKER	
37.	Three phase, Circuit Breaker interrupting chamber complete with all necessary apparatus.	1 no. of each rating
38.	Rubber gaskets, 'O' rings and seals	1 set
39.	Trip coils with resistor.	3 nos.
40.	Closing coils with resistor	3 nos.
41.	Relays, Power contactors, push buttons, timers & MCB etc.	1 set
42.	Closing valve assembly (3 no. of each type)	1 no.
43.	Trip valve assembly (3 no. of each type)	1 no.
44.	Auxiliary switch assembly	1 no.
45.	Operation Counter	1 no.
46.	Rupture disc/diaphragm	1 no.
	220kV GIS Isolators & E/Switch	
47.	Complete set of 3 nos. of single phase / one no. of 3-phase dis-connector including main circuit, enclosure, driving mechanism etc.	1 Set
48.	3 no. of single phase / one no. of 3-phase Earthing switch including main circuit, enclosure, driving mechanism etc.	1 Set
49.	Copper contact fingers for dis-connector male & female contact – for one complete (3 phase) dis-connector of each type and rating.	1 Set
50.	Copper contact fingers for earthing switch male & female contacts, for one complete (3 phase) earthing switch of each type and rating	1 Set
51.	Open / Close contactor assembly, timers, key interlock for one complete (3 phase) dis-connector and (3 phase) earthing switch of each type and rating	1 Set
52.	Push button switch. -each type, as applicable	1 Set
53.	Limit switch and Aux. Switches for complete 3 phase equipment	1 Set
54.	Motor with gear assembly for complete 3 phase equipment	1 Set
55.	For Isolator	3 Sets
56.	For earth switch	1 Set

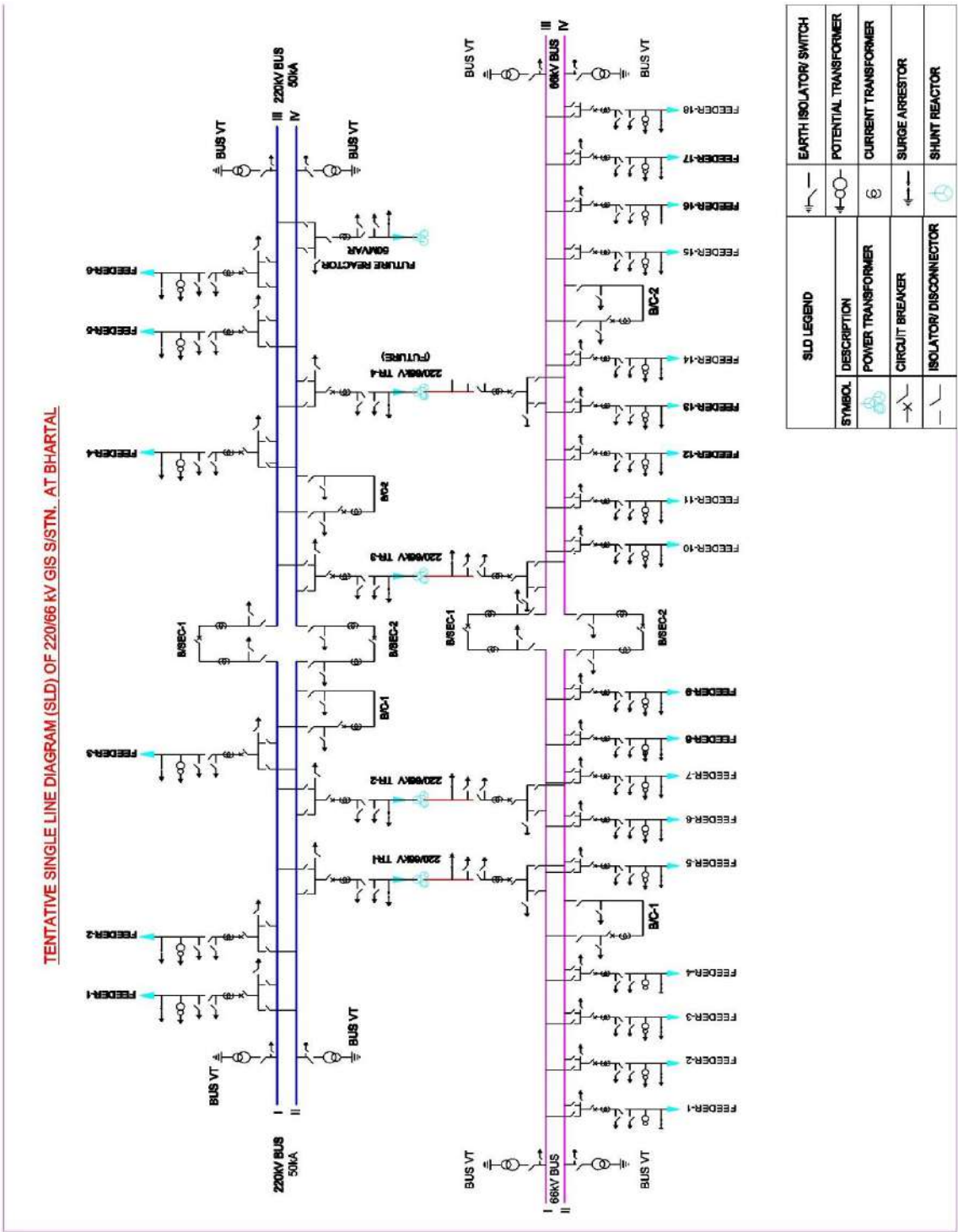
57.	Hinge pins for complete 3 phase	1 Set
58.	Relays, Power contactors, resistors, fuses, push buttons & MCBs (complete for one 3 phase equipment)	3 no
59.	Aux. switch assembly (complete) with 10 NO & 10 NC OR more contacts for both isolator & earth switch	1 Set
66kV GIS ISOLATORS & E/Switch		
60.	Three ph, Disconnecting Switch internal parts, complete with all necessary gaskets, mounting hardware, etc.	1 set.
61.	Three ph, Disconnecting Switch operating mechanism, complete with all necessary connecting apparatus.	1 set.
62.	Three ph., Grounding Switch internal parts, complete with all necessary gaskets, mounting hardware etc.	1 set.
63.	Three ph., Grounding Switch operating mechanism, complete with all necessary connecting apparatus.	1 set.
220kV GIS CURRENT TRANSFORMER		
64.	Complete CT of each type and rating with packing.	2 Nos.
65.	Secondary Terminal bushing of each type	2 Sets
66kV GIS CURRENT TRANSFORMER		
66.	Single phase current transformers of each rating with packing.	3 no. of each rating
220kV GIS Voltage Transformer		
67.	Complete VT of each type and rating	1 No.
66kV GIS Voltage Transformer		
68.	Three phase VT complete with all Gaskets and mounting hardware.	1 no. of each rating
220kV GIS SURGE ARRESTOR		
69.	Complete L.A. of each type and ratings with insulating base, terminal connector, Surge counter & accessories	1 No.
70.	Surge counter/ monitor	1 No.
66kV GIS SURGE ARRESTOR		
71.	Complete L.A. including insulating Base with Surge counter & accessories.	3 No.
72.	Surge counter/ monitor	3 No.
DG Set		
73.	Set of Fuel filter (each type)	1 set
74.	Solenoid Coil Assembly	1 No.
75.	Self-Starter assembly with clutch engaging and disengaging arrangements complete with motors	1 No.
76.	Lube Oil pressure safety control	1 No.
77.	High water temp. safety control	1 No.
BATTERIES		
78.	Spare Battery Cell	5 No.
79.	Terminal connectors with nuts & bolts	10 No.
BATTERY CHARGER		
80.	Set of control cards (All PCB cards)	1 set
81.	Set of relays	1 set
82.	Set of contractor	1 set

83.	Micro-switches (if applicable)	1 set
84.	Filter Capacitor	1 set
85.	Three phase full wave bridge rectifier (Thyristor/Diode)	1 set
86.	Set of wound resistor (if applicable)	1 set
87.	Set of switches	1 set
88.	Potentiometer	1 set
89.	Fuses of Thyristor with indicator	1 set
	Relay & Protection Spare (for each voltage class)	
	Breaker Relay Panel	
90.	Breaker failure Relay	1 No.
91.	Trip Circuit Supervision Relay	2 No.
92.	Self reset Trip Relay of each type (if applicable)	1 No.
93.	Timer Relay of Each type (if applicable)	1 No.
94.	DC Supervision Relays (if applicable)	1 No.
	Line Protection Panel Equipment spare	
95.	Main 1 Numerical distance relay (excluding external trip relays)	1 No.
96.	Main 2 Numerical distance relay (excluding external trip relays)	1 No.
	Transformer Protection Panel	
97.	Transformer Differential Protection Relay including all aux. CTs (if applicable)	1 No.
98.	Restricted Earth Fault Protection Relay with non-linear resistor (if applicable)	1 No.
99.	Backup protection relay with 3 O/C and E/F element	1 No.
100.	Over fluxing relay (if Stand alone)	1 No
101.	CVT selection relay (if stand alone)	1 No.
102.	Over load relay with timer (if Stand Alone)	1 No.
	Sub-station Automation System Spare	
103.	Bay Control Unit (of each type)	1 No.
104.	Ethernet Switch of Each type	1 No.
105.	Optical cable with end terminations of each length/type	5 set
106.	Fire Fighting System	1 LS
107.	Illumination System	1 LS
108.	LT Switchgear	1 LS

List of Drawings:

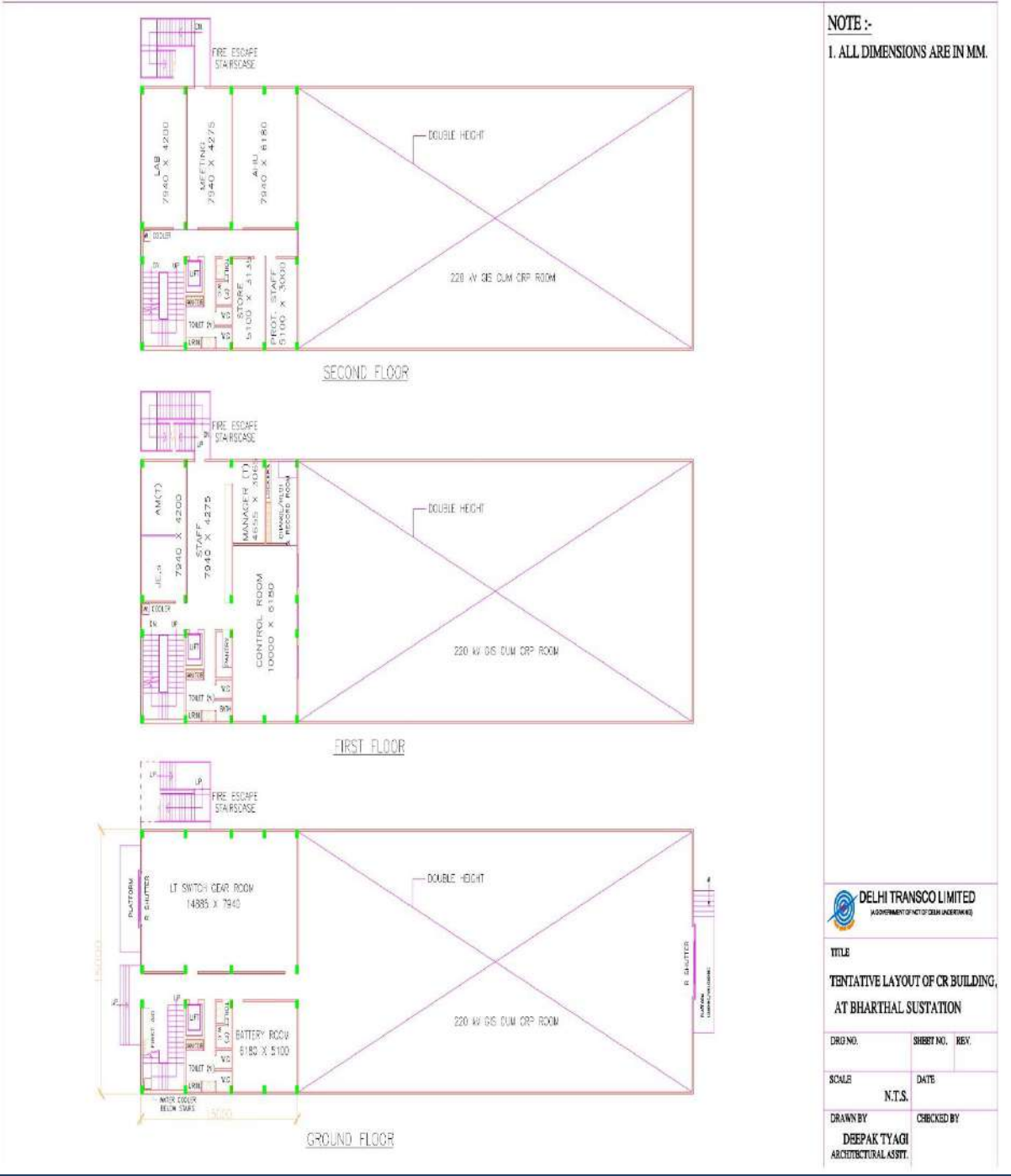
220/66kV GIS Substation at Bharthal:

1. Tentative Single Line Diagram : **Annexure-II(A).**
2. Tentative Layout Plan and Location : **Annexure-II(B).**
3. Tentative Layout of CR Building : **Annexure-II(C).**
4. Tentative requirements of : **Annexure-II(D).**
offices/rooms in Control Room
Building
5. Tentative SAS Architecture : (In Section XIII: Substation Automation;
Annexure-4).
6. Approved Sub-Vendor List of DTL : **Annexure-II(E).**



The above SLD is tentative and shall be finalized during the detailed engineering stage as per the technical specifications.





Tentative Layout of CR Building at 220/66kV Bharthal Substation

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**Tentative Offices/ Rooms requirements in Control Room building at 220/66kV
GIS Sub Station Bharthal**

Ground Floor			
S.No.	Descriptions	Size (in mm) approx.*	Remarks
1	LT Switch Gear Room	14885 x 7940	
2	Battery Room	6180 x 5100	
3	First Aid Room		
First Floor			
1	Control Room along with Change, Lockers, Rest & Record Room	10000 x 6180	
2	Manager (T)	+4655 x 3000	
3	AM(T)	4655 x 3065	
4	JE,s	7940 x 4200	
5	Staff Room having workstations	7940 x 4275	
6	Pantry		
7	Bath room		
Second Floor			
1	Lab	7940 x 4200	
2	Meeting room	7940 x 4275	
3	AHU	7940 x 6180	
4	Store room	5100 x 3135	
5	Protection Staff	5100 x 3000	
General Requirement			
1	Toilet (M)		All Floors
2	Toilet (F)		G.F. & S.F.
3	Janitor room		All Floors
4	Water cooler space alongwith RO system		All Floors
5	Common staircase along with Mumty		
6	Fire escape staircase		
7	Lift	1650 x 1500 (Pit Size)	

*The location & dimensions are tentative. These would be final at the time of Drawings approval.

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Approved Sub-Vendor List.

S. No.	Category	Name of Equipment/Material	Name of sub-Vendor	Date of approval
1	AC	AIR CONDITIONING	AON ENGINEERS	03.01.2019
2		2.0TR Split AC	Mark Engineerig Inc.	04.10.2023
3		AC System	Mark Engineering	24.12.2021
4		AHU & AIR CONDITIONING UNIT	AON ENGINEERS & CONSULTANT PVT LTD.	28.07.2017
5		AHU, VENTILATION SYSTEM	AON ENGINEERS	03.01.2019
6		Air Conditiong System	Voltas	23.09.2021
7		Air conditioning System (Volts make) & Ventilation System (Edgetech air system Pvt Ltd make)	Aon Engineers and Consultants Pvt.Ltd.	08.01.2021
8		AIR CONDITIONING, VENTILATION DB AND DCDB	SHIVALIC POWER CONTROL	20.12.2018
9		Split AC & AHU	Aon Engineers and Consultants Pvt Ltd	25.11.2021
10		Ventillation System	Mark Engineering	08.10.2021
11		Ventillation System	Wollaque Ventillation & Conditioning Pvt Ltd	10.06.2021
12	Battery	BATTERY CHARGER	HBL	03.01.2019
13		Battery Bank	HBL Power Systems Ltd	23.12.2021
14		Battery Bank	Exide Industries Limited	27.08.2021
15		BATTERY BANK	HBL	03.01.2019
16		Battery Charger	Chloride Power Systems & Solutions Ltd	17.08.2021
17		Battery Charger	Statcon Energia Pvt Ltd	23.12.2021
18	Bushing	220 KV, 1250 AMP RIP BUSHINGS	MOSER GLASER, SWITZERLAND	01.04.19
19		220kV RIP Bushing	MGC (Moser Glaser)	25.01.2021
20		33 KV 3150A HV PORCELAIN BUSHING, M-TYPE OLTC	EASON MR	21.06.2017
21		33 KV, 3150 AMP BUSHINGS	CJI, KHURJA	01.04.19
22		33kV LV Bushing	CJI Porcerlian (P) Limited	17.02.2021
23		1.1kV , 1Cx630 Sqmm XLPE, Armoured Power Cable & 1.1kV, 1Cx150Sqmm PVC, Armoured Power Cable	KEI Industries Ltd	15.10.2020
24		1.1kV , 10Cx2.5Sqmm FRLS Control Cable & 1.1kV , 6Cx2.5Sqmm FRLS Control Cables	KEI Industries Ltd	15.10.2020
25		1.1KV 3CX50 SQ.MM POWER CABLE	SURAJ CABLES	06.08.2018
26		1.1kV FRLS, AL, PVC, Armoured Control & Power Cables	KEI Industries Ltd	31.12.2020
27		1.1kV Grade PVC Power & Control Cables	Cords Cable Industries Ltd	27.07.2021
28		1.1kV LT Cable	Gemscab Industries Ltd.	25.09.2023

29	Cable	1.1kV LT Power & Control cable	Gemscab Industries Limited	27.12.2021
30		1.1kV Power & Control cables	KEI Industries Limited	14.10.2021
31		1.1KV POWER & CONTROL CABLES	CORDS CABLE INDUSTRIES LTD	17.10.2017
32		1.1KV XLPE & PVC POWER & CONTROL CABLES	KEI	15.01.2019
33		1.1kV, 3.5cX300Sq.mm. AL XLPE Power Cable	KEI Industries Limited	06.07.2021
34		220kV , 1000Sq.MM XLPE Cable	KEC International Limited	08.03.2021
35		220kV 1000 Sq.mm. XLPE Cable	LS Cable India Pvt. Ltd.	10.10.2024
36		33kV XLPE cable	KEI Industries Limited	03.11.2021
37		33kV, 3X400 Sq.mm XLPE Power Cable & 1.1kV, 10x2.5 Sq.mm FRLS Control Cable	KEI Industries Ltd	10.02.2021
38		66kV , XLPE , 1x1200Sqmm Power Cables	KEI Industries Ltd	15.10.2020
39		66KV XLPE 1Cx1000 SQ. MM CABLE	KEI	09.01.2019
40		66KV,1200 SQ.MM. XLPE CABLE, COPPER CONDUCTOR	UNIVERSAL CABLE LTD	11.10.2017
41		CONTROL CABLE 10 CORE 2.5 SQ MM	CORDS CABLE	10.05.2018
42	Capacitor Bank	33kV , 10MVAR Capacitor Bank	Universal Cables Ltd	21.10.2020
43	CB	33KV CB	CG POWER	17.08.2017
44		220 KV CB	GE T&D	13.02.2018
45		220kV & 66kV SF6 CB	Siemens Ltd.	10.06.2020
46		220KV CB	CG POWER	01.08.2018
47		220kV CB	ABB India Ltd	21.10.2020
48		220kV SF6 CB	Siemens Ltd.	23.12.2020
49		33kV CB	CG Power and Industries Solutions Ltd	12.01.2021
50		33kV CB	Siemens Ltd.	29.09.2020
51		33KV O/D CB	CG POWER	17.08.2017
52		33KV SF6 O/D CB	CG POWER	21.01.2019
53		400 KV CB	GE T&D	13.02.2018
54		400kV CB	Siemens Ltd.	24.02.2021
55		66kV CB	Siemens Ltd.	12.02.2021
56		66kV O/D SF6 CB	Siemens Ltd	19.08.2021
57		66kV SF6 CB	Siemens Ltd	07.09.2021
58		66KV SF6 CB	CG POWER	19.12.2017
59		72.5kV SF-6 Circuit Breaker	CG Power and Industrial Solutions Ltd.	22.09.2023
60		CB (22KV & 66KV)	CG POWER	15.05.2018
61	CCTV	CCTV	Delcom Telesystems Pvt Ltd	16.09.2021
62		CCTV	Siemens Ltd.	29.09.2020
63		CCTV ALONG WITH ITS ACCESSORIES	DELCOM	25.01.2019
64		400KV CLAMPS CONNECTOR	PRECICAST	04.05.2018

65	Clamp	Clamp , Connector & Hardware fitting	Legion Energy	19.01.2021
66		Clamps & Connectors	Precicast	05.08.2021
67		Clamps & Connectors	Legion Energy	08.12.2021
68		CLAMPS, CONNECTORS	PRECICAST	11.04.19
69		CLAMPS, CONNECTORS	NOOTAN	13.06.19
70		CLAMPS, CONNECTORS	LEGION ENERGY	17.07.19
71		C-WEDGE CONNECTOR	RPG RAYCHEM	27.06.2018
72		Terminal Connectors	Legion Energy	23.09.2021
73	Conductor	EARTH WIRE	CABCON	19.12.2017
74		4" DIA IPS TUBE	SUDAL INDUSTRIES LIMITED	05.10.208
75		4" IPS AL tube	Alom Extrusions Limited	20.12.2021
76		ACSR ZEBRA CONDUCTOR	HARYANA CONDUCTOR	06.03.2019
77		ACSR Zebra Conductor	Mahavir Transmission Limitd	08.09.2021
78		ACSR Zebra Conductor	Cabcon India Ltd	08.12.2021
79		ACSR ZEBRA CONDUCTOR	LUMINO LTD.	15.03.2018
80		ACSR ZEBRA CONDUCTOR	CABCON	25.04.2018
81		ACSR Zebra Conductor	Haryana Conductor Pvt Ltd	23.12.2020
82		Bersimis Conductor	Gupta Power Infrastructure Limited	01.12.2020
83		EARTH WIRE	BHARAT WIRE ROPE	15.03.2018
84		OPGW	ZTT LTD.	15.03.2018
85	Crane	EOT Crane	Reva Industries Limited	23.12.2020
86	CT	17.5 KV NCT	MEHRU ELECTRICAL & MECHANICAL ENGINEERING PVT LTD.	07.06.2017
87		17.5kV, 800-400/1 A NCT	Kapco Electric Ltd	01.01.2021
88		220 KV CT 1600-800/1/1/1/1 A	MEHRU ELECTRICAL	16.08.19
89		220kV CT	Mehru Electricals and Mechanical Engginers Pvt Limited	01.12.2020
90		220KV CT	HEPTA CARE	14.09.2018
91		245kV CT, 1600-800/1-1-1-1-1	ABB India Ltd	05.10.2020
92		33 kv GIS Sectionlizer CT	Narayan Powertech Pvt. Ltd., India	16.12.2021
93		33kV CT	Mehru Electrical & Mechanical Engineering Pvt Ltd	08.10.2021
94		33kV CT	Kapco Electric Ltd	25.03.2021
95		33kV GIS Bus Coupler CT	Zelisko	13.10.2021
96		33kV GIS CT (bus sectionalizer)	Zelisko	20.12.2021
97		33kV GIS CT, PT & LA	Zelisko & Narayan Powertech Pvt. Ltd., India & RITZ, Germany & Nexans Euromould, Belgium	22.12.2021
98		400 KV CT	GE T&D	08.03.2018
99		400kV CT	Mehru Electricals and Mechanical Engginers Pvt Limited	23.12.2020

100		66 KV CT	MEHRU ELECTRICAL & MECHANICAL ENGINEERING PVT LTD.	29.02.2018
101		66kV NCT	Mehru Electricals and Mechanical Engginers Pvt Limited	04.12.2020
102		NCT	HEPTACARE	03.06.19
103		NCT	Kapco Electric Ltd	06.08.2021
104		220KV CVT	CG POWER	01.08.2018
105		220kV & 66kV CVT	Mehru Electricals and Mechanical Engginers Pvt Limited	12.06.2020
106		220KV CVT	MEHRU	25.04.2018
107		66KV CVT	CG POWER	25.04.2018
108		66kV O/D CVT	Mehru Electrical & Mechanical Engineering Pvt Ltd	08.10.2021
109		AMF PANEL	JAKSON	16.01.2019
110		250 KVA DG SET	ELMECH ENGINEERS LTD	01.08.2017
111		250 KVA DG SET	SUDHIR POWER LTD.	19.06.19
112		250kVA DG Set	Jakson Ltd	08.02.2021
113		250kVA DG SET	Electro Equipments	17.02.2021
114		DTS System	A P Sensing Gmbh, Germany	22.09.2021
115		Earthing Material & Structural Steel	Good Luck Steel Tubes Limited	10.06.2021
116		Earthing Material, Steel Structure and Cable Tray	HS Engineering Works	06.11.2023
117		Fire Detection & Alarm system	3D Fire & Safety Private Limited	01.12.2020
118		Fire Extinguishers	3D Fire and safety Private Limited	20.12.2021
119		Fire Fighting System	Bhartiya Caccianlanza Fire System Ltd	09.12.2021
120		FIRE PREVENTION & EXTINGUISHING SYSTEM	3D FIRE & SAFETY	03.01.2019
121		Fire Prevention System & Extinguishers	3D Fire and safety Private Limited	16.09.2021
122		FIRE PROTECTION SYSTEM	3D FIRE & SAFETY	22.01.2018
123		NIFPES	CTR	01.04.19
124		NIFPES	CTR Manufacturing Industries Ltd	17.02.2021
125		HARDWARE FITINGS AND CLAMP CONNECTORS	LEGION ENERGY	19.06.2018
126		400KV & 220KV TOWER HARDWARE FITTING	SRI RAM ENGINEERING	17.04.2017
127		Hardware and Accessories	IAC Electricals	26.02.2021
128		Hardware Fitting	Legion Energy Products Pvt. Ltd.	19.09.2023
129		Hardware Fitting of HTLS conductor	Sicame India Connector Pvt. Ltd.	22.07.2024
130		HARDWARE FITTING, ACCESSORIES FOR HTLS	SICAME INDIA CONNECTOR PVT LTD	04.04.2018

Fitting

131	Fittings	HARDWARE FITTINGS	LEGION ENERGY	16.10.2018
132		HARDWARE FITTINGS	SICAME INDIA CONNECTORS	18.07.19
133		HARDWARE FITTINGS OPGW	LEGION ENERGY	12.10.2018
134		HARDWARE FITTINGS(400KV&220KV)	LEGION ENERGY	01.06.2018
135		Hardware Items(Tesnion, Suspension, Bus Bar Spacers and Equipment Clamps)	Legion Energy	07.08.2020
136		STRING HARDWARE FITTINGS	INTERNATIONAL TRANSMISSION LTD.	18.07.19
137	GIS	220kV GIS	Siemens Ltd.	29.09.2020
138		33kV GIS	Schneider Electric Infrastructure Ltd	28.01.2021
139		66kV GIS	GE T&D India Limited	31.07.2020
140	Illumination	Illumination System	Bajaj	23.09.2021
141		Light Cum Lightening Mast	Bajaj	22.09.2023
142		Lighting Fixtures	Bajaj	27.08.2021
143		LIGHTING MAST	TRANSRAIL	23.01.2018
144		Lighting Mast	Bajaj	24.12.2021
145	Insulator	11KV 120 KN ANTI-FOG DISC INSULATOR	IEC	19.02.2018
146		66KV PORCELAIN INSULATORS	IEC	19.12.2017
147		11kV ,120kN Disc Insulators & 33kV BPI	IEC	28.10.2021
148		11kV, 120KN Anti Fog Disc Insulators	Aditya Birla Insulators Pvt Ltd	01.02.2021
149		160 KN LONG ROD POLYMER INSULATOR	SRI RAM ENGINEERING	09.05.2017
150		220kV & 66kV BPI and Disc Insulator	IEC	22.07.2020
151		220KV & 66KV INSULATOR	IEC	25.04.2018
152		220kV BPI	Aditya Birla Insulators Pvt Ltd	23.12.2020
153		33 KV BPI	ADITYA BIRLA INDUSTRIES	02.08.19
154		33kV & 66kV BPI	Aditya Birla Insulators	17.08.2021
155		33kV BPI	IEC	29.09.2020
156		400kV BPI	Aditya Birla Insulators Pvt Ltd	23.12.2020
157		90KN LONG ROD POLYMER INSULATOR	SRI RAM ENGINEERING	09.05.2017
158		Disc Insulator	IEC	27.07.2020
159		DISC INSULATOR, 160KN & 90 KN	IEC	22.10.2018
160		LONG ROD POLYMER INSULATOR	SHREE RADHE INDUSTRIES	02.09.2019
161		Long Rod Polymer Insulator	Olectra Green Tech limited	03.07.2020
162		LONG ROD POLYMER INSULATOR	DECCAN ENTERPRISES	09.10.2018
163		POLYMER INSULATOR	SPARK INSULATOR	15.03.2018
164		POST INSULATORS	ADITYA BIRLA	24.11.2017
165		SOLID CORE INSULATORS	IEC	01.11.2018

166	Isolator	220 KV ISOLATOR	G NANDY & CO.	05.10.208
167		220kV Isolators	G.R.Power Switchgear Ltd	01.12.2020
168		33kV Isolator	GR Power Switchgear Ltd	14.10.2021
169		33kV Isolator	Switchgear Manufacturing Company (SMC) Private Limited	27.05.2021
170		33kV O/D Isolator	G.K.Electricals	17.02.2021
171		33KV,630 AMP,O/D ISOLATOR	G K ELECTRICAL	12.10.2017
172		400 KV & 220 KV ISOLATOR	GR POWER	28.02.2018
173		400 KV & 220 KV SOLID CORE POST INSULATOR	CG POWER	19.02.2018
174		400kV Isolator	G.R.Power Switchgear Ltd	23.12.2020
175		66kV Isolator	GR Power Switchgear Ltd	21.09.2021
176		72.5kV Isolators	G.R.Power Switchgear Ltd	07.09.2020
177		ISOLATOR(220KV & 66KV)	G NANDY & CO.	19.07.2018
178	Joint	11KV I/D & O/D TERMINATION KIT	3M ELECTRO & COMMUNICATION	03.10.2017
179		220KV I/D GIS TERMINATION KIT	RAYCHEM(P) LTD	14.09.2017
180		220kV Indoor & Outdoor Termination Kit	Reychem RPG Ltd	08.01.2021
181		33KV I/D & O/D TERMINATION KIT	3M ELECTRO & COMMUNICATION	03.10.2017
182		33KV END TERMINATION KIT	RAYCHEM RPG	16.08.2017
183		33KV GIS TERMINATION KIT	RAYCHEM/ TYCO ELECTRONE	16.08.2017
184		33kV O/D & 11kV I/D & O/D Termination kits	3M Electro & Communication India Pvt Ltd	20.12.2021
185		33kV O/D touch proff Termination kit	Nexans Euromould	21.12.2021
186		66kV Indoor Termination Kit	3M Electro & Communication India Pvt Ltd	15.06.2021
187		66KV O/D & I/D TERMINATION KIT	RPG RAYCHEM	01.11.2018
188		66KV O/D TERMINATION KIT	3M ELECTRO & COMMUNICATION	03.10.2017
189		66kV Outdoor Termination Kit, 33kV Indoor & outdoor Termination Kit	3M Electro & Communication India Pvt. Ltd	15.10.2020
190		Cable Link Box	Peace Power	02.09.2021
191		CABLE LINK BOX & CABLE CLEAT	PEACE POWER	23.05.2018
192		LINK BOX	ALFA ELMECH	04.06.2018
193		O/D & I/D TERMINATION AND STRAIGHT THROUGH	NKT GERMANY	19.02.2018
194		Out Door Termination Kit	3M Electro & Communication India Pvt Ltd	14.10.2021
195		Out Door Termination Kit	Raychem RPG	29.11.2021
196		Straight through joints	Bruggkabel	26.10.2021
197		STRAIGHT THROUGH JOINTS,220KV, 630 SQ.MM	BRUGG KABEL AG, SWITZERLAND	23.07.2018

198		Termination Kit	3M Electro & Communication India Pvt. Ltd	17.07.2020
199		Termination Kit	NKT Cables Gmbh, Germany	27.07.2021
200		TERMINATION KIT , 66KV I/D	RAYCHEM RPG (P) LTD	10.10.2017
201		TERMINATION PART MALE FOR 33KV XLPE CABLE	PFISTER	05.12.2017
202	LA	11KV SURGE ARRESTOR	OBLUM ELECTRICAL INDUSTRIES PVT LTD	07.06.2017
203		400 KV & 220 KV LA	CG POWER	19.02.2018
204		11kV LA	Lamco Industries Pvt Ltd	12.02.2021
205		220KV LA	CG POWER	07.08.2018
206		220kV LA	Lamco Industries Pvt Ltd	22.12.2020
207		33kV GIS LA	Nexans Euromould, Belgium	18.10.2021
208		33kV LA	Lamco Industries Pvt Ltd	14.12.2020
209		400kV LA	Lamco Industries Pvt Ltd	01.12.2020
210		66kV LA	Lamco Industries Pvt Limited	06.09.2021
211		66KV LA	CG POWER	19.12.2017
212		LA 198 KV & 60 KV	LAMCO	20.11.2018
213	Machine	OIL FILTERATION PLANT, 6000 LPH	CEE DEE VACCUM EQUIPMENT PVT LTD	17.06.2017
214		OIL STORAGE TANK	CEE DEE VACUUM EQUIPMENT PVT. LTD.	01.04.19
215		OIL STORAGE TANK	SUMESH PETROLEUM	11.03.2019
216		TRF. OIL STORAGE TANK	VACCUM PLANT & INSTRUMENTS	27.02.2018
217	OFC	OFC	VINDHYA TELELINK LTD.	19.02.2018
218		48F & 4F Optical Fibre Cable (OFC)	Vindhya Telelinks Ltd	12.08.2021
219		4F and 48F OFC	Aksh Optifibre Ltd.	10.10.2024
220		OFC,48F SINGLE MODE ARMOURED CABLE	PARAMOUNT	28.08.2017
221	Oil	Oil for Reactor	Savita Oil Technologies Ltd	12.03.2021
222		Oil for Reactor	APAR Industries Limited	16.02.2021
223		Tranformer Oil	APAR Industries Limited	04.08.2021
224		TRANSFORMER OIL	SAVITA OIL	13.05.19
225		TRANSFORMER OIL	APAR INDUSTRIES	16.05.19
226		Transformer Oil	Savita Oil Technologies Ltd	08.12.2020
227		Transformer Oil (Type-II Un-inhabited)	Columbia Petro Chem Pvt Ltd	27.10.2020
228		JB/ BMK	UNILEC ENGINEER	20.12.2017
229		11kV CRP	ABB India Ltd	26.02.2021
230		11kV Indoor Switchgear	CG Power and Industrial solution limited	15.06.2021
231		11kV Switchgear	Schneider Electric Infrastructure Ltd	14.12.2020
232		11KV SWITCHGEAR PANEL BOARD	CG POWER	21.01.2019
233		220 KV C&R PANEL	SHIFANG AUTOMATION	11.05.2018
234		220kV & 33kV CRP and SAS	Schneider Electric Infrastructure Ltd	08.12.2020

235	Panel	220kV & 33kV CRP and SAS	Schneider Electric Infrastructure Ltd	14.12.2020
236		220kV & 66kV C&R Panel	Siemens Ltd.	03.07.2020
237		220kV C&R Panel	Siemens Ltd.	23.12.2020
238		220KV CRP	SIEMENS	25.04.2018
239		400 KV & 220 KV C&R PANEL FOR TRANSFORMER	GE T&D	13.02.2018
240		400kV C&R Panel	Siemens Ltd	05.04.2021
241		415V MAIN SWITCH BOARD,ACDB,DCDB,MLDB,ELDB	SHIVALIC POWER CONTROL	20.12.2018
242		66 KV C&R PANELS	SIFANG AUTOMATION (I) PVT LTD	16.03.2018
243		66kV C&R panel	Siemens Ltd	07.12.2021
244		66kV CRP Panel	Siemens Ltd.	19.08.2020
245		66kV CRP Panel	GE T&D India Limited	31.07.2020
246		AC Koisk	SRD Building Products Ltd	07.01.2021
247		BMK & TK	NITYA ELECTRO CONTROL	14.09.2018
248		CRM	Scope	14.08.2020
249		CRP & SAS	Schneider Electric Infrastructure Ltd	13.10.2021
250		FOTE	Siemens Ltd.	04.12.2020
251		FOTE	GE T&D India Limited	31.07.2020
252		JB & BMK	Nitya Electrocontrols Pvt Ltd	10.07.2020
253		LT SWITCHGEAR	NITYA ELCTRO CONTROLS PVT. LTD.	21.05.19
254		LT Switchgear	Ultima Switchgears Ltd	09.07.2021
255		LT Switchgear	Nitya Electrocontrols Pvt Ltd	20.12.2021
256		MARSHALLING BOX FOR 400 KV CVT	ADOBE METAL PRODUCTS	30.08.19
257		SAS	GE T&D India Limited	31.07.2020
258		Terminal Kiosk	Nitya Electrocontrols Pvt Ltd	17.11.2021
259		TERMINAL KIOSK(TK)	NITYA ELECTRO CONTROL	05.10.208
260		Terminal Kisok / BMK	Nitya Electrocontrols Pvt Ltd	01.12.2020
261	Pipe	HDPE Pipe 250mm & 50mm dia	Trupati structures Ltd.	10.10.2024
262		HDPE Pipe 250mm dia	Flow Well Profile	10.10.2024
263		PE 80 PN06 250MM HDPE Pipe	Flow Well Profiles	04.12.2020
264	PT	11KV PT	MEHRU ELECTRICAL & MECHANICAL ENGINEERING PVT LTD.	07.06.2017
265		11KV PT	KAPCO ELECTRIC(P) LTD	09.01.2019
266		33kV Class, 170kVp, O/D,11kV ratio PT	Mehru Electrical & Mechanical Engineering Pvt Ltd	06.07.2021
267		33kV Class, 170kVp, O/D,11kV ratio PT	Kapco Electric Ltd	12.07.2021
268		33kV GIS PT	RITZ, Germany	18.10.2021

269		33kV PT	Mehru Electrical & Mechanical Engg. Pvt. Ltd.	07.12.2023
270		PT & LA (Components of 220kV GIS)	Shandong Taikai High Volt Sitchgear Co Ltd	07.07.2021
271	Slab	RCC cable Cover	Anmol Products/ Accurate Electrotech India Pvt. Ltd.	10.10.2024
272		RCC Cover Slab	Anmol Products	09.03.2021
273		RCC Cover Slab	Accurate Electrotech India Pvt Ltd.	21.09.2021
274		RCC Cover Slab, Route & Joint Marker	J K Spun Pipes	01.10.2021
275		RCC Cover Slab, Route & Joint Marker	Accurate Electrotech India Pvt Ltd.	16.02.2021
276		RCC SLAB	ANMOL PRODUCTS	18.09.2018
277		Route Marker	Anmol Products/ Accurate Electrotech India Pvt. Ltd.	10.10.2024
278		Structural Steel	H S Engineering	22.09.2021
279		Anti Theft Nut Bolts	Nexo Industries Ltd	02.09.2021
280	Structure	Anti Theft Nuts & Bolts	Capital Bolts and Hardwares	24.11.2020
281		EARTHING & TOWER & BEAM MATERIAL	HS ENGINEERING	13.12.2018
282		FABRICATION & SUPPLY OF TOWER PARTS A-TYPE SUSPENSION NARROW BASE TOWER	NEXO INDUSTRIES PRIVATE LIMITED	14.02.2019
283		FABRICATION & SUPPLY OF TOWER PARTS A-TYPE SUSPENSION NARROW BASE TOWER	SAWARIA PIPES PRIVATE LIMITED	30.01.2019
284		GI Angle	HS Engineering	28.08.2020
285		GI STEEL FOR SUPPORTING STRUCTURE	HS ENGINEERING	26.05.2017
286		GI STRUCTURE	HS ENGINEERING	05.10.208
287		Glavanised Structure & Earthing Materials	H S Engineering	17.02.2021
288		Grounding/Earthing and Pipe / Lattice Structure	HS Engineering	01.12.2020
289		LATTICE STRUCTURE & EARTHING MATERIAL	HS ENGINEERING	19.12.2017
290		LATTICE STRUCTURE&EARTHING MATERIAL	H S ENGINEERING	25.04.2018
291		NUT & BOLTS	BHARTI OVERSEAS	15.03.2018
292		Steel Structure	HS Engineering	02.09.2021
293		Structural Steel & Foundation Bolts	HS Engineering	29.09.2020
294		STUB & TOWER PARTS	ANIL STEEL PRIVATE LIMITED	09.10.2018
295		TOWER ACCESSORIES	AISHA TRANSMISSION	15.03.2018
296		TOWER PARTS	UTKARSH LTD.	15.03.2018
297		3-PHASE RELAY TESTING KIT	DOBBLE ENGINEERING (P) LTD	24.01.2018
298		CB operational Analyser	Doble	14.08.2020
299		Dew Point Meter	Phymetrix	14.08.2020

300	Testing Kit	DEW POINT METER	BEACON ENERGY SOLUTION PVT LTD	11.07.2017
301		Fiber Splicing Machine	Keith Electronics Pvt. Ltd. (Fujikura make)	24.09.2024
302		Gas Mask	3M	14.08.2020
303		Gas Mask	3M	19.09.2023
304		LEAKAGE DETECTOR	BEACON ENERGY SOLUTION PVT LTD	11.07.2017
305		OTDR	Agmatel India Pvt. Ltd.(VIAVI Make)	24.09.2024
306		Partial discharge monitoring kit	Om Technical Solutions (Make- Qualitrol)	25.09.2023
307		Partial Discharge Monitoring system	Qualitrol	14.08.2020
308		Primary Injection Kit	Kamtron System Pvt. Ltd.(Megger Make)	19.09.2023
309		SF6 FILLING & EVACUATING EQUIPMENT	BEACON ENERGY SOLUTION PVT LTD	11.07.2017
310		SF-6 Gas Analyzer	Wika Instruments India Pvt. Ltd.	25.01.2024
311		SF6 Gas Filling and Evacuation Plant	DILO	01.12.2020
312		SF-6 Gas Filling and Evacuation Plant	WIKA	23.09.2024
313		SF6 Leakage detector	Enervac	14.08.2020
314		Warning Tape	V4 You Group	06.10.2021
315	Transformer	220kV , 25MVAR Shunt Reactor	Transformers & Rectifiers India Ltd	28.10.2020
316		400 KVA TRANSFORMER	TBEA	15.01.2018
317		400kVA, 11/0.433kV LT Transformer	Svasca Industries India Ltd	06.07.2021
318		630 KVA, 11/0.433 KV,170 KVP LT TRANSFORMER	TOSHIBA	01.11.2018
319		800kVA LT Transformer	Tesla Transformers (India) Ltd	23.09.2020
320		Bucholz Relay, SPR & PRV/PRD	VIAT Instruments Pvt Ltd (ATVUS)	08.04.2021
321		OLTC	Easun MR Tap Changers(P) Ltd	03.12.2020
322		OLTC	CTR Manufacturing Industries Ltd	11.08.2021
323		PRV	VIAT Instruments Pvt Ltd (ATVUS)	04.08.2021
324		Series Reactor	Shrihans Electricals Pvt Ltd	23.12.2021
325		WTI & OTI	Precimeasure Controls Pvt. Ltd.	04.08.2021

TECHNICAL PARAMETERS FOR TERTIARY LOADING EQUIPMENTS FOR 100/160MVA TRANSFORMER

A. TECHNICAL SPECIFICATION OF “33 KV SF6 CIRCUIT BREAKER”

1.0. GENERAL FEATURES

- 1.1 The 33 KV Circuit Breaker shall be outdoor, SF6 gas, 3 phase, gang operated, spring charged mechanism completed with terminal connectors. The Circuit breaker & accessories shall conform to general requirement and design in accordance with the relevant IS/IEC.
- 1.2 The equipment quoted under this specification shall conform to the standards specified below. Unless otherwise specified, the equipment shall conform to the latest applicable IS/IEC.
- 1.3 The following standards shall apply:

1. CIRCUIT BREAKER

- | | | |
|----|---|------------------|
| a. | High voltage alternating current Circuit Breaker. | IEC 62271-100 |
| b. | Specification for high voltage alternating current Circuit breaker. | IS-13118:1991 |
| c. | Bushing for alternating voltage above 1000 Volts. | IS-2099-1973 |
| d. | SF ₆ Gas | IEC-376 |
| e. | Hollow column insulators | IS-5621/ IEC-233 |
| f. | High Voltage Switchgear and Control gear | IEC 62271-1 |

2. INDUCTION MOTOR

- | | | |
|----|--|---------|
| a. | Single phase small AC and Universal Electric Motor. | IS-996 |
| b. | Guide for testing single phase AC and Universal motor. | IS-7572 |
| c. | Three phase induction motors | IS: 325 |

3. CONTROL CABINETS

- | | | |
|----|--|------------------|
| a. | General Requirement for switchgear for voltage not exceeding 1 KV. | IS-5039/ IS-8623 |
|----|--|------------------|

- b. Degree of protection IS-12063/ IS-13947
Provided by enclosures.

4. CABLE & MCB

- a. PVC insulated cable upto IS-1554 Part I
& including 1100 volts.
- b. MCB IS: 13703

2.0 CONTACTS

- i. All making and breaking contacts shall be hermetically sealed, free from atmospheric effects and wherever applicable, shall be adjustable to allow for wear. These should be easily replaceable and shall have a minimum of moveable parts and adjustments to accomplish these results.
- ii. The arcing contacts shall be first to close and last to open and main contact shall be first to open and last to close.
- iii. Main & arcing contacts shall be silver plated & arcing contacts shall have tungsten alloy tipping or other better alloy with proven performance. The quality of coated contacts shall be as per IS/IEC of circuit breaker.

3.0 SULPHUR HEXA FLUORIDE GAS (SF₆ GAS)

- i. SF₆ Gas shall comply with IEC 376 and be suitable in all respect for use in the switchgear under all the operating conditions.
- ii. The high pressure cylinders in which the SF₆ Gas is supplied and stored at site shall comply with the requirements of standards stipulated under clause 1.3.
- iii. Means shall be provided for treating the SF₆ Gas by the use of desiccants driers, filters etc. to remove impurities in the gas. These shall be provided as permanent facilities.

4.0 SF₆ GAS CIRCUIT BREAKER

- i. Design and construction of circuit breakers shall be such that there is no possibility of gas leakage and ingress moisture content. There should not be any condensation of SF₆ Gas on internal insulating surface of the circuit breaker. Temperature Compensation shall be provided and the system shall be an integral part of breaker. Suitable arrangement for monitoring the density of SF-6 gas in Circuit breaker for each pole, like density monitor / temperature compensated gas pressure switch shall

be provided. Suitable arrangement should be provided for alarm and cut off for low pressure of SF₆ gas in the circuit breaker.

- ii. Material used in the construction of circuit breakers shall be fully compatible with SF₆. The internal surfaces of all porcelain shall be glazed.
- iii. The position of vents, diaphragms and pressure relief devices, if provided, shall be so arranged to minimize danger to the operators in the event of gas or vapours escaping under pressure.
- iv. Sufficient SF₆ Gas shall be provided to fill the circuit breakers installed plus 10% additional quantity.
- v. Each pole of SF₆ breaker shall consist of independent interrupting chamber with contact housing and support insulator.

5.0 OPERATING MECHANISM GENERAL

5.1 GENERAL

- i. Circuit breaker shall be operated by spring charged mechanism.
- ii. The operating mechanism shall be suitable for high speed re-closing. It shall be anti-pumping and trip free (as per IEC definition) electrically or mechanically under every method of closing (except during closing for maintenance). A latch-check switch shall be provided on mechanically trip free mechanisms to prevent re-closure before test. Anti-pumping feature and pole discrepancy relay shall be provided.
- iii. The operating mechanism shall be such that the failure of any auxiliary spring will not prevent tripping and will not cause tripping or closing operation of the power operated tripping/closing devices. When the circuit breaker is already closed, it shall not cause damage to the circuit breaker or endanger the operator.
- iv. Electrical as well as a mechanical indicator shall be provided to show open and close positions of breaker. It shall be located in a position where it will be visible to a man standing on the ground with mechanism housing closed. An operation counter shall also be provided with each breaker.
- v. Closing coil shall operate correctly at all values between 85% and 110% of the rated voltage. Shunt trip shall operate correctly under all operating conditions of the circuit breaker upto the rated breaking capacity of the circuit breaker and all values of supply voltage between 85% to 110% of the rated voltage.
- vi. The trip coil of circuit Breaker shall be suitable for trip circuit Supervision, during both open and close position of breaker.

- vii. Working part of the mechanism shall be of corrosion resisting material. Bearings which require grease shall be equipped with pressure type grease fittings. Bearing pin, bolts, nuts and other parts shall be adequately pinned or locked to prevent loosening or changing adjustment with repeated operations of the breakers.
- viii. Operating mechanism shall normally be operated by remote electrical control. Electrical tripping shall be performed by shunt trip coils. Provision shall be made for local electrical control. Local/Remote selector switch and close and trip push buttons shall be provided.
- ix. A conveniently located manual tripping lever or button shall also be provided for local tripping of the breaker and simultaneously opening the reclosing circuit. It shall be possible to trip the breaker in the event of auxiliary supply failure. For spring charged mechanism a local manual closing device which can easily be operated by one man standing on the ground shall also be provided for maintenance purposes and direction of motion of handle shall be clearly marked.
- x. Operating mechanism and all accessories shall be enclosed in a control cabinet conforming to clause 6.0. A common marshalling box for the three poles of the breaker shall be provided.

5.2 SPRING OPERATED MECHANISM

- i. Spring operated mechanism shall be complete with motor in accordance with clause 15.0, opening and closing springs with limit switches for automatic charging and all other necessary accessories to make the mechanism a complete operating unit.
- ii. As long as power is available to the motor, a continuous sequence of closing and opening operations shall be possible.
- iii. One reserve close-open operation shall be possible.
- iv. Breaker operation shall be independent of the motor which shall be used solely for charging the springs.
- v. Motor spring charging time, including reset time shall be co-ordinated with the duty cycle specified under clause 15.0. Motor shall be rated for 220/ 415 volts AC and shall operate satisfactorily at all value of voltage between 85% and 110% of rated voltage.
- vi. Closing action of the circuit breaker shall compress the opening spring ready for tripping.

6.0 CONTROL CABINETS

- i. Control cabinets shall be sheet steel enclosed and shall be dust, weather and vermin proof. Sheet steel used shall be at least 2.0 mm thick and properly braced to prevent webbing.
- ii. The enclosures of the control cabinets shall provide a degree of protection of not less than IP- 55.
- iii. Control cabinets shall be of free standing floor mounting or structure mounted for outdoor breakers.
- iv. Control cabinets shall be provided with double-hinged doors with padlocking arrangement.
- v. All doors, removable covers and plates shall be gasketed all around with neoprene gaskets. Louvers shall have screens and filters. The screens shall be of fine wire mesh made of brass or G.I. wire.
- vi. Cable entries shall be from bottom. Suitable removable cable gland plate shall be provided on the cabinet for this purpose. Necessary number of cable glands shall be fitted on to this gland plate. Control cable glands shall have suitable arrangement for fixing with the base plate and shall be made of brass. Provision shall also be made for earthing the cable armour in the gland itself. Suitable heaters with auto control for ON/OFF at preset temperature shall be mounted in the cabinet to prevent condensations. ON/OFF switch and MCBs shall also be provided. Heater shall be suitable for 230 V AC supply voltage.
- vii. The terminals shall be so staggered that the connection of external cable to any terminal block should be possible without disturbing the rest of the connections. The terminal block arrangement shall be such as to provide maximum accessibility to all conductor terminations and any arrangement preventing ready access to other terminal screws shall not be accepted. The terminals shall further be ferruled and tagged for ease of identification.
- viii. The arrangements shall be in such a manner so that it is possible to safely connect or disconnect terminals on live circuits and replace MCB links when the cabinet is live or dead.
- ix. A suitable switch to operate on opening of the door shall be provided to illuminate the interior of the control cabinet.

7.0 CONTROL CUBICLE WIRING

- i) The control cubicle shall be supplied completely wired, ready for Owner's external cable connections at the terminal blocks.
- ii) All wiring shall be carried out with 1100 Volt Grade single core stranded conductor wire with PVC insulation and shall be FRLS, Vermin and rodent proof. The least size of conductor shall be 2.5 sq. mm.
- iii) Panel wiring shall be securely supported, neatly arranged readily accessible and connected to equipment terminals and terminal blocks. Wiring gutters, troughs shall be used for this purpose where necessarily. While terminating wiring at terminal blocks the wiring shall be securely bunched so that the position of each

individual connection wire does not get disturbed when disconnected from equipment terminals.

- iv) Wire terminations shall be made with solder less crimping type of tinned copper lugs, which firmly grip the conductor and insulation.
- v) Insulated sleeves shall be provided at all the wire ends and shall fit tightly on the wires and shall not fall off when the wire is disconnected from terminal blocks. The wire numbers on the wiring diagram shall be in accordance with IS-5578/ IS-11353.
- vi) Tenderer shall be solely responsible for the completeness and correctness of the internal wiring and for the proper functioning of the connected equipment.

8.0 PUSH BUTTONS

- i. Push buttons shall be momentary contact type with rear terminal connections. The color of the push button shall be subjected to approval of the Owner. Each push button shall be provided with integral inscription plates engraved with their function.
- ii. All push button shall have two normally open and two normally closed contacts. The contact shall be able to make and carry 5 Amps at 250 volt DC and shall be capable of breaking one Amp. inductive load.

9.0 TERMINAL BLOCKS

- i. Terminal blocks shall be 1100 V grade 10 Amps rated, one piece moulded, complete with insulated barriers stud type terminals, washers, nuts and lock nuts and identification strips. Separate stud shall be provided for incoming and outgoing wires. Marking of terminals strip shall correspond to wire number on diagrams.
- ii. Terminal blocks shall be fully enclosed with easily removable covers and made of moulded non-inflammable plastic material. The terminals shall be clearly marked with identification numbers or letters to facilitate connection to the external wiring.
- iii. 30 Nos. spare terminal blocks shall be provided for Owners use in addition to those already provided for interlocks.

10.0 EARTHING

- i. All metal parts, not intended for carrying current, shall be connected to duplicate earthing system and suitable terminals shall be provided on earth equipment or part of equipment in conformity with relevant IS/IEC.
- ii. The earth continuity conductor shall have sufficient cross-sectional area so as to afford a low resistance path for the full fault current corresponding to the Circuit Breaker rating.
- iii. The size of earth continuity conductor shall be as large as possible to reduce to the barest minimum the potential rise of the metal frame of the circuit breaker and in no case, more than 10 V.

- iv. The size of earth conductor shall also be adequate, so as to restrict the temperature rise to the limit without causing any damage to the earth connection while short circuit current flows through it for the short time rating of the equipment.
- v. No seated / riveted joints in current conduction path shall be permitted. Only bolted joint with proper size of nuts & bolts with plain / spring washer and also locking washer is permitted.

11.0. CAUTION NOTICE

Caution notice shall be provided at all points where terminals are likely to remain live and isolation is possible only at remote end.

12.0. SAFETY INTERLOCKS

- i. 33 KV Circuit breaker shall be provided with mechanical interlocking with the isolator, preferably castle interlocks or equivalent, spare castle type interlock for mounting on line isolator shall be provided with each breaker.
- ii. Suitable provision for electrical interlocks shall be made as per advise of the Purchaser.
- iii. Any other inter-lock as may be deemed necessary by the supplier shall be quoted.

13.0. MCB

MCB's shall be provided conforming to IS: 13703 with visible operation indicators to show that they have operated. All accessible live connections shall be adequately shrouded, and suitable NO & NC contacts should be provided.

14.0 BUSHINGS / HOLLOW COLUMN INSULATORS / SUPPORT INSULATORS

- i. Porcelain used in bushing/Insulator manufacture shall be homogenous, 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.
- ii. Glazing of the porcelain shall be of uniform brown colour free from blisters, burns and similar other defects. Bushings/Insulator shall be designed to have ample insulation, mechanical strength and rigidity for the conditions under which they will be used.
- iii. When operating at normal rated voltage, there shall be no electric discharge between the conductors and bushing/Insulator, 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 bushings/Insulator when operating at the normal rated voltage.
- iv. All iron parts shall be hot dip galvanized and all joints shall be airtight. Surfaces of the joints shall be dried up; porcelain parts by grinding and metal part by machining.

Bushing/Insulator design shall be such as to ensure a uniform compressive pressure on the joints.

- v. The Creepage distance of the bushing/Insulator shall in no case be less than 25 mm / KV suitable for heavily polluted atmosphere.
- vi. Bushings / hollow insulator column/ support insulator column shall be tested for type tests & routing tests in accordance with stipulation of IS-2099/ IS-5621. Routine as well as type test reports in conformity with IS-2099/ IS-5621 shall be furnished to the Owners.

15.0. MOTOR & IT's DUTY REQUIREMENT

- i. Motor shall be single / three phase, of robust design, of proven quality with IS mark capable of satisfactory operation for the application & duty as required by the driven equipment.
- ii. 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 arise in service.
- iii. Motor shall be capable of giving rated output without reduction in the expected life span when operated continuously in the system having the following particulars.
- iv. SUPPLY CONDITIONS
 - (a) Variation of supply voltage from rated motor voltage +/-10%.
 - (b) Frequency differing from rated frequency +/-5%
 - (c) Combination variation of voltage and frequency shall be limited to +/-10%.
- v. The motor shall be tested in accordance with type tests and routine tests stipulated in the IS: 996. The reports for the type and routine tests shall be submitted to the Owner.

16.0 SYSTEM PARAMETER

(a)	Nominal system voltage	33 KV
(b)	Highest system voltage	36 KV
(c)	Frequency	50 Hz.
(d)	No. of phase	3
(e)	Neutral earthing	Solidity earthed

17.0 DUTY REQUIREMENT OF CIRCUIT BREAKER

- (a) The circuit breakers shall be totally restrike free under all duty conditions and shall be capable of performing the duties satisfactorily.
- (b) The circuit breakers shall meet the above duty requirements in case of application on U/G cable circuits as also on power transformers.

- (c) The circuit breaker offered shall be suitable for both single & 3 ph. Auto reclose duty. The operating duty shall be as follows:
- (i) O-0.3 sec-CO-3 min.-CO
- (d) The circuit breaker shall be capable of
- Breaking the steady and transient magnetizing current corresponding to transformers.
 - Breaking line charging currents as per IS / IEC without the use of opening resistors.
 - The circuit breaker shall be suitable to break the required inductive current in accordance with national / international standard. The values thereof shall be clearly specified at the time of offer.
 - Clearing short line faults (Kilometric faults) with source impedance behind the bus as equivalent to the symmetrical fault current specified.
 - Breaking 25% of the rated fault current at twice the rated voltage under phase opposition condition.
- (e) The rated transient recovery voltage for terminal fault and short line faults shall be as per IS / IEC.
- (f) The 33KV breakers shall be capable of capacitor bank switching of at least 10 MVAR.

18.0. TECHNICAL PARAMETERS

S.No	Particulars	Details
(i)	Highest system voltageKV (r.m.s.)	36
(ii) Rated insulation level		
(I)	Impulse with stand voltage with 1.2/50 micro-second wave of positive / negative polarity between line terminals and ground (KVp).	170
II)	One minute power frequency dry and wet withstand voltage to earth(KV, rms)	70
iii)	Rated Normal current in Amps.	2000A
(iv)	Rated short circuit breaking current for 1 sec duration	31.5KA
(v)	Rated making current	2.5 times the rated breaking current
(vi)	Transient recovery voltage for short line faults	As per IS
(vii)	Rated out of phase breaking Current	25% of symmetrical short circuit breaking current.
(viii)	Operating mechanism	Motor operated spring charging.

(ix)	Auxiliary contacts	10NO+10NC exclusive for Owner use other than used-by manufacturer
	(a)Rating of auxiliary contacts b)Breaking capacity of auxiliary Contacts	10 Amp DC 1 Amp DC (resistive)
(x)	Trip and Closing coil voltage	220 V.D.C

19. TEMPERATURE RISE:

The temperature rise and the maximum temperature on any part of the equipment, when in service at site under continuous full load condition and exposed continuously in the direct rays of the sun, shall not exceed the permissible limits as per IEC-62271-1. This shall not be exceeded when corrected for the difference between the ambient temperature specified relevant specifications. The correction proposed shall be stated in the tender and shall be subject the approval of the Owner.

20. TERMINAL CONNECTOR

The terminal connector shall be suitable for single / Double / Quad ACSR zebra conductor and for horizontal/ vertical take off.

21. FITTINGS AND ACCESSORIES:

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

- (a) Operating mechanism housing in accordance with clause 6.0 complete with
 - i) Cable glands.
 - ii) Local / remote change-over switch.
 - iii) Manually operated tripping/closing push button / lever (Mechanical) conveniently located to trip all three phases simultaneously.
 - iv) Operation counter.
 - v) Control switches to cut off control power supply.
 - vi) MCB as required.
 - vii) Terminal block (including spare)
 - viii) Heater & Heater switch.
 - ix) Holder & switch.
 - x) Socket & switch.
 - xi) Electrical and mechanical indicator to show close & open position of breaker.
 - xii) Motor for spring charging.

- (b) Anti-pumping relay.
- (c) Rating and diagram plate in accordance with IS incorporating year of manufacture.
- (d) Terminal connectors
- (e) SF-6 gas circuit breaker shall be complete with:-
 - (i) Gas pressure gauge.
 - (ii) Gas cylinder
 - (iii) Filling valve and tubing

22. **TEST:**

All the routine and type test shall be carried out as per latest IS / IEC. All the routine tests shall be carried out in the presence of purchaser's representative.

Type test certificates for circuit breaker along with drawings shall be submitted along with the tender. The type test reports shall be considered for the purpose of technical acceptability of the offers. Upon failure to do so, the offers shall be rejected.

GUARANTEED TECHNICAL PARTICULARS FOR 33KV CIRCUIT BREAKER

- | | |
|--|---|
| 01. Name of manufacturer | : |
| 02. Manufacturer's type and designation | : |
| 03. Governing standard | : |
| 04. Rated voltage (KV) | : |
| 05. Rated insulation level | : |
| 06. Frequency (Hz) | : |
| 07. Class | : |
| 08. Normal current rating (amps) | : |
| (a) Under standard conditions | : |
| (b) Under site conditions | : |
| (c) De-rating factor, if any | : |
| for site conditions | : |
| (d) Temperature rise at 150% rating for 3 hours. | : |
| 09. Short time current rating (KA) For 1 second | : |
| 10. Maximum temperature rise over ambient (°C) | : |
| due to rated current in main contacts, | : |
| measured after breaking test | : |
| 11. Rated short circuit breaking current | : |
| (a) Rated short circuit current | : |
| (Symmetrical AC component) | : |
| KA (rms) – at KV | : |
| (b) Percentage DC component at KV | : |
| (c) Assymmetrical breaking Current | : |

- (including DC component)
- KA (rms) – at KV :
12. Making capacity (KA peak) at KV :
 13. Total break time (Milli-seconds)
 - (a) For interruption of 10% Of the rated capacity :
 - (b) For interruption of 30% Of the rated capacity :
 - (c) For interruption of 60% of the rated capacity :
 - (d) For interruption of the full rated capacity :
 14. Arcing time (Milli-seconds) :
 15. Opening time & break time :
 16. Closing time (Milli-second) :
 17. Rated Operating Sequence :
 18. Minimum re-closing time at rated interrupted capacity
from the instant of the trip coil energisation
(Milli-seconds) :
 19. Minimum dead time
 - (a) 3 phase re-closing (Milli seconds) :
 - (b) Limit of adjustment of dead
Time for 3 phase re-closing :
 20. Data on re-striking voltage for 100%, 50% or 30% rated
capacity
 - (a) Amplitude factor :
 - (b) Phase factor :
 - (c) Natural frequency (Hz) :
 - (d) Rate of rise of re-striking
Voltage (V/Micro sec.) :
 21. Rated out of phase breaking current :
 22. Rated line charging breaking current :
 23. Maximum line charging current breaking capacity
and corresponding over voltage recorded in test
 - (a) On supply side :
 - (b) On line side :
 24. Maximum cable charging current breaking capacity and corresponding
over voltage recorded in test
 - (a) On supply side :
 - (b) On line side :
 25. Rated single capacitor bank :
 - i) Capacitive in rush current
Handling capability
 - ii) Capacitive breaking current Capability
 26. Rated small inductive breaking
current and the corresponding
over voltage. :
 27. First pole to clear factor :
 28. Rated transient recovery voltage for terminal faults :

29. Rated characteristic for short line faults i.e. rate of rise.
30. Dry-1 minute power frequency test withstand voltage for complete circuit breaker
 - (a) Between line terminal and grounded Parts (KV rms.) :
 - (b) Between terminals with breakers Contacts open (KV rms.) :
 - (c) Between poles. :
31. Wet-1 minute power frequency test withstand voltage
 - (a) Between line terminal and grounded parts (KV rms):
 - (b) Between terminals with breakers contacts open (KV rms):
32. 1.2/50 microsecond wave impulse with stand test voltage for complete circuit breaker :
 - (a) Between line terminals and ground (KV peak)
 - (b) Between terminals with circuit Breaker contacts
 - (c) Between poles
33. Minimum clearance :
 - (a) Between phases (mm)
 - (b) Live parts and earth (mm)
 - (c) Live parts to ground level (mm)
34. Number of operation possible without maintenance :
 - (a) At full rated interrupting capacity
 - (b) At 150% of rated current
 - (c) At 100% of rated current
 - (d) At 50% of rated current
35. **SUPPORTING INSULATORS**
 - (a) Make and type
 - (b) Weight
 - (c) Transport dimensions
 - (d) Insulation class
 - (e) Visible corona discharge voltage
 - (f) Dry-1 minute power frequency Flash over / voltage
 - (g) Wet one minute power frequency Flash over / withstand voltage.
 - (h) 1.2/50 microsecond impulse flashover / withstand voltage.
 - (i) Creepage distance to ground (mm) for heavily polluted atmosphere :
 - (i) Total
 - (ii) Protected
36. No. of poles per circuit breaker :

37. No. of breaks per pole :
38. Total length of breaks per phase (mm) :
39. Type of main contacts :
40. Material of main contacts :
41. Whether main contacts silver plated (Yes/No) :
42. Thickness of silver coating on main contacts (mm) :
43. Contact pressure on arcing contacts
(Kg/m²) :
44. Type of arcing contacts. :
45. Contact pressure on main contacts
(Kg/m²) :
46. Type of auxiliary switches
47. Whether contacts of auxiliary switches silver plated
(Yes / No) :
48. No. of auxiliary switch contacts
operating with all three poles of breaker :
- (a) Which are closed when breaker
is closed
- (b) Which are open when breaker is closed
- (c) Those adjustable with respect to
the position of main contacts.
49. No. of spare auxiliary switch contacts
operation with all three poles of breaker :
- (a) Which are closed when
Breaker is closed.
- (b) Which are open when breaker
Is closed.
- (c) Those adjustable with respect
to the position of main contacts
50. Number of spare terminal block :
51. Tripping and closing circuit voltage (V) :
52. Power required for trip coil :
53. Power required for closing coil :
54. Contingencies for which alarm Provided :
55. Design data for supporting structure :
56. Weight of supporting steel structure for breaker:
57. Whether descriptive leaflets enclosed (Yes/No) :

FOR SF₆ GAS CIRCUIT BREAKER

58. Rated pressure of SF₆ Gas in the gas cylinder (Kg/cm²) :
59. Quantity of SF₆ gas required per single pole unit (Kg.) :
60. Quantity of SF₆ gas per cylinder (Kg.) :
61. Weight of empty cylinder (Kg.) :
62. No of density monitor per pole :

63. Quantity of absorbent required per pole (Kg) :
64. Recommended interval for renewal of absorbent in case of outdoor Circuit breaker operating in tropical conditions :
65. Chemical composition of the absorbent :
66. Quantity of absorbent covered in the scope of supply (including spare qty (Kg)) :
67. Limit of gas pressure for proper operation of circuit breaker:
68. Pressure at which the temperature compensated gas pressure switch will
 - (a) Give alarm :
 - (b) Cut off :
69. Name of SF₆ supplier and country of origin :
70. Quantity of SF₆ gas supplied for :
 - (a) Actual use in breakers (Kg.)
 - (b) As spare (Kg.)
71. Chemical composition of gas :
 - (a) Qty. of air by weight (ppm) :
 - (b) Qty of H₂O by weight (ppm) :
 - (c) Qty of CF₄ by weight (ppm) :
72. Type of operating mechanism offered :
73. Dimension of the control cabinets :
74. Weight of control cabinet :

WEIGHT AND SPACE REQUIREMENT :

75. Weight of 3-phase breaker complete with operating mechanism, insulating supports frame work etc.
76. Impact loading for foundation design to include dead load plus impact value opening at maximum interrupting rating in terms of equivalent of static load.
76. Weight of heaviest package.

B. TECHNICAL SPECIFICATION OF “33 KV CURRENT TRANSFORMER OF RATIO 400-200-100/1-1-1 A”

1.0 GENERAL

- 1.1. The 33 KV Current Transformer shall be out door, of Ratio 400-200-100/1-1-1A complete with terminal connectors.
- 1.2. The Technical features and construction details of each current transformer shall be in accordance with the requirement stated herein under.
- 1.3. The equipment quoted under this specification shall conform to the standards specified below unless otherwise specified, the equipment shall conform to the latest applicable IS/IEC.

2.0 STANDARDS

2.1. The design, manufacture and performance of the equipment provided under this specification shall comply with the standards given in the clause 2.2.

<u>2.2 Indian Standard No.</u>	<u>Title</u>
a) IS-2705 (part I to V)	: Specification for current Transformer
b) IS-4201	: Application guide for current Transformer.
c) IS-2099/ IS-5621	: High voltage porcelain Bushings/Hollow Column insulators.
d) IS-731	: Insulator for O/H Power line
e) IS-335	: New insulating oil for transformer and switchgear.
f) IS-9676	: Reference ambient temperature

3.0 SYSTEM PARAMETER

The 33 KV system parameters are as follows:

a)	Nominal system voltage	33 KV
b)	Highest system voltage	36 KV
c)	Frequency	50 Hz.
d)	Earthing of the system	solidly grounded
e)	Insulation level	
	i) Impulse voltage withstand	170 KV (P)
	ii) Power frequency withstand	70 KV (rms)
f)	Short time current rating and its duration	31.5 KA for 1.0 Second

4.0 TECHNICAL PARTICULARS OF CURRENT TRANSFORMERS

4.1. 33 KV C.T. of ratio 400-200-100/1-1-1 A

CORE – I METERING

a)	Secondary Current	1 Amp.
b)	Purpose	Metering
c)	Rated output	20 VA
d)	Class of Accuracy	0.2
e)	Instrument security factor	≤ 5

CORE – II BACK UP PROTECTION (O/C & E/F)

a)	Secondary Current	1 Amp.
b)	Purpose	O/C & E/F Protection
c)	Min. Knee point voltage VK	$40(R_{ct}+8)$ V (Rct.-Resistance of secondary winding)
d)	Class of Accuracy	PS
e)	Max. exciting current at VK/2	30 mA

CORE – III TRANSFORMER DIFFERENTIAL PROTECTION

a)	Secondary Current	1 Amp.
b)	Purpose	Transformer differential
c)	Class of Accuracy	PS
d)	Min. Knee point voltage VK	$40(R_{ct}+8)$ V (Rct.-Resistance of secondary winding)
e)	Max. exciting current at VK/2	30 mA

6.0 CONSTRUCTION DETAILS

- 6.1. The current transformers shall be oil immersed and self cooled outdoor type suitable for the specified services indicated, completed in all respects and in accordance with best engineering practice design and workmanship.
- 6.2. The core shall be of high grade non ageing, electrical silicon laminated steel of low hysteresis loss high permeability to ensure high accuracy at normal and over current conditions and shall produce undistorted secondary current under transient conditions at all ratios.
- 6.3. The oil immersed CT shall be hermetically sealed to eliminate breathing and to prevent air and moisture and shall be provided with a pressure relieving device capable to releasing abnormal internal pressure. C.T. shall be provided with oil level gauge, and necessary arrangement for replacing the oil shall be provided.
- 6.4. The current transformers shall be suitable for simultaneous 100% full load continuous rating of the winding.
- 6.5. The ratio changing taps shall be provided only on the secondary winding of the C.T.
- 6.6. The current transformer cores to be used for metering and instrumentation shall be of accuracy class specified and suitable for commercial and industrial metering. The

Saturation factor of this core shall be low enough not to cause any damage to measuring instruments in the event of maximum short circuit current.

- 6.7. Current transformers cores to be used for protective relaying purposes shall be of accuracy class specified, suitable for distance protection, pilot wire protection, differential protection, restricted earth fault protection, over current and earth fault protection. Over current and earth fault for a maximum saturation factor as specified for the highest setting.
- 6.8. The secondary terminals shall be brought out in a weather proof terminal box (with degree of protection IP55) on the side of the current transformer and shall be accessible through a removable cover. The secondary tap shall be adequately reinforced to withstand normal handling without damage. Suitable cable glands shall be provided to accommodate purchaser's control cables.
- 6.9. The maximum permissible temperature rise of the windings over the ambient shall not exceed 50°C.
- 6.10. The magnetising curve for each core shall be furnished with the tender.
- 6.11. The secondary terminals shall be provided with short circuiting and earthing arrangements at the terminal block.
- 6.12. The C.T.s shall be suitable for horizontal as well as vertical transportation.
- 6.13. The Instrument security factor at all ratios shall be less than 5 for metering cores.
- 6.14. The C.T. shall be suitable for high speed auto-reclosing.

7.0 INSULATION OIL:

The quality of insulating oil in each transformer shall be best available and the complete specification of the oil shall be furnished in the tender. The current transformers offered shall be hermetically sealed completely filled with insulating oil. The insulating oil shall conform to the latest Indian Standard specification No. 335.

8.0. BUSHINGS / INSULATORS:

- i)
 - a) Porcelain used in bushing/Insulator manufacture shall be homogeneous, free from laminations, cavities and other flaws or imperfections that might effect the mechanical or dielectric quality and shall be thoroughly vitrified tough and impervious to moisture.
 - b) Glazing of the porcelain shall be of uniform brown colour free from blisters, burrs and similar other defects. Bushings shall be designed to have ample insulation, mechanical strength and rigidity for the conditions, under which they will be used.
- ii) When operating at normal rated voltage there will 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 bushings/ Insulator when operating at the normal rated voltage.

- iii) All iron parts shall be hot dip galvanized and all joints shall air tight. Surfaces of the joints shall be trued up, porcelain parts by grinding and metal parts by machining. Bushing/ Insulator design shall be such as to ensure a uniform compressive pressure on the joints.
- iv) The creepage distance of the bushing /Insulator shall in no case be less than 25mm/KV, suitable for heavily polluted atmosphere.
- v) Bushing/ Insulator shall be tested for type tests and routine tests in accordance with stipulation of IS-2099/ IS-5621 Routine as well as type tests reports in conformity with IS-2099/ IS-5621 shall be furnished to the purchaser.
- vi) Parameters of Bushings/Insulators:

a)	Rated Voltage	36 KV
b)	Impulse withstand voltage	170 KVp
c)	Power frequency withstand voltage (dry & wet)	70 KV (rms)
d)	Total creepage distance	900 mm
e)	Pollution level	Suitable for Heavily Polluted Atmosphere

9.0 TERMINAL CONNECTORS

- 9.1. The current transformer offered shall be supplied with indigenous rigid type, Die casted, bimetallic (wherever applicable) terminal connectors suitable for single/double/quad ACSR Zebra conductor as per requirement conforming to IS-5561 for maximum current rating of CT.
- 9.2. The Neutral current transformer offered shall be supplied with one no. rigid type bimetallic (wherever applicable) terminal connector suitable for connecting to twin 75x12 mm flat of station earth. Also one no. terminal connector for connection to transformer neutral and suitable for ACSR Zebra shall be supplied.
- 9.3. Suitable terminal connectors for earthing connections shall also be supplied.

10.0 TESTS

- 10.1 The copies of certificates of all type tests as stipulated in IS: 2705 shall be furnished along with the tender.
- 10.2 Each current transformer shall be subjected to routine tests as specified in IS: 2705 in the presence of Purchaser's representative if so desired by the Purchaser. All test reports should be submitted and should be approved by the purchaser before dispatch of the equipment

11.0 MARKING

- 11.1. Rating plate: As per IS-2705 (Part-I)
- 11.2. Terminal marking: As per IS- 2705 (Part. I)

12.0 GUARANTEED TECHNICAL PARTICULARS FOR CURRENT TRANSFORMERS

- 1. Manufacturer's Name
- 2. Type / Designation
- 3. Country of Manufacture
- 4. Rated Voltage
- 5. Standard Applicable
- 6. Rated frequency
- 7. Rated primary current
 - a. Rated continuous normal current (A)
 - b. Rated extended primary current (A)
 - c. Rated thermal current (A)
- 8. Transformation ratio
- 9. Number of Secondary turns
- 10. Rated Secondary current
- 11.

No. of Cores	Rated output (VA)	Accuracy Class at Rated and extended Primary current	Instrument Security Factor/Accuracy limit factor
Core-I			
Core-II			
Core-III			

12.

No. of Cores	Knee Point Voltage	Corresponding Max. exciting current	Resistance of the secondary winding at different taps	Secondary limiting voltage

Core-I				
Core-II				
Core-III				

13. Short time thermal rating of primary (KA).
 - a) one Seconds
14. Rated dynamic current of primary (KA_p)
15. Temp rise at rated cont. thermal current over ambient at site
 - b) Winding
 - c) Oil at the top
16. One minute power frequency dry withstand voltage (KV rms)
17. One minute power frequency wet withstand voltage (KV rms)
18. 1.2/50 microsecond Lightning impulse withstand voltage (KV Peak).
19. Radio interference voltage (micro volts)
20. Whether corona shield is provided on not
21. Primary data
 - a) Number of primary turns
 - b) Material and cross section of primary
 - c) Whether bar type or ring type.
 - d) Current Density in the primary winding.
22. Whether CT is suitable for horizontal and vertical Transportation
23. Whether Magnetization curve and Other characteristic curves enclosed
24. Quantity of oil per CT
25. Standard to which oil conforms.
26. Whether current transformer Hermetical sealed?
27. Total weight (kg)
28. Transport weight (kg)
29. Dimensional details
 - a. Overall height from mounting plane
 - b. Height upto terminals from mounting plane

- c. Mounting dimensions and diameter of Mounting holes
- d. Terminal pad diameter & length
- e. Material of terminal pad
- f. Diameter of insulator at
 - i. top end
 - ii. bottom end

30. BUSHING/SUPPORT INSULATOR

- 1. Manufacturer's Name and country
- 2. Type
- 3. Applicable standards
- 4. (i)Height
(ii)Diameter (Top & Bottom)
- 5. Cree page distance Total (mm)
- 6. Rated voltage
- 7. Power frequency withstand voltage for 1 min. (KV) (rms)
 - a) Dry
 - b) Wet
- 8. 1.2/50 micro sec Lightning impulse withstand voltage (KVp)
- 9. Corona Extinction Voltage (KV)
- 10. Weight (Kg)

C. TECHNICAL SPECIFICATION OF "33 KV, 3 PHASE MOM TYPE ISOLATOR WITH/ WITHOUT EARTH SWITCH"

1.0 GENERAL:

- 1.1. The 33 KV Isolators shall be outdoor, horizontal mounting, central post rotating double break type/ centre break type (HCB)/ Tandem type complete with terminal connectors suitable for both manual and motor operation as applicable as per existing site condition. Earth switches shall be provided on Isolators wherever called for.
- 1.2. The equipment quoted under this specification shall conform to the standards specified below. Unless otherwise specified, the equipment shall conform to the latest applicable IS/IEC.

2.0 STANDARDS:

- 2.2. The design, manufacture and performance of the equipment provided under this specification shall comply with the standards and rules given in the clause 2.2.
- 2.2. a) IS : 9921 : Alternating current isolators
(Disconnectors & earthing switches).

- b) IS: 2544 : Porcelain Post insulators for systems with nominal voltages greater than 1000 Volts.
- c) IS: 2147 /13947 : Degree of protection provided by enclosure.
- d) IS: 325 : Three phase induction motors.

3.0 CONSTRUCTIONAL FEATURES :

All constructional features should be as per best engineering practice and in conformity with standards specified in clause 2.2.

4.0 CONTACTS:

- a) The contacts shall be self aligning and self cleaning and so designed that binding cannot occur after remaining closed for prolonged periods of time in a heavily polluted atmosphere.
- b) No undue wear or scuffing shall be evident during the mechanical endurance tests. Contacts and spring shall be designed so that readjustments in contact pressure shall not be necessary throughout the life of the isolator or earthing switch. Each contact or pair of contacts shall be independently sprung so that full pressure is maintained on all contacts at all time.
- c) Contact springs shall not carry any current and shall not lose their characteristics due to heating effects.
- d) The minimum number of the fingers and the size thereof for various ratings of the isolators should not be less than specified hereafter:-

2000 Amps. – 7 Nos. x 32 mm x 6mm	: Fingers on each side i.e. bottom and top separately or equivalent size.
1250 Amps. – 5 Nos. x 34 mm x 5mm	: Fingers on each side i.e. bottom and top separately or equivalent size.
800 Amps. – 5 Nos. x 30 mm x 4mm	: Fingers on each side i.e. bottom and top separately or equivalent size.

5.0 BASE:

- a) Each pole of the Isolator shall be provided with a complete galvanized steel base provided with holes and designed for mounting on a supporting structure to be provided by the purchaser. The base shall be rigid and self-supporting and shall require no guying or cross bracing between phases other than the supporting structure.
- b) The bidder shall give design of the recommended supporting structure for the Isolator.

- c) The position of moving contact system (main Blade) of each Isolator and earthing switches shall be indicated by a mechanical indicator at the lower end of the vertical operating rod or shaft for the Isolator and earthing switch. The indicator shall be of metal and shall be visible from operation level.

BLADES:

- a) All metal parts shall be of non-rusting and non-corroding material. All current carrying parts shall be made from high conductivity electrolytic Copper / aluminium. The current density in case of copper should not be more than 1.5A/mm^2 and in case of aluminum, it is should not be more than 1A/mm^2 . The Isolator blades male contact portion should be silver plated copper and the silver plating should not be less than 25 microns.
- b) Bolts, screws and pins shall be provided with lock washers. Keys or equivalent locking facilities if provided on current carrying parts shall be made of copper silicon alloy or stainless steel or equivalent. The bolts or pins used in current carrying parts shall be made of non-corroding material. All ferrous castings except current carrying parts shall be made of malleable cast iron or cast steel. No grey iron shall be used in the manufacture of any part of the isolator.
- c) The live parts shall be designed to eliminate sharp joints, edges and other Corona producing surfaces, where this is impracticable adequate corona shield shall be provided. Corona shields / rings etc., shall be made up of aluminium / aluminium alloy. The Isolator blade shall be of tinned copper.
- d) Isolators and earthing switches including the operating parts shall be such that they cannot be dislodged from their open or closed positions by short circuit forces, gravity, wind pressure, vibrations, shocks or accidental touching or breaking of the connecting rods of the operating mechanism.
- e) The switch shall be designed such that no lubrication of any part is required except at very frequent intervals i.e. after every 1000 operations or after 5 years whichever is earlier.
- f) Isolator blades shall be so assembled that no part of the blade can move relative to the other. Fixed guides shall be provided so as to obtain proper setting of the contacts, even when the blade is out of the alignment up to 25 mm. All movable parts which are in current carrying path shall be shunted by flexible copper or bronze conductor.

7.0 TERMINAL CONNECTORS

The isolator shall be supplied complete with universal type terminal connectors suitable for single / double/quad ACSR Zebra conductor and for horizontal / vertical takeoff as per requirement.

INSULATORS

- a) The porcelain of the Insulator, used in the manufacture shall be homogenous, free from laminations, cavities and other flaws or imperfections that might affect the closing or dielectric quality and shall be thoroughly vitrified tough and impervious to moisture.
- b) Glazing of the porcelain shall be of uniform brown colour free from blisters, burns and similar other defects.
- c) Solid core insulator shall be designed to have ample insulation mechanical strength and rigidity for the conditions under which they will be used.
- d) The puncture voltage of hollow insulator columns shall be greater than dry flash over voltage.
- e) Pressure due to the contact shall not be transferred to the insulators after the main blades fully close.
- f) The insulators shall be as arranged that leakage current will pass to earth and not between terminals of the same pole or between phases.
- g) All iron parts shall be hot-dip galvanized.
- h) The insulators shall be suitable for heavily polluted atmospheric conditions. The creepage distance should not be less than 25mm/KV.

OPERATING MECHANISM

- a) The bidder shall offer motor operated Isolators and earth switches with manual operating facility.
- b) Operating mechanism box shall be made of steel sheet of adequate thickness and shall conform to the requirement as stipulated below :-
 - i) Operating mechanism box shall generally conform to & be tested in accordance with IS-5039/IS-8623, as applicable, and the clauses given below:
 - ii) Operating mechanism box shall be made of sheet steel and shall be dust, water and vermin proof. Sheet steel used shall be at least 2.0 mm thick cold rolled or 2.5 mm hot rolled. The box shall be properly braced to prevent wobbling. There shall be sufficient reinforcement to provide level surfaces, resistance to vibrations and rigidity during transportation and installation.
 - iii) Operating mechanism box shall be provided with double hinged doors with padlocking arrangements. The distance between two hinges shall be adequate to ensure uniform sealing pressure against atmosphere. The quality of the gasket shall be such that it does not get damaged / cracked during the operation of the equipment.

- iv) All doors, removable covers and plates shall be gasketed all around with suitably profiled EPDM gaskets. The gasket shall be tested in accordance with approved quality plan. The quality of gasket shall be such that it does not get damaged / cracked during the ten years of operation of the equipment or its major overhaul whichever is earlier. All gasketed surfaces shall be smooth straight and reinforced if necessary to minimize distortion and to make a tight seal. Ventilating Louvers, if provided, shall have screen and filters. The screen shall be fine wire mesh made of brass.
- v) All control switches shall be of rotary switch type and Toggle / piano switches shall not be accepted.
- vi) Positive 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.
- vii) The enclosure of operating mechanism box shall conform to IP - 55 as per IS : 13947 including application of, 2.5 KV rms for 1 (One) minute, insulation resistance and functional test after IP-55 test.
- c) A “Local / Remote” selector switch and a set of open/close push buttons shall be provided on the control cabinet of the isolator to permit its operation through local or remote push-button.
- d) Motor shall be an AC motor.
- e) Suitable reduction gearing shall be provided between the motor and the drive shaft of the isolator. The mechanism shall stop immediately when motor supply is switched off. If necessary, a quick electromechanical brake shall be fitted on the higher speed shaft to effect rapid braking.
- f) Manual operation facility (with handle) should be provided with necessary interlock to disconnect motor.
- g) Gear should be of forged material suitably chosen to avoid bending / jamming on operation after a prolonged period of non-operation. Also, all gear and connected material should be so chosen/surface treated to avoid rusting.
- h) Motor operated mechanism shall be subjected to blocked rotor test as sample test / type test, at no extra cost to Purchaser.
- i) The design shall be such that minimum energy is required for operation and one man shall be able to operate the isolator without undue effort.

- j) The ganging mechanism shall be provided with sufficient adjustment to allow for final alignment of the isolator blades for simultaneous operation and adjustable stores shall be provided to prevent over travel.
- k) The operating pipes and rods shall be sufficiently rigid to maintain positive control under the most adverse conditions and when operated in tension or compression for isolator closing. They shall also be capable of withstanding all torsional and bending stresses due to operation of isolator.
- l) It shall not be possible, after final adjustment has been made for any part of the mechanism to be displaced at any point in the travel sufficient enough to allow improper functioning of the isolator when the isolator is opened or closed at any speed.
- m) All holes in pranks, linkages, etc. having pins shall be drilled to accurate fit so as to maintain the minimum amount of slack and lose motion, in the entire mechanism.
- n) All isolator with earthing switches shall be provided attaching the operating mechanism to the isolator supporting structure shall be supplied as an integral part of the isolator.
- o) All brackets, angles or other members necessary for attaching the operating mechanism to the isolator supporting structure shall be supplied as an integral part of the isolator.
- p) Rust proof pins and bearings of the bronze bushing ball or roller type shall be furnished.
- q) Each rotating insulator stack shall be supported on double roller or ball bearings. These shall be protected from the weather by means of covers and grease retainers. Bearing pressure shall be kept low to ensure long life in case of operation.
- r) Signaling of closed position shall not take place unless the movable contact reaches a position where rated normal current, peak withstand current and short time withstand current can be carried safely.
- s) Signaling of open position shall not take place unless movable contacts have reached a position such that clearance between contacts is atleast 80% of the isolating distance.
- t) A simultaneous signaling device for all poles of isolator or earthing switch shall be arranged in such a way the signal is given only in the case all poles of the isolator or earthing switch having a position in accordance with 9.0 r & s.
- u) Counter balance springs shall be provided for counter balancing of the isolator to prevent impact at the end of travel both of opening and closing of the isolators. The spring shall be made of non-rusting type metal.

MOTOR OPERATED MECHANISM:

- a) The motor operating mechanism shall be provided with squirrel cage induction motor conforming to IS-325. The motor insulation shall be given fungicidal and tropical treatment as per IS-3202. The operating supply of the motor shall be $415 \pm 20\%$ volts, 3 phase 50 cycles.
- b) Suitable limit switches for motor control shall be fitted on the Isolator shaft, within the cabinet, to sense the open and close positions of the isolator.

EARTHING SWITCHES :

The isolator with earthing switch shall include:

- a) Complete operating mechanism and auxiliary contacts.
- b) The earthing switch shall form integral parts of the isolator.
- c) Earthing switch shall be only local operated.
- d) The earthing switch shall be constructionally interlocked with the isolator or so that the earthing switch can be operated only when the isolator is open.
- e) The earth switch shall be provided with flexible copper braids for connections to ground mat. These braids shall have the same short time current carrying capacity as the earth blade.
- f) The plane of movement and final position of the earth blades shall be such that adequate electrical clearance are obtained from adjacent live parts.
- g) The frame of each isolator and earthing switch shall be provided with two reliable earth terminals for connection to earth mat and shall be marked with the symbol legible and indelible manner.
- h) The flexible copper connectors between the rotating shaft and the frame shall have a minimum section of 50 mm and shall also have same short time short circuit current rating as the earth blades.
- i) The isolator design shall be such as to facilitate the addition of earth switches at a future date.

12.0 AUXILIARY SWITCHES :

- a) The breaking capacity of the auxiliary switches shall be adequate for the circuits to be controlled, particulars of which should be supplied by the manufacturer. In the absence of such information the breaking capacity shall be 2 A at 220 V dc, with a circuit time constant not less than 20 ms.

- b) The auxiliary circuits, the PMS value of withstand voltage shall be equal to twice the biggest rated auxiliary supply voltage plus 1000 V, with a minimum of 1500 V.
- c) The auxiliary switches shall be positively driven in both directions by rigid members.
- d) The isolators and the earthing switch shall be provided with auxiliary switches for indication of the open and closed position of the switch as well as providing of the electrical interlock. At least 6 Nos. NO and 6 Nos. NC for 33 KV Isolators shall be provided and for earthing device is 6 NO and 6 NC shall be provided.
- e) Auxiliary switches and auxiliary circuits shall have a continuous current carrying capacity of at least 10 Amps with permissible temperature rise as per IS – 9921.
- f) Auxiliary switches which are installed on the frame of Isolators of earthing switches shall be suitable protected against accidental arcing from the main circuit.
- g) The insulating materials of auxiliary switches and terminals of auxiliary circuits, which are to be used in outdoor installations, shall be ceramics or other non-tracking materials.

13.0 INTERLOCK:

- a) Necessary interlocks to prevent the closing and opening of the isolators under low voltage and devices for initiating alarm shall be provided. Provision shall also be made to enable mechanical interlocking with the breaker associated with the isolator, to prevent the opening or closing of the isolator, when the breaker is closed or opened.
- b) Mechanical interlocks with Castel lock of equivalent shall be provided with different numbered keys. Also provision should be kept for electrical interlocks.
- c) Line controlling circuit breaker mechanism shall be mechanically interlocked with the line isolators preferably by Castel interlocks or equivalent.
- d) Bus section / Bus coupler circuit breaker operating mechanism shall be mechanically interlocked with its associated isolators.
- v) All isolators shall be mechanically interlocked so as to avoid operation on load magnetizing current of transformer and charging current of lines.
- f) For line isolating-cum-earthing switches mechanical interlocks shall be provided so that both the earthing and main blades cannot be closed at the same time.
- g) Any other interlocks as may be deemed necessary by suppliers.

14.0 NAME PLATE:

- 14.1. The Name Plate shall be visible in the position of normal service and installation.
- 14.2. The isolators and earthing switches may also be marked with the ISI certification mark.
- 14.3. The following particulars should be given on the Name Plate :
 - a) Manufacturer
 - b) Serial Number
 - c) Year of manufacturing
 - d) Rated voltage in KV
 - e) Impulse withstand voltage to earth
 - f) Rated current in Amps.
 - g) Rated auxiliary voltage in volts.
 - h) Rated short circuit current for 1 second.

15.0 TESTS :

The Isolators shall be subjected to the following type tests and routine tests as per IS-9921 and with latest amendments thereof:-

I) TYPE TESTS:

- a) Impulse withstand voltage test.
- b) Power frequency voltage withstand tests.
- c) Tests on auxiliary and control circuits.
- d) Temperature rise test.
- e) Rated peak withstand current test and rated short time current withstand test.
- f) Short circuit marking test for earthing switch.
- g) Satisfactory operation & endurance tests.

II) ROUTINE TESTS :

- a) Power frequency voltage dry tests.
- b) Voltage tests of control & auxiliary circuits.
- c) Operation test.
- d) Measurement of the resistance of the main circuit.

16.0 ELECTRICAL CHARACTERISTICS AND PERFORMANCE REQUIREMENT FOR 33 KV ISOLATORS:

- 16.1. The 33 KV Isolator shall be outdoor type horizontal upright mounting, central post, rotating, double break type/ centre break type (HCB)/ Tandem type and suitable for heavily polluted atmospheric condition and shall be designed for the system parameter given below:

- a) Nominal system : 33 KV
- a)
- b) Highest system voltage : 36 KV
- c) System frequency : 50 Hz
- d) System earthing : Effectively earthed

16.2 The design parameters of the isolator shall satisfy requirements enlisted here below:-

- a) Type : Outdoor, horizontal central post rotating double break type/ centre break type (HCB)/ Tandem type
- b) Rated current at rated ambient temperature. : (i) 2000 Amp.
(ii) 1250 Amp.
(iii) 800 Amp.
- c) Rated short time (1 sec.) withstand current of Isolator and Earth Switch. : 31.5 KA r.m.s.
- d) Rated dynamic short circuit withstand current : 75KA peak
- e) Rated insulation levels
 - i) 1.2/50 micro second lightening impulse withstand voltage (Positive& negative polarity).
 - a) To earth :
 - b) Across isolating distance : 170 KV peak
195 KV peak
 - ii) One minute power frequencies withstand voltage.
 - a) To earth : 75 KV rms.
 - b) Across isolating distance : 100 KV rms.

16.3 Temperature Rise Over Design Ambient Temperature: As per IS-9921.

16.4 Operating Mechanism:

Motor operated as well as manually operated.

16.6 Phase to phase spacing : 1500 mm.

16.6 Creepage distance (Total) : 900 mm.

17.0 SPECIAL REQUIREMENTS:

17.1. The earthing switch should have the rated making capability for discharging the line trap charge for a line length of 50 Kms (Over-head) or 10 Kms Underground cable.

- 17.2 The isolator should have the rated capability for make/break of rated magnetizing current of power transformers.

18.0 GUARANTEED TECHNICAL PARTICULARS OF 33 kV ISOLATOR

01. Make of Isolators.
02. Type and catalogue No. of Isolators.
03. Rated current.
04. System voltage.
05. Rated voltage
06. Short time current
 - a) one second
 - b) Instantaneous
07. Maximum magnetizing current make/break capacity.
08. Earthing switch making capacity for discharging line charge.
09. Construction Rate:
 - a) Number of break per circuit per pole.
 - b) No. of Isolators pedestals on one phase.
 - c) Type of contacts
 - d) Type of hearing or rotating insulator.
 - e) Material for rotating blade.
 - f) Material for contact.
10. Minimum clearance in air:
 - a) Between poles
 - b) Between live parts and earth
11. Max. Current density:
12. Number of auxiliary switches in operating mechanism:
 - a) Normally close
 - b) Normally open.
13. Insulation Data:
 - a) Dry withstand value (1 minute) KV rms.
 - b) Wet withstand value (1 minute) KV rms.
 - h) Impulse withstand value (1.2/50 u.s) KV (Peak)
14. Earthing device:
 - a) Short time current rating.
 - b) One second.
15. Total weight of one complete triple pole isolator.
16. Mounting structure weight.
17. Terminal connectors.
18. Desired phase to phase clearance.
19. Terminal connector for ACSR 'ZEBRA'
20. List of spares for 5 years maintenance.
21. Operating device details.

22. Rated Insulation level.
23. Length of chassis each pole
24. Centre to centre distance between terminal stud of male and female blade

Technical specifications for LED Luminaries switchyard lighting**1. SCOPE**

This specification covers the general requirements of design, engineering, and manufacture, assembly, testing at manufacturer's works, packing and delivery at site of the energy efficient LED outdoor lamps along with associated LED drivers, fixtures and other accessories for switchyard lighting in Substations.

2. APPLICABLE STANDARDS & CODES

LED Street Light shall be designed, manufactured and tested in accordance with the latest applicable Indian Standard and IEC standard as listed below –

Standard Code	Standard Description
IS 16101 : 2012	General Lighting -LEDs and LED modules – Terms and Definitions
IS16102(Part 1) 2012	Self-Ballasted LED Lamps for General Lighting Services, Part 1 Safety Requirements
IS16102(Part 2) 2012	Self-Ballasted LED Lamps for General Lighting Services, Part 2 Performance Requirements
IS16103(Part 1) 2012	Led Modules for General Lighting, Part 1 Safety Requirements
IS16103(Part 2) 2012	Led Modules for General Lighting, Part 2 Performance Requirements
IS15885(Part2/Sec13)	Safety of Lamp Control Gear , Part 2 Particular Requirements , Section 13 dc. or ac. Supplied Electronic Control gear for LED Modules
IS16104 : 2012	d.c. or a.c. Supplied Electronic Control Gear for LED Modules -Performance Requirements
IS16105 : 2012	Method of Measurement of Lumen Maintenance of Solid State Light (LED) Sources
IS16106 : 2012	Method of Electrical and Photometric Measurements of Solid-State Lighting (LED) Products

IS 16107(Part 1)2012	Luminaries Performance ,Part 1 General Requirements
IS 16107(Part 2)2012	Luminaries Performance, Part 2 Particular Requirements, Section 1 LED Luminaries
IS 16108 : 2012	Photo biological Safety of Lamps and Lamp Systems
IS 10322 : 2012	Luminaries: Part 5 Particular requirements, Section 3 Luminaries for road and street lighting
IEC 62612	Self-ballasted LED lamps for general lighting services for voltage above 50 V — Performance requirements
IEC : 60598-2-3	Particular requirements - Luminaries for road and street Lighting
IEC 62471	Photo biological safety of lamps and lamp systems
IEC 62778	Application of IEC 62471 for the assessment of blue light hazard to light sources and luminaries
IEC 61000-4-5	Electromagnetic compatibility (EMC) - Part 4-5: Testing and measurement techniques - Surge immunity test
IEC/PAS 62717	Performance requirements – LED modules for general lighting
IEC/PAS 62722	Performance requirements – LED luminaires for general lighting

Material conforming to other internationally accepted standards, which ensure equal or better quality than the standards mentioned above would also be acceptable. In case the bidder who wishes to offer material conforming to the other standards, salient points of difference between the standards adopted and the specific standards shall be clearly brought out in relevant schedule. Four copies of such standards with authentic English translations shall be furnished along with the offer.

3. CLIMATIC CONDITIONS:

The equipment covered under this specification is for outdoor installation and the climatic conditions that are prevailing at the sites in Delhi.

Temperature: The reference ambient temperature be taken as 43.3 ° C as per IS 9676.		
	Maximum ambient air temperature	50°C
	Maximum daily average ambient temp	40°C
Relative Humidity:		
	Maximum Relative Humidity	100%
	Minimum Relative Humidity	10%

3.	Average annual rainfall	750 mm
4.	Average no. of rainy day	50
5.	Average no. of thunderstorm days per annum	40
6.	Altitude	Not exceeding 300 meters
7.	Rain months	June to Oct.
8.	Wind pressure as per IS 875	195 Kg/Sq. meters up to 30 meters

The atmosphere is generally laden with mild acid and dust in suspension during the dry months and is subjected to fog in cold months. Heavy lightening occurs in the area during rainy months (June to October).

All equipment shall be designed to withstand seismic forces, corresponding to an acceleration of 0.3 g horizontal.

4. Technical Design & construction Parameters:

S.No.	Technical Particulars	Required technical parameters	
A	Fitting (Luninairs)	LED Switch Yard Lighting	
1.	Distribution	Type-II	
	Usage hours	Dusk to dawn (12 hours)	
2.	Lens Type	Polycarbonate	
	Beam angle	120 Degree-min	
3.	Working Humidity	10-100% RH 1	
	Working temperature	-10 to 50 °c	
4.	Wattage (System wattage)	100W ± 5%	150W ± 5%
5.	Luminary efficacy as per LM-79	>100 Lumen/watt	>100 Lumen/watt
6.	Minimum Lumens of Fitting	Minimum 12000Lumens	Minimum 15000 Lumens
7.	Pole entry dia	50-60 mm	50-60mm
8.	Luminaries protection	Class 1	
9.	Maximum variation allowed in luminary light output (lumen) throughout in the input operating voltage range	The voltage variations/fluctuations in the specified voltage range shall not impinge upon the lumen it produces. Maximum variation +/-2% is allowed in luminary light range	

		output (lumen) throughout in the input operating voltage range.
10.	Input Voltage	240 Volts +/- 10%
11.	Input Frequency	50Hz +/-3%
12.	Operating voltage range	120-270V
13.	Power Factor	≥ 0.95
14.	Overall total harmonic distortion	<10% as per EN 55015 or EN 61000-3-2
15.	Surge protection	$\geq 10\text{kv}$ inbuilt or “5KV internal (inbuilt) and 5KV external” with NABL Lab test report
16.	Index of protection level for optical & control gear	IP 66
17.	Impact resistance	$\geq \text{IK07}$
18.	Housing	Single piece Corrosion free High Pressure aluminum die cast with manufacturer's embossed/engraved. The luminaries shall be built in such a way that it can withstand wind speed of 150kmph. NABL accredited lab report supporting the same shall be furnished by the manufacturer.
19.	Driver Housing	Integral
20.	The luminaries should meet the standard	IEC 60598-1
21.	Cover/Glass	UV stabilized poly carbonate/Toughened glass
22.	Screw/faster & clamps	Stainless Steel
23.	Type Tests report as per IS : 10322 Part 5 sec-3/IEC : 60598-2-3	From NABL accredited TPL (IP classification is IP 66, INSITU/Junction temp measurement shall be part of Thermal test)
24.	Test report as per LM79/IS:16106	From ILAC/MRA/NVLAP/KOLAS/EPA/NABL accredited TPL (IP classification is IP 66)
25.	Test report for IK07	As per IS 10322

26.	Test report with summary for compliance as per tender parameters (Operating voltage, Constant light output, Luminous flux per watt, CCT, CRI, Uniformity calculation, P.F, Wattage.	For LED parameters like lumen per watt, CCT, CRI, Beam Angle from LED Manufacturer or TPL.
27.	LM80/IS:16105 report	From ILAC/MRA/NVLAP/LOLAS/EPA/NABL accredited Manufacturer or TPL.
28.	Conformation standards of luminaire (Test reports of luminaire)	<p>The luminaire should conform to IEC 60598/IS:10322 The luminaire should be tested as per IEC 60598-2-3:2002/IS:10322 Part 5 Sec-3 standards and following test reports should be submitted from NABL certified TPL TEST REPORT as per IS:10322 part 5 Sec-3/IEC:60598-2-3: Heat Resistance Test, Thermal Test, Ingress Protection Test, Drop Test.</p> <p>Electrical/Insulation Resistance Test, Endurance Test, Humidity Test, Photometry Test (LM79 report), Vibration Test.</p>
B)	LED	
1)	Single LED chip for a single category/wattage of product.	Single LED chip is allowed for a single category/wattage of product, mixing of chip is not allowed for single product.
2)	LED Test Report	<p>For LED parameters like Lumen per watt, CCT, CRI, Beam Angle from ILAC/MRA/NVLAP/KOLAS/EPA/NABL accredited Manufacturer or TPL</p> <p>LM 80/IS:16105 report from ILAC/MRA/NVLAP/KOLAS/EPA/NABL accredited Manufacturer or TPL</p> <p>IEC 62471 and assessment of blue light as per IEC/TR 62778-Ed.1.0</p>
3)	Type of LED	Discrete high power LED with individual lens >1W and <3W
4)	Color Rendering Index (CRI)	>70

5)	CCT	$\geq 5700\text{K}$ as per ANSI Bin
6)	Junction temperature	$T_j \leq 85^\circ$ provided Luminary housing temperature rise should not be more than 25°C over ambient temperature after 48 hours continuous operation.
7)	LED Efficacy	$>135\text{lm/W}$
8)	Life expectancy	$\geq 60,000$ hours at 70% lumen maintenance (LM70)
9)	LED should meet the standard	IEC 62471 2006-07 (photo biological safety of lamps and lamp systems) LM-80 and Assessment of blue light as per IEC/TR 62778.
10)	Light distribution	LED with secondary lens
C	LED Driver	
1)	Efficiency	$\geq 85\%$
2)	Make of Driver	Similar to manufacturer make
3)	LED Driver Test Report	Type Tests report as per IS:15885-Part 5 Sec-13, IS: 16104
		Test Report as per tender specification (Driver Efficiency, $>85\%$ THD, $< 10\%$ Surge Protection $> 10\text{KV}$)
4)	Life of Driver	≥ 50000 hours
5)	Surge Voltage Protection	$\geq 10\text{kV}$ inbuilt or “5KV internal (inbuilt) and 6KV external”
6)	Driver Current (Ampere)	$\geq 350\text{MA} \leq 1000\text{mA}$
7)	Protection	Over voltage, short circuit, open circuit and Reverse polarity, Environmental. Potted with flame retardant thermal potting compound.
8)	Construction	
9)	Driver Certification	
10)	Driver Approval	BIS approved driver with R Number certificate to submitted.
D	Body & Other Parameters	

1)	Type of housing (Material & Const.)	Single piece Corrosion free aluminum High Pressure die cast with manufacturer's Embossed/engraved.
2)	Type of Cover/Glass	Toughened glass/UV stabilized Polycarbonate cover
3)	Type of heat Sink	Pressure die cast
4)	IP Protection Class	IP -66
5)	Finish	Polyester Power coated
6)	Screw/fastener & clamps	Stainless steel
7)	Product qualities	The luminaries shall be supplied with label, giving indication of serial number, model and system lumen pack, nominal CCT, wattage of fitting, Date of Manufacturer, and other labeling details as per IS.
F	Documents to be submitted	
1)	5 year Guarantee Certificate	From Manufacturer/OEM.
2)	Test reports (LM 79, LM 80, Type Test Report, Technical Data Sheet, IP	From NABL accredited Third party lab covering NIT specifications.
3)	Copy of Technical Catalogues	
4)	Details of Service Centres	
5)	Photometric Report of fitting	LM 79 report from NABL Lab.
6)	Ref. of IS/IEC (if any) for type test	IS-10322 (Part 5/Sec 3)

5. NAME PLATE & MARKING:

1.1.5. Followings shall be clearly engraved/embossed on the die cast housing of LED Luminaries Housing:

- a. Rated voltage or voltage range (marked 'V' or 'Volt');
- b. Rated current (marked 'A' or 'Ampere');
- c. Rated wattage (marked 'W' or 'Watts');
- d. Rated frequency (marked in 'Hz')

- e. Power factor
- f. Rated lumen
- g. Indian/International Standards to which it is
- h. Manufactured
- i. Month and year manufacture
- j. Customer name as DTL
- k. Fitting serial number
- l. DTL PO no and date
- m. Guarantee period

Following information shall be printed on the Control gear Driver Name plate:-

- a. Operation Voltage range
- b. Output voltage
- c. Guaranteed period
- d. DTL PO no. & date
- e. Customer name as Delhi Transco Ltd.

6. TESTS:

The LED light must be of type tested from CPRI/ERDA/NABL/Equivalent accredited laboratory in accordance with IS 16102, IS 16103 and IS 16107 (PART-1,PART-2 2012) and reports shall be furnished along with the tender.

All Routine Tests, Acceptance tests shall be carried out in accordance with the relevant IS/IEC with latest in the presence of purchaser representative if so desired by the purchaser.

7. DRAWINGS, DATA & MANUALS TO BE SUBMITTED (FOR INFORMATION ONLY)

7.1	To be submitted along with bid	<p>The bidder has to submit the following documents:</p> <ul style="list-style-type: none"> a. Catalogues of the selected LED and Luminaire fittings. b. Guaranteed Technical Particulars c. General arrangement drawing of the LED light d. Calculation documents to substantiate choice of the LED and the Luminaire fittings. e. Verifiable Type Test Certificate of the LED and its luminaire carried out on identical Design and type of the unit of the same rating f. An illustrated literature on the LED giving technical information on the operational details and the current ratings, short circuit ratings, derating factors for different types of installation, packing date, weights and other relevant information.
7.2	After award of contract, seller has	<p>The bidder has to be submit the following documents:</p> <ul style="list-style-type: none"> a. Guaranteed Technical Particulars

	to submit mentioned drawings for buyer's Approval (A) /Reference (R)	b. Calculations to substantiate choice of electrical, mechanical component size / ratings c. General arrangement drawing of the LED street light d. Programme for production & testing e. Detailed installation and commissioning instructions f. Quality Assurance plan
7.3	Submittals required prior to dispatch	a. Inspection and test reports, carried out in manufacturer's work b. Test certificates of all bought out items c. Operation and maintenance instruction as well as trouble shooting charts / manuals.

8. WARRANTY/GUARANTEE PERIOD

The full luminary shall be guaranteed against manufacturing defects, material, workmanship and design for the period of 05 years from date of receipt of material. The guarantees for replacement of materials/accessories shall be provided free of charge at purchasers premises. The guarantee will be without prejudice to certificate of inspection or material receipt note issued by DTL.

Guarantee Technical particular of LED Luminaries:

S.No.	Technical Particulars	To be submitted by Bidder
A	Fitting (Luminaries)	
1)	Make	
2)	Manufacturing address	
3)	Model No.	
4)	Distribution	
5)	Usage hours	
6)	Lens Type	
7)	Beam angle	
8)	Working Humidity	
9)	Working temperature	
10)	Wattage (System wattage)	
11)	Luminary efficacy as per LM-79	

12)	Minimum Lumens of Fitting	
13)	Pole entry dia	
14)	Luminaries protection	
15)	Maximum variation allowed in luminary light output (lumen) throughout in the input operating voltage range	
16)	Input Voltage	
17)	Input Frequency	
18)	Operating voltage range	
19)	Power Factor	
20)	Overall total harmonic distortion	
21)	Surge protection	
22)	Index of protection level for optical & control gear	
23)	Impact resistance	
24)	Driver Housing	
25)	The luminaries standard	
26)	Type Tests report as per IS : 10322 Part 5 sec-3/IEC : 60598-2-3	
27	Test report as per LM79/IS:16106	
28	Test report for IK07	
29)	Test report with summary for compliance as per tender parameters (Operating voltage, Constant light output, Luminous flux per watt, CCT, CRI, Uniformity calculation, P.F, Wattage.)	
30	LM80/IS:16105 report	
31	Conformation standards of luminaire (Test reports of luminaire)	
B	LED	
1)	Make of LED	
2	Type of LED	

3	Model No. of LED	
4	Wattage of LED	
5	Number of LED used	
6	Color Rendering Index (CRI)	
7	CCT	
8	Junction temperature	
9	LED Efficacy	
10	Life expectancy	
11	LED Ref standard	
12	Light distribution	
13	Driving Current	
C	LED Driver	
1)	Efficiency	
2)	Make of Driver	
3)	LED Driver Test Report	
4)	Life of Driver	
5)	Model No. of Driver	
6)	Surge Voltage Protection	
7)	Driver Current (Ampere)	
8)	Protection	
9)	Construction	
10)	Driver Certification	
11)	Driver Approval	
D	Body & Other Parameters	
1)	Type of housing (Material & Const.)	
2)	Type of Cover/Glass	
3)	Type of heat Sink	

4)	IP Protection Class	
5)	Weight of fitting	

Fire Detection and alarm System

This system shall be provided for control room building and Switchyard panel rooms of substations.

1. Suitable fire detection system using smoke detectors and/or heat detectors shall be provided for the entire building, including corridor and toilets. Fire detectors shall be located at strategic locations in various rooms of the building. Each Switchyard panel room shall be considered a separate zone. Adequate number of extra zones shall be provided for Switchyard panel rooms for future bays identified in Single line diagram of the substation. The operation of any of the fire detectors/ manual call point should result in the following;
 - a. A visual signal exhibited in the annunciation panels indicating the area where the fire is detected.
 - b. An audible alarm sounded in the panel, and
 - c. An external audible alarm sounded in the building, location of which shall be decided during detailed engineering.
 - d. If the zone comprises of more than one room, a visual signal shall be exhibited on the outer wall of each room.
2. Each zone shall be provided with two zone cards in the panel so that system will remain healthy even if one of the cards becomes defective.
3. Coverage area of each smoke detector shall not be more than 80 m² and that of heat detectors shall not be more than 40 m². Ionisation type smoke detectors shall be provided in all areas except pantry room where heat detectors shall be provided. If a detector is concealed, a visible visual indication of its operation shall be provided. Manual call points (Break glass Alarm Stations) shall be provided at strategic locations in the control room building. All cabling shall be done through concealed conduits.
4. Cables used should be exclusively for fire detection and alarm system and shall be 2C x 1.5 sq. mm Cu. cables. Un-armoured PVC insulated FR cables conforming to IS 1554 (Part 1) shall be used.

SPECIFICATIONS FOR ACSR ZEBRA POWER CONDUCTORS**1. GENERAL**

1.0. SCOPE: The material to be supplied under this specification shall be engineered, designed, manufactured, tested and delivered as per requirements specified here in for use in the DTL network as per relevant IS/IEC with latest amendment.

1.1. Power conductor:

- 1.1.1. ACSR 'ZEBRA' conductor 54/3.18 mm Al. + 7/3.18 mm Steel.
- 1.1.2. The material to be supplied under this specification shall conform to the standards specified under clause 2.0 of this specification.
- 1.1.3. The design and workmanship shall be in accordance with the best engineering practice to ensure satisfactory performance and service as specified.
- 1.1.4. The tenderer shall furnish all drawings as called for in this specification.
- 1.1.5. Any deviation from the specification shall be brought out clearly. Unless brought out clearly, the tender shall be deemed to conform to specifications scrupulously, information given in pamphlets or other literature enclosed with the offer shall not be considered as valid deviation.
- 1.1.6. The material offered shall be complete in all respects for efficient performance and satisfactory operation. Material and accessories not specifically included but required for completeness of the order shall be deemed to be included in the scope of supply.

1.2. Climatic Conditions:

- 1.2.1. The items covered under this specification are for outdoor installation under the sun and the conditions prevailing at site are as follows:-

I	a	Temperature (°C)	Maximum Ambient Temperature in Open	50
	b		Maximum Temperature under the sun	65
	c		Minimum temperature of air	0
II	a	Relative Humidity		Maximum 100%
	b			Minimum 10%.
III		Average Annual Rainfall (mm)		750
IV		Average No. of Thunderstorm per/Annum		40
V		Average No. of rainy days per/annum		50
VI		Altitude not exceeding		300 Mts. Above M.S.L

- 1.2.2. The atmosphere is generally laden with **mild acid and dust** in suspension during the dry months and subject to fog in cold months. The variation between daily maximum and minimum temperature is of the order of 15-20°C. Heavy lightening is in the air during the rainy months.

- 1.2.3. The design shall be suitable to withstand **seismic forces** corresponding to an acceleration of 0.3g.

2.0. STANDARD:

- (i) The conductor shall conform to the applicable Indian standards which shall mean latest revisions amendments/changes adopted/published.
- (ii) In the event of supply of the material conforming to any other standard than Indian standard listed below the salient features of comparison shall be brought out and furnished along with the bid. The copies of such standards specifications in the English language or their English translation shall be attached with the offer.

IS:398-1976	Hard drawn stranded Aluminium and steel cored aluminium conductor for overhead transmission purpose.
IS:2629-1966	Recommended practice for hot dip galvanizing of Iron and steel.
IS:2633-1972	Method of testing of uniformity of coating of Zinc coated articles.
IS:1548-1969	Manual on basic principles of lot sampling.
IS:4826-1979	Hot dipped galvanized coating on round steel wires.
IS:1778-1961	Reel & drum for bare wire.
IS:6745-1972	Method of determination of weight of zinc coating on zinc coated Iron and steel articles
IS:209-1966	Specification for zinc.

3.0 Material and workmanship:

- (i) The material shall be of the latest design and shall confirm to the best modern practice adopted in the extra high voltage field. The bidder shall offer only such material as guaranteed by him to be new, satisfactory and suitable for good performance.
- (ii) The design manufacturing process and individual control of all the material shall be such to give maximum factor of safety and maximum weight in respect of maximum working load, highest mobility, maximum possible elimination of sharp edges and corners, to limit radio interference, best resistance to corrosion and best finishing.
- (iii) All ferrous parts of the conductor shall be hot dip galvanized after all machining has been complete. Galvanizing shall be done in accordance with IS: 2629 and satisfy the test mentioned in IS: 2633. The galvanized material shall be guaranteed to withstand five dip each lasting for 60 seconds under the standard 'Preece Test' for galvanizing.
- (iv) In case of casting, the same shall be free from all internal defects like shrinkage, blow holes, cracks or other casting defects and the quality of the product shall be uniform throughout.
- (v) Particular care shall be taken during manufacture and during subsequent handling to ensure smooth surface from abrasions or cuts.

4.0 TESTS:

- i. **ACSR Zebra conductor offered shall be type tested. The tenderer shall**

furnish all the applicable type test reports of conductor in line with relevant IS/IEC with latest amendment/revision. The type test reports shall not be older than 10 years prior to the date of expiry of bid , otherwise the offer shall not be considered.

- ii. The conductors shall be subjected to routine tests in accordance with the relevant IS of the item and such other tests, as may be required to ensure that the conductors are satisfactory and are in accordance with the specifications.
- iii. Any modification required in testing procedure shall be made as directed by purchaser at no additional cost to the purchaser. No material shall be dispatched from the manufacturers works before the relevant test reports, have been approved by the purchaser.
- iv. The routine and special test as per IS-398 (Part-I) shall be performed in presence of the representative of the Delhi Transco Limited/Third party engaged by D.T.L. at the time of inspection.

5.0 SPECIFICATIONS FOR ACSR ZEBRA POWER CONDUCTORS:

- 5.1 Technical Specification:** The ACSR Zebra Conductor required is to be used for 220 KV single/double circuit power lines and system parameters are as per details below:-

I	System voltage	220 KV RMS
II	Highest system voltage	245 KV RMS
III	Impulse withstand voltage	1050 KV Peak
IV	1 minute power frequency dry withstand voltage	460 KV RMS
V	1 minute power frequency wet withstand voltage	460 KV RMS
vi	System short circuit current	40 K Amp. for 1 seconds

- 5.2 Power Conductor:** The ACSR ZEBRA Conductor offered against this specification shall conform to the following particular requirements:-

Serial	Particulars			Conductor			
1	Type			ACSR ZEBRA Conductor			
2	Stranding and wire diameter	a	Aluminium	54/3.18 mm			
		b	Steel	7/3.18 mm			
3	Nominal area of Aluminium mm ²			420			
4	Total Sectional are mm ²			484.5			
5	Approximate over all diameter mm.			28.62			
6	Approximate mass Kg./KM.			1621			
7	Calculated Resistance at 20 ⁰ C			0.06868 (As per IS:398)(Part-2)			
8	Approximate calculated breaking load KN			130.32			
9	Modulus of Elasticity KN/mm ²			69			
10	Co-efficient of liner expansion			19.3x10 ⁻⁶ per degree centigrade			
11	Lay Ratio						
	i	Steel core		Maximum	28	Minimum	13
		Aluminum Core					

	i	a	Outside layer	Maximum	14	Minimum	10
	i	b	Layer immediately beneath outside	Maximum	16	Minimum	10
		c	Innermost layer conductors with three Aluminum wire layer	Maximum	17	Minimum	10
12	Ratio aluminum wire diameter to steel wire diameter					1.0	
13	Configuration of phases of conductor of D/C line					Vertical	

- 5.2.1** The material offered shall be of best quality and workmanship. The steel cored Aluminum conductor strands will consist of hard-drawn Aluminum wire manufactured from 99.5% pure electrolytic Aluminum rods of EC grade. The steel wire shall be made from material produced either by the acid or basic open hearth process or by electric process. No steel wire drawn from “Bessemer process” shall be used. The steel wire shall not contain sulphur or phosphorus exceeding 0.05 percent and the total of sulphur and phosphorus shall not exceed 0.085 percent.
- 5.2.2** The steel wires shall be evenly and uniformly coated with zinc complying with Indian Standard 209-1961 specification for zinc (Revised) The uniformity of zinc coating shall be uniform and the weight of coating shall be 259 gm/m² and shall be tested and determined according to Indian standards 429-1954 with latest amendment if any.
- 5.3 SIZES:** The size of steel –cored Aluminum conductors shall be as given in clause 5.2. The resistance and weights shall be in accordance with the values given in the same clause.
- 5.4 Tolerances:** The following tolerances shall be permitted on standard diameter and on the resistance of aluminum wires.
- Tolerances on standard diameter of aluminum wires + 1%
- Tolerances on standard resistances of aluminum wires + 1% when corrected to standard weight and temp.
- NOTE:** The cross section of any wire shall not depart from circularity by more than an amount corresponding to a tolerance of 2% on the standard diameter. A tolerance of + 2% shall be permitted on the standard diameter of the galvanized steel wires the variation from the approximate weights shall not be more than +5%.
- 5.5 Mechanical properties:** The value of the final modules of elasticity for steel cored aluminum conductor is the average of values obtained from actual stress-strain tests. The co-efficient of linear expansion for steel cored aluminum conductor has been calculated on the basis of co-efficient of linear expansion of 23.0×10^{-6} per degree centigrade of aluminum and 11.5×10^{-6} per degree centigrade for steel and represents only the average values. These values shall, however, be given by the tenderer under the guaranteed technical particulars.
- 5.6 Surface conditions:** The wires shall be smooth and free from inequalities spills and splits. The surface conductor shall be free from point’s sharp edges, abrasions or other departures from smoothness or uniformity of surface contour that increase radio interference and corona-losses. When subjected to tension up to 50% of the ultimate strength of the

conductor the surface shall not depart from its cylindrical form nor any part of the components parts or strands more relative to each other in such a way as to get out of place and disturb the longitudinal smoothness of the conductor.

5.7 Joints in wires & conductors: For steel cored Aluminum conductors, joints shall be permitted provided no two joints in the complete stranded conductor occur closer together than 15 meters. Joints in aluminum wires shall be made autogenously. No joints shall be permitted in steel wires forming the core of a steel cored aluminum conductor unless the core consists of seven or more steel wires. Joints in steel wires shall be made by brazing and shall be protected against corrosion.

5.8 Stranding: The wires used in construction of stranded conductor shall before stranding, satisfy all requirements of IS: 398. For steel cored Aluminum conductors, the lay ratio of the different layers shall be within the limits given under particulars in clause 2.1 of this specification. For all constructions, each alternate layer shall be stranded in opposite direction. The wires in each layer shall be closely stranded round the underlying wire or wires the final layer of wires shall have a right hand lay.

5.9 PACKING AND MARKING: The conductor shall be wound in non returnable reels drums conforming to Indian standards 1778-1961; specification for reels and drums for bare wires, and marked with the following:

<ul style="list-style-type: none">• Trade name if any• Name of manufacturer;	<ul style="list-style-type: none">• Size of conductor• Length of conductor.
---	--

The reel shall be such construction as to assure delivery of conductors in the field free from displacement and damages and should be able to withstand all stresses due to handling and the stringing operation so that conductor surface is not dented scratched or damaged in any way during manufacture, transport and erection. The spindle bushing of each reel shall be reinforced with metal plates. The conductor shall be properly lagged on the drums and the method of lagging to be employed may be clearly stated in the tender .It should be notched to sit in the reel and held in place by steel strapping. Lagging should not be nailed or bolted in place. Each reel shall have full or more through steel bolts to act as tie rods between two end plates and to provide support to the reels. These through bolts shall not be less than 20mm in diameter.

The conductor drums should be suitable for wheel mounting before reeling, the cardboard or other suitable material shall be secured to the drum and inside flanges of the drum. After reeling the conductor, the exposed surface should be wrapped with suitable soft material to prevent the conductor from dirt and grit. Any space between the drum lagging and conductor should be suitable filled with soft filler material compactly packed. Tenderer must submit dimensioned drawings of the reel along-with the tender.

5.10 Lengths: The conductor shall be supplied in the standard length of 1.5 km. per drum and such lengths will be specifically indicated in the tender. Not less than 90% of the total quantity of the conductor shall be supplied in the standard length. Thus the quantity of the

conductor in lengths shorter than standard ones shall not exceed 10% of the total quantity to be supplied. Further, no single conductors lengths in respect of such 10% (Max.) supply in random lengths shall be shorter than 50% of the standard length.

Technical Provisions for Green Buildings for DTL grid substations

1. Water Conservation and Management

- **Rainwater Harvesting:** Buildings are incorporate rainwater harvesting systems to collect and store rainwater for non-potable uses like landscaping and toilet flushing.
- **Water-Saving Fixtures:** Low water consumption plumbing fixtures.
- **Overhead water tank alarm system:** To reduce wastage of water.
- **Reduction of Hard scope:** Adequate land for landscape/ soft land and to increase water table.

2. Solar Energy Utilization

- **Solar Water Heating:** Installing solar water heaters in buildings to reduce the use of conventional energy sources for water heating.
- **Photovoltaic Systems:** Install solar panels for generating electricity.

3. Energy Efficiency

- **Lighting:** Implementation of energy-efficient lighting solutions such as LED bulbs and advanced lighting controls like occupancy sensors and daylight harvesting systems.
- **Solar Lighting:** Use of solar powered outdoor lighting to reduce reliance on grid electricity.
- The distributed cooling systems (unitary air conditioners / split air conditioners) shall be BEE 5 star rated products.
- **Insulation and Glazing:** Use of high-performance insulation materials for roof and energy-efficient glazing using hermitically sealed double glass to minimize energy loss.

4. General Green Building Norms

- **Indoor Air Quality:** Requirements for proper ventilation systems and maintain indoor air quality standards by using air purifier with display system in control room and office room.
- **Waste Management:** Implementation of waste segregation.

Details for Raising Height of Substation Boundary Wall

The height of boundary wall is to be raised by 01 meter after dismantling of the existing Y-section & concertina coil and new 610mm dia concertina coil over boundary wall shall be fixed with arrangement of new Y shape angle grouted on RCC columns. The boundary wall columns are to be extended with steel reinforcement and RMC (M-30 grade), coping, filling in brick panneling cement mortar 1:4 (1 cement: 4 coarse sand). The boundary wall shall be finished with 12mm/15mm cement plaster in cement mortar mix 1:4 (1 cement : 4 coarse sand) and acrylic smooth exterior paint on base of white cement base putty minimum thickness 1mm. Painting with synthetic enamel paint on steel work.

Specification for Full Face Mask with Dual Cartridges

1. Introduction

Full face masks with dual cartridges are used for respiratory protection of working personnel exposed to toxic chemicals like TDI, TCE, DCM and Benzene at process facilities.

2. Specification for Full Face Mask with Dual Cartridges

I. Full face mask		
a. Material of the mask face piece	:	Silicone rubber/ TPE
b. Size	:	Medium
c. Type of construction of the mask face piece	:	Should have secure single flange face seal along the contours of the users face and nose bridge area. This is to ensure a reliable seal at all times.
d. Type of head harness	:	4 – Strap head harness which gives head support and distribution of weight
e. Nose cup	:	To be integral part of the mask
f. Material of the Nose cup	:	Silicone rubber/ TPE
g. Speech diaphragm/ facilitator	:	Should have a speech diaphragm/ facilitator
h. Material of speech diaphragm/ facilitator	:	As per IS 14166
i. Speech diaphragm/ facilitator assembly	:	As per IS 14166
j. Material of visor	:	Polycarbonate
k. Colour of the visor	:	Clear
l. Effective field of vision of visor	:	As per IS 14166
m. Inhalation valve	:	Shall have two well-designed apertures fitted with one-way non-return valves to ensure only inhalation through the cartridges. Shall function correctly in all orientations.
n. Fit of inhalation valve with cartridges	:	Twist N Click/ Bayonet
o. Exhalation valve	:	Shall have a well-designed one-way non-return valve to ensure only exhalation through the face piece.
p. Operational limit of exhalation valve	:	Shall continue to operate correctly after a continuous exhalation flow of 300 l/min and a negative pressure (static) in the mask of 80 mbar as per IS14166
q. Weight	:	Should not weigh more than 800gms
r. Approvals conform to	:	IS 14166/ EN/ NIOSH
s. All face masks shall be from latest stock and to be supplied within 6 months from the date of manufacture.		

II. Cartridges		
a. No. of cartridges	:	2 nos. per full face mask and should be compatible for the above full-face mask.
b. Class of the cartridge	:	Class 2 (medium capacity) as per IS 15323
c. Filter type	:	ABEK1/ A1B1E1K1 as per IS 15323
d. Max. User Level (MUL)	:	1000 ppm or 20 X OEL whichever is lower
e. Protection against	:	Organic Vapors (OV)/ Inorganic Gases (IG)/ Acid Gases (AG)/ Ammonia (AM)
f. Weight	:	Should not weigh more than 110gms each
g. Material of the housing of the cartridge	:	ABS or equivalent to withstand normal usage and exposures to those temperatures, humidity and corrosive environments those are likely to be encountered as per IS 15323.
h. Minimum shelf life of the cartridge	:	4 years (to be indicated by manufacturer)
i. Approvals conform to	:	IS 15323/ EN/ NIOSH
j. All cartridges shall be from latest stock and to be supplied within 6 months from the date of manufacture.		
k. Cartridges shall be packaged in such a way that they are protected against mechanical damage or visible contamination before use.		
l. The filter shall be designed to ensure its full function in any orientation.		

TECHNICAL SPECIFICATIONS OF NEUTRAL CURRENT TRANSFORMER

1.1 NCT for 220 KV side Neutral for 160 MVA OR 100 MVA 220kV Class Transformers

- | | |
|--|--|
| a) C.T. Ratio | 800-400/1 Amp. |
| b) Highest voltage for equipment | 17.5 KV |
| c) Rated short duration power frequency
withstand voltage | 38 KV(r.m.s) |
| d) Secondary current | 1 Amp. |
| e) Rated impulse withstand voltage | 95 KV (P) |
| f) Purpose | Relaying (restricted earth fault protection) |
| g) Class of accuracy | PS |
| h) Min. Knee point voltage V_k | $V_k > K \cdot I_s \cdot (R_{ct} + R_b) V$
(Rct.-Resistance of secondary winding) |
| i) Max. exciting current at $V_k/2$ | 30 mA |

1.2 NCT for 66kV OR 33 KV side Neutral of 100 MVA OR 160 MVA 220kV Class Transformers

- | | |
|--|--|
| a) C.T. Ratio | 2000-1000 /1 Amp. |
| b) Highest voltage for equipment | 17.5 KV |
| c) Rated short duration power frequency
withstand voltage | 38 KV |
| d) Rated impulse withstand voltage | 95 KV (P) |
| e) Purpose | Relaying (restricted earth fault protection) |
| f) Secondary current | 1 Amp. |
| g) Class of accuracy | PS |
| h) Min. Knee point voltage V_k | $V_k > K \cdot I_s \cdot (R_{ct} + R_b) V$
(Rct.-Resistance of secondary winding) |
| i) Max. exciting current at $V_k/2$ | 30 mA |

1.3 **CONSTRUCTION DETAILS :**

- i) The current transformers shall be oil immersed and self cooled outdoor type suitable for the specified services indicated, completed in all respects and in accordance with best engineering practice design and workmanship.
- ii) The core shall be of high grade non ageing, electrical silicon laminated steel of low hysteresis loss high permeability to ensure high accuracy at both normal and over current, extended current conditions and shall produce undistorted secondary current under transient conditions at all ratios.
- iii) The oil immersed CT shall be hermetically sealed to eliminate breathing and to prevent air and moisture and shall be provided with a pressure relieving device capable to releasing abnormal internal pressure. C.T. shall be provided with oil level gauge, and necessary arrangement for replacing the oil shall be provided.
- iv) The current transformers shall be suitable for simultaneous 100% full load continuous rating of the winding.
- v) The ratio changing taps if any, shall be provided only on the secondary winding of the C.T.
- vi) Current transformers cores to be used for protective relaying purposes shall be of accuracy class specified, suitable for restricted earth fault protection.
- vii) The secondary terminals shall be brought out in a weather proof terminal box (with degree of protection IP55) on the side of the current transformer and shall be accessible through a removable cover. The secondary tap shall be adequately reinforced to withstand normal handling without damage. Suitable cable glands shall be provided to accommodate purchaser's control cables.
- viii) The maximum permissible temperature rise of the windings over the ambient shall not exceed 40°C.
- ix) The magnetizing curve for each core shall be furnished with the tender.
- x) The secondary terminals shall be provided with short circuiting and earthing arrangements at the terminal block.
- xi) The C.T.s shall be suitable for horizontal as well as vertical transportation.

Product Specification for True Rms Clamp Meter

Specification	Sub-Spec	Value
GENERAL FEATURES	Type	Hand Held
	Display	3.5-digit Backlit LCD
	Measurement Type	True RMS
	Count	6000
MEASUREMENT FEATURES	Resistance Measurement Range	4 kiloOhm
	Resistance Measurement Accuracy (+/-)	2 percent
	Frequency Measurement Range	0.5 kiloHertz
	Frequency Measurement Accuracy (+/-)	0.5 percent
	AC Current Measurement Range	100 Ampère
	AC Current Measurement Accuracy (+/-)	2 percent
	AC Voltage Measurement Range	400 Volt
	AC Voltage Measurement Accuracy (+/-)	2 percent
	DC Current Measurement Range	100 Ampère
	DC Current Measurement Accuracy (+/-)	2 percent
	DC Voltage Measurement Range	0.4 Volt
	DC Voltage Measurement Accuracy (+/-)	2 percent
	Other features, if applicable	True RMS Clamp Meter
GENERIC	Jaw Size (Dia in Closed State)	40 millimeter
	Dimensions (H x W x L) (mm x mm x mm)	234x100x46
	Weight	400 gram
POWER REQUIREMENTS	Power Requirements	Battery Operated
	Type of Battery	Non- Rechargeable (Alkaline)
	If rechargeable, then chemistry of the battery	NA
	If non-rechargeable, then size of the battery / cell	AA
	Number of non- rechargeable the battery / cell	2
	Voltage of rechargeable Battery milliamphere hour	0
	Suitable charger/adaptor provided	NA
OPERATING CONDITION	Minimum Operating Temperature	-10 degree Celsius
	Maximum Operating Temperature	50 degree Celsius
	Operating Humidity (RH)	80 percent

SAFETY	Safety Certification	CE
	Safety Rating	CAT III 600 V of IEC 61010 -2 D31
ACCESSORIES	Details of the Standard Accessories Supplied with the Equipment	Test Lead
SERVICE	Warranty	1 year

STANDARD FOR GENERIC REQUIREMENTS

No.: TEC 88090:2012

**OPTICAL FIBRE
SPLICING MACHINE**

REFERENCES

TEC STANDARDS

- | | |
|---|--|
| 1. TEC/TX/GR/ORM-01/04/SEP-09
(Section-I) | GR for Raw Material used in manufacturing of Optical Fibre Cable. |
| 2. TEC/GR/TX/PTS-01/03/JAN-2011 | GR for Splice protection sleeve for Optical fibre |
| 3. No. GR/OFT-01/03 APR 2006
(Section XVII, XVIII & XIX) | GR of Stripper for Primary & Secondary Coating and Precision Cleaver |
| 4. TEC/EMI/TEL-001/01/FEB-09 | EMC Standard for Telecommunication Equipment |
| 5. SD:QM-333 (March 2010) | Standards for Environmental Testing of Telecommunication Equipment. |

OTHER STANDARDS (CISPR/IEC/ISO/ASTM etc.)

- | | |
|--|---|
| 1. IS 8437 (1993) | Guide on the effects of current passing through the human body (equivalent to IEC publication 60479-1 {1984}). |
| 2. IEC 61000-1 (2001) with
corrigendum 1 (2002) and
corrigendum 2 (2003) | Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory use” |
| 3. CISPR 11 (2004) | Industrial Scientific and Medical (ISM) radio frequency Equipment – Electromagnetic disturbance characteristics- Limits and methods of measurement ”; |
| 4. IEC 61000-4-2 (2001) | Testing and measurement techniques of Electrostatic discharge immunity test" |
| 5. IEC 61000-4-3 (2006) | "Testing and measurement techniques-Radiated RF Electromagnetic Field Immunity test" |
| 6. IEC 61000-4-4 (2004) | Testing and measurement techniques of and electrical fast transients/burst immunity test" |
| 7. IEC 61000-4-5 (2005) | “Testing & Measurement techniques for Surge immunity test" |

- | | |
|--------------------------|---|
| 8. IEC 61000-4-11 (2004) | “Testing & measurement techniques- voltage dips, short interruptions and voltage variations immunity tests” |
| 9. ISO 9001-2008 | International quality standards |
| 10. D 2794 and D2197 | ASTM Standards |

PART 1 - TECHNICAL SPECIFICATIONS

1.0 Introduction :

This document describes the Generic requirements of the Optical Fibre Splicing machine used for splicing the optical fibres. The Optical Splice Machine is designed to splice fibres by fusing the fibres together using localised heating at the interface of the butted fibres. An electric arc is generated by the electrodes contained in the unit. The splicing consists of fusion cycles resulting in permanently jointing of the optical fibres with minimum splice loss and low reflection.

2.0 Functional Requirements:

- 2.1 The instrument shall be designed for continuous operation. The manufacturer shall indicate the period of continuous operation for which it shall be checked.
- 2.2 The instrument shall guarantee the satisfactory performance of the instrument without any degradation at an altitude up to 5000 meters above mean sea level. A test certificate from the manufacturer shall be acceptable.
- 2.3 The instrument shall have the facility for altitude compensation such that stable splicing can be done even at high altitudes or at low altitude. The method used for the altitude compensation shall be indicated by the manufacturer.
- 2.4 Power cord shall have moulded plug.
- 2.5 Visual indication to show power ON/OFF status shall be provided.
- 2.6 Provision for self check of the instrument shall be provided.
- 2.7 The software/hardware in instrument shall not pose any problem in the normal functioning of the instrument due to changes in date and time caused by events such as leap year etc.
- 2.8 The instrument shall provide error message information.
- 2.9 All controls shall be clearly marked or labelled with an easy to understand symbol or key word to indicate its intended use.
- 2.10 It shall have the facility to view the fibres on X-axis and Y-axis before splicing.
- 2.11 It shall have the facility of perfusion/pre-arc for cleansing the fibre before actual splicing.
- 2.12 It shall have the facility of assessment of splice loss in dB.
- 2.13 It shall have the provision of cover during splicing to avoid the entry of dust and for the safety of operating personal during fusion.

- 2.14 The splicing machine shall have an override capability to bypass the automatic controls.
- 2.15 It shall have facility for proof testing the strength of fibre joint. The device to test the strength shall be capable of applying a stress of 4.1 Newton's for a minimum period of one second and shall be able to test the strength of the fibre joint
- 2.16 It shall have facility for easy replacement & cleaning of electrodes.
- 2.17 Marking of the push buttons shall be such that their functions are clear in both the extended and depressed position.
- 2.18 It is desirable for the marking on the operating knobs to be done in a raised relief design or with etched and filled characters to enhance the permanence of the identification.
- 2.19 It is desirable to have recessed push buttons or touch screen to avoid damage.
- 2.20 The manufacturer shall state the minimum requirements for the safe operation of the splicing machine.
- 2.21 It shall have high frequency AC, tungsten or equivalent electrodes with long life. The manufacture shall provide the information for the life (number of splices) of a single set of electrodes.
- 2.22 It shall have arc test function with automatic compensation for easy setting of optimum splice condition
- 2.23 It shall have facility to illuminate the V-groove for easy setting of fibre.
- 2.24 It shall have easy operation by splice menu (user friendly) selected on large size monitor.
- 2.25 It shall be possible for the user to down load the information and again the splicer shall be able to store the data from the starting.
- 2.26 It shall have the facility for viewing fibres in focus.

3.0 Technical Requirements:

- 3.1 Principle of operation : Direct core monitoring using Profile Alignment
- 3.2 Type of fibres : Conforming to Section - I of TEC GR No. TEC/GR/TX/ORM-01/04/SEP-09
- 3.3 Nominal Cladding diameter : $125 \pm 1 \mu\text{m}$
- 3.4 Fibre coating diameter : a) Primary coated : $245 \pm 10 \mu\text{m}$
b) Secondary coated : $900 \pm 50 \mu\text{m}$ (Tight jacket)
- 3.5 Fibre strip length : 16 mm maximum
- 3.6 Operating mode : Auto and Manual Mode
- 3.7 Fibre Alignment : 3 Axis alignment capability
- 3.8 Splice Loss for splicing following types of Single Mode fibres at 1310 nm and 1550 nm
a) Homogeneous : $\leq 0.03 \text{ dB}$
b) Heterogeneous : $\leq 0.05 \text{ dB}$

Note: 25 samples of both types of fibres shall be spliced and all the samples shall have to meet the following requirements

- i. The splice loss of 80 % of fibres of homogeneous fibre shall be $\leq 0.03 \text{ dB}$, and of 20 % of the fibres shall be $\leq 0.10 \text{ dB}$.
- ii. The splice loss of 80 % of fibres of heterogeneous fibre shall be $\leq 0.05 \text{ dB}$, and of 20 % of the fibres shall be $\leq 0.10 \text{ dB}$.

3.9 Splice Loss Estimation system:

- a) The splicing machine shall provide a mean for estimating the splice loss.
- b) The splice loss estimation device shall not cause damage to the splice or fibre.
- c) The difference between the estimated loss measured by splicing machine & average loss measured by OTDR shall be within $\pm 0.02 \text{ dB}$.
- d) Splice reflectance: better than or equal to 60 dB at 1310 & 1550nm.

Note: Splice loss Estimation shall be Optional in Manual Mode

- 3.10 Arc Current adjustment : Auto/Manual adjustable for different fibre type, altitude and temperature
- 3.11 Display Monitor : Minimum 3.5 inches LCD or any equivalent display
- 3.12 Viewing method : CMOS camera

- 3.13 Reinforcement of the splice : By Heat shrinkable sleeve
(GR No.TEC/GR/TX/PTS-01/03/JAN-2011)

Note: The heat shrinkable sleeve shall not stick to the walls of the heater after specified cooling time.

- 3.14 No. of Splice Program : The splicing machine should have sufficient splice programs i.e. min. 40 Factory installed, 50 User program and min. 10 Heating program
- 3.15 Splice Time : ≤ 9 Second
- 3.16 Splice Memory : Minimum 2000 splice data
- 3.17 Heater : In-built (For fibre protection sleeve)
- a) Sleeve length : Up to 60 mm
- b) Heating time : < 35 Second
- 3.18 Size & Weight : Light & Compact
- 3.19 Interface : USB
- 3.20 Operating Environment : As per clause No.5.3 of this document
- 3.21 Power Supply:

- a) The instrument shall work from the single phase AC power supply without any degradation with nominal 230V AC with voltage variation from 150V to 270V at $50\text{Hz} \pm 2\text{ Hz}$.

OR

The instrument shall work from AC/DC adopter without any degradation with input voltage from 150V to 270V, $50\text{Hz} \pm 2\text{Hz}$ AC. The manufacturer shall furnish the output DC voltage of the AC/DC adopter and safe operating input voltage for the instrument.

- b) The Splicing Machine shall be supplied along with suitable in-built/external rechargeable battery source, capable of working continuously at least for six hours or for 100 splices with heating and shall have charging facilities. Indication of low battery shall be provided and the unit shall be protected against battery reversals.
- c) The power consumption shall be minimal and its consumption shall be furnished by the manufacturer.
- d) It shall have External DC input port of 12 Volts for operating the Splicing machine (Optional).

3.22 Setting and Adjustment:

3.22.1 The splicing machine shall have facility to pre-program and select the programmes. It shall have the capability of adjusting the fibre parameters and other parameters required for best results. The adjustments shall be available to user by suitable settings:

- a) To allow the joining of homogeneous and heterogeneous fibres from different manufacturers.
- b) To allow the joining of fibres at different altitudes.
- c) To allow the joining of fibres at different humidity conditions.
- d) The manufacturer shall provide the settings for splicing the dissimilar fibre combinations currently available and update of these settings shall be made available for new fibre designs.

Note:

Homogeneous fibre - In homogeneous splicing, the fibre is cut and re-spliced retaining the same orientation.

Heterogeneous fibre - In heterogeneous splicing, the fibres are of the same type but may come from different lots and from different manufactures

3.22.2 It shall have menu driven settings (minimum) for:

- a) Splice mode i.e. Auto, Manual & Arc Test
- b) Electrode Mode i.e. Manual arc
- c) Heater Mode i. e. Selection of type of protection sleeve
- d) Function Mode i.e. Easy function setting menu for operation.
- e) Fibre name mode i.e. Editing fusion program name for each fibre.
- f) Parameter mode i.e. Renewal of parameter settings.
- g) Maintenance mode i.e. Menu for maintenance operator.

3.23 Additional Consumable Items:

The following consumable items shall be supplied along with splicing machine:

- | | | | |
|----|---|---|----------------------------|
| 1. | Electrodes | : | 2 sets (Total four pieces) |
| 2. | Precision Cleaver | : | 1 no. |
| 3. | Primary Coating Stripper | : | 1 no. |
| 4. | Secondary Coating stripper | : | 1 no. |
| 5. | Optical Fibre Protection Sleeves | : | 1000 or as per order |
| | for Optical Fibre | | |
| 6 | Spare Battery | : | One |
| 7. | Brush | : | One |
| 8. | Mid-span Loose tube Cutter | : | One |
| 9. | Any other items required like special tools, etc., for fixing and removing the electrodes and maintenance of the splicing machine, etc. | | |

Note: The Stripper for Primary & Secondary Coating, Precision Cleaver and Splice Protection Sleeves supplied along with splicing machine shall meet the TEC GR No. GR/OFT-01/03.APR.2006 (Section-XVII, XVIII & XIX respectively) and TEC/GR/TX/PTS-01/03/JAN-2011 respectively and subsequent amendment issued, if any.

PART-II GENERAL REQUIREMENTS

4.0 Engineering Requirements:

- 4.1 The instrument shall adopt state of the art technology.
- 4.2 The instrument shall be light for splicing of aerial and underground cables. The dimensions and weight of the instrument shall be specified by the manufacturer.
- 4.3 All switches shall be reliable and of standard type to ensure failure free operation over 1000 on-off operations for switches. This shall be under specified environmental conditions.
- 4.4 The instrument shall be compact and composite in construction. The mechanical design and construction of each card or unit shall be inherently robust and rigid under all conditions of installation operation, adjustment, replacement, storage and transport and conforming to TEC document no. SD: QM 333 {March 2010} "Standards for Environmental Testing of Telecommunication Equipment".
- 4.5 The instrument shall have self cooling arrangement including usage of internal fans, if required.
- 4.6 Important Do's and Don'ts about the operation of the instrument shall be clearly indicated at a convenient place on the instrument.

5.0 Quality Requirements:

- 5.1 The manufacturer shall furnish the MTBF and MTTR values and warranty for a period of minimum 1 year with free repair and replacement unless otherwise specified in tender. The minimum value of MTBF shall be 10,000 hrs.
- 5.2 The instrument shall be manufactured in accordance with international quality standards ISO 9001- 2008 for which the manufacturer should be duly accredited. A quality plan describing the quality assurance system followed by the manufacturer would be required to be submitted by the manufacturer.

5.3 Environmental Requirements:

- a) The instrument shall conform to the requirements for Environment specified in TEC document SD: QM-333 (March 2010) "Standards for Environmental Testing of Telecommunication Equipment. The applicable tests shall be for environmental category "B2" including Drop, Topple, Vibration tests (instrument kept in carrying case) and Corrosion test, if applicable.
- b) The instrument shall be able to work without any degradation in coastal areas & should be protected against corrosion.
- c) The Splicing machine is required to work in Indoor environments like Central offices, equipment huts and outside environments like manhole, open trench and a splicing van. It is required to work in bright sunlight, poorly lit or dark areas.

6.0 Maintenance Requirements:

- 6.1 The instrument shall have facility for power-on self test.
- 6.2 The instrument shall have easy access for servicing and maintenance.
- 6.3 All parts used shall be capable of being repaired by the supplier with turnaround time of maximum 2 weeks from the date it is handed over to supplier. If this turnaround time cannot be met then a loaner unit should be provided for the duration of the repair period.

7.0 Accessories:

- 7.1 The supplier shall provide one complete set of:
 - a) All the necessary interfaces, connectors, connecting cables (including power cord) and accessories required for satisfactory and convenient operation of the instrument. Types of connectors, adapters to be used and the accessories of the approved quality shall be clearly indicated in the operating manuals.
 - b) Software (if any), along with software version and the arrangement to load the software at site. Any updating of software shall be supplied free of cost. (Additional sets may be ordered optionally). This upgrade shall be done at the site via internet, if required.
- 7.2 Special tools, extender boards, extender cables and accessories essential for installation, operation and maintenance of the instrument shall be clearly indicated and supplied along with the instrument.
- 7.3 The source of the components/ accessories, from where these have been procured, is also to be submitted by the manufacturers.
- 7.4 Detailed information for components/module accessories used shall be clearly indicated.

8.0 Documentation:

Technical literature in English language shall be provided. All aspects of installation, operation, maintenance and repair shall be covered in the manuals. The soft copy as well as hard copy of the manuals shall also be provided. The manuals shall include the following:

Installation, operation and maintenance manual - This manual shall include the following in addition to other details:

- a) Safety measures to be observed in handling the Testing Instrument.
- b) Precautions for setting up, measurements and maintenance.
- c) Test equipment required for routine maintenance and calibration including their procedures.
- d) Illustration of internal and external mechanical parts.

- e) The detailed description about the operation of the software used in the equipment including its configuration procedure, installation, loading and debugging etc.

9.0 Protection Requirements:

- 9.1 The instrument panel shall have a terminal for grounding the chassis, if required.
- 9.2 The plug-in units, if provided, shall have suitable protection to allow their removal/insertion while the instrument is in energized condition.
- 9.3 Protection against short circuit and open circuit in the accessible points for measurements shall be provided.
- 9.3 All switches and controls on front panel shall have suitable safeguards against accidental operation.
- 9.4 The instrument shall be adequately safeguarded to prevent entry of dust, insects and lizards.

10.0 Safety requirements:

- 10.1 The operating personnel should be protected against shock hazards as per IS 8437 {1993} "Guide on the effects of current passing through the human body" [equivalent to IEC publication 60479-1 {1984}]
- 10.2 The instrument shall conform to the relevant clauses of the IEC 61010-1(2001) with corrigendum 1 (2002) and corrigendum 2 (2003) "Safety requirements for Electrical Equipment for Measurement, Control and laboratory use"

11.0 Electromagnetic Compatibility (EMC) Requirements: - The equipment shall conform to the EMC requirements as per the following standards and limits indicated therein. A test certificate and test report shall be furnished from an accredited test agency.

a) Conducted and radiated emission:

Name of EMC Standard: "CISPR 11 {2004}- Industrial, scientific and medical (ISM) radio- frequency equipment-Electromagnetic disturbance characteristics- Limits and methods of measurement"

Limits:

- i) To comply with the category of Group 1 of Class A of CISPR 11 {2004}
- ii) The values of limits shall be as per clause No. 8.5.2 of TEC Standard No. TEC/EMI/TEL-001/01/FEB-09.

b) Immunity to Electrostatic discharge:

Name of EMC Standard: IEC 61000-4-2 {2001} "Testing and measurement techniques of Electrostatic discharge immunity test".

Limits:

- i) Contact discharge level 2 { ± 4 kV} or higher voltage;
- ii) Air discharge level 3 { ± 8 kV} or higher voltage;

c) Immunity to radiated RF:

Name of EMC Standard: IEC 61000-4-3 (2006) "Testing and measurement techniques-Radiated RF Electromagnetic Field Immunity test"

Limits:-

Under Test level 2 {Test field strength of 3 V/m} for general purposes in frequency range 80 MHz to 1000 MHz

d) Immunity to fast transients (burst):

Name of EMC Standard: IEC 61000- 4- 4 {2004} "Testing and measurement techniques of electrical fast transients/burst immunity test"

Limits:-

Test Level 2 i.e. a) 1 kV for AC/DC power lines; b) 0. 5 kV for signal / control / data / telecom lines;

e) Immunity to surges:

Name of EMC Standard: IEC 61000-4-5 (2005) "Testing & Measurement techniques for Surge immunity test"

Limits:-

For mains power input ports : (a)1.0 kV peak open circuit voltage for line to ground coupling (b) 0.5 kV peak open circuit voltage for line to line coupling

f) Immunity to voltage dips & short interruptions:

Name of EMC Standard: IEC 61000-4-11 (2004) "Testing & measurement techniques- voltage dips, short interruptions and voltage variations immunity tests"

Limits:-

- i) a voltage dip corresponding to a reduction of the supply voltage of 30% for 500ms (i.e. 70 % supply voltage for 500 ms)
- ii) a voltage dip corresponding to a reduction of the supply voltage of 60% for 200ms (i.e. 40% supply voltage for 200ms)
- iii) a voltage interruption corresponding to a reduction of supply voltage of > 95% for 5s.

Note 1: The test agency for EMC tests shall be an accredited agency and details of accreditation shall be submitted.

Note 2:For checking compliance with the above EMC requirements, the method of measurements shall be in accordance with TEC Standard No. TEC/EMI/TEL-001/01/FEB-09 and the references mentioned therein unless otherwise specified specifically. Alternatively, corresponding relevant Euro Norms of the above IEC/CISPR standards are also acceptable subject to the condition that frequency range and test level are met as per above mentioned sub clauses (a) to (f) and TEC Standard No. TEC/EMI/TEL-001/01/FEB-09. The details of IEC/CISPR and their corresponding Euro Norms are as follows:

IEC/CISPR	Euro Norm
CISPR 11	EN55011
IEC 61000-4-2	EN61000-4-2
IEC 61000-4-3	EN61000-4-3
IEC 61000-4-4	EN61000-4-4
IEC 61000-4-5	EN61000-4-5
IEC 61000-4-11	EN61000-4-11

12.0 Surface finish and Marking, Packaging and Shipping

12.1 Marking

12.1.1 Splicing machine and its carrying case shall be marked for the following and shall be legible:

- a) The name of the product, manufacturer's model and serial number.
- b) The name of the supplier / manufacturer
- c) The date of manufacture
- d) Any other relevant information

12.2 Surface finish

12.2.1 The inside and outside surfaces shall have uniform colour and texture.

12.2.2 The painted finish on metallic surfaces shall be resistant to impact and shall not exhibit radial cracking when subjected to 2.8 N-meter load and tested as ASTM D 2794 or any other equivalent International Standard.

12.2.3 The finish and markings shall adhere to the base metal and shall not show any separation of coats when tested as per ASTM D 2197 or any other equivalent International Standard.

12.2.4 The surface finish and markings shall be resistant to chemicals that are normally found in the telephone plant and shall not exhibit any perceivable changes when exposed to ultra violet light. In particular the surface shall not be affected by the following:

- a) Cable Filling compound
- b) Isopropyl Alcohol
- c) Cable cleaning solutions.

12.3 Packaging & shipping

- 12.3.1 Packaging of the instrument shall be adequate to ensure that no damage will occur under normal shipping, handling and storage in reasonably dry unheated quarters. The supplier shall also ensure proper protection against bumps etc.
- 12.3.2 The splicing machine shipping container and packaging should be reusable recyclable and biodegradable.

12.4 Portability

- 12.4.1 A suitable hard rugged moulded carrying case (suitable for air, Rail & Road transport) for the instrument shall be provided. The carrying case used for transporting the instrument to a field location shall be equipped with carrying handle so that it may be carried with one hand.
- 12.4.2 It is desirable the splicing system be packaged as a single unit.
- 12.4.3 The Optical Fibre Fusion splicing machine shall be compact and light weight, with a minimum sub-assemblies, in order to provide a reasonable degree of portability and simplicity of operation.

Note: Manufacturers/Traders having approval certificate against existing TEC GR No. GR/OSM-01/03.APR 2005 can apply for approval certificate against revised TEC GR No. TEC/GR/TX/OSM-001/04/SEP-12 but the period of validity shall remain the same as applicable for the earlier certificate. In case there is no change in Hardware/Software and Make & Model No. of the instrument remains the same then all the tests may not be repeated in next approvals and tests will be conducted only for the modified/inserted clauses. However, if the Manufacturer/Trader has made any Hardware/Software changes then the case will be considered for fresh Approval against the new GR.

GUIDELINES FOR THE PURCHASER

Following guidelines are for the reference of the purchaser only, and are not to be tested during Evaluation/Testing:

- a) As and when bugs are found/determined in the software, the manufacturer shall provide patches and firmware replacement if involved free of cost for three years. Modified documents wherever applicable shall also be supplied free of cost.
- b) The manufacturer/supplier shall furnish the list of recommended spares for three years maintenance.
- c) The supplier shall have maintenance/repair with calibration facility in India.
- d) Supplier shall guarantee the supply of spares so long as the instrument is in service, at least for seven years from the date of supply. The purchaser would like to stock spares as and when the supplier decides to close down the production of the offered instrument. In such an event, supplier shall give a two years notice to the purchaser so as to stock the spares.
- a) Purchaser can order additional measurement options separately.

Ordering information:

- | | |
|--------------------|---|
| Clause no. 3.21(d) | The provision for External DC input port of 12 Volts for operating the splicing machine is an Optional requirement. The purchaser may, however, ensure its feasibility and order accordingly. |
| Clause no. 3.23 | The typical spares/accessories requirement has been mentioned. The purchaser may, however, ensure its adequacy and order accordingly. |

ABBREVIATIONS

AC	- Alternating Current
ASTM	- American Society for Testing Materials
CISPR	- International Special Committee on Radio Interference
EMC	- Electromagnetic Compatibility
GR	- Generic Requirement
IEC	- International Electro -Technical Commission
IS	- Indian Standards
ISO	- International Standard Organisations
ITU	- International Telecommunication Union
MTBF	- Mean Time Between Failure
MTTR	- Mean Time to Restore Service
OTDR	- Optical Time Domain Reflectometer
QA	- Quality Assurance
QM	- Quality Manual

----- End of Document -----

Technical Specifications

Parameter	Required Technical Specification	Compliance (Yes/No)
Offered Product Make & Model	To be provided by Bidder	
Fiber Compatibility	Single Mode	
Central Wavelength (nm)	1310 & 1550 for Single Mode;	
Wavelength Tolerance (\pm)	20 nanometer	
Dynamic range@ Max Wavelength	32 decibel	
Event dead zone - Maximum	0.5 meter	
Attenuation dead zone - Maximum	3 meter	
Maximum Display Distance Range	256 kilometer	
Pulse width Range	3 to 20000 for Single Mode/Live Fiber Testing	
Distance Measurement Accuracy (\pm)	0.75 meter	

Reflection Detection Accuracy (\pm)	± 4 dB for Single Mode or better
Linearity (dB/dB) (\pm)	0.05
Sampling points	256000
Measurement time	User Selectable 15 seconds to 180 seconds

DISPLAY / STORAGE

Display	Colour Display,LCD,Daylight Readable Display,TFT,Touch Screen,Backlit Display
Display Size	7 inch
Connectivity interface	USB
Internal Storage OTDR traces	1000
External Storage / Memory Stick Slot provided	USB
External Storage Capacity inclusive in the scope of supply	32 gigabyte

STABILIZED LIGHT SOURCE

Integrated Stabilized Light Source	Yes
Light Source Wave Length	Same as OTDR
Modulation	CW
Optical output power	– 6 dBm for Single Mode
Optical output port	On OTDR Port

POWER SOURCE

Power Source	Internal / Removable-Rechargeable Battery
Battery Chemistry, if Rechargeable Battery	Li-Ion
Voltage of each Battery	7.2 Volt
Battery Capacity (mAh)	3250
Number of Batteries required for operation	1
Number of Batteries supplied (Inclusive in the Scope of Supply)	1

Operating Time per full charge (Minimum)	8 hour
Suitable Adapter to be supplied to make the equipment Work on 230 V ± 10 %, 50 Hz	Yes

VISUAL FAULT LOCATOR (VFL) / VISUAL LIGHT SOURCE (VLS) FOR OTDR

Built-in Visual Fault Locator (VFL) / Visual Light Source (VSL)	Yes
Wave Length Range (VFL/VSL)	650 nm ± 20 nm
Output Function (VFL/VSL)	CW
Maximum Optical output power (Peak) (VFL/VSL) - dBm	- 3 dBm or more
Laser Safety of VFL/VSL as per IEC 60825-1 latest or equivalent international standard	Class 2

POWER METER FOR OTDR

Built-in Power Meter	Yes
Power Meter input port	Dedicated Port on OTDR

Wavelength Range	850 nm to 1650 nm
Modulation (Power Meter)	NA
Minimum Power measurement range (dBm)	-70
Maximum Power measurement range (dBm)	10
Accuracy (Power Meter) (±)	0 percent

GENERIC

Connector Tip	APC
Connector / Adapter End	FC
OTDR Data Format	.sor
Laser Safety of OTDR as per IEC 60825-1 latest or equivalent international standard	Class 1M (1310 nm)
Dimensions (mm x mm x mm)	To be provided by agency
Weight (with battery)	To be provided by agency

ACCESSORIES

Aceesories inclusive in the Scope of Supply (Select included Accessories Only)	Carry Case, Suitable VFL/VSL adapter
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OPERATING CONDITIONS

Minimum Operating Temperature	-10 degree Celsius
Maximum Operating Temperature	60 degree Celsius
Maximum Operating Humidity	95 percent

WARRANTY

WARRANTY	1 year
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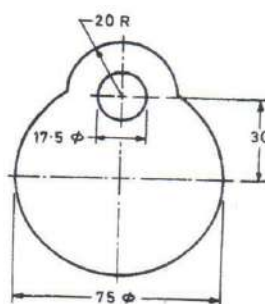
CERTIFICATION

Conformance to Safety requirements as per IEC 61010- 1 latest or equivalent international standard	To be provided by agency
Conformance to EMC requirements as per IEC 61326-1 latest or equivalent international standard	To be provided by agency

Certifications	To be provided by agency
Availability of Test Reports from Central Govt/ NABL/ ILAC accredited lab to prove conformity to the Specifications	To be provided by agency
If Yes, Test Report to be furnished to the Buyer on demand	To be provided by agency
Test Report No and Date	To be provided by agency
Name of the Lab and Address	To be provided by agency

Technical Specifications

IS : 5613 (Part 2/Sec 1) - 1985



NOTE 1 — One set consisting of 3 plates having red, blue and yellow colours shall be required for single circuit line.

NOTE 2 — Two sets each consisting of 3 plates having red, blue and yellow colours shall be required for double circuit line.

NOTE 3 — The plate shall be of minimum 1.6 mm thick mild steel sheet. Front and back of the plate shall be enamelled: Front with colours as per Notes 1 and 2 and back enamelled black.

All dimensions in millimetres.

FIG. 6 PHASE PLATE

6.9.1 Washers — Washers shall conform to IS : 2016-1967*. Heavy washers shall conform to IS : 6610-1972†. Spring washers shall conform to type B of IS : 3063-1972‡.

6.9.2 Galvanizing — Bolts and other fasteners shall be galvanized in accordance with IS : 1367 (Part 13)-1983§ galvanizing of the members of the tower shall conform to IS : 4759-1979|| and spring washers shall be galvanized in accordance with IS : 1573-1970¶.

*Specification for plain washers (first revision).

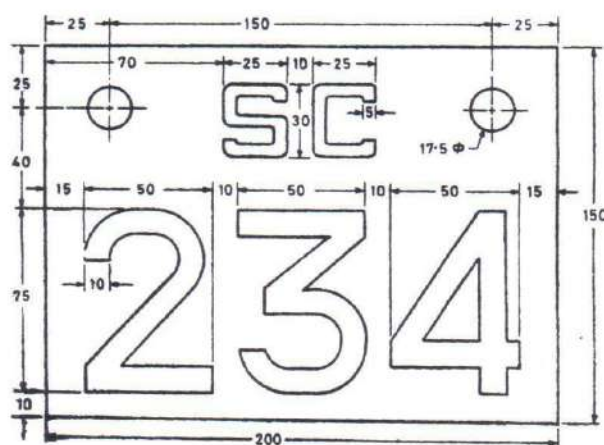
†Specification for heavy washers for steel structures.

‡Specification for single coil, rectangular section spring washers for bolts, nuts and screws (first revision).

§Technical supply conditions for threaded steel fasteners: Part 13 Hot-dip galvanized coatings on fasteners (second revision).

||Specification for hot-dip zinc coatings on structural steel and other allied products (first revision).

¶Specification for electroplated coatings for zinc on iron and steel (first revision).



NOTE 1 — Lettering should be in red enamelled on white background.

NOTE 2 — The rear side of the plate shall be enamelled black.

NOTE 3 — The plate shall be of minimum 1.6 mm thick mild steel sheet.

NOTE 4 — For number plate, numbering shall be in sequence of tower numbers as per specification.

NOTE 5 — 'SC' represents first letter of starting and ending place of line respectively.

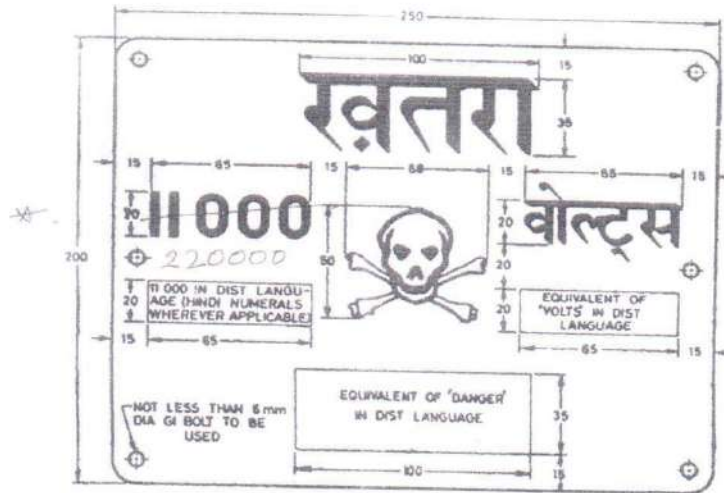
All dimensions in millimetres.

FIG. 5 NUMBER PLATE

6.9 Bolt and Nuts — Bolts and nuts shall conform to IS : 6639-1972*. The mechanical properties shall conform to property class 4.6 and class 4 of IS : 1367-1967† for bolts and nuts respectively.

*Specification for hexagon bolts for steel structures.

†Technical supply conditions for threaded fasteners (first revision).



NOTES

- 1 All letterings should be centrally spaced.
- 2 The dimensions for the words in district language are mainly for guidance, however, care should be taken to space them centrally between the edges and the area of the skull and bones.
- 3 The location of the fixing holes shall be left to the choice of the user.
- 4 ~~11000 volts is the specimen actual voltage to be inserted for different system voltages~~
- 5 The corners of the plates should be rounded off.

टिप्पणीयाँ

- 1 सभी शब्द बीच में लिखे हों।
- 2 हर मिले की भाषा में मुख्यतः अक्षरों की अक्षर भारदर्शन के लिए हैं। तथापि यह आवश्यक नहीं जाए कि उन्हें किसमें तथा खोपड़ी और हड्डियों के बीच में बीच लिखा जाए।
- 3 चढ़ने हेतु छेदों की अवस्थिति की प्रयोक्ता की इच्छा पर छोड़ दिया जाए।
- 4 ~~11000~~ 220000 वोल्ट केवल नमूना है, अलग-अलग वोल्टता तब हेतु प्रासंगिक वोल्टता लिखी जाए।
- 5 प्लेट के किनारे गोल किए गए हों।

सभी अक्षर मिलाने में।

आकृति 2 उच्च और अतिरिक्त-उच्च वोल्टता प्रतिस्थापन हेतु खतरा सूचना प्लेट

All dimensions in millimetres

FIG. 2 DANGER NOTICE PLATE FOR HIGH AND EXTRA-HIGH VOLTAGE INSTALLATION

5.2 The danger notice plates may also be marked with the Standard Mark.

The use of Standard Mark is governed by the provisions of Bureau of Indian Standards Act, 1986 and the rules and regulations made thereunder. The details of conditions under which the licence for the use of Standard Mark may be granted to manufacturers or producers may be obtained from Bureau of Indian Standards.

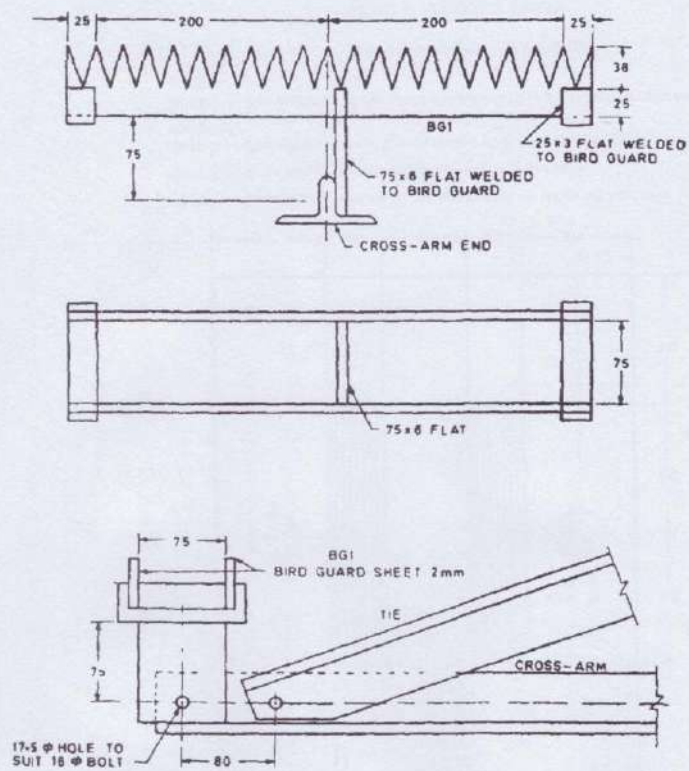
5.2 खतरा सूचना प्लेटों पर मानक मुहर भी अंकित की जा सकती है।

मानक मुहर का उपयोग भारतीय मानक ब्यूरो अधिनियम, 1986 और उसके अधीन बने नियमों और विनियमों के प्रावधानों अनुसार हो। निर्माताओं और संस्कर्ताओं को जिन शर्तों के अधीन मानक मुहर लगाने के लिए लाइसेंस दिया जाता है उसका विवरण भारतीय मानक ब्यूरो से प्राप्त किया जा सकता है।

* Taken 220000 in place of 11000
other item & size are same.

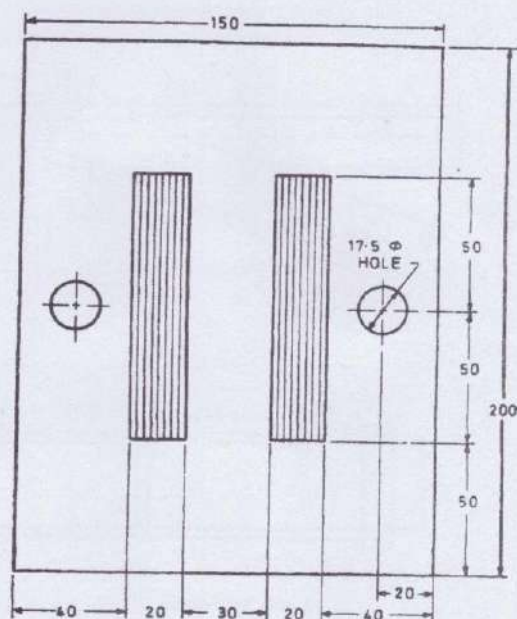
Yuv

IS : 5613 (Part 2/Sec 1) - 1985



NOTE --- All parts to be galvanized.
All dimensions in millimetres.

FIG. 10 BIRD GUARD



NOTE 1 — Lettering should be in red enamelled on white background.

NOTE 2 — Rear side of the plate shall be enamelled black.

NOTE 3 — One set consists of 2 such plates with markings 'I' and 'II' for double circuit tower only.

NOTE 4 — The material of the plate shall be of mild steel having minimum thickness 1.6 mm.

All dimensions in millimetres.

FIG. 7 CIRCUIT PLATE

19



insulator strings. Full details of the attachments shall be provided to the contractor. To achieve requisite clearances, if the design calls for providing extra D-shackles, link plate etc. before connecting the insulator string the same shall be supplied by the Contractor. These item shall be same rating/strength as that of as that of corresponding rating/ Ultimate tensile Strength of Insulator string.

- c) D shackles, if required for attachment of Insulator strings, shall be supplied by the contractor from the identified and approved sub-vendor / supplier of Hardware fittings.

1.3.3 Earth wire Clamps Attachments

For Suspension and tension clamp for attachment of earthwire Wherever required, the Contractor shall supply U – bolts, D – Shackles etc. for attachment of clamp to the tower. Full details of the attachments shall be provided to the contractor. These items shall be same rating/strength as that of corresponding rating/ Ultimate tensile Strength of earthwire suspension/tension clamp.

1.3.4 Anti climbing Device

Barbed wire type anti climbing device, as per enclosed drawing shall be provided and installed by the Contractor for all towers. The barbed wire shall conform to IS-278 (size designation A1). The barbed wires shall be given chromating dip as per procedure laid down in IS:1340

1.3.5 Danger, Number, Circuit and Phase plate

Danger Plates, Circuit plates, Phase Plates and Number plates shall be provided and installed by the Contractor. These Danger/Number/Phase/ Circuit Plate shall be as per the drawings enclosed in the section of drawing. The contractor shall submit distribution copies of the same endorsing the package details (i.e. line name, LOA No. etc) and installed by the Contractor.

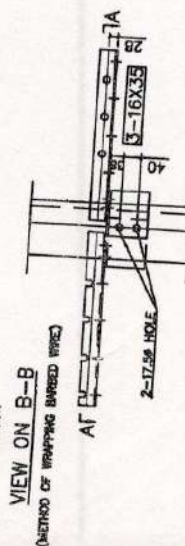
- a) Each tower shall be fitted with a danger plate, number plate, circuit plate and a set of phase plates for single circuit tower and two sets of phase plates for double circuit tower. The transposition towers should have provision of fixing phase plates on both the transverse faces.
- b) The letters, figures and the conventional skull and bones of danger plates shall conform to IS-2551 and shall be in a signal red on the front of the plate.
- c) The corners of the danger, number and circuit plates shall be rounded off to remove sharp edges.
- d) The letters of number and circuit plates shall be red enameled with white enameled background.

1. ALL DIMENSIONS ARE IN MM.
2. ALL HOLES ARE 17.5MM± FOR 16MM± BOLTS.
3. BLANK HOLES AT GATE ARE TO RECEIVE BARBED WIRE.
4. STD. SPRING WASHER TO BE SUPPLIED WITH EACH BOLT AND SHALL CONFORM TO IS : 3083 (Type B) 41573 SERVICE GRADE-A.
5. ALL STEEL SHALL BE HOT-DIP GALVANIZED.
AS PER IS : 2629.
6. ALL STEEL SHALL CONFORM TO IS : 2062 GRADE A.
7. GALVANIZED STEEL BARBED WIRE SHALL CONFORM TO IS : 278.
8. BOLT TO BE CONFORMING TO IS:12472-2001 G. 5.6 & NOT CONFORMING TO IS:14384-1986 (G: 5)
9. BOLT / PUT TO BE HOT DIP GALVANIZED AS PER IS:1367 (P-13) - 1983.
10. BARBED WIRE SHALL BE GIVEN CHROMATING DIP AS PER PROCEDURE LAD DOWN IN IS : 1340

1. NOMINAL LENGTH OF BARBED WIRE SHALL BE WORKED OUT AS PER FOLLOWING FORMULAE

$$L = B + (X - 3.5) \times 2 \times \text{Tanp} \times N$$

B = B' Width of Cl for Normal Tower in Mtrs.
X = Height of Tower in Mtrs.
N = NUMBER OF BARBED WIRE TURNS
p = TOWER SLOPE



MARK NO	SECTION	LENGTH (mm)	QTY NOS
AC1	AC1X L 100x100x6	128	4+4=8
AC2	L 50x50x6	617	4
AC3	L 50x50x6	617	1
AC4	L 50x50x6	470	1
AC5	L 50x50x6	617	3

LIST OF BOLTS & NUTS / TOWER			
S.NO	SIZE	QTY	
1	STUB THICK (mm) 7-11 12-18 17-21 25-38 LENGTH OF M16 BOLT (mm) 45 50 55 80		
2	M-16 x 35L		
3	10MM DIA 3.5MM THICK SP WASHED	19	

STANDARD DRAWING

**POWER GRID CORPORATION
OF INDIA LIMITED**
(A GOVERNMENT OF INDIA ENTERPRISE)

Product:

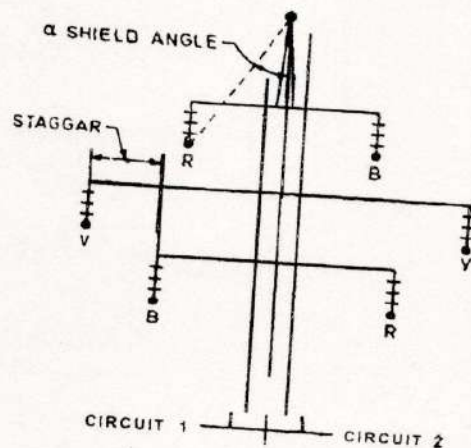
906/400/220KV TRANSMISSION SYSTEM

TITLE

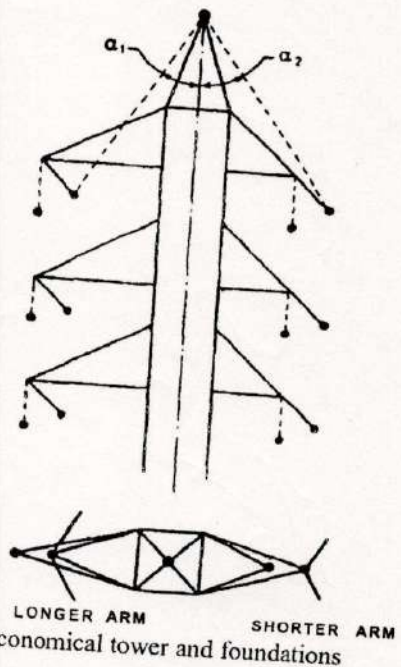
ANTICLIMBING DEVICE

RECEIVED PROSECUTOR GENERAL A57

about 1/2	1/2
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Suitable for snow bound areas
3C Vertical Formation With Middle Cross-arm Staggered



3D Configuration with Dis-similar Cross Arm for O-5" Suspension and Various Tension Locations

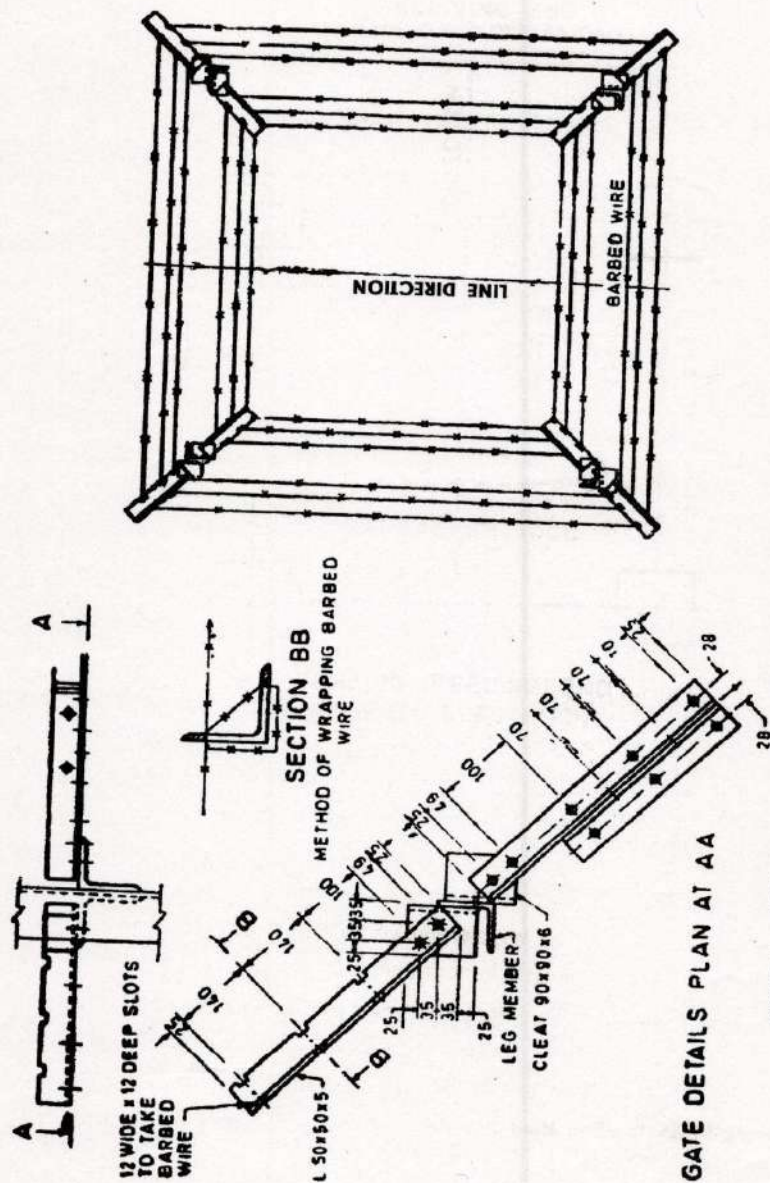
FIG. 3 TYPICAL CONFIGURATION OF CONDUCTORS OF OVERHEAD LINES ON TOWERS (DOUBLE CIRCUIT)

6.7.3 Phase Plates — These shall be in sets of red, yellow and blue colours and conform to Fig. 6.

6.7.4 Circuit Plates — These shall conform to Fig. 7. This may be combined with phase plate referred in 6.7.3.

6.7.5 Anticlimbing Device — These shall conform to the specifications laid down by the user of the installation. A typical example of providing anti-climbing device is given in Fig. 8.

6.7.6 Step Bolts — The step bolt shall be provided on leg No. 1 (see Fig. 9) of the tower starting from 2.5 m above the ground level and spaced at a maximum distance of 450 mm centre-to-centre up to the top of the tower. In case of double circuit lines for the sake of convenience of maintenance, the user may specify the provisions of



NOTE 1 — All holes are 17.5 mm diameter to suit 16 mm diameter bolts.

NOTE 2 — Blank holes at gate are to receive barbed wire.

NOTE 3 — One 3-mm spring washer to be provided under each nut.

All dimensions in millimetres.

FIG. 8 DETAIL OF ANTICLIMBING DEVICE

Technical specification for danger, number, circuit and phase plate

A) Danger Plates:

Danger plate made of mild steel sheet not less than 200mm X 250mm size & minimum 1.6 mm thickness and vitreous enamelled white with the letters, figures and conventional skull and bones painted in signal red on the front side conforming to relevant IS/IS : 2551-1982.

It should specifically mentioned 2,20,000 Volts on the Danger Plate .The rear side of the plate shall also be enameled & corners of the plate shall be rounded off.

B) Number Plates

The number plate shall be of size 200 x 150 mm minimum 1.6 mm thick sheet of mild steel enameled red on white enameled background, will indicate the number of tower with numbering not less 75mm height. The rear side of the plate shall be enameled black as per IS 5613. Plates shall be numbered indicating the tower number as per DTL site requirement.

C) Phase plates:

Phase plates shall be Circular enameled disc of 75mm diameter of mild sheet steel minimum 1.6mm thick, with a 17.5mm dia. hole for provision of bolt and nut as per specifications & design given/IS 5613.

In sets of 6, 2- enameled red ,2- yellow and 2-blue and back side enameled black for phase identification of each circuit.

D) Circuit plates:

Each circuit plate shall be made of mild steel having minimum thickness of 1.6mm with rear side black enameled and front should have lettering in red enameled on white enameled background. The circuit plate should conform to DTL/IS 5613 specification with the size of 150x200mm.

Technical Specification of 500MVA, 11 KV Indoor switchgear panel

SECTION-I

GENERAL SPECIFICATIONS FOR 11KV SWITCHGEAR PANELS

VACCUM TYPE:

1.1 GENERAL:

1.1.1 This specification covers design, engineering, manufacture, assembly, testing at manufacturer's works, supply and delivery of 11KV switchgear panels.

1.1.2 The 11KV switchgear panels shall be complete with all components and accessories which are necessary or usual for their efficient performance and satisfactory trouble free operation under the various operating and atmospheric conditions.

Such of the parts that may have not been specifically included, but otherwise form part of the equipment as per standard trade and or professional practice and/or are necessary for the proper operation of the equipment will be deemed to be also included in this specifications. The successful tenderer shall not be eligible for any extra charges for such accessories etc. notwithstanding the fact that at the time of initial offer he had segregated such items and quoted for them separately.

The design and workmanship shall be in accordance with best engineering practices to ensure satisfactory performance throughout the service life. All corresponding parts and components of equipment liable to replacement shall be interchangeable.

All equipments being offered shall be **type tested and shall be subjected to Routine and acceptance Tests in accordance with relevant IS with all latest revision/amendments**. The purchaser reserves the right to witness any or all the routine tests

1.2 CLIMATIC CONDITIONS

1.2.1 The climatic conditions prevailing at site are as follows:

1.2.2 A) TEMPERATURE

The reference ambient temperature be taken as 43.3⁰ C as per IS-9676.

B) RELATIVE HUMIDITY & RAINFALL

i) Maximum Humidity	100%
ii) Minimum Humidity	10%
iii) Average annual rainfall	750mm
iv) Average No. of rainy days per annum	50
v) Average No. of thunder storm days per annum	40
vi) Altitude	Not exceeding 300 mts. above mean sea level
vii) Rainy Month	June to October
viii) Wind Pressure	195 Kg/M2 up to 30 meters Elevation as per IS-875

- 1.2.3 The atmosphere is generally laden with mild acid and dust in suspension during the dry months and is subjected to fog in cold months. Heavy lightning occurs in the area during rainy months (June to October).
- 1.2.4 All the equipment shall be designed to withstand seismic forces in Delhi (Zone-IV) as per IS-1893 Part-I 2002.

1.3 STANDARDS :

- 1.3.1 The design, manufacture and performance of the equipment provided under the specification shall comply with the standard given in the clause 1.3.2. Unless otherwise specified; the equipment shall conform to the latest applicable IS/IEC.

1.3.2	<u>Indian Standard No.</u>	<u>Title</u>
	1 IS - 5	Paints, finishing exterior
	2. IS : 513	Cold rolled low carbon steel sheets and strips
	3. IS : 1730	Steel sheet and strip dimensions
	4. IS :2419	Dimensions for panel mounted Indicating and electrical recoding instruments
	5. IS : 13118	Specification for alternating current Breakers
	6. IS : 2705	Current Transformers
	Parts I to IV	
	7. IS 13947 :Part 4	Section 1 AC & DC Contactors
	8. IS: 3156	Voltage Transformers
	9. IS : 3427	Metal Enclosed Switchgear and Control gear for Rated Voltages Above 1 kV and Up to and Including 52 kV.
	10. IS: 4146	Application guide for voltage transformers
	11. IS : 4201	Application guide for current transformers
	12. IS : 4777	Performance tests for protective schemes used in protective of light gauge steel against corrosion
	13. IS : 4794	Push button switches
	Parts I&II	
	14. IS : 5608	PVC wires, and sheaths
	Parts I to IV	
	15 . IS : 6236	Direct recording electrical measuring instruments

- | | | |
|-----|--------------------------------|--|
| 16. | IS 13947 : | Control Switches Part-V Section-I |
| 17. | IS: 7118 | Recommendation for direction movement for control devices/operating electrical devices. |
| 18. | IS : 8130 | Conductors for insulated Electric cables |
| 19. | IS : 8197 | Terminal markings of Electrical measuring instruments And accessories |
| 20. | IS 13703:
Part 1,2&4 : 1993 | Specification for Low-voltage Fuses |
| 21. | IS: 9954 | Pictorial Surface Preparation Standards for Painting of Steel Surfaces. |
| 22. | IS: 10118
(Part III) | Code of practice for installation of switchgear |
| 23. | IS : 10276
(Part I&II) | Edison screw lamp holders |
| 24. | IS: 11431 | Code of practice for packaging of Electrical indicating and recording instruments |
| 25. | IEC: 56
breakers 1987 | High voltage alternating current circuit |
| 26. | IEC: 694 | Common clauses for high voltage switchgear and control gear standards |
| 27. | IS-9676 | Reference ambient temperature |
| 28. | IS 5578 : 1984 | Guide for Marking of Insulated Conductors |
| 29. | IS 11353 : 1985 | Guide for Uniform System of Marking and identification of Conductors and Apparatus terminals |

1.4 TESTS

- 1.4.1** The offered equipment **should have been subjected to** all type tests as stipulated in relevant IS and the reports shall be supplied along with the tender **which** shall be considered for the purpose of technical acceptability of the offers.

- 1.4.2 The offered equipment shall be subjected to **routine and acceptance** tests as specified in IS and reports should be submitted and should be got approved by the purchaser before dispatch of equipment.

1.5 PAINTING:

- (a) All sheet steel work shall be phosphated in accordance with IS-6005 “Code of practice for phosphating iron & steel”.
- (b) Oil, grease, Dirt and Swarf shall be thoroughly removed by emulsion cleaning.
- (c) Rust and scale shall be removed by pickling with dilute acid followed by washing with running water and drying.
- (d) After phosphating, thorough rinsing shall be carried out with clean water followed by final rinsing with dilute dichromate solution and oven drying.
- (e) The phosphate coating shall be sealed with the application of two coats of ready mixed stoving type Zinc Chromate Primer. After application of the primer two coats of finishing synthetic enamel paints shall be applied. Each coat shall be followed by stoving. The second coat shall be applied after completion of tests and inspection. The colour for the finishing paint shall be light grey as per shade No. 631 of IS-5. Each coat of primer and finishing paint shall be of slightly different shade to enable inspection of the painting. A small quantity (Half litre per cabinet) of finishing paint shall be supplied for minor touching up required at site after the installation.

SECTION – II: TECHNICAL SPECIFICATIONS

- 2.1 The technical features and construction details of 11KV switchgear panels shall be in accordance with the requirement stated herein under and standard specified under clause 1.3.2 and general requirement covered under clause 1.2.

2.2 DESIGN AND CONSTRUCTION:

2.2.1 GENERAL:

2.2.1.1 As per IS 3427 Clause 3.1

2.2.1.2 The type of construction shall be welded sheet steel. The minimum thickness of the sheet steel shall not be less than 3mm for the base and load bearing members and not less than 2.5 mm for the top cover, side sheets, doors and partitions. Sheet steel of size less than 3mm shall be cold rolled conforming to IS-513. The panel door shall be provided with louvers and with translucent plastic covered windows directly opposite the close/open indicating lamps and spring status indicator. The panel door shall be hinged, swing door provided with pad locking facility. Rear door shall also be hinged on one side and bolted on the other side.

2.2.1.3 The design and construction shall be with the following features:

- a) Compact and robust construction
- b) Easily extensible on both sides
- c) Dust protected and vermin proof
- d) Fully compartmentalized.
- e) Horizontal draw out type
- f) Safe and positive interlocks
- g) Automatic safety shutters. FRP flap or safety shutters shall be installed so as to prevent accessibility/ exposure for all the HV live parts.
- h) Easy interchangeability of identically rated components including breakers.
- i) Extremely reliable operation
- j) Integral base channel to be fixed below ground level.
- k) Test facility with the truck in the test position and it shall be possible for closing the door in test position.
- i) All instruments, and switches mounted on the instruments panel shall be accommodated at a height in between 0.5 to 2.0 meters from ground level in the control panel.

2.2.1.4 The size of the base channel for cable entry type switchgear shall not be less than 75mm.

- 2.2.2 ENCLOSURES:
Generally as per clauses 3.2. 1 of IS 3427.
- 2.2.3 COVERS:
Generally as per clause 3.2.2 of IS 3427.
- 2.2.4 PARTITIONS:
Generally as per clause 3.2.3 of IS 3427.
- 2.2.5 SHUTTERS:
Generally as per clause 3.2.4 of IS 3427.
- 2.2.6 VENTILATING OPENINGS, VENTS OUTLETS:
Generally as per clause 3.2.4 of IS 3427.
- 2.2.7 INSPECTION WINDOWS
Generally as per clause 3.2.6 of IS 3427.
- 2.2.8 AUXILIARY DEVICES AND CIRCUITS:
Generally as per clause 3.2.7 of IS 3427.
- 2.2.9 INTERLOCKS
Generally as per clause 3.4 (e) with mechanical interlocks of IS3427.
- 2.2.10 EARTHING:
Generally as per 3.5 of IS 3427, however the earthing conductor shall be of copper flat , size shall not be less than 25 x 6 mm. 2 Nos. each of M12 size earthing shall be provided at either ends of the switch gears assembly to receive 50 x 6 mm G.1 flat of station earthing system. Earthing of all metallic parts relays covers etc., which are not electrically alive shall be done with stranded insulated copper wire. The earth connections for individual equipment shall be of size not less than 15 Sq. mm and Main earth connection shall be not less than 70 Sq. mm.
- 3.0 SWITCHGEAR COMPONENTS:**
- 3.1 COMMON COMPONENTS:

The following shall be common components in all the incomer, outgoing and bus inter-connection panels.

- a) Vacuum / Horizontal isolation and horizontal draw out truck type circuit breaker.
- b) Current Transformer
- c) Instruments and selector switches.
- d) Copper bus bars.
- e) Cable termination boxes in the incomer and outgoing.

Incomer shall suit to receive 6 runs of S.C cable 1000 sq. mm and outgoing feeder panel shall be suitable to receive 1 run of 400 Sq. mm 3 core cable and suitable glands with gland plates shall be provided. Gland plates shall be easily removable type, even when the cable termination kit is in fixed position.

A caution board "Ensure fixing of gland plate before energizing of cable" should be provided at an appropriate place in the cable chamber.

A caution board "Ensure transformer breaker is off for access to cable chamber" to be provided on front portion of cable chamber of incomer.

f) Control switches, indicating lamps, contactors and test terminal blocks.

3.2 ADDITIONAL COMPONENTS:

These are required panel wise as follows:

- a) Voltage transformer in the incomer panels. If space constraint is there in the incomer panel, separate VT panel adjacent to incoming panel is acceptable.

3.3 COMPARTMENTALIZATION

3.3.1 The various switchgear components shall be housed in separate compartments as follows:

- a. Circuit breaker compartment should be located at the bottom portion of the switchgear.
- b. Bus bar compartment.
- c. CT compartment

- d. Cable compartment
- e. PT compartment either at bottom or at top or in a separate panel.
- f. Indication and control compartment.

3.3.2 It shall not be possible to approach any part of circuit breaker during its service/ test /isolation.

The following shall be provided in each panel as applicable.

- a. Cubicle space heater with thermostat.
- b. View glass for breaker position indication.
- c. Name plates on front and rear sides of switch boards.
- d. Danger board on front and rear switch board
- e. One set of racking handle per switch board.
- f. One set of spring charging handle per switch board
- 9. Control cable duct and supporting clamps
- h. Mimic bus
- i Test/ service/ isolated positions for the breakers.
- j. Operation counter for the breaker
- k One set of ramp for withdrawal of breakers.

4.0 GENERAL ARRANGEMENT OF THE SWITCH GEAR PANELS:

4.1 The switchgear assembly consisting of the incomer panels, outgoing feeder panels and Bus Inter connector panel being installed side by side in a straight-line formation. Provision shall be made for future extension of the switchgear board.

4.2 The line up of the panels shall be as indicated below:

Feeders, Incomer, bus coupler, Incomer and feeders.

5.0 SWITCHGEAR RATINGS

5.1 CHARACTERISTICS:

- a) Rated voltage as per clauses 4.2 of IS 3427 for nominal system voltage of 11KV.
- b) Rated insulation level 28 KV/ 75 KV Peak- for 11 KV nominal system voltage.

- c) Rated Frequency - 50 Hz.
- d) Rated normal current -800A (Outgoing) / 2000 Amps (I/C & Bus coupler). / (As per scope)
- e) Rated short time current – 26.3KA for 3 sec
- f) Rated peak short - time current. As per relevant clause of IS3427 and in conjunction with sub-clause (e)
- g) **Degree of protection shall be as per relevant clause of IS:3427 with latest amendments/revisions, if any.**
- h) The temperature rise limits for the various materials shall be as per table V of IEC 694.
- i) Internal Arc classification : IAC-A-FLR

6.0

SWITCH GEAR COMPONENTS:

Rated values of the components forming part of the main enclosed switchgear and control gear are detailed here below individually against each component

6.1.1

Circuit Breakers:

- a) Type: vacuum
- b) Rated voltage 11 KV r m s
- c) Highest system voltage 12 KV r m s.
- d) Frequency 50 Hz
- e) Number of poles- 3
- f) Class - indoor
- g) Power frequency withstand voltage: 28 KV r m s,
- h) Basic insulation level - 75 KVp.
- i) Rated normal current 800(for outgoing)and 2000 Amps(for I/C and Bus coupler).
- j) Rated symmetrical Breaking current: *25KA for*

k) Rated transient recovery voltage: as per clauses 4.102.2, 4.102.3 of IEC 56, Table - IIA for 12KV rated voltage.

l) Rated making current peak: 62.5 KA.

m) Short time withstand current – 26.3 KA for 3 seconds

n) Operating sequence : As per clause 4.104 (a) of IEC-56
0-0.3 sec - CO-3min-CO.

o) Rated supply voltage of opening /closing devices with operating limits.

Opening coil (shunt trip coil) - 220V DC to operate satisfactorily between 70 to 110% of rated voltage as the case may be.

Closing coil (shunt trip coil) - 220V DC to operate satisfactorily between 85 to 110% of rated voltage as the case may be.

p) Rated voltage of auxiliary supplies.

i. Space heater - AC 230V, S. Ph 50Hz

ii Spring charging motor - AC 230V, S. Ph 50Hz

iii Cubicle illumination - AC 230V, S. Ph. 50 Hz

q) Method of closing and opening - The breaker shall be capable of being closed by discharging the energy stored in springs. These springs should be capable of being compressed or charged by an AC motor. It should also be possible to charge the springs manually by means of a spring charging handle or lever. During manual charging of the springs an electromechanical device shall be provided to prevent charging of the same by the motor. The springs should also be capable of being charged even with the breaker in the closed position so as to restore tension in the springs. Besides, there should be provision to automatically cut - off power supply to the motor when the springs are fully charged and also to automatically switch - on the power supply to the motor when the springs are fully discharged. There shall also be provision to indicate spring status namely "FREE" / "Charged," by means of a mechanical lever at the panel. This shall be arranged through potential free auxiliary contacts or limit switches. The mechanism shall be "Trip Free Mechanism" providing priority for "tripping" over "closing". The

mechanism shall be provided with an anti-pumping device to prevent closing impulses from being transmitted, to the closing coil when the breaker is in the closed position.

- r) Auxiliary Contacts: 8 NO + 8 NC conforming to clause 5.4 of IEC 694.
- s) Name Plates- As per clause 5.9 of IEC 56.
- t) Requirements for simultaneity of poles - As per clause 5. 101 of IEC 56.

6.2 CURRENT TRANSFORMERS:

6.2.1 The current transformer to be mounted in the incomer panels and outgoing panels shall conform in all respects to IS-2705 parts I to IV. CTs are required in Bus-Coupler Panel also.

6.2.2 The CTs shall be of the cast resin double bar type with a single CT having multiple cores for each phase. Alternatively, they can be of the ring type with separate cores for each function. They shall be located in separate compartment next to the cable termination end box.

6.2.3 Rating Characteristics:

- a. Nominal voltage 11 KV r m s.
- b. Highest system voltage 12 KV r m s.
- c. Frequency 50 Hz.
- d. Power frequency withstand voltage 28 KV r m s
- e. Basic insulation level 75 KVP
- f, Ratio and cores
 - i. Incomer panel-3 cores 1600/1-1-1A
 - ii Bus Coupler panel-2cores 1600/1-1A
 - iii. Outgoing panel-2cores 800-400/1-1A
- g.. Accuracy class /burden
 - i. Incomer panel
 - Core 1 (metering) 0. 2S/ 10VA
 - Core 2 (OCR & EFR Protection) 5P20/10VA
 - Core 3 (differential Protection) $PS/V_k \geq 40I(R_{ct}+4)$
+ REF Imag $\leq 30mA$ at $V_k/2$

- ii. Bus coupler/section panel
 - Core 1(metering) 0.2S/ 10VA
 - Core 2 (protection) 5P 20/10VA
- iii. Out going panel
 - Core 1 (metering) 0. 2S/ 10VA
 - Core 2 (OCR/ EFR Protection) 5P 10/ 10VA
- h. Instrument security factor 5 at all ratios for metering core
- i. Earthing As per clause 4.3 of IS 2705 (Part-1)
- J• Short time current rating
 - i. Thermal rating: 26.3 for 3 second
 - ii Dynamic rating As per 562 of IS 2705 Part -1
- k. Terminal Marking As per Clause 6.2 of IS 2705 Part -1
- l Rating plate As per IS 2705 Part-1 Clause 6.1 & 7.1

6.2.4 Burden/no. of cores of CT are indicative. Same are to be finalized during detailed engineering.

6.3 VOLTAGE TRANSFORMERS:

6.3.1 The voltage transformers in case of cable entry type switchgear are to be mounted in the incomer panels only and shall conform in all respects to IS-3156 parts (I to III). They shall be of the cast resin type and shall be connected on the incoming side of the cables in a separate compartment so as to give a positive indication of the supply conditions, even with the incomer breaker in the "open" position. The VTs shall be three phases or 3 single phase Star connected on the primary and secondary sides and provided with HRC fuses on HV side and LV side.

6.3.2 RATING AND CHARACTERISTICS:

- a. Nominal Voltage - 11 KV rms.
- b. Highest system voltage - 12KV rms.

c.	Power frequency withstand voltage	-28 KV rms
d.	Frequency	- 50 Hz
e.	Basic Insulation level	- 75 KVp
f.	Ratio	$(11\ 000/\sqrt{3}) / (110/\sqrt{3}) / (110/\sqrt{3})V$ Core-1 Connected in star Core-2 Connected in star
g.	Accuracy class/ Burden	
	Core-1	0.2/ 50VA (metering)
	Core-2	3P/50VA (Protection)
h,	Earthing	As per clause 4.3 of IS 3156 (Part- 1)
i.	Rating	1.2 Continuous and 1.5 for 30 seconds.
j.	Limits of Temperature Rise	As per Clause 6.2 of IS 3156 (part -1)
k.	Terminal Markings	As per Clause 7.2 of IS 3156 (Part -1)

6.3.3 The secondary of PTs shall be such that the potential of various meters, relays etc., change-over to second set of PTs located in INCOMER-2, if breaker for INCOMER-1 is opened out, However, under normal condition each set of PTs shall feed potentials to half number of feeder circuits, (one third in case of 3 incomers) and auto-change over as described earlier, should take place when one of the breakers is opened out for maintenance and bus coupler is closed. The PT secondary shall not be paralleled under any circumstance. PT selection shall be carried out through auxiliary contact of breakers. **Burden/no. of cores of PT/VT are indicative. Same are to be finalized during detailed engineering.**

6.4 BUS BARS AND BUS BAR ARRANGEMENT:

6.1.1 A Bus bar shall be of EC grade copper flats with suitable spacers and able to carry the expected maximum load current continuously (2000A) without exceeding the temp. Limit as per relevant IS: 8084 with latest amendment. The capacity of Bus bar shall also be checked for maximum temp rise of the conductor under short circuit conditions.

6.4.2 All bus bars shall be coated with non-inflammable bus bar paint. The material of bus bars shall be EC grade copper conforming to IS: 8084.

6.4.3 The Bus-bar risers, connectors and tees shall be of EC grade copper flats for the continuous rating of 2000A.

6.4.4 Bus bar shall be arranged in a staggered vertical formation.

6.4.5 Bus bar supports-porcelain bus supports shall be used. However epoxy insulators, reputed make with rain-shed type and adequate creepage distance acceptable.

6.4.6 Bus bar joints: All riser, bus bar joints shall be lap bolted joints. All straight joints in the run of the bus shall be butt joints with double cover plates of adequate current carrying capacity. All butt joints shall be provided with expansion spaces at the butt point. The cover plates shall be of the same material as that of the bus bars. All bolts and nuts used in the joints shall be of brass and adequate in number and liberal in current rating.

6.4.7 **CLEARANCES:**

- i) Between Phases Not less than 120mm
- ii). Between Phase to Earth Not less than 120mm

6.5 **SELECTOR SWITCHES**
Local/Remote switch

6.6 **INDICATION LED'S:**

6.6.1 Indicator lamps shall be integral LED module type 0.5 watts suitable for 220V DC and these shall be integral self contained LED indicator units which can be directly mounted in the panel. The rated in put voltage can be directly applied to the module input as all the controlling circuitry is built into the module body it self. These modules shall be suitable for panel cutouts of size 22.5 mm dia with the use of Crome plated standard mounting bezel / adopter sets and of colors, red, Green, Amber/ Yellow, white and blue. The axial light intensity should be min 40 milli Candella.

6.6.2 **COLOUR CODE FOR LED'S**

Breaker open	-	Green
Breaker closed	-	Red
Auto trip	-	Amber
Spring charged	-	Violet/ Blue
Trip Circuit Healthy	-	White

6.6.3 **REQUIREMENT LED'S:**

- a. One set of green amber and red LED's in each incomer, bus coupler and outgoing panels along with spring status violet, blue and trip circuit healthy white on command.
- b. One set of green, red, amber violet / blue and white

LED'S for indicating the status of each incomer, bus coupler and outgoing breakers in the remote indoor annunciation panel.

6.6.4 10% of the total of integral LED module type lamps for each panel shall be supplied as spare without extra cost.

6.7 FUSES/MCB'S

6.7.1 GENERAL:

All MCB'S shall be of reputed make and fuses shall be moulded Bakelite complete with fuses, fuse carriage and HRC cartridge fuses. All fuse fittings should be labeled by etching on an anodized plate with details of the fuse rating and the circuit for which the fuse is provided.

6.7.2 a. RATING:

i. AC 415 V for all AC supply.

ii DC 220V .

b. Rated current: As per IS: 13703: (part - 1) 1993 and as per requirement with graded rating.

6.7.3 REQUIREMENTS:

All AC and DC circuits shall be provided with suitable MCB's /fuses and fuse links for each phase /pole.

6.7.4 10% of the MCB's/H.R.C fuse cartridge shall be supplied as spares without Extra cost.

6.8 MIMIC DIAGRAM:

6 mm wide mimic bus shall be painted on each panel. The colour shall be signal Red, conforming to IS- 120-1962 shade No. 537. Mimic bus shall also be provided on the remote indoor control panel.

6.9 WIRING:

6.9.1 GENERAL:

The wiring shall be done by using PVC - insulated 660V annealed, stranded copper wire. The wires shall run straight and shall be given right angle bends wherever necessary so as to give a pleasing appearance. The size of wiring in different circuits shall not be less than the sizes specified below:

a. Metering and Relay circuits : 2.5 Sq. mm connection from

CT's and VT's.

- b. All terminal connections to the equipments and terminal blocks shall be done by using Tin coated copper lugs. All the outgoing wiring from the panel shall be terminated on the terminal block mounted in the front of the panel with suitable provision for connection to the interconnecting control cable. The wiring shall conform to IS 375 with latest amendments if any.
- c. All wiring shall be provided with alphanumeric ferules at either ends as per the wiring schedule.

7.0 CONTROL & RELAY (As per Scheme)

- 7.1 All the control and relays panel shall be SCADA compatible and IEC 61850 protocol compliant.
- 7.2 All relays shall conform to the requirements of IS: 3231/IEC-60255 or other applicable standards.
- 7.3 Protective relays shall be numerical, microprocessor based with the provision for multifunction protection, control, metering and monitoring features

8.0 TESTS

8.1 TESTS ON SWITCH GEAR:

- 8.1.1 **Type Tests shall be as per IS: 3427 –with latest amendment/revision**
- 8.1.2 Routine tests - **Routine tests shall be as per IS 3427 – with latest amendment/revision.**

8.2 TESTS ON CIRCUIT BREAKERS:

- 8.2.1 Type tests as per clause 6.0 of IS 13118 with latest.
- 8.2.2 Routine test - as per clause 7.0 of IS 13118 with latest.

8.3 TESTS ON CURRENT TRANSFORMERS

- 8.3.1 Type test: As per clause 7. 1. 1 (a) to (h) of IS 2705 (Part- 1), clause 8.1 of IS-2705 (Part-11). , clause 8.2 of IS: 2705 (Part - III)-, clause 8.3 of IS-2705 (Part-III)- and clause 6 of IS 2705 (Part -IV).

8.4 TEST ON VOLTAGE TRANSFORMERS;

- 8.4.1 Type tests: As per clause 6. 1. 1 of IS 3156 (Part -I)-, clause 8.1 of IS 3156 (part-II), and clause 9.1 of IS 3156 (Part - III) -

- 8.4.2 Routine Tests: As per clause 8.1.2 of IS 3156 (part - 1)-, clause 8.2 of IS 3156 (Part-11), and clause 9.2 of IS: 3156 (part - III) - .
- 9.0 Marking and name plates:
- 9.1 As per clause 7.1 of IS 3427.
- 9.2 The above markings shall be in addition to the individual nameplates to be provided on the various switchgear components.
- 9.3 All instruments, relay and other components shall be provided with nameplates at their rear and shall be supplied separately as disassembled components.

ANNEXURE-'A'

SCHEDULE OF GUARANTEED AND OTHER TECHNICAL PARTICULARS

1. Manufacturer's name & country of manufacturer.
2. Type and Governing standard.
3. Nominal system Voltage
4. Rated Insulation Level.
5. Frequency
6. Normal current ratings
 - a) At ref. ambient temp.
as per relevant standard.
 - b) As per site conditions,
overload rating for
 - i. one hour
 - ii. three hours
 - c) Derating factor, if any
for site conditions.
 - d) Temperature rise at 150%
rating for 3 HRS.
7.
 - a. Symmetrical breaking capacity.
 - b. Asymmetrical breaking capacity
8. Max temp. rise over ambient (oC) due to
Rated current in main contacts measured
After Breaking test
9.
 - a) Symmetrical breaking current
 - b) Short time current rating for 1 sec.
 - c) Short time current rating for 3 sec.
 - d) Percent DC component.
10. Making capacity.
11. 1.2/50 Micro second impulse wave with stand test voltage.

12. One minute power frequency withstand test voltage.
13. No. of poles
14. No. of breaks in circuit per pole.
15. Length of break per phase.
16. Total break time (ms)
 - a) For interruption of 10% of rated capacity.
 - b) For interruption of 30% of rated capacity.
 - c) For interruption of 60% of rated capacity.
 - d) For interruption of the full rated capacity.
17. Making time
18.
 - a. Arc duration
 - b. Opening time
 - c. Break Time
19.
 - a) Type and material and main contacts
 - b) Material & thickness of plating of contacts.
20. Type of arcing contacts and/or arc control device.
21.
 - a) Whether the circuit breaker is trip free ?
 - b) Whether it is with lock out preventing closing ?
22. Nominal voltage of closing mechanism.
23. Power required to close circuit breaker at nominal voltage.
24. Minimum clearance in air
 - a) Between phases.
 - b) Between the live parts and earth
25. Minimum clearance in vacuum
 - a) Between phases
 - b) Between live parts & earth
26. Rated operating sequence.
27. Minimum re-closing time at rated interrupted Capacity from the instant of the trip coil Energisation (ms).
28. Minimum dead time.
 - a) 3 phase re-closing(ms)
 - b) Limit of adjustment of dead time for 3 phase re-closing.
29. Data on re-striking voltage for 100%,50% or 30% Rated capacity.
 - a) Amplitude factor.
 - b) Phase factor.

- c) Natural frequency.
 - d) Rate of rise of re-striking voltage (V/micro sec.)
30. Rated out of phase breaking current.
 31. Rated line charging breaking current.
 32. Maximum line charging current breaking Capacity and corresponding over voltage recorded in test.
 - a) On supply side.
 - b) On line side.
 33. Maximum cable charging current breaking Capacity and corresponding over voltage recorded in test.
 - a) On supply side.
 - b) On line side.
 34. Rated single capacitor bank.
 - a) Capacitive inrush current handling capability.
 - b) Capacitive breaking current capability.
 35. Rated small inductive breaking current and the corresponding over voltage.
 36. First pole to clear factor.
 37. Rated transient recovery voltage for terminal fault.
 38. Rated characters for short line fault in rate of rise.
 39. Rated short circuit breaking current.
 40. Dry one minute power frequency withstand Test voltage for complete circuit breaker.
 - a) Between line terminal and grounded part(KV RMS)
 - b) Between terminals with breaker contact open (KV RMS)
 - c) Between poles(KV RMS)
 41. Wet one minute power frequency withstand Test voltage
 - a) Between line terminal and grounded part(KV RMS)
 - b) Between terminals with breaker contact open (KV RMS)
 - c) Between poles (KV RMS).
 42. 1.2/50 micro second wave impulse withstand test voltage for complete circuit breaker.
 - a) Between line terminal and ground(KV peak)
 - b) Between terminals (KV RMS)
 - c) Between poles (KV RMS).
 43. Minimum clearance line
 - a) Between phase (mm)
 - b) Live parts and earth (mm)
 - c) Live parts and ground level (mm).
 44. Number of operation possible without maintenance.
 - a) At full rated interrupting capacity
 - b) At 150% of rated current.
 - c) At 100% of rated current

d) At 50% of rated current.

45. Supporting Insulators.
- a) Make and type
 - b) Weight
 - c) Transport dimension
 - d) Insulation class.
 - e) Visible corona discharge voltage
 - f) Dry-1 minute power frequency flashover/voltage.
 - g) Wet 1-minute power frequency flashover/voltage
 - h) 1.2/50 micro second impulse flashover/voltage.
 - i) Creepage distance to ground (mm)
 - j) Heavily polluted atmosphere:
 - i) Total
 - ii) Protected.
- 47 No. of poles per circuit breaker.
48. Number of breaks per pole phase.
49. Total length of breaks per phase (mm)
50. Type of main contacts.
51. Material for main contact.
52. Whether main contacts silver Plated (Yes/No)
53. Thickness of silver coating on main contacts (mm)
56. Contact pressure on main contacts (kg/m²)
57. Type of arcing contacts.
58. Contact pressure on arcing contacts (Kg/m²)
59. Type of auxiliary switches.
60. Whether contacts silver plated (Yes/No.)
61. Number of Auxiliary switch contact
- Operating with all three poles of breaker.
 - i) Which are closed when breaker is closed.
 - ii) Which are open when breaker is opened.
 - iii) Those adjustable with respect to Position of main contacts.
62. Number of Spare Auxiliary Switch Contacts.
- Operating with all three poles of breaker :
 - i) Which are closed when breaker is closed.
 - ii) Which are open when breaker is opened.
 - iii) Those adjustable with respect to Position of main contacts.
63. Number of spare terminal block.
64. Mounting flange details.
 - a) Opening.
 - b) Closing.
65. Tripping and closing circuit voltage(V)
66. Power required for trip coil
67. Power required for closing coil
68. Contingencies for which alarm provided.
69. Design data for supporting structure.
70. Weight of supporting steel structure For breaker.
71. Descriptive leaflets enclosed.

WEIGHT AND SPACE REQUIREMENT

1. Weight of 3 phase breaker complete with operating mechanism, insulating supports fame works etc.
2. Impact loading for foundation design to
3. include dead load plus impact value on opening at maximum interrupting rating in terms of equivalent of static load.

4. Weight of heaviest package.

B. INSTRUMENT TRANSFORMERS :

i) CURRENT TRANSFORMERS :

- a) Name of manufacturer.
- b) Rated primary current
- c) Rated secondary current
- d) Rated transformation ratio
- e) V.A. output at rated current & accuracy
- f) Class of accuracy.
- g) Rated over current factor with time in seconds.
- h) Type of CTs(whether wound or bar type)
- i) One minute power frequency withstand test voltage.
- j) 1.2/50 micro second impulse withstand voltage.
- k) Standard to which conform.
- l)

Ratings	For metering core	For Protection core	PS core
i) V.A burden			-----
ii) Saturation factor		-----	-----
iii) Knee point voltage	-----	-----	
iv) Accuracy class			-----
v) Imag. At VK/2	-----	-----	

VOLTAGE TRANSFORMER :

- (i) Name of manufacturer.
- (ii) Rated primary voltage
- (iii) Rated secondary voltage
- (iv) Rated burden For metering For protection
- (v) Class of accuracy
- (vi) Rated voltage factor and time
- (vii) One minute power frequency withstand test voltage.
- (viii) 1.2/50 micro second impulse withstand test voltage.
- (ix) Standard to which conform.

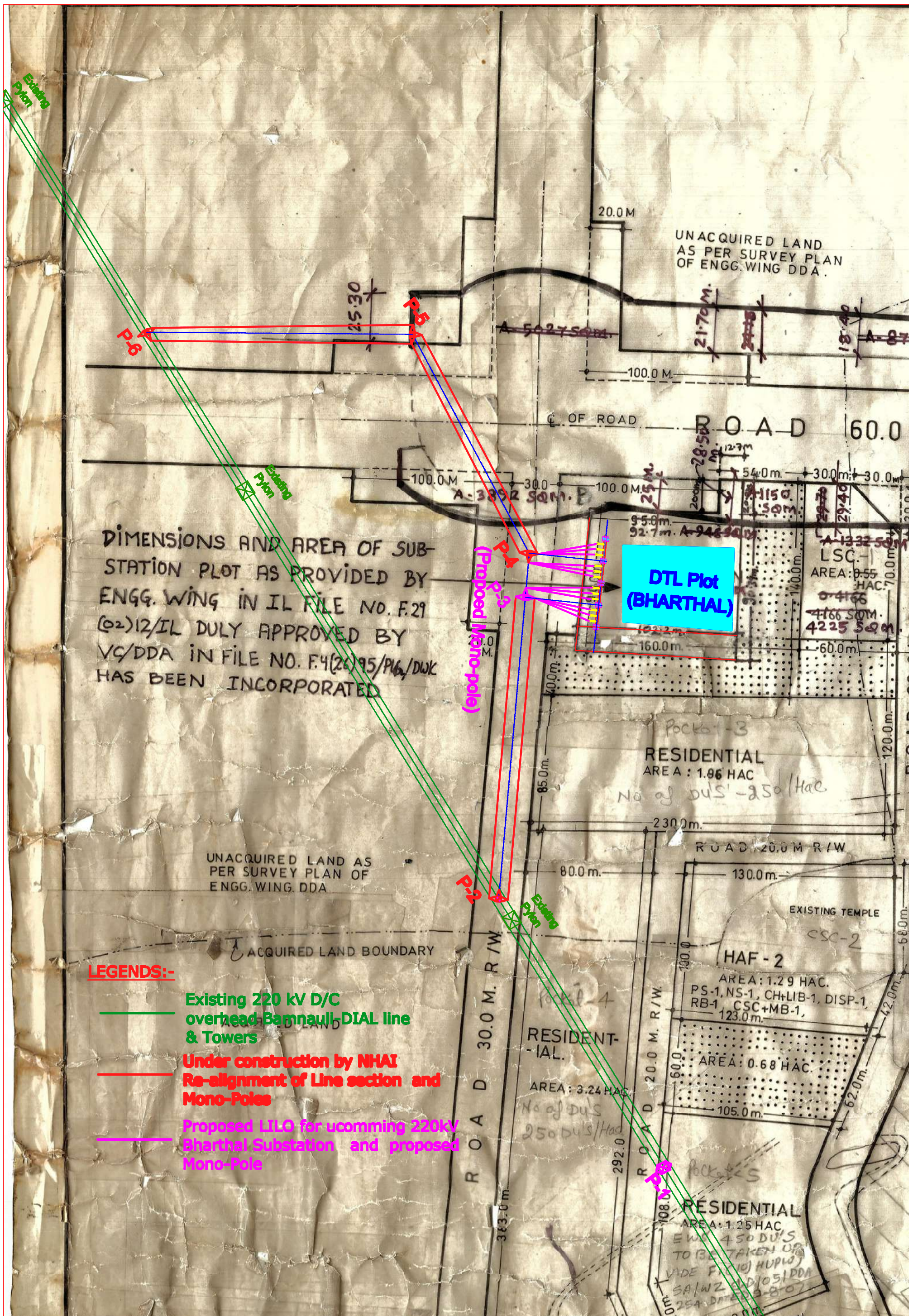
C. BUS BAR

- 1. Material
- 2. Normal current rating
- 3. Section of bus bar with size
- 4. Shape.
- 5. Type of insulation.
- 6. Temperature rise on continuous rated current above the ambient temp 43.3 Deg.C

D VACUUM INTERRUPTER BOTTLE

- 1. Name of manufacturer.
- 2. Whether imported or indigenous.
- 3. Manufacturer's type, normal Amps. & rupturing capacity for vacuum bottles used on incoming panel.
- 4. Manufacturer's type, normal Amp. & rupturing capacity for vacuum bottles used on outgoing panel.
- 5. Manufacturer's type,. normal Amps. & rupturing capacity for vacuum bottles used on capacitor control panel.
- 6. Degree of vacuum inside the vacuum interrupters.
- 7. Short time rating of vacuum bottles.

8. Number of full short circuit operation, as per test duty 1 to 5 of IEC-56 which the vacuum bottles offered can safely withstand.
9. Whether the vacuum bottles used on incoming and outgoing panels are same or different.
10. Whether the operating mechanism is imported or indigenous.



SECTION-II

GAS INSULATED SWITCHGEAR

SECTION-II

GAS INSULATED SWITCHGEAR

This Technical Specification is applicable only to 220kV & 66kV voltage levels. The Purchaser 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 Bid Price Schedule, the technical specification for such items should not be referred to.

Technical Specification of 400kV, 220kV, 66kV, 33kV Gas Insulated Switchgear (GIS)

1. General

The GIS manufacturer shall design, manufacture, test, deliver and guarantee the GIS components and services as defined in this Technical Specification. The complete GIS based on the Single Line Diagram and as defined in Section Project, shall be provided for connection to Power Transformers/Reactors/Lines feeders with associated circuit breaker, disconnect switch and grounding switch (maintenance and high speed), instrument transformers, and surge arrester (if applicable) etc.

2. GENERAL CHARACTERISTICS

- 2.1 The SF6 gas insulated metal enclosed switchgear shall be totally safe against inadvertent touch of any of its constituent parts. It should be designed for indoor application with meteorological conditions as specified.
- 2.2 All parts of the bus bar, switchgear and the bus ducts (for both indoor and outdoor applications) shall be as mentioned below:

400 kV GIS	Single phase enclosed
220 kV GIS	Single Phase/Three Phase enclosed
66 kV/33kV GIS	Three Phase enclosed

- 2.3 The design should be such that all parts subjected to wear and tear are easily accessible for maintenance purposes. The equipment offered shall be protected against all types of voltage surges and any equipment necessary to satisfy this requirement shall be deemed to be included. The required overall system parameters of GIS are as per **Annexure -6**

3. REFERENCE STANDARDS

The GIS offered shall conform to IEC 62271-203 and other relevant IEC standard except to the extent explicitly modified in the specification and shall be in accordance with requirement specified in GTR.

The metal-enclosed gas-insulated switchgear, including the operating devices, accessories and auxiliary equipment forming integral part thereof, shall be designed, manufactured, assembled and tested in accordance with the following International Electro-technical Commission (IEC) Publications including their parts and supplements as amended or revised as on date of bid opening

IEC 62271-203	Gas Insulated metal-enclosed switchgear for rated voltages above 52 kV
IEC 62271-207	Seismic qualification for gas-insulated switchgear assemblies for rated voltages above 52 kV
IEC 60376	New sulphur hexafluoride
IEC 62271-100	High voltage alternating current Circuit breakers
IEC 62271-1	Common clauses for high voltage Switchgear and control-gear

	Standards
IEC 62271-102	Alternating current Disconnect Switch (isolators) and earthing switches
IEC 61869	General Requirements Instrument Transformers
IEC 60137	Bushings for alternating voltages above 1000 V
IEC 62271-209	Cable connections for gas-insulated switchgear
IEC 60480	Guide to checking of sulphur hexafluoride taken from electrical equipment
IEC 60099 -1/4	Non-linear resistor type arresters for AC systems
IEC 60439	Factory-built assemblies of low-voltage switchgear and control Gear.
IEEE 80 2013	IEEE Guide for Safety in AC Substation grounding.
CIGRE-44	Earthing of GIS- an application guide. (Electra no.151,Dec'93).
IEC 62271-211	Direct connection between Power Transformers and gas insulated metal enclosed switchgear for rated voltage 72.5 kV and above.

The components and devices which are not covered by the above standards shall conform to, and comply with, the latest applicable standards, rules, codes and regulations of the internationally recognized standardizing bodies and professional societies as may be approved by the Employer. The manufacturer shall list all such applicable standards, codes etc and provide copies thereof for necessary approval.

In case the requirements laid down herein differ from those given in above standard in any aspect, the switchgear shall comply with the requirements indicated herein in regard thereto.

4. DEFINITIONS

- 4.1. **Assembly:** Assembly refers to the entire completed GIS equipment furnished under contract.
- 4.2. **Bay:** Bay refers to the area occupied by one Circuit Breaker and associated equipment used to protect one feeder/line/bus coupler in double bus scheme.
- 4.3. **Compartment:** When used in conjunction with GIS equipment, compartment refers to a gastight volume bounded by enclosure walls and gas tight isolating barriers.
- 4.4. **Enclosure:** When used in conjunction with GIS equipment, enclosure refers to the grounded metal housing or shell which contains and protects internal Power system equipment (breaker, disconnecting switch, grounding switch, voltage transformer, current transformer, surge arresters, interconnecting bus etc.)
- 4.5. **Manual Operation:** Manual operation means operation by hand without using any other source of power.
- 4.6. **Module:** When used in conjunction with GIS equipment, module refers to a portion of that equipment. Each module includes its own enclosure. A module can contain more than one piece of equipment, for example, a module can contain a disconnecting switch and a grounding switch.
- 4.7. **Reservoir:** When used in conjunction with GIS equipment reservoir refers to a larger gas-tight volume.

5. GENERAL DESIGN AND SAFETY REQUIREMENT

- 5.1. The GIS shall be designed, manufactured and tested in accordance with the best international engineering practices under strict quality control to meet the requirement stipulated in the technical specification. Adequate safety margin with respect to thermal, mechanical, dielectric stress and insulation coordination etc. shall be maintained during design, selection of raw

material, manufacturing process etc. so that the GIS provides long life with least maintenance.

The workmanship shall be of the highest quality and shall conform to the latest modern practices for the manufacture of high technology machinery and electrical switchgear.

- 5.2. The GIS assembly shall consist of separate modular compartments e.g. Circuit Breaker compartment, Bus bar compartment filled (single phase design) with SF₆ Gas and separated by gas tight partitions so as to minimize risk to human life, allow ease of maintenance and limit the effects of gas leaks failures & internal arcs etc. These compartments shall be such that maintenance on one feeder may be performed without de-energising the adjacent feeders. These compartments shall be designed to minimize the risk of damage to adjacent sections and protection of personnel in the event of a failure occurring within the compartments. Rupture diaphragms with suitable deflectors shall be provided to prevent uncontrolled bursting pressures developing within the enclosures under worst operating conditions, thus providing controlled pressure relief in the affected compartment.
- 5.3. The switchgear, which shall be of modular design, shall have complete phase isolation. The conductors and the live parts shall be mounted on high graded epoxy resin insulators. These insulators shall be designed to have high structural strength and electrical dielectric properties and shall be free of any voids and free of partial discharge at a voltage which is at least 5% greater than the rated voltage. These shall be designed to have high structural and dielectric strength properties and shall be shaped so as to provide uniform field distribution and to minimize the effects of particle deposition either from migration of foreign particles within the enclosures or from the by-products of SF₆ breakdown under arcing conditions.
- 5.4. All circuit breakers disconnect switches and other component of GIS having identical rating shall have identical and interchangeable parts and operating mechanism as far as possible.
- 5.5. Gas barrier insulators and support insulators shall have the same basis of design. The support insulators shall have holes on both sides for proper flow of gas.
Gas barrier insulators shall be provided so as to divide the GIS into separate compartments. These shall be suitably located in order to minimize disturbance in case of leakage or dismantling. They shall be designed to withstand any internal fault thereby keeping an internal arc inside the faulty compartment. Further, it is prohibited to work adjacent to a gas Compartment while it is fully pressurized on the other side. For such cases, the gas pressure in the adjacent compartments needs to be reduced.
Due to safety requirement for working on this pressurized equipment, whenever the pressure of the adjacent gas compartment is reduced during maintenance, this compartment shall be designed so that it shall remain in service to perform its intended duty. The gas tight barriers shall be clearly marked on the outside of the enclosures.
The bus enclosure should be sectionalized in a manner that maintenance work on any bus disconnect (when bus and bus disconnect are enclosed in a single enclosure) can be carried out by isolating and evacuating the small effected section and not the entire bus. The design of GIS shall be such that in case a circuit breaker module of a feeder is removed for maintenance, both busbars shall remain in service. For achieving the above requirements, adequate Mechanical support and number of intermediate gas tight compartments as required, shall be provided to ensure equipment and operating personnel's safety.
- 5.6. The switchgear shall be of the free standing, self-supporting with easy accessibility to all the parts during installation & maintenance with all high-voltage equipment installed inside gas-insulated metallic and earthed enclosures. GIS should be suitably sub-divided into individual arc and gas-proof compartments preferably for:
 - i. Bus bars
 - ii. Intermediate compartment

- iii. Circuit breakers
- iv. Feeder Disconnect Switch
- v. Voltage Transformers
- vi. Gas Insulated bus duct section between GIS and XLPE cable/Overhead Conductor.
- vii. Gas Insulated bus section between GIS & Oil filled Transformer/ Reactor (if applicable)

5.7. Service continuity requirement:

The GIS equipment with the given bus switching arrangement is divided into different gas compartments. During the work such as a fault repair or major maintenance, requiring the dismantling of a gas compartment for which more than one compartments may need to be de-gassed.

Working conditions, method statements and procedures are to be furnished by the GIS manufacturer in order to ensure equipment and operating personnel's safety and to achieve following service continuity conditions to the extent possible:

- 5.7.1. For One & half breaker bus switching scheme during a fault in CB compartment, No bus bar and feeder is permitted out of service during maintenance and repair/replacement.
- 5.7.2. For Double Main bus switching scheme during a fault in CB compartment, No bus bar permitted out of service during maintenance and repair/replacement.
- 5.7.3. During a fault in GIS compartment other than CB compartment, maximum one bus bar and/or one feeder permitted out of service during maintenance and repair/replacement.
- 5.8. The material and thickness of the enclosures shall be such as to withstand an internal flash over without burns through for a period of 300 ms at rated short time withstand current. The material shall be such that it has no effect of environment as well as from the by-products of SF6 breakdown under arcing condition. This shall be validated with Type Test.
- 5.9. Each section shall have plug- in or easily removable connection pieces to allow for easy replacement of any component with the minimum of disturbance to the remainder of the equipment. Inspection windows (View Ports) shall be provided for Disconnect Switch and both type of earth switches i.e. Maintenance and fast operating.
- 5.10. The material used for manufacturing the switchgear equipment shall be of the type, composition and have physical properties best suited to their particular purposes and in accordance with the latest engineering practices. All the conductors shall be fabricated of aluminum/ copper tubes of cross sectional area suitable to meet the normal and short circuit current rating requirements. The finish of the conductors shall be smooth so as to prevent any electrical discharge. The conductor ends shall be silver plated and fitted into finger contacts or tulip contacts. The contacts shall be of sliding type to allow the conductors to expand or contract axially due to temperature variation without imposing any mechanical stress on supporting insulators.
- 5.11. Each pressure filled enclosure shall be designed and fabricated to comply with the requirements of the applicable pressure vessel codes and based on the design temperature and design pressures as defined in IEC-62271-203.
- 5.12. The maximum SF6 gas leakage shall not exceed 0.5% (half percent) per year for the whole equipment and for any individual gas compartment separately. The SF6 gas leakage should not exceed 0.5% per year and the leakage rate shall be guaranteed for at least 10 years. In case the leakage under the specified conditions is found to be greater than 0.5% after one year of commissioning, the manufacturer will have to supply free of cost, the total gas requirement for subsequent ten (10) years, based on actual leakage observed during the first year of operation after commissioning.

- 5.13. Each gas-filled compartment shall be equipped with static filters, density switches, filling valve and safety diaphragm. The filters shall be capable of absorbing any water vapor which may penetrate into the enclosures as well as the by-products of SF₆ during interruption. Each gas compartment shall be fitted with non-return valve connectors for evacuating & filling the gas and checking the gas pressure etc.
- 5.14. The switchgear when installed and operating under the ambient conditions shall perform satisfactorily and safely under all normal and fault conditions. Even repeated operations up to the permissible servicing intervals under 100% rated and fault conditions, shall not diminish the performance or significantly shorten the useful life of the switchgear. Any fault caused by external/internal reasons shall be positively confined to the originating compartment and shall not spread to other parts of the switchgear.
- 5.15. The thermal rating of all current carrying parts shall be minimum for one sec. for the rated symmetrical short-circuits current.
- 5.16. The arrangement of the individual switchgear bays shall be such so as to achieve optimum space-saving, neat and logical arrangement and adequate accessibility to all external components.
- 5.17. The layout of the substation equipment, bus bars and switchgear bays shall preferably be based on the principle of “phase grouping”. Switchgear layout based on the “mixed phases” principle shall not be accepted without mutual agreement between supplier and employer. The arrangement of the equipment offered must provide adequate access for operation, testing, Repair and maintenance.
- 5.18. All the elements shall be accessible without removing support structures for routine inspections. The removal of individual enclosure parts or entire breaker bays shall be possible without disturbing the enclosures of neighboring bays and LCC panels.
- 5.19. It should not be possible to unwillingly touch live parts of the switchgear or to perform operations that lead to arcing faults without the use of tools or brute force. All interlocks that prevent potentially dangerous mal-operations shall be constructed such that they cannot be operated easily, i.e. the operator must use tools or brute force to over-ride them.
- 5.20. In general the contours of energized metal parts of the GIS and any other accessory shall be such, so as to eliminate areas or points of high electrostatic flux concentrations. The surfaces shall be smooth with no projection or irregularities which may cause visible corona. No corona shall be visible in complete darkness which the equipment is subjected to specified test voltage. There shall be no radio interference from the energized switchgear at rated voltage.
- 5.21. The GIS shall be designed, so as to take care of the VFT over voltages generated as a result of pre-strikes and re-strikes during isolator operation. Maximum VFT over voltages peak shall not be higher than rated lightning impulse withstand voltage (LIWV) of the equipment. Necessary measures shall be under taken by GIS manufacture to restrict maximum VFT over voltages lower than the LIWV. Manufacturer shall submit the study report of VFTO generated for GIS installation.
- 5.22. The enclosure shall be of continuous design and shall meet the requirement as specified in of IEEE 80 2013 (special considerations for GIS).

The enclosure shall be sized for carrying induced current equal to the rated current of the Bus. The conductor and the enclosure shall form the concentric pair with effective shielding of the field internal to the enclosure.
- 5.23. The fabricated metal enclosures shall be of Aluminum alloy having high resistance to corrosion, low electrical losses and negligible magnetic losses. All joint surfaces shall be machined and all castings shall be spot faced for all bolt heads or nuts and washers. All screws, bolts, studs and nuts shall conform to metric system.

- 5.24. The elbows, bends, cross and T-sections of interconnections shall include the insulators bearing the conductor when the direction changes take place in order to ensure that live parts remain perfectly centered and the electrical field is not increased at such points.
- 5.25. The enclosure shall be designed to practically eliminate the external electromagnetic field and thereby electro-dynamic stresses even under short circuit conditions. The average intensity of electromagnetic field shall not be more than 50 micro Tesla on the surface of the enclosure. The contractor shall furnish all calculations and documents in support of the above during detailed engineering.
- 5.26. The switchgear shall have provision for connection with ground mat risers through copper connections. This provision shall consist of grounding pads to be connected to the ground mat riser in the vicinity of the equipment.
- 5.27. Stairs, fixed ladder, platforms, and walkways for operation and maintenance access to the operating mechanism and monitoring devices should be provided to permit access. The structures shall be either aluminum or hot-dipped galvanized steel. All structures, stairs, platforms, and walkways shall conform to the relevant occupational health and safety regulations and designed in accordance with the latest industry standards and guidelines. The platforms and walkways shall have anti-skid surfaces that can be walked on. Handrails shall be provided where necessary. The GIS supplier shall provide 3-D arrangement drawing to show the location of equipment and access to it.
- 5.28. In addition to above suitable portable scissor lift shall be provided for access of distant portion of GIS installation.
- 5.29. New Gasket, sealant and desiccant shall be installed for permanent sealing of all site/field assembled joints. No gaskets are to be reused for any permanent seal broken or disturbed in the field/site.
- 5.30. The enclosure & support structure shall be designed such that person of 1780 mm in height and 80 Kg in weight is able to climb on the equipment for maintenance.
- 5.31. The sealing provided between flanges of two modules / enclosures shall be such that long term tightness is achieved.
- 5.32. Alarm circuit shall not respond to faults for momentary conditions. The following indications including those required elsewhere in the specifications shall be generally provided in the alarm and indication circuits.

Gas Insulating System:

- i) Loss of Gas Density
- ii) Any other alarm necessary to indicate deterioration of the gas insulating system.

Operating System:

- i) Low operating pressure
 - ii) Loss of Heater power
 - iii) Loss of operating power
 - iv) Loss of control supply
 - v) Pole Discordance.
- 5.33. The equipment will be operated under the following ambient conditions (or as defined in the section project):
 - a) The ambient temperature varies between 0 degree-C and 50 degree-C. However, for design purposes, ambient temperature should be considered as 50 degree-C.
 - b) The humidity will be about 95% (indoors)
 - c) The elevation is less than 1000 meters

- 5.34 Temperature rise of all current carrying parts and enclosures shall be limited to the values stipulated in IEC-62271-1, under rated current and the climatic conditions as specified. The temperature rise for accessible enclosure shall not exceed 20 degree C above the ambient temperature of 50 degree C.
- 5.35. Wherever required, the heaters shall be provided for the equipment in order to ensure the proper functioning of the switchgear at specified ambient temperatures. All cabinet heaters shall be rated for 240V AC (1-phase) supply and shall be complete with thermostat, control switches and fuses, connected as a balanced 3-phase 4-wire load. The heaters shall be so arranged and protected as to create no hazard to adjacent equipment from the heat produced.
- 5.36. **Bellows or Compensating Units:-**Adequate provision shall be made to allow for the thermal expansion of the conductors & enclosures and for differential thermal expansion between the conductors and the enclosures. The bellows metallic(preferably stainless steel) with suitable provision for permitting the movement during expansion and contraction may be provided and shall be of following types:.
1. Lateral / Vertical mounting units: These shall be inserted, as required, between sections of busbars, on transformer, shunt reactor and XLPE cable etc. Lateral mounting shall be made possible by a sliding section of enclosure and tubular conductors.
 2. Axial compensators: These shall be provided to accommodate changes in length of busbars due to temperature variations.
 3. Parallel compensators: These shall be provided to accommodate large linear expansions and angle tolerances.
 4. Tolerance compensators: These shall be provided for taking up manufacturing, site assembly and foundation tolerances.
 5. Vibration compensators: These bellows compensators shall be provided for absorbing vibrations caused by the transformers and shunt reactors when connected to SF6 switchgear by oil- SF6 bushings.

The electrical connections across the bellows or compensating units shall be made by means of suitable connectors. For sliding type compensators, markers/pointers shall be provided to observe expansion or contraction during climatic conditions.

- 5.37. **Indication and verification of switch positions:** Indicators shall be provided on all circuitbreakers, isolators and earth-switches, which shall clearly show whether the switches are open or closed. The indicators shall be mechanically coupled directly to the main contact operating drive rod or linkages and shall be mounted in a position where they are clearly visible from the floor or the platform in the vicinity of the equipment.

Inspection windows shall also be provided with all isolators and earth switches so that the switch contact positions can be verified by direct visual inspection.

- 5.38. **Pressure relief device:** Pressure relief devices shall be provided in the gas sections to protect the gas enclosures from damage or distortion during the occurrence of abnormal pressure increase or shock waves generated by internal electrical fault arcs (preferably in downward direction).

Pressure relief shall be achieved either by means of diaphragms or plugs venting directly into the atmosphere in a controlled direction.

If the pressure relief devices vent directly into the atmosphere, suitable guards and deflectors shall be provided. Contractor shall submit to the owner the detailed criteria design regarding location of pressure relief devices/rupture diaphragms.

- 5.39. **Pressure vessel requirements:** The enclosure shall be designed for the mechanical and thermal loads to which it is subjected in service. The enclosure shall be manufactured and tested according to the Pressure Vessel Code (ASME/CENELEC code for pressure Vessel.)

The bursting strength of Aluminum castings has to be at least 5 times the design pressure. A bursting pressure test shall be carried out at 5 times the design pressure as a type test on each type of enclosure.

Each enclosure has to be tested as a routine test at 1.5 times the design pressure for one minute.

5.40. Grounding:

5.40.1. The grounding system shall be designed and provided as per IEEE-80-2013 and CIGRE-44 to protect operating staff against any hazardous touch voltages and electro-magnetic interferences.

5.40.2 The GIS supplier shall define clearly what constitutes the main grounding bus of the GIS. The contractor shall supply the entire material for grounding bus of GIS viz conductor, clamps, joints, operating and safety platforms etc. The contractor is also required to supply all the earthing conductors and associated hardware material for the following:

1. Connecting all GIS equipment, bus ducts, enclosures, control cabinets, supporting structure etc. to the ground bus of GIS.
2. Grounding of transformer, CVT/VT, SA and other outdoor switchyard equipments/structures etc.

5.40.3. The enclosure of the GIS may be grounded at several points so that there shall be grounded cage around all the live parts. A minimum of two nos. of grounding connections should be provided for each of circuit breaker, cable terminals, surge arrestors, earth switches and at each end of the bus bars. The grounding continuity between each enclosure shall be effectively interconnected either internally or externally with Copper/Aluminum bonds of suitable size to bridge the flanges. Subassembly to subassembly bonding shall be provided to bridge the gap & safe voltage gradients between all intentionally grounded parts of the GIS assembly & between those parts and the main grounding bus of the GIS.

5.40.4. Each marshaling box, local control panel, power and control cable sheaths and other non-current carrying metallic structures shall be connected to the grounding system of GIS via connections that are separated from GIS enclosures.

5.40.5. The grounding connector shall be of sufficient mechanical strength to withstand electromagnetic forces as well as capable of carrying the anticipated maximum fault current without overheating. At least two grounding paths shall be provided to connect each point to the main grounding bus. Necessary precautions should be under taken to prevent excessive currents from being induced into adjacent frames, structures of reinforcing steel and to avoid establishment of current loops via other station equipment.

5.40.6. All flexible bonding leads shall be tinned copper. All connectors, for attaching flexible bonding leads to grounding conductors and grounding conductors to support structures shall be tinned bronze with stainless steel or tinned bronze hardware.

5.40.7. The contractor shall provide suitable measure to mitigate transient enclosure voltage caused by high frequency currents due to by lightning strikes, operation of surge arrestor, phase to earth fault and discharges between contacts during switching operation. The grounding system shall ensure safe touch & step voltages in all the enclosures. The contractor shall provide suitable barrier of non-linear resistor/ counter discontinued SF6/ Air termination, SF6/ Transformer or Reactor termination, SF6/ HV cable bushing etc. to mitigate transient enclosure voltage.

5.40.8 The bidders shall provide lightening mast/GS shield wire at suitable place for protection of whole sub-station including transformers, GIS cum control room building etc. The bidder shall submit detailed proposal for grounding system of whole substation including indoor and outdoor equipments with Earthmat using 40mm. dia MS rod for approval of purchaser. The riser shall be GS flat of size 75X12mm for outdoor equipments and 50X6mm for indoor.

The bidder shall submit detailed proposal for grounding system for approval of purchaser. Any provision to be made in the building design to take care of earthing requirement shall also be clearly spelt-out.

5.41. UHF sensors for PD detection:

Adequate number of UHF sensors shall be provided in the offered GIS for detection of Partial discharge (of 5 pC and above) as per IEC 60270. The number and location of these sensors shall be based on laboratory test on typical design of GIS as per recommendations of CIGRE Document No. 654 (*APPLICATION GUIDE FOR SENSITIVITY VERIFICATION for UHF PARTIAL DISCHARGE DETECTION SYSTEM FOR GIS*). Offered numbers and location of UHF sensors shall be submitted based on above said criteria along with attenuation calculation for approval of the employer. Further UHF sensors shall necessarily be provided in close proximity to VT compartments.

However adequacy of number of sensors and their location shall be verified at site as per recommendations of above CIGRE Document No. 654. In case during site testing, additional UHF sensors are required, the same shall also be supplied & installed to complete the technical requirement.

The calibration and frequency response of PD couplers shall be as per NGC Technical Guidance note TGN (T) 121, issue 1, 1997. Data sheet shall be submitted for the UHF couplers meeting this requirement.

5.42. Gas Insulated Bus (GIB) layout :

GIB shall be designed based on the following criteria

- (1) Maximum weight of gas in a gas tight section of GIB shall not exceed 400 kg (for 400 kV)/ 250 kg (for 220 kV, 66 kV & 33 kV).
- (2) GIB shall be generally in horizontal layer. However in exceptional circumstance GIB in vertical layers can be provided with the approval of employer.
- (3) The minimum vertical ground clearance of GIB at road crossing shall be 5.5 meters
- (4) The horizontal clearance between GIB and GIS building /any other building wall shall be preferably three (3) meters.
- (5) The GIB route inside the GIS Hall shall not obstruct easy access to GIS and control room buildings and shall not obstruct movement of crane, equipment including HV test equipment for maintenance works.
- (6) The GIB clear height outside the GIS hall in switchyard area shall be minimum 3.5 meter, so as not to obstruct easy access to GIB, movement of crane for maintenance work.
- (7) Optimization of outdoor GIB length using overhead AIS connection with Bus Post Insulator of respective voltage class is generally acceptable subject to meeting the electrical clearances as stipulated.
- (8) For the maintenance of GIB of one circuit, only that circuit shall be isolated. Adequate clearance between bus ducts of two circuit shall be ensured by the contractor during layout finalization.
- (9) GIS manufacturer as per their design shall preferably use maximum three standard straight horizontal outdoor bus duct lengths for entire GIS installation to optimize the spare requirement.
- (10) The minimum outer to outer horizontal clearance between each GIS bus duct shall be 0.5 meter for 400kV, 220 kV, 66 kV & 33kV voltage level.

5.43. Extension of GIS

- 5.43.1. The arrangement of gas sections or compartments shall be such as to facilitate future extension of any make without any drilling, cutting or welding on the existing equipment. To add equipment, it shall not be necessary to move or dislocate the existing switchgear bays.
- 5.43.2. As the GIS is likely to be extended in future, during detailed engineering stage, the contractor shall make available the complete design detail of interface module such as cross section, enclosure material, enclosure dimensions (inner & outer), Flange diameter (inner & outer), conductor cross-section & connection arrangement, bolt spacing & dimension, rated gas pressure, Gasket detail etc. Further GIS manufacturer supplying GIS under present scope shall furnish all the required details in addition to mentioned above necessary for design and successful implementation of an interface module during later stage while extending GIS by any other GIS manufacturer, without any help of GIS manufacturer who has supplied the GIS equipment in present scope.
- 5.43.3. The Interface module shall be designed to provide Isolating link with access hole on enclosure. The Isolating link shall be provided in such a way so that HV test can be performed on either side of the interface module separately, keeping other side of GIS remained isolated. Interface Module drawing with necessary detail shall be submitted for approval.
- 5.43.4. Further the contractor who is extending the existing GIS installation, it shall be his responsibility to provide interface module matching with the existing GIS interface module. The drawing of existing GIS interface/end piece module shall be provided by the employer. However it shall be the responsibility of contractor to verify the existing details during site visit.
- 5.43.5. The Contractor shall optimally utilize the space inside the GIS hall (including the extension portion) for accommodating the interface module being supplied under the contract and the space (along the length of the hall) inside the GIS hall for interface module shall preferably be limited to 1 meter for 400/220/66/33kV.

5.44. SF6 GAS

The SF6 gas insulated metal-clad switchgear shall be designed for use with SF6 gas complying with the recommendations of IEC 60376, 60376A & 60376B, at the time of the first charging with gas. All SF6 gas supplied as part of the contract shall comply with the requirements of IEC & should be suitable in all respects for use in the switchgear under all operating conditions. Necessary statutory clearances from concerned authorities for import of the Gas and for storage of the Gas shall be obtained.

The high pressure cylinders in which SF6 gas is supplied & stored at site shall comply with the requirements of following standards & regulations:

IS : 4379 Identification of the contents of industrial gas cylinders.

IS : 7311 Seamless high carbon steel cylinders for permanent & high pressure liquefiable gases. The cylinders shall also meet latest Gas Cylinder Rules (PESO)

SF6 gas shall be tested for purity, dew point, air, hydrolysable fluorides and water contents as per IEC: 60376, 60376A & 60376B and test certificates shall be furnished to the Employer indicating all test results as per IEC standards for each lot of SF6 gas. Further site tests for dew point and purity shall be done during commissioning of GIS. Gas bottles should be tested for leakage during receipt at site.

The contractor shall indicate diagnostic test methods for checking the quality of gas in the

various sections of GIS during service. The method proposed shall have as a minimum check the moisture content & the percentage of purity of the gas on annual basis.

The contractor shall also submit clearly the precise procedure to be adopted by maintenance personnel for handling equipment that are exposed to the products of arcing in SF6 Gas so as to ensure that they are not affected by possible irritants of the skin and respiratory system. Recommendations shall be submitted for suitable protective clothing, method of disposal of cleaning utensils and other relevant matters.

The contractor shall also indicate the details and type of filters used in various gas sections, and should also submit the operating experience with such filters.

- 5.44.1. **SF6 gas monitoring devices and alarm circuits:** Dial type temperature compensated gas density monitoring devices with associated pressure gauge will be provided. The devices shall provide continuous & automatic monitoring of gas density. A separate device shall be provided for each gas tight compartment so that it can be monitored simultaneously as follows:-

Comparison/ Sl. No.	Compartments except CB	Circuit Breaker compartments
1	“Gas Refill level: This will be used to annunciate the need for the gas refilling. The contractor shall provide a contact for remote indication.	'Gas Refill' level: This will be used to annunciate the need for gas refilling. The contractor shall provide a contact for remote indication.
2	“SF6 low level” : This will be used to annunciate the need for urgent gas filling . A contact shall be provided for remote indication	“SF6 low level”: This will be used to annunciate the need for urgent gas filling . A contact shall be provided for remote indication
3	'Zone Trip' level: This is the minimum level at which the Manufacturer will guarantee the insulation rating of the assembly.	'Breaker Block' level : This is the minimum gas density at which the manufacturer will guarantee the rated fault interrupting capability of the breaker .At this level the breaker block contact shall operate and the closing & tripping circuit shall be blocked.
4	Not Applicable	'Zone Trip' level: This is the Minimum level at which the manufacturer will guarantee the insulation rating of the assembly.

The density monitor/pressure switch contacts shall be in accordance with the above requirement.

It shall be possible to test all gas monitoring relays/devices without de-energizing the primary equipment & without reducing pressure in the main section. It shall also damp the pressure pulsation while filling the gas in service, so that flickering of the pressure switch contacts does not take place.

5.44.2. **Gas Supply:** The contractor shall include the supply of all SF6 gas necessary for filling & putting into operation the complete switchgear installation being supplied. The empty gas cylinders shall be returnable to the contractor.

5.45. **Documentation**

The contractor shall prepare and submit to the employer, drawings; details that show the GIS design in order for the employer to verify the equipment conform to the specifications. The Design Document to be submitted for review and approval are as follows:

- i. Design Review Document as per clause no. **19** of this specification
- ii. Single Line Diagram
- iii. Gas Schematic Diagram
- iv. GTP-Guaranteed Technical Particulars
- v. GIS layout (Plan and Section) including 3D drawing
- vi. GIS Component Drawings
- vii. Interface modules drawing for GIS extension
- viii. Rating and Name Plate Drawing
- ix. GIS/LCC Schematics Drawing
- x. Foundation loading plan and detail
- xi. GIS Support Structure Drawing
- xii. GIS platforms and Walkway Drawing
- xiii. GIS grounding plan and details along with design calculation for GIS grounding
- xiv. GIS key Diagram enlisting and marking each and every GIS Module clearly and separately identifiable (indoor and outdoor). This separately identified module shall be complete along with its enclosure, gasket and all active parts such as conductor, conductor joints, corona shield etc.
- xv. Method Statement along with sequential instruction for dismantling and assembling of all major components of GIS exhibiting service continuity requirement
- xvi. Type Test Reports
- xvii. Seismic Analysis Report
- xviii. Study report of VFTO generated for GIS installation for 400 kV
- xix. The general arrangement drawing of interconnecting bus-duct from GIS bay module to XLPE cable termination end
- xx. The general arrangement drawing of Terminal connection arrangement to connect GIS duct to SF6/Oil bushing and duct mounting arrangement details
- xxi. Gas handling procedure
- xxii. The design & construction proposal of the building along with necessary information, data, and drawings according to the complete requirements
- xxiii. Capacity calculation of EOT crane for GIS hall considering a factor of safety of 5
- xxiv. Method statement/ procedure of ON SITE high voltage testing with PD measurement and Switching Impulse test.
- xxv. **Additional CB data to be furnished during detailed engineering :**
 - a) Design data on capabilities of circuit breakers in terms of time and number of operations at duties ranging from 100 % fault currents to load currents of the lowest possible value without requiring any maintenance or checks.
 - b) Curves supported by test data indicating the opening time under close open operation with combined variation of trip coil voltage and hydraulic pressure.
 - c) Contact Travel: Operating mechanism operating shaft travel and contact overlap of Circuit Breaker to be provided.
- xxvi. PD Monitoring System
 - a) The technical proposal for PDM system along with detailed design documentation.
 - b) Data sheet for the UHF couplers.

- c) The Sub-station GIS layout as a separate drawing indicating position of spacers, spread over of PD sensors with distance, sensor identification, the detector unit identification etc., total numbers of offered UHF Sensors along with attenuation calculation.
- d) Guaranteed Technical Particulars & Data Sheet for various components used in the PDM system.
- e) Electromagnetic compatibility Test Reports.
- f) List of critical spares.

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6. CIRCUIT BREAKERS

- 6.1. **General :** SF₆ gas insulated metal enclosed circuit breakers and accessories shall conform to IEC: 62271-100, IEC: 62271-1 and other relevant IEC standards except to the extent explicitly modified in the specification and shall also be in accordance with requirements specified in Section-GTR.

Circuit breakers shall be equipped with the operating mechanism. Circuit breakers shall be of single pressure type. Complete circuit breaker with all necessary items for successful operation shall be supplied. The circuit breakers shall be designed for high speed single and three phase reclosing (as applicable) with an operating sequence and timing as specified.

- 6.2. **Duty Requirements:** Circuit breaker shall be C2 - M2 class as per IEC 62271-100.
- 6.3. Circuit breaker shall meet the duty requirements for any type of fault or fault location also for line charging and dropping when used on effectively grounded system and perform make and break operations as per the stipulated duty cycles satisfactorily.
- 6.4. The circuit breaker shall be capable of:
1. Interrupting the steady and transient magnetizing current shall be as follows:
Interrupting the steady and transient magnetizing current corresponding to 400 kV/220 kV, 220/66 kV and 220/33 kV class transformers of 500 MVA, 315 MVA, 160 MVA and 100 MVA ratings on 400 kV, 220 kV, and 66 kV & 33 kV side.
 2. Interrupting line/cable charging current as per IEC without re-strikes and without use of opening resistors. The breaker shall be able to interrupt the rated line charging current as per IEC-62271-100 with test voltage immediately before opening equal to the product of $U/\sqrt{3}$ and 1.4.
 3. Clearing short line fault (Kilometric faults) with source impedance behind the bus equivalent to symmetrical fault current specified.
 4. Breaking 25% the rated fault current at twice the rated voltage under phase opposition condition.
 5. The breaker shall satisfactorily withstand the high stresses imposed on them during fault clearing, load rejection and re-energisation of shunt reactor and/or series capacitor compensated lines with trapped charges.
 6. Withstanding all dielectric stresses imposed on it in open condition at lock out pressure continuously (i.e. shall be designed for 2 p.u. across the breaker continuously, for validation of which a power frequency withstand test conducted for a duration of at least 15 minutes is acceptable).
 7. Circuit breakers shall be able to switch in and out the shunt reactor as detailed below:

Voltage Level	Reactor Rating (in MVAR)	Max. rise of overvoltage (in p.u.)
400 kV	50 to 125	2.3
220 kV	25 to 50	2.3

6.5. **Total Break Time :** The total break time shall not be exceeded under any of the following duties :

- a) Test duties T10,T30,T60,T100 (with TRV as per IEC- 62271-100)
- b) Short line fault L90, L75 (with TRV as per IEC-62271-100)

The Contractor may please note that total break time of the breaker shall not be exceeded under any duty conditions specified such as with the combined variation of the trip coil voltage (70-110%), hydraulic pressure and SF6 gas pressure etc. While furnishing the proof for the total break time of complete circuit breaker, the contractor may specifically bring out the effect of non-simultaneity between poles and show how it is covered in the total break time.

The values guaranteed shall be supported with the type test reports.

6.6. **Constructional features :**

The features and constructional details of breakers shall be in accordance with requirements stated hereunder:

- 6.6.1. If multi-break interrupters are used, these shall be so designed and augmented that a uniform voltage distribution is developed across them. Calculations/ test reports in support of the same shall be furnished. The thermal and voltage withstand rating of the grading elements shall be adequate for the service conditions and duty specified.
- 6.6.2. **Contacts:** All making and breaking contacts shall be sealed and free from atmospheric effects. Contacts shall be designed to have adequate thermal and current carrying capacity for the duty specified and to have a life expectancy so that frequent replacement due to excessive burning will not be necessary. Provision shall be made for rapid dissipation of heat generated by the arc on opening.
- 6.6.3. Any device provided for voltage grading to damp oscillations or, to prevent re-strike prior to the complete interruption of the circuit or to limit over voltage on closing, shall have a life expectancy comparable of that of the breaker as a whole.
- 6.6.4. Breakers shall be so designed that when operated within their specified rating, the temperature of each part will be limited to values consistent with a long life for the material used. The temperature rise shall not exceed that indicated in IEC-62271-100 under specified ambient conditions.
- 6.6.5. The gap between the open contacts shall be such that it can withstand at least the rated phase to ground voltage for eight hours at zero pressure above atmospheric level of SF6 gas due to its leakage. The breaker should be able to withstand all dielectric stresses imposed on it in open condition at lockout pressure continuously (i.e. 2 p.u. power frequency voltage across the breaker continuously)
- 6.6.6. In the interrupter assembly there shall be an adsorbing product box to minimize the effect of SF6 decomposition products and moisture. The material used in the construction of the circuit breakers shall be such as to be fully compatible with SF6 gas decomposition products.
- 6.6.7. Provisions shall be made for attaching an operational analyzer to record travel, speed and making measurement of operating timings etc. after installation at site. The contractor shall supply three set of transducer for each substation covered under the scope.
- 6.6.8. Circuit Breaker shall be supplied with auxiliary switch having additional 8 NO (normally open) and 8 NC (normally closed) contacts for future use over and above those required for switchgear interlocking and other control and protection function. These spare NO and NC contacts shall be wired upto the local control cubicle.
- 6.6.9. The CO (Close-open) operation and its timing shall be such as to ensure complete

travel/insertion of the contact during closing operation and then follow the opening operation.

6.7. Operating mechanism

6.7.1. General Requirements :

- a) Circuit breaker shall be operated by spring charged mechanism or electro hydraulic mechanism or a combination of these. The mechanism shall be housed in a dust proof cabinet and shall have IP: 42 degree of protection.
- b) The operating mechanism **box** shall be strong, rigid, rebound free and shall be readily accessible for maintenance.
- c) The operating mechanism shall be suitable for high speed reclosing and other duties specified. During reclosing the breaker contacts shall close fully and then open. The mechanism shall be anti-pumping and trip free (as per IEC definition) under every method of closing.
- d) The mechanism shall be such that the failure of any auxiliary spring will not prevent tripping and will not cause unwanted trip or closing operation of the Circuit Breaker.
- e) A mechanical indicator shall be provided to show open and close position of the breaker. It shall be located in a position where it will be visible to a man standing on the ground level with the mechanism housing closed. An operation counter shall also be provided in the central control cabinet.
- f) Working parts of the mechanism shall be of corrosion resisting material, bearings which require grease shall be equipped with pressure type grease fittings. Bearing pin, bolts, nuts and other parts shall be adequately pinned or locked to prevent loosening or changing adjustment with repeated operation of the breaker.
- g) The contractor shall furnish detailed operation and maintenance manual of the mechanism along with the operation manual for the circuit breaker.

6.7.2. Control

- a) The close and trip circuits shall be designed to permit use of momentary-contact switches and push buttons.
- b) Each breaker pole shall be provided with two (2) independent tripping circuits and trip coils which may be connected to a different set of protective relays.
- c) The breaker shall normally be operated by remote electrical control. Electrical tripping shall be performed by shunt trip coils. However, provisions shall be made for local electrical control. For this purpose a local/remote selector switch and close and trip control switch/push buttons shall be provided in the breaker control cabinet.
- d) The trip coil shall be suitable for trip circuit supervision during both open and close position of breaker.
- e) Closing coil and associated circuits shall operate correctly at all values of voltage between 85% and 110% of the rated voltage. Shunt trip and associated circuits shall operate correctly under all operating conditions of the circuit breaker upto the rated breaking capacity of the circuit breaker and at all values of supply voltage between 70% and 110% of rated voltage. If additional elements are introduced in the trip coil circuit their successful operation and reliability for similar applications on circuit breakers shall be clearly brought out in the additional information schedules. In the absence of adequate details the offer is likely to be rejected.
- f) Density meter contacts and pressure switch contacts shall be suitable for direct use as permissive in closing and tripping circuits. Separate contacts have to be used for each of tripping and closing circuits. If contacts are not suitably rated and multiplying relays are

used then fail safe logic/schemes are to be employed. DC supplies shall be monitored for remote annunciations and operation lockout in case of dc failures.

- g) The auxiliary switch of the breaker shall be positively driven by the breaker operating rod.

6.7.3. Spring operated Mechanism

- a) Spring operated mechanism shall be complete with motor as per manufacturer practice. Opening spring and closing spring with limit switch for automatic charging and other necessary accessories to make the mechanism a complete operating unit shall also be provided.
- b) As long as power is available to the motor, a continuous sequence of the closing and opening operations shall be possible. The motor shall have adequate thermal rating for this duty.
- c) After failure of power supply to the motor one close open operation shall be possible with the energy contained in the operating mechanism.
- d) Breaker operation shall be independent of the motor which shall be used solely for compressing the closing spring. Facility for manual charging of the closing spring shall also be provided. The motor rating shall be such that it required preferably not more than 90 seconds for full charging of the closing spring.
- e) Closing action of circuit breaker shall compress the opening spring ready for tripping.
- f) When closing springs are discharged after closing a breaker, closing springs shall automatically be charged for the next operation and an indication of this shall be provided in the local control cabinet & SAS.
- g) Provisions shall be made to prevent a closing operation of the breaker when the spring is in the partial charged condition.
- h) Mechanical interlocks shall be provided in the operating mechanism to prevent discharging of closing springs when the breaker is in the closed position.
- i) The spring operating mechanism shall have adequate energy stored in the operating spring to close and latch the circuit breaker against the rated making current and also to provide the required energy for the tripping mechanism in case the tripping energy is derived from the operating mechanism.
- j) The spring charging failure alarm shall be provided with a time delay relay having setting range from 0-3 minutes.
- k) Separate MCBs shall be provided for each spring charging motor and the rating of MCBs shall be suitably selected to match the starting, running and stalling time.
- l) An overload relay shall be provided for protection of the spring charging motor.

6.7.4. Hydraulically Operated Mechanism :

- a) Hydraulically operated mechanism shall comprise of operating unit with power cylinder, control valves, high and low pressure reservoir, motor etc.
- b) The hydraulic oil used shall be fully compatible for the temperature range to be encountered during operation.
- c) The oil pressure switch controlling the oil pump and pressure in the high pressure reservoir shall have adequate no. of spare contacts, for continuous monitoring of low pressure, high pressure etc. at switchyard control room.
- d) The mechanism shall be suitable for at-least two close open operations after failure of AC supply to the motor starting at pressure equal to the lowest pressure of auto reclose duty plus pressure drop for one close open operation.
- e) The mechanism shall be capable of operating the circuit breaker correctly and performing the duty cycle specified under all conditions with the pressure of hydraulic operated fluid in the operating mechanism at the lowest permissible pressure before make up.
- f) Trip lockout shall be provided to prevent operations of the circuit breaker below the

minimum specified hydraulic pressure. Alarm contacts for loss of Nitrogen shall also be provided.

- g) All hydraulic joints shall have no oil leakage under the site conditions and joints shall be tested at factory against oil leakage.

6.8. Controlled Switching Device(CSD):

6.8.1. 400 kV Circuit Breaker shall be equipped with controlled switching device with consequent optimization of switching behavior, when used in:

- 1. Switching of transformer (400 kV side circuit breakers only)
- 2. Switching of shunt reactor

6.8.2. The CSD shall be provided in 400 kV Circuit breakers for controlling transformers and reactors (ie for breakers of switchable line reactor and in Main& Tie circuit breakers of Transformers, Transmission lines with non-switchable line reactors and Bus reactors). The requirement of CSD shall be explicitly specified in price schedule

6.8.3. Technical Requirement for Controlled switching device:

- a) The CSD shall be designed to operate correctly and satisfactorily with the excursion of auxiliary A/C & DC voltages and frequency as specified in section - GTR.
- b) The CSD shall meet the requirements of IEC-61000-4 16 class IV regarding HF disturbance test and fast transient test shall be as per IEC-61000 – 4-4 level IV and insulation test as per 60255 – 5.
- c) The CSD shall have functions for switching ON & OFF the circuit breakers.
- d) The CSD shall get command to operate the breakers manually or through auto re-close relay at random. The controller shall be able to analyze the current and voltage waves available through the signals from secondaries of CTs & CVTs for the purpose of calculation of optimum moment of the switching the circuit breaker and issue command to circuit breaker to operate.
- e) The CSD shall have an adaptive control feature to consider the next operating time of the breaker in calculation of optimum time of issuing the switching command. In calculation of net operating time of the breaker the controller must consider all factors that may affect the operating time of the breaker such as, but not limited to, ambient temperature, control voltage variation, SF6 gas density variations etc. Schematic drawing for this purpose shall be provided by the contractor. The accuracy of the operating time estimation by the controller shall be better than + 0.5 ms.
- f) The CSD shall have communication port to facilitate online communication of the control switching device with SCADA directly on 61850 or through gateway which shall be under present scope.
- g) The CSD shall be PC compatible for the setting of various parameters and downloading of the settings and measured values date time of switching etc. Window based software for this purpose shall be supplied by the contractor to be used on the owner's PC.
- h) The CSD shall be suitable for current input of 1 amp from the secondary of the CTs. and 110 V (Ph to Ph) from the CVTs. The controller shall withstand transient and dynamic state values of the current from the secondary of the CTs and CVTs.
- i) The CSD shall have time setting resolution of 0.1 ms or better.
- j) The CSD shall have sufficient number of output/input potential free contacts for connecting the monitoring equipment and annunciation system available in the control room. Necessary details shall be worked out during engineering the scheme.
- k) The CSD shall also record and monitor the switching operations and make adjustments to the switching instants to optimize the switching behavior as necessary. It shall provide self-diagnostic facilities, signaling of alarms and enable downloading of data captured from the switching events.
- l) The provision for bypassing the Controlled switching device shall be provided through

BCU and SCADA both so that whenever, the CSD is not healthy due to any reason (including auxiliary supply failure), uncontrolled trip/close command can be extended to the circuit Breaker. Alternatively, in case of any non-operation of the CSD after receiving a close/trip command after a pre-determined time delay, the CSD should automatically be bypassed so as to ensure that the trip and close commands are extended to the Trip/Close coils through subsequent command.

- m) The CSD shall be provided with a communication port to facilitate online communication of the CSD with Substation automation system directly on IEC 61850 protocols. If the CSD does not meet the protocols of IEC 61850, suitable gateway shall be provided to enable the communication of CSD as per IEC 61850.

6.9. The technical parameters of circuit breakers are as per **Annexure –1**

6.10. Tests

6.10.1. Type Tests

- i. In accordance with the requirements stipulated under Section GTR the circuit breaker along with its operating mechanism shall conform to the type tests as per IEC-62271-100.
- ii. The type test report of Electromagnetic Compatibility Test (EMC) of CSD shall be submitted for approval
- iii. Circuit breakers meant for controlled switching shall conform to requirements of IEC/TR-62271-302. The contractor shall submit test reports to demonstrate that the offered CB conforms to the requirements of performance verification tests and parameter definition tests as per IEC/TR 62271-302. The contractor shall also furnish the report for the re-ignition free arcing window for switching 3-phase shunt reactor as demonstrated in the shunt reactor switching test.

6.10.2. Routine Tests:

Routine tests as per IEC: 62271-100 shall be performed on all circuit breakers.

In addition to the mechanical and electrical tests specified by IEC, the following shall also be performed.

- i. Speed curves for each breaker shall be obtained with the help of a suitable operation analyzer to determine the breaker contact movement during opening, closing, auto reclosing and trip free operation under normal as well as limiting operating **control** voltage conditions. The tests shall show the speed of contacts directly at various stages of operation, travel of contacts, opening time, closing time, shortest time between separation and meeting of contacts at break make operation etc. This test shall also be performed at site for which the necessary operation analyzer along with necessary transducers, cables, console etc. shall be **arranged by the contractor at his** own cost. After completion of site pre-commissioning test, 03 nos. travel transducer shall be handed over to DTL.
- ii. During testing of CB, dynamic contact resistance measurement (DCRM) shall be carried out for close-open (CO) operations with delay of 300ms between close and trip operations. Minimum 100A current shall be injected for DCRM test. Travel characteristics, injected current, trip/close coil current shall also be recorded along with DCRM test. This test shall also be performed at site for which the necessary operation analyzer along with necessary transducers, cables, console etc. shall be provided. The test for getting signature of the dynamic contact resistance measurement shall also be carried out at factory. The test result shall be treated as reference signature for condition monitoring in future.
- iii. Routine tests on circuit breakers with controlled switching device as per IEC/TR 62271-302.

7. DISCONNECTORS (ISOLATORS)

Disconnectors shall be three-pole group operated or Single-pole individual operated (as per single line diagram of the substation) and shall be installed in the switchgear to provide electrical isolation. The disconnectors shall conform to IEC- 62271-102 and shall have the ratings as specified in BPS/ Project Section.

7.1. Construction & Design.

- 7.2.1. The disconnectors shall be operated by electric motor suitable for use on 220 Volt DC systems and shall be equipped with a manual operating mechanism for emergency use. The motor shall be protected against over current and short circuit.
- 7.2.2. Disconnectors shall be suitable to switch the bus charging currents during their opening and closing and shall conform to all three test duties viz TD1,TD2 and TD3 as per Annexure –F of IEC: 62271- 102.They shall also be able to make and break rated bus transfer current at rated bus transfer voltage which appears during transfer between bus bars in accordance with Annexure –B of IEC: 62271-102. The contact shielding shall also be designed to prevent restrikes and high local stresses caused by transient recovery voltages when these currents are interrupted.
- 7.2.3. The disconnect switches shall be arranged in such a way that all the three phases operate simultaneously. All the parts of the operating mechanism shall be able to withstand starting torque of the motor mechanism without damage until the motor overload protection operates.
- 7.2.4. It shall be possible to operate the disconnect switches manually by cranks or hand wheels.
- 7.2.5. For motor-operated disconnect switches, the control should be electrically and/or mechanically uncoupled from the drive shaft when the switch is operated manually to prevent coincident power operation of the switch and the drive mechanism(s).
- 7.2.6. The operating mechanisms shall be complete with all necessary linkages, clamps, couplings, operating rods, support brackets and grounding devices. All the bearings shall be permanently lubricated or shall be of such a type that no lubrication or maintenance is required.
- 7.2.7. The opening and closing of the disconnectors shall be achieved by either local or remote control. The local operation shall be by means of a two-position control switch located in the Local Control Cabinet (LCC).
- 7.2.8. Remote control of the disconnectors from the control room/SAS shall be made by means of remote/ local transfer switch.
- 7.2.9. The disconnector operations shall be inter-locked electrically with the associated circuit breakers in such a way that the disconnector control is inoperative if the circuit breaker is closed.
- 7.2.10. Each disconnector shall be supplied with auxiliary switch having additional 8 NO (Normally Open) and 8 NC (Normally Closed) contacts for future use over and above those required for switchgear interlocking and automation purposes. These spare NO and NC contacts shall be wired up to the local control cabinet.
- 7.2.11. The signaling of the closed position of the disconnector shall not take place unless it is certain that the movable contacts will reach a position in which the rated normal current, peak withstand current and short-time withstand current can be carried safely.
- 7.2.12. The signaling of the open position of the disconnector shall not take place unless the movable contacts have reached such a position that the clearance between the contacts is at least 80 percent of the rated isolating distance.

- 7.2.13. The disconnectors and safety grounding switches shall have mechanical/electrical inter-locks to prevent closing of the grounding switches when isolator switches are in the closed position and to prevent closing of the disconnectors when the grounding switch is in the closed position. Integrally mounted lock when provided shall be equipped with a unique key for such three phase group. Master key is not permitted.
- 7.2.14. The local control of the Isolator and high-speed grounding switches from the Local Control Cabinet (LCC) should be achieved from the individual control switches with the remote/local transfer switch set to local.
- 7.2.15. All electrical sequence interlocks will apply in both remote and local control modes.
- 7.2.16. Each disconnector shall have a clearly identifiable local, positively driven mechanical position indicator, together with position indicator on the local control cubicle (LCC) and provisions for taking the signals to the control room. The details of the inscriptions and colouring for the indicator are given as under :

INSCRIPTION	COLOUR
Open Position	OPEN GREEN
Closed Position	CLOSED RED

- 7.2.17. All the disconnecting switches shall have arrangement allowing easy visual inspection of the travel of the switch contacts in both open and close positions, from the outside of the enclosure.
- 7.2.18. The disconnecting switches shall be provided with rating plates and shall be easily accessible.
- 7.2.19. The mechanical endurance class shall be M2 as per IEC.
- 7.2.20. Mechanical position indication shall be provided locally at each disconnector and Electrical indication at each Local Control Cabinet (LCC) / SAS.
- 7.2.21. All auxiliary switches and auxiliary circuits shall be capable of carrying a current of at least 10 A DC continuously.
- 7.2.22. The auxiliary switches shall be capable of breaking at least 10 A in a 220 V DC circuit with a time constant of not less than 20 milliseconds.
- 7.2.23. The disconnecting switches shall be capable of being padlocked in both the open and closed positions with the operating motor automatically disengaged. The padlocking device shall be suitable for a standard size lock with a 10 mm shank. The padlock must be visible and directly lock the final output shaft of the operating mechanism. Integrally mounted lock when provided shall be equipped with a unique key for such three phase group. Master key is not permitted.

7.3. The technical parameters of disconnectors are as per **ANNEXURE-2**

8. SAFETY GROUNDING SWITCHES

- 8.1. Safety grounding switches shall be three-pole group operated or single-pole individual operated (as per single line diagram of the substation). It shall be operated by DC electric motor and shall be equipped with a manual operating mechanism for emergency use. The motor shall be protected against over-current and short circuit.
- 8.2. Each safety grounding switch shall be electrically interlocked with its associated disconnectors and circuit breaker such that it can only be closed if both the circuit breaker and disconnectors are in open position. Safety grounding switch shall also be mechanically key interlocked with its associated disconnectors.
- 8.3. Each safety grounding switch shall have clearly identifiable local positive driven mechanical indicator together with position indicator on the Local Control Cabinet (LCC) and provision for taking the signal to Control room.

8.4. The details of the inscription and coloring for the indicator are given as under :

	INSCRIPTION	COLOUR
Open Position	OPEN	GREEN
Closed Position	CLOSED	RED

- 8.5. Interlocks shall be provided so that manual operation of the switches or insertion of the manual operating device will disable the electrical control circuits.
- 8.6. Each ground switch shall be fitted with auxiliary switches having 6NO (Normally Open) and 6NC (Normally Closed) contacts for use by others over and above those required for local interlocking and position indication purposes.
- 8.7. Provision shall be made for padlocking / suitable locking arrangement for the ground switches in either the open or closed position.
- 8.8. All portions of the grounding switch and operating mechanism required for grounding shall be connected together utilizing flexible copper conductors having a minimum cross-sectional area of 100 sq. mm.
- 8.9. The main grounding connections on each grounding switch shall be rated to carry the full short circuit current for 1 sec. and shall be equipped with a silver-plated terminal connector suitable for steel strap of adequate rating for connection to the grounding grid.
- 8.10. The safety grounding switches shall conform to the requirements of IEC- 62271- 102 and shall have electrical endurance class: E0 & shall have mechanical endurance class M2 for 400 kV & M1 for 220/66/33 kV voltage level.
- 8.11. The grounding switch shall be provided with test provision (insulated link) to permit test voltage up to 10 kV and up to 200 A to be applied to the main conductor without removing SF6 gas from the enclosure and without disassembling the enclosure except for ground shunt leads.
- 8.12. Combined Disconnectors & Safety grounding switch arrangement shall also be acceptable.
- 8.13. Mechanical position indication shall be provided locally at each switch and Electrical indication at each Local Control Cabinet (LCC) / SAS.

9. HIGH SPEED MAKE PROOF GROUNDING SWITCHES:

- 9.1. Grounding switches located at the beginning of the line feeder bay modules shall be of the high speed, make proof type and will be used to discharge the respective charging currents, trapped charge in addition to their safety grounding function. These grounding switches shall be capable of interrupting the inductive and capacitive currents and to withstand the associated TRV. These shall conform to class B and electrical endurance class E1 as per annexure – C of IEC : 62271-102
- 9.2. High Speed Grounding switches shall be provided with individual/three pole operating mechanism suitable for operation from DC.
- 9.3. The switches shall be fitted with a stored energy closing system to provide fault making capacity.
- 9.4. The short circuit making current rating of each ground switch shall be at least equal to its peak withstand current rating as specified. The switches shall have inductive/ capacitive current switching capacity as per IEC-62271-102.
- 9.5. Each high speed make proof grounding switch shall have clearly identifiable local positive driven mechanical indicator together with position indicator on the Local Control Cabinet (LCC) and provision for taking the signal to Control Room/SAS.
- 9.6. The details of the inscription and coloring for the indicator shall be as under:-

	INSCRIPTION	COLOUR
Open Position	OPEN	GREEN
Closed Position	CLOSED	RED
9.7.	High speed ground switch operation should be possible locally from Local Control Cabinet (LCC)	
9.8.	These high speed grounding switches shall be electrically interlocked with their associated circuit breakers and disconnectors so that the grounding switches cannot be closed if disconnectors are closed. Interlocks shall be provided so that the insertion of the manual operating devices will disable the electrical control circuits.	
9.9.	Each high speed ground switch shall be fitted with auxiliary switches having 6NO (Normally Open) and 6 NC (Normally Closed) contacts for use by others, over and above these required for local interlocking and position indication. All contacts shall be wired to terminal blocks in the Local Control Cabinet. Provision shall be made for padlocking the ground switches in their open or closed position.	
9.10.	All portion of the grounding switches and operating mechanism required for connection to ground shall be connected together utilizing copper conductor having minimum cross-sectional area of 100 sq. mm.	
9.11.	The main grounding connection on each grounding switch shall be rated to carry the peak withstand current rating of the switch for 1 sec. and shall be equipped with a silver plated terminal connector suitable for steel strap of adequate design for connection to the grounding grid.	
9.12.	The high speed make proof grounding switches shall confirm to the requirements of IEC-62271-102.	
9.13.	The grounding switch shall be provided with test provision (insulated link) to permit test voltage up to 10 kV and up to 200 A to be applied to the main conductor without removing SF6 gas from the enclosure and without disassembling the enclosure except for ground shunt leads.	

10. INSTRUMENT TRANSFORMERS

10.1. CURRENT TRANSFORMERS

The current transformers and accessories shall conform to IEC:61869 and other relevant standards except to the extent explicitly modified in the specification.

The particulars of the various cores may change within reasonable limits as per the requirements of protection relay supplier. The manufacturer is required to have these values confirmed from the purchaser before proceeding with design of the cores. The other characteristics of CTs shall be as given in TECHNICAL PARAMETER of Current Transformer.

- 10.1.1. **Ratios and Characteristics:** The CT core distribution for various voltage levels shall be as per Table 3A, 3B, 3C 3D & 3E. Further the numbers of cores, rating, ratios, accuracy class, etc. for the individual current transformers secondary cores shall be in accordance with above table attached at **Annexure-3**.

Where multi-ratio current transformers are required the various ratios shall be obtained by changing the effective number of turns on the secondary winding.

- 10.1.2. **Rating and Diagram Plates:** Rating and diagram plates shall be as specified in the IEC specification incorporating the year of manufacture. The rated current & extended current rating in case of current transformers and rated voltage, voltage factor & intermediate voltage in case of voltage transformers shall be clearly indicated on the name plate.

The diagram plates shall show the terminal markings and the relative physical arrangement of the current transformer cores with respect to the primary terminals (P1 & P2).

The position of each primary terminal in the current transformer SF6 gas section shall be clearly marked by two plates fixed to the enclosure at each end of the current transformer.

10.1.3. Constructional Details:

- a) The current transformers incorporated into the GIS will be used for protective relaying and metering purposes and shall be of metal- enclosed type.
- b) Each current transformer shall be equipped with a secondary terminal box with terminals for the secondary circuits, which are connected to the Local Control Cubicle. The star/ delta configuration and the inter connection to the line protection panels will be done at the CT terminal block located in the local control cubicle.
- c) Current transformers guaranteed burdens and accuracy class are to be intended as simultaneous for all cores.
- d) The rated extended currents for 420 kV class Current transformers shall be as given below:
 - I. The secondary winding shall be rated for 2A continuously.
 - II. For 400 kV systems CT, the rated extended primary current of the CT shall be 200% of rated primary on all except 2000/1A tap. At 2000/1A tap the rated extended primary current shall be 120%. At 2000/1A ratio, the CT shall be thermally rated for 200% for 15minutes and 120% continuous.
 - III. For 400 kV CT rated for 3000A, the rated extended primary current shall be 120% for 3000/1A tap and 180% for 2000/1A tap and 200% for lower tap ratios. The secondary windings shall be rated for 2A continuously.
- e) For 245/72.5 /36 kV class CTs, the rated extended primary current shall be 120% (or 150% if applicable) on all cores of the CTs as specified in the Section – Project.
- f) For 420/245/72.5/36 kV current transformer, characteristics shall be such as to provide satisfactory performance of burdens ranging from 25% to 100% of rated burden over a range of 5% to 120%(or specified rated extended current whichever is higher) of rated current in case of metering CTs and up to the accuracy limit factor/knee point voltage in case of relaying CTs.

For 0.2S accuracy shall be maintained between 1% to 120% of rated current.
CT burden shall not be less than 5VA to achieve required 0.2S accuracy class
- g) For 420/245/72.5/36 kV CTs, the instrument security factor at all ratios shall be less than five (5) for metering core. If any auxiliary CTs/reactor are used in the current transformers then all parameters specified shall have to be met treating auxiliary CTs as an integral part of the current transformer. The auxiliary CTs/reactor shall preferably be inbuilt construction of the CTs. In case these are to be mounted separately these shall be mounted in the LCC panel suitably wired up to the terminal blocks.
- h) The wiring diagram, for the interconnections of the three single phase CTs shall be provided inside the Secondary terminal box.
- i) The current transformers shall be suitable for high speed auto-reclosing.
- j) Provisions shall be made for primary injection testing either within CT or outside.
- k) All the current transformers shall have effective electromagnetic shields to protect against high frequency transients. Electromagnetic shields to be provided against high frequency

- transients typically 1-30 MHz.
- l) The bidder will take care for the compatibility of the CT vis-à-vis burden of relay and connecting leads, however for calculation purpose fault current may be taken as 63kA for 400kV, 50kA for 220kV & 31.5 kA for 66kV/33kV and secondary current may be calculated accordingly.
 - m) The output burden of cores shall be as **Annexure 3A, 3B, 3C, 3D**. However burden of each core shall be finalized during detailed engineering.

10.2. VOLTAGE TRANSFORMERS

The voltage transformers shall conform to IEC- 61869 and other relevant standards except to the extent explicitly modified in the specification.

Voltage transformers shall be of the electromagnetic type with SF6 gas insulation. The earth end of the high voltage winding and the ends of the secondary winding shall be brought out in the terminal box.

10.2.1. **Ratios and Characteristics:** The rating, ratio, accuracy class, connection etc. for the voltage transformers shall be in accordance with **Annexure-4 & Table 4A,4B,4C,4D**

10.2.2. **Rating and diagram plates :**Rating and diagram plate shall be provided complying with the requirements of the IEC specification incorporating the year of manufacture and including turns ratio, voltage ratio, burden, connection diagram etc.

10.2.3. Secondary Terminals, Earthing and Fuses

The beginning and end of each secondary winding shall be wired to suitable terminals accommodated in a terminal box mounted directly on the voltage transformer section of the SF6 switchgear.

All terminals shall be stamped or otherwise marked to correspond with the marking on the diagram plate. Provision shall be made for earthing of the secondary windings inside the terminal box.

10.2.4. The transformer shall be able to sustain full line to line voltage without saturation of transformer. The accuracy class will be at maximum tap.

10.2.5. Constructional Details of Voltage Transformers:

- a) The voltage transformers shall be located as a separate bay module and will be connected phase to ground and shall be used for protection, metering and synchronization.
- b) The voltage transformers shall be of inductive type, nonresistant and shall be contained in their own-SF6 compartment, separated from other parts of installation. The voltage transformers shall be effectively shielded against high frequency electromagnetic transients. The supplier shall ensure that there is no risk of Ferro resonance due to the capacitance of the GIS.
- c) The voltage transformers shall have three secondary windings.
- d) Voltage transformers secondary shall be protected by Miniature Circuit breakers (MCBs) with monitoring contacts for all the windings. The secondary terminals of the VT's shall be terminated to preferably stud type non-disconnecting terminal blocks in the secondary boxes via the fuse.
- e) The voltage transformer should be thermally and dielectrically safe when the secondary terminals are loaded with the guaranteed thermal burdens.
- f) The accuracy of 0.2 on secondary III should be maintained throughout the entire burden range up to 50 VA on all the three windings without any adjustments during operation.
- g) The diagram for the interconnection of the VTs shall be provided inside secondary terminal box.

- h) It should be ensured that access to secondary terminals is without any danger of access to high voltage circuit.

10.3. Tests:

- 10.3.1. Current Transformer and Voltage Transformer should have been type tested and shall be subjected to routine tests in accordance with relevant IEC.
- 10.3.2. The test reports of type tests, as applicable, as per IEC-61869-2 for CT, and IEC-61869-3 for IVT and following additional tests shall be submitted for the Employer's review.
 - a) Current Transformers (CT): Transmitted over voltage test for 66kV and above voltage rating
 - b) Inductive Voltage Transformers (IVT): Transmitted over voltage test for 66kV and above voltage rating

11. SURGE ARRESTORS

- 11.1. The surge arrestors shall confirm in general to latest IEC –60099-4.
- 11.2. **Insulation co-ordination and selection of surge arrester:** The contractor shall be fully responsible for complete insulation co-ordination of switchyard including GIS. Contractor shall carry out detailed studies and design calculations to evolve the required parameters locations, energy capability etc. of surge arrestors such that adequate protective margin is available between peak impulse, surge and power frequency discharge voltages and BIL of the protected requirement. The locations of surge arrestors shown in single line diagram is indicative only. If the contractor feels that at some more locations the surge arrestors are required to be provided the same should also be deemed included in the offer. If distance between Surge Arrester and transformer bushing terminal inclusive of head length is more than 60 m or 170 ft then one surge arrester shall be with GIS System and another shall be with transformer. The contractor shall perform all necessary studies and the report shall detail the limits of all equipment parameters which could affect the insulation co-ordination. The report shall also detail the characteristics of the surge arrester and shall demonstrate that the selected arrester's protective and withstand levels, discharge and coordinating currents and arrester ratings and comply with the requirement of this specification.

The contractor shall also consider in the studies the open circuit breaker condition, fast transients generated by slow operation of disconnecting switches. The study report and design calculations shall be submitted for Owner's approval.

11.3. Duty requirements of GIS Surge Arrester

- 11.3.1. The surge arrester shall be SF6 gas insulated metal oxide and gapless type. The metal housing of the arrester shall be connected to the metal enclosure of the GIS with flange, bolted and gasketed joint so that the arrester housing is grounded through GIS enclosure.
- 11.3.2. Surge arrester shall be disconnect-link type and be attached to the gas-insulated system in such a manner that they can be readily disconnected from the system while the system is being dielectrically tested.
- 11.3.3. The surge arrester shall be of heavy duty station class and gapless (Metal oxide) type without any series or shunt gaps.
- 11.3.4. The surge arresters shall be capable of discharging over-voltages occurring during switching of unloaded transformers, reactors and long lines.
- 11.3.5. Surge arresters for the 400 kV class arrester shall be capable of discharging energy equivalent to class 4 of IEC for a 400 kV system on two successive operation followed immediately by 50 HZ energisation with a sequential voltage profile as specified below:

705 kVp for 3 peaks

580 kVp for 0.1 Sec.
565 kVp for 1 Sec.
550 kVp for 10 Secs.

- 11.3.6. 245 kV, 72.5kV & 33kV class arrester shall be capable of discharging energy equivalent to class 3 of IEC for 245 kV, 72.5 kV & 36kV systems respectively on two successive operations.
- 11.3.7. The reference current of the arresters shall be high enough to eliminate the influence of grading and stray capacitance on the measured reference voltage.
- 11.3.8. The surge arresters are being provided to protect the followings whose insulation levels are indicated in the table given below:-

Equipment	Lightning impulse(kVp) for 420 kVsystem	Lightning surge(kVp) for 420 kV system	Lightning impulse(kVp) for 245 kVsyst em	Lightning impulse(kVp) for 72.5 kVsystem	Lightning impulse(kVp) for 36 kVsystem
Pr. Transformer	+/-1300	+/-1050	+/-950	+/-325	170
Instr. Transformer	+/-1425	+/- 1050	+/- 1050	+/-325	170
Reactor	+/-1300	+/- 1050	+/- 1050		
CB/ Isolator Phase to Ground	+/-1425	+/- 1050	+/- 1050	+/-325	170
Across Open Contact	+/-1425 (+ 240)	+/- 900 (+345)	+/- 1200	+/-375	195

11.3.10. Constructional Features

The nonlinear blocks shall be of sintered/inferred metal oxide material. These shall be provided in such a way as to obtain robust construction, with excellent mechanical and electrical properties even after repeated operations.

The arrester enclosure shall be vertically or horizontally mounted to suit the layout of the switchgear as suggested by the supplier and each arrester shall be fitted with a Online continuous resistive leakage current monitoring system along discharge counter. The system shall be provided with an interface to integrate with the substation automation system.

The main grounding connection from the surge arrester to the earth shall be provided by the contractor. The size of the connecting conductor shall be such that all the energy is dissipated to the ground without getting overheated.

11.4. TESTS

- 11.4.1. In accordance with the requirements stipulated, the surge arrestors shall conform to type tests and shall be subjected to routine and acceptance tests in accordance with IEC document.
- 11.4.2. Each metal oxide block shall be tested for the guaranteed specific energy capability in addition to the routine/acceptance test as per IEC-60099.
- 11.4.3. Test on Surge Monitors: The Surge monitors shall also be connected in series with the test specimens during residual voltage and current impulse withstands tests to verify efficacy of the same. Additional routine/functional tests with one 100A and 10 kA current impulse, (8/20 micro sec.) shall also be performed on the surge monitor.

- 11.5. **Technical Parameters:** Technical parameters of surge arrestor is as per **ANNEXURE-5**.

12. OUTDOOR SF6/Air BUSHINGS :

Outdoor bushings, for the connection of conventional external conductors to the SF6 metal enclosed switchgear, shall be provided where specified and shall conform to the requirements given in GTR. The dimensional and clearance requirements for the metal enclosure will be the responsibility of the manufacturer and their dimensions must be coordinated with the switchgear.

Bushings shall generally be in accordance with the requirements of IEC -60137.

- 12.1 Insulation levels and Creepage distances: All bushings shall have an impulse and power frequency withstand level that is greater than or equal to the levels specified for GIS.

The creepage distance over the external surface of outdoor bushings shall not be less than 31mm/kV.

- 12.2 **Bushing types and fitting:** The details of bushing shall be as follows

SF6 to air Bushing shall be of Polymer / composite type and shall be robust and designed for adequate cantilever strength to meet the requirement of seismic condition, substation layout. The electrical and mechanical characteristics of bushings shall be in accordance with IEC: 60137. All details of the bushing shall be submitted for approval and design review.

Polymer / composite insulator shall be seamless sheath of a silicone rubber compound. The housing & weather sheds should have silicon content of minimum 30% by weight. It should protect the bushing against environmental influences, external pollution and humidity. The hollow silicone composite insulators shall comply with the requirements of the IEC publications IEC 61462 and the relevant parts of IEC 62217. The design of the composite insulators shall be tested and verified according to IEC 61462.

- 12.3 **Mechanical forces on bushing terminals:** Outdoor bushings must be capable of withstanding cantilever forces due to weight of bus duct (GIB) on one side & AIS conductor/Al tube on the other side and short circuit forces.

- 12.4 Type test reports as per applicable IEC including radio interference voltage (RIV) test shall be submitted in line with the requirement as specified in section GTR for approval. Design calculations in support of the cantilever strength chosen shall be submitted for owners review and approval.

- 12.5 The technical parameters of Bushing are as per **ANNEXURE-6**.

13. GIS TO CABLE TERMINATION (If applicable)

- 13.1. This scope covers the supply, erection, commissioning of connection assembly of fluid-filled or extruded cables to gas-insulated metal enclosed switchgear (GIS) as per IEC 62271-209

- 13.2. The XLPE cables shall be connected to GIS by the interfacing of XLPE cable sealing end to GIS Cable termination enclosure.

- 13.3. The GIS to XLPE cable termination shall conform to IEC-62271-209.

- 13.4. The rating of XLPE cables for different voltages is specified in the Section project.

- 13.5. The limits of supply of gas-insulated metal-enclosed switchgear and the cable termination shall be in accordance with IEC 62271-209.

- 13.6 Cable termination and cable connection enclosure shall be suitable for the requirements for which it is designed. This interface section shall be designed in a manner which will allow ease of operation and maintenance.

- 13.7 The SF6 cable end unit and connection support structure should be equipped with provisions for isolating the cable sheath or pipe to permit cathodic protection of cable system.(see IEC62271-209)

- 13.8 The provision shall be made for a removable link. The gap created when the link is removed should have sufficient electric strength to withstand the switchgear high voltage site tests. The

contractor may suggest alternative arrangements to meet these requirements. The corona rings/stress shields for the control of electrical field in the vicinity of the isolation gap shall be provided by the GIS manufacturer.

- 13.9 All supporting structures for the SF6 bus-duct connections between the XLPE cable sealing ends and the GIS shall be the scope of the contract. The supplier may specify alternative connecting & supporting arrangements for approval of the Employer.
- 13.10 The opening for access shall be provided in each phase terminal enclosures as necessary to permit removal of connectors to isolate the XLPE cables to allow carrying out the insulation tests. The general arrangement drawing of interconnecting bus-duct from GIS bay module to XLPE cable termination end shall also be submitted.
- 13.11 Type test reports of radio interference voltage (RIV) level shall be submitted for approval.

14. TRANSFORMER / REACTOR TERMINATION

14.1. TRANSFORMER / REACTOR Direct Connection with GIS (if applicable)

- 14.1.1. The limits of supply of gas-insulated metal-enclosed switchgear and the direct connection to oil filled transformer shall be in accordance with IEC 62271-211.
- 14.1.2. The transformer / reactor termination module enables a direct transition from the SF6 gas insulation to the bushing of an oil-insulated transformer / reactor. For this purpose, the transformer/reactor bushing must be oil-tight, gas-tight and pressure resistant. Any temperature related movement and irregular setting of the switchgear's or transformer's/reactor's foundations are absorbed by the expansion fitting.
- 14.1.3. Terminal connection arrangement to connect GIS duct to bushing and duct mounting arrangement details shall be submitted during detailed engineering for Employer's approval and for co-ordination with transformer and reactor supplier. Any modification suggested by transformer and reactor supplier shall have to be carried out by the GIS supplier to facilitate proper connection with the bushings of the transformer and reactors.

14.2. TRANSFORMER / REACTOR Connection with SF6/Air Bushing

- 14.2.1. The oil filled transformers and reactors are as shown in the substation SLD. The oil to air bushings of the transformers and reactors shall be supplied by the respective Transformer/Reactor supplier and the same shall be connected to the SF6 ducts thru air to SF6 bushings to be provided under present scope.
- 14.2.2. In case of single phase Transformers/Reactors are being installed in the substation, HV&IV auxiliary bus for the Transformer/Reactor bank for connecting spare unit shall be formed inside the GIS hall as per the SLD furnished and as specified in Section project.

15. LOCAL CONTROL CUBICLE (LCC)

15.1. Functions

- 15.1.1. Each circuit-breaker bay shall be provided with a local control cubicle containing local control switches and a mimic diagram for the operation and semaphore/indicating lamp for status indication of the circuit-breaker and all associated isolators and earth switches together with selector switches to prevent local and remote and supervisory controls being in operation simultaneously.
- 15.1.2. Status indications in the LCC shall be semaphore type or LED type.
- 15.1.3. Closing of the circuit- breaker from the local control unit shall only be available when the breaker is isolated for maintenance purposes. Circuit-breaker control position selector, operating control switch and electrical emergency trip push button shall be installed in the Local Control Cubicle. Circuit-breaker control from this position will be used under maintenance and emergency conditions only. The emergency trip push buttons shall be properly shrouded.
- 15.1.4. If Disconnecter or earth switch is not in the fully open or closed position a "Control Circuit Faulty" alarm shall be initiated, and electrical operation shall be blocked.
- 15.1.5. 20% spare terminals shall be provided in each LCC apart from terminals provided for the termination and interconnection of all cabling associated with remote and supervisory control,

alarms, indications, protection and main power supply etc .

- 15.1.6. Where plugs and sockets connect control cabling between the local control cubicle and the switchgear these shall not be interchanged. In plug in connector type cable arrangement, min 2 cores of the cable with connected condition on both side up to the TB to be left unused as spare.
- 15.1.7. Hydraulic/pneumatic and SF6 auxiliary equipment necessary for the correct functioning of the circuit breaker, isolators and earth switches shall be located in a separate cubicle compartment.
- 15.1.8. LCC shall be suitable for remote operation from substation automation system (SAS). Each gas tight compartment shall be monitored individually per phase basis through SAS.

15.2. Constructional features

- 15.2.1. Local Control cubicle shall be either mounted on the GIS with front access or free standing, floor mounting type. It shall comprise structural frames completely enclosed with specially selected smooth finished, cold rolled sheet steel of thickness not less than 3 mm for weight bearing members of the panels such as base frame, front sheet and door frames, and 2.0mm for sides, door, top and bottom portions. There shall be sufficient reinforcement to provide level transportation and installation. Alternatively folded sheet panels of adequate thickness and strength is also acceptable.
- 15.2.2. Access to all compartments shall be provided by doors. All fastenings shall be integral with the panel or door and provision made for locking. Cubicles shall be well ventilated through vermin-proof louvers(if required) having anti insect screen. All doors shall be gasketed all around with suitably profiled Neoprene/EPDM/PU gaskets conforming to the provision of IS 11149. However, XLPE gaskets can also be used for fixing protective glass doors.
- 15.2.3. For LCC panel of each feeder bay (i.e. line, transformer, and reactor etc.), Bus Coupler bay and Bus Sectionalizer bay, separate AC/DC supply for power circuit of GIS switchgear shall be provided, fed directly from ACDB/DCDB. The control DC supply (for control, interlocking, signaling) shall be tapped from respective relay & protection panel. For LCC panel illumination and heating purpose Loop in Loop out AC Supply can be provided.
- 15.2.4. Each panel shall be provided with necessary arrangements for receiving, distributing and isolating of DC and AC supplies for various control, signaling, lighting and space heater circuits. The incoming and sub-circuits shall be separately provided with Fuses/MCBs. All fuses shall be HRC cartridge type conforming to IS: 13703 mounted on plug-in type fuse bases. The short time fuse rating of Fuses shall be not less than 9 KA. Fuse carrier base shall have imprints of the fuse 'rating' and 'voltage'.
- 15.2.5. Each LCC Panel shall be provided with the following
 1. **Plug Point:** 240V, Single phase 50Hz, AC socket with switch suitable to accept 5/15Amps pin round standard Indian plug, shall be provided in the interior of each cubicle with ON-OFF switch.
 2. **Interior Lighting:** Each panel shall be provided with a door-operated LED lighting fixture rated for 240 Volts, single phase, 50 Hz supply for the interior illumination of the panel controlled by the respective panel door switch.
 3. **Space Heater:** Each panel shall be provided with a thermostatically connected space heater rated for 240V, single phase, 50 Hz AC supply for the internal heating of the panel to prevent condensation of moisture. The fittings shall be complete with switch unit.
- 15.2.6. Operating mechanisms, auxiliary switches and associated relays, control switches, control cable terminations, and other ancillary equipment shall be accommodated in sheet steel vermin proof cubicles.
- 15.2.7. Local control cubicles shall be provided to be free standing and shall be equipped with anti-condensation heaters. A suitable humidity stat and thermostat shall be included in the heater circuit.

- 15.2.8 The interior of each cubicle shall be finished with a semi gloss white surface. An interior lamp suitable for the local LVAC supply, controlled by a door-operating switch, shall be fitted at the top of each panel.
- 15.2.9 The arrangement of equipment within cubicles shall be such that access for maintenance or removal of any item shall be possible with the minimum disturbance of associated apparatus. All the control switches shall be internal i.e. installed behind a lockable glass door, that allows a complete view of the annunciator and mimic diagram when the LCC door is closed. Necessary protection shall be provided to avoid inadvertent operation of control switches.
- 15.2.10 An interlocking scheme shall be provided that takes into account the following basic requirements.
- I. To safeguard maintenance personnel who may be working on one section of the equipment with other sections live.
 - II. prevent incorrect switching sequences that could lead to a hazardous situation to plant, equipment and personnel.
- 15.2.11 Electrical bolt interlocks shall be energized only when the operating handle of the mechanism is brought to the working position. Visible indication shall be provided to show whether the mechanism is locked or free. Means, normally padlocked/handle lock, shall be provided whereby the bolt can be operated in the emergency of a failure of interlock supplies.
- 15.2.12 Where key interlocking is employed tripping of the circuit breaker shall not occur if any attempt is made to remove the trapped key from the mechanism. Any local emergency-tripping device shall be kept separate and distinct from the key interlocking.
- 15.2.13 Disconnecting switches shall be so interlocked that they cannot be operated unless the associated circuit-breaker is open except that where double bus bar arrangements are specified, on-load transfer of feeder circuits from one bus bar to another shall be made possible by interlocks which ensure that the associated bus coupler and its isolators are closed.
- 15.2.14 Bus coupler circuit breaker shall be interlocked so that it shall not be possible to open a bus coupler circuit breaker while on load change over on that side of the breaker is in progress.-
- 15.2.15 All isolating devices shall be interlocked with associated circuit-breakers and isolators in the same station so that it shall not be possible to make or break current on an isolating device unless a parallel circuit in that station is already closed.
- 15.3. **Cabling between LCC Panel and GIS equipment**
- 15.3.1. The unarmored screen cable shall be of 1.1kV grade, multi core, annealed copper conductor, Tinned copper braided screen (approx. 85% coverage).
- 15.3.2. The core insulation and outer sheath of cable shall be of halogen-free special polymer.
- 15.3.3. The cable shall be flame-retardant, flexible, abrasion-and wear-resistant.
- 15.3.4. The size of core shall not be less than 2.5 sq. mm for instrument transformers and 1.5 sq. mm for other control cable.
- 15.3.5. Prefabricated cables with heavy duty multi-point plug-in connections on GIS end shall be provided.
- 15.3.6. All instrument transformer connections shall be hard wired to terminal block via ring type connection.

16. GIS BUILDING

- 16.1. The buildings shall house each voltage class Gas Insulated Switchgear (GIS) and other associated equipment inside each of the GIS buildings. GIS building(s) shall be constructed for the specified number of bays/diameters as per section project.
- 16.2. For finalizing the dimensions of GIS building the requirement of Turning radius to rotate the largest removable component for assembly/disassembly shall be taken in to consideration.
- 16.3. Wherever GIS Building of already exists, then the existing GIS Building(s) for respective voltage class shall be suitably extended keeping the width of the building same to accommodate the number of bays/diameters as specified in the Section Project/BPS.
- 16.4. The contractor shall submit the design & construction proposal of the building along with necessary information, data, and drawings during the detailed engineering according to the complete requirements.
- 16.5. The area for GIS Building(s) is indicated in the BPS. The area given is for reference only and

may vary according to the requirement of the equipment to be installed inside. The contractor shall finalize the dimensions according to the equipment offered by them providing enough space & access for erection, operation and maintenance.

- 16.6. The contractor shall place their panels i.e. Bay level units, bay mimic, relay and protection panels, RTCC panels, Communication panels etc. in a separate Relay Panel Room in the GIS building. The size of the room shall be such that all the panels for the bays/ diameters as per clause 16.1 shall be accommodated in the above room. The panel room shall be air-conditioned. Further, the temperature of the room shall be monitored through substation automation system by providing necessary temperature transducers.

17. ELECTRIC OVERHEAD CRANE :

- 17.1. Two EOT Cranes of suitable capacity shall be provided for erection & maintenance of largest/heaviest GIS component/assembly for each of 400kV, 220kV, 66kV GIS hall/building. The crane shall consist of all special requirements for erection & maintenance of GIS equipment.
- 17.2. The capacity of the crane shall be sized to lift the heaviest GIS switchgear component.
- 17.3. The Crane shall be used for the erection and maintenance of the GIS switchgear components installed in the GIS switchgear room. On completion of erection of the switchgear, the Contractor shall completely service the crane before the Taking Over Certificate is issued.
- 17.4. Crane hook approaches shall be of the minimum possible dimensions to ensure maximum coverage of the GIS building area.
- 17.5. The crane(s) shall be capable of lifting and accurately positioning all loads ranging from full crane rated capacity to at least 10% rated capacity.
- 17.6. Crane shall be designed for operation under following variable speeds through VVVF drives at full load :

Hoisting: 0.3 – 3 Meters per Minute

Cross Travel: 1.6 – 16 Meters per Minute

Long Travel: 2.0 – 20 Meters per Minute

- 17.7. The electric overhead cranes shall be provided with walkways, platforms. shall be provided along the bridge rails and on the crab of EOT crane to facilitate cleaning/maintenance of the crane and to give access to the GIS room high bay lighting and ventilation duct and grilles.
- 17.8. The platform and walkways shall be designed to support any weight to be imposed upon them during crane overhaul.
- 17.9. An access platform shall be provided together with a guarded ladder to allow access to the bridge rails.
- 17.10. The crane shall be provided with pendant control and RF control.
- 17.11. Contractor shall submit the capacity calculation of crane for GIS hall considering a factor of safety of rope as at least 5.
- 17.12. The Capacity of Cranes to be provided for GIS Hall shall confirm following.
- a) The crane for 400kV GIS hall shall have capacity of minimum 6T safe working load & minimum hook height of crane have shall be 9.0 meters or as per actual requirement whichever is higher.
- b) The crane for 220kV GIS/66kV/33kV GIS shall have capacity of minimum 5T/3T safe working load & minimum hook height of crane have shall be 8.0/6.0 meters respectively or as per actual requirement whichever is higher.
- 17.13. In case the GIS hall is to be extended, the scope of work also involves extension of EOT crane girders and all necessary Electrical & Mechanical accessories to facilitate movement of existing EOT crane in the extended portion of GIS hall. Cost of the same shall be deemed to be covered in the building cost.
- 17.14. The following tests shall be carried out on EOT Crane.

1. The crane shall be tested at manufacturer work under full load and 25 percent overload of hoisting and cross transverse motions as a routine test.
2. Further the following tests may be done at site after installation of the crane at site
 - a. Check all the accessories for proper function
 - b. No load test
 - c. Load test as per site conditions

18. SEISMIC DESIGN CRITERIA:

The equipment shall be designed for operation in seismic zone for earthquake resistance. The seismic loads are due to the horizontal and vertical acceleration which may be assumed to act non concurrently. Seismic Qualification requirements shall be as per IEC 62271-207 for the design of equipment. The equipments along with its parts shall be strong enough and sufficiently well connected to resist total operating stresses resulting from the forces in normal operation but in case of abnormal condition shall also resist with forces superimposed due to earthquakes. The copies of type test reports for similar rated equipment, if tested earlier, should be furnished. If the equipment has not been type tested earlier Test Report/Analysis Report should be furnished during detailed engineering.

To prevent the movement of GIS sub assemblies i.e. various bay modules during the earthquake, suitable devices shall be provided for fixing the sub assemblies to the foundation. The contractor shall supply necessary bolts for embedding in the concrete foundation. The fixing of GIS sub assemblies to the foundation shall be designed to withstand the seismic events. It will also be ensured that the special devices as well as bolts shall not be over stressed. The details of the devices used and the calculations for establishing the adequacy shall be furnished by the supplier and shall be subject to the approval.

19. DESIGN REVIEW

- 19.1. Design reviews shall be conducted by Employer; however the entire responsibility of design shall be with the supplier.
- 19.2. Employer may also visit to the supplier's works to inspect design, manufacturing and test facilities.
- 19.3. The design review will commence after placement of award with the successful contractor and shall be finalized before commencement of manufacturing activity. These design reviews shall be carried out in detail to the specific design with reference of the GIS under the scope of this specification. Employer reserve the right to waive off the design review during detailed engineering.
- 19.4. The design review shall be conducted generally following the, "User Guide for the application of Gas Insulator Switchgear (GIS) rated voltage of 72.5kV and above" – CIGRE report No. 125 prepared by CIGRE Working Group 23.10.
- 19.5. The manufacturer will be required to demonstrate the use of adequate safety margins for thermal, mechanical, dielectric, insulation coordination and vibration etc. design to take into the account the uncertainties of his design and manufacturing processes.
- 19.6. The scope of such a design review shall at least include the following:
 1. Dielectric Stress of Solid Insulation Like Gas barrier, Support insulator etc.
 2. Dielectric Stress of SF6 Gas Volume.
 3. Mechanical strength of enclosure, expansion joints etc.
 4. Criteria for providing expansion joint.
 5. Sealing system

6. Insulation coordination
 7. Thermal stress and resulting increase in gas pressure during short circuit condition.
 8. Earthing of enclosure w.r.t circulating current.
 9. Seismic design, as per IEC 62271-207
 10. Circuit Breaker.
 11. Isolator and Earth switch.
 12. Voltage transformer.
 13. Current Transformer.
 14. Arrester.
 15. Bushing.
 16. Ducting.
 17. Corrosion protection.
 18. Electrical and physical Interfaces with substation.
 19. Testing capabilities.
 20. Inspection and test plan
 21. Transport and storage.
 22. Maintainability.
 23. Site Test
- 19.7. Further, the manufacturer shall furnish the following information during detailed engineering:
- a) Details regarding the loosely distributed metallic particles within the GIS encapsulation and calculations of critical field strength for specific particles of defined mass and geometry.
 - b) Study report of VFTO generated for GIS installation.
 - c) The methodology and all the equipment for electrical partial discharge (PD) detection, including that mentioned in the specification else-where.
 - d) The calculations and documents in support of the average intensity of electromagnetic field on the surface of the enclosure above during detailed engineering.
 - e) The detailed criteria/ design regarding location of pressure relief devices/rupture diaphragms
 - f) Calculations to show that there is no Ferro resonance due to capacitance of GIS for the voltage transformers
 - g) Design calculation for simulated parameters for Seismic level as applicable
 - h) Insulation Coordination studies including studies to recommend for additional surge arrestor
 - i) Calculations in support of touch & step voltages in all enclosures and earthing of complete GIS installation.
 - j) Measures to mitigate transient enclosure voltage by high frequency currents.
 - k) Calculation for providing bus duct supports.

20. TYPE TESTS

The offered GIS equipment shall conform to the type tests as per IEC-62271-203. Contractor shall submit type test reports for the following type tests & additional type tests.

Sl.	Description of the Type Test for GIS
1	Tests to verify the insulation level of the equipment and dielectric test on auxiliary circuits
2	Tests to prove the temperature rise of any part of the equipment and measurement of the resistance of the main circuit
3.	Tests to prove the ability of the main and earthing circuits to carry the rated peak and rated short time withstand current.
4	Tests to verify the making and breaking capacity of the included switching Devices.
5.	Tests to prove the satisfactory operation of the included switching devices.

6	Tests to prove the strength of the enclosures.
7	Gas tightness tests.
8	Tests on partitions.
9	Tests to prove the satisfactory operation at limit temperatures
10	Tests to assess the effects of arcing due to internal fault
11	Verification of the degree of protection of the enclosure
12	Tests to prove performance under thermal cycling and gas tightness tests on Insulators.
13	Additional tests on auxiliary and control circuits
14.	Reactor current switching test For Reactive Current switching capability as per Clause 6.4.1.
15.	Test to demonstrate the Power frequency withstand capability of breaker in open condition at lock out pressure
16	Electromagnetic compatibility tests (if applicable)
17	Radio inference voltage tests

The test reports of the above type tests for GIS (including type test report on Circuit breaker, Disconnect Switch, Grounding switches, Current and Voltage transformers as per relevant IEC and type tests of SF6/Air & Oil bushing as per IEC 60137 shall be submitted for approval as per Section- GTR, Technical Specification.

21. MISCELLEANOUS

- 21.1. **Painting of enclosure:** All enclosures shall be painted externally as per manufacturer's painting procedure.
- 21.2. **Heaters:** Wherever required, heaters shall be provided to prevent moisture condensation inside various Marshaling boxes.
- 21.3. **Identification & rating plate**
Each bay shall have a nameplate showing
 - a) Each module will have its own Identification & rating plate. The rating plate marking for each individual equipment like Circuit breaker, Disconnect Switch Grounding switches, Current transformer, Voltage transformers, Surge arrester etc shall be as per their relevant IEC.
 - b) A schematic diagram indicating their relative locations.
 - c) DTL Contract no.

22. TRANSPORT OF EQUIPMENT TO SITE

The contractor shall be responsible for the loading, transport, handling and offloading of all equipment and materials from the place of manufacture or supply to site. The contractor shall be responsible to select and verify the route, mode of transportation and make all necessary arrangement with the appropriate authorities as well as determining any transport restrictions and regulations imposed by the government and other local authorities. All transport packages containing critical units viz Circuit breakers and Voltage transformers shall be provided with sufficient number of impact recorders (on returnable basis) during transportation to measure the magnitude and duration of the impact in all three directions. In case of electronic impact recorder, the recording shall commence in the factory and must continue till the units reach site. The data of electronic impact recorders shall be downloaded at site and a soft copy of it shall be handed over to Engineer – in –charge. Further, contractor shall communicate the interpretation of the data within three weeks.

23. PACKING, STORAGE AND UNPACKING

- 23.1. All the equipment shall be carefully packed for transport by sea, rail and road in such a manner that it is protected against the climatic conditions and the variations in such conditions that will be encountered enroute from the manufacturer's works to the site.

- 23.2. The SF6 metal clad equipment shall be shipped in the largest factory assembled units that the transport and loading limitations and handling facilities on site will allow to reduce the erection and installation work on site to a minimum.
- 23.3. Where possible all items of equipment or factory assembled units shall be boxed in substantial crates or containers to facilitate handling in a safe and secure manner. Should the units be considered too large for packing in crates, they shall be suitably lagged and protected to prevent damage to any part, particularly small projections, during transport and handling. Special lugs or protective supports shall be provided for lifting to prevent slings and other lifting equipment from causing damage. Each crate, container or shipping unit shall be marked clearly on the outside to show where the weight is bearing and the correct position for the slings.
- 23.4. Each individual piece to be shipped, whether crate, container or large unit, shall be marked with a notation of the part or parts contained therein.
- 23.5. Special precautions shall be taken to protect any parts containing electrical insulation against the ingress of moisture. This applies particularly to the metal clad equipment of which each gas section shall be sealed and pressurized prior to shipping. Either dry nitrogen/air or dry SF6 gas shall be used and the pressure shall be such as to ensure that, allowing for reasonable leakage, it will always be greater than the atmospheric pressure for all variations in ambient temperature and the atmospheric pressure encountered during shipment to site and calculating the pressure to which the sections shall be filled to ensure positive pressure at all times during shipment.
- 23.6. Blanking plates, caps, seals, etc., necessary for sealing the gas sections during shipment to site which may on later stage necessarily be used during repair and maintenance shall remain the property of DTL. Balance blanking plates, caps, seals, etc shall be returnable to the contractor. If considered necessary, blanking plates or other sealing devices shall be provided with facilities for measuring the gas pressure and recharging at any time during the transport period. Any seals, gaskets, 'O' rings, etc. that may be used as part of the arrangement for sealing off gas sections for shipment of site, shall not be used in the final installation of the equipment at site. Identification numbers shall be stamped into the blanking plates, etc., and on the switchgear equipment to which they are fitted so that they can easily be identified and refitted should it ever be necessary to ship sections of the switchgear back to the manufacturer's works for repair.
- 23.7. Valves and other gas couplings associated with the switchgear gas systems shall be adequately protected against damage from any bumps or physical blows. They shall also be capped to prevent ingress of dirt or moisture or damage to any coupling, pipes, threads or special fittings. Any explosion vents and other pressure relief devices shall be suitably sealed and protected to prevent accidental exposure of the sealed sections during shipment to site.
- 23.8. For bus ducts involving male and female joints of the current carrying conductor, the same shall be transported in disassembled condition to avoid any damage during transit. All bright parts liable to rust shall receive a coat of anti rusting composition and shall be suitably protected.
- 23.9. The contractor shall ensure that during the period between arrival at site and erection, all materials and parts of the contract works are suitably stored in such approved manner as to prevent damage by weather, corrosion, insects, vermin or fungal growth. The scope of providing the necessary protection, storing on raised platform, as required etc. is included in the works to be performed by the contractor. Cost of the raised platform for temporary storage is deemed to be included in overall cost. The raised platform needs to be made ready before arrival of GIS equipment at site. The contractor may use the available storage areas at site with permission of site in charge.
- 23.10. The equipment shall be unpacked immediately before Installation. They shall not be left lying unnecessarily in open crates or containers. Special precautions shall be taken when gas sections which have been sealed and pressurized for shipping are opened up to reduce the ingress of dirt and atmospheric moisture to a minimum. Whenever possible this shall only be done immediately prior to installation and if any section is to be left outside for any length of time after being opened, it shall be resealed and pressurized with either dry nitrogen or SF6

gas until required.

- 23.11. For the purpose of release of payment linked to receipt and physical verification in case of GIS equipment it shall mean random opening and physical verification of one number of packing unit of each type of main equipment (i.e. GIS CB/ISO/ES/PT/LA etc.) for each voltage level. Thereafter proper re-packing of the GIS unit shall be ensured as per manufacturer recommendation.

24. INSTALLATION OF GIS

- 24.1. Civil works of GIS Hall shall be completed in all respects before taking up the installation and it shall be ensured that Ventilation System is operational and all dust and dirt in the hall are removed. The GIS hall needs to be in positive pressure before starting Installation.
- 24.2. The installation area shall be secured against entry of unauthorized personnel. Only certified manufacturer's engineer and supervisor shall undertake the erection works. Engineers and supervisors of the manufacturer shall submit authorization and competency certificate to DTL.
- 24.3. Un-packaging of GIS modules shall be done outside the GIS hall and in no case module to be taken inside GIS hall with packing.
- 24.4. All assembly work shall be done by qualified personnel only who are to be identified and list submitted to DTL site before starting of erection work.
- 24.5. Assembly drawing for GIS erection for the section under progress shall be available and displayed in GIS hall at the time of erection work.
- 24.6. Working personnel shall clean their shoes or apply covers on shoes before entering the immediate working area. The working clothes of authorized personnel shall be made of non-fluffy material.
- 24.7. GIS hall door shall have automatic close facility after entry of personnel to avoid dust and moisture entry. Walls and ceiling shall be in a condition so that neither dirt nor plaster might fall or rub off and formation of condensation water in ceiling shall be prevented under any circumstances.
- 24.8. Floor in the installation area shall have a firm surface and shall be kept dust free with a vacuum cleaner. Vacuum cleaning to be done on regular basis.
- 24.9. Only T&P and consumables required for GIS erection shall be kept in GIS during erection.
- 24.10. In case of outdoor installation of GIS or of GIS components open gas compartments shall be protected from dust and moisture ingress (by tarpaulin covers/protective enclosure/chamber etc)
- 24.11. Bus duct exits in the GIS hall's wall shall be kept covered by suitable means until permanent cover is provided after installation of bus ducts.
- 24.12. Maintenance room (as a part of LCR room) shall be constructed for carrying out repair works/ small part assembly. All excess material (not required for immediate installation works) test equipment and tools and tackles to be stored separately from GIS hall in this room for rework.
- 24.13. Erection agency shall submit method statement and make available formats for checking during each stage of hall preparation, assembly process and final checks to be approved by DTL site before start of erection. Shock recorder down loaded data and analysis shall be submitted preferably before commencement of erection work. In case of violation of shock limits, expert from manufacturer shall visit and do the joint internal inspection and shall submit analysis report before giving clearance for erection. If required the module shall be taken back to factory for further analysis and testing.
- 24.14. Cleaning is of utmost importance and hence before assembly, all the loose metal parts, subassemblies and all contact & sealing surfaces shall be cleaned before installation. Cleaning shall be carried out with specified cleaning agents of the manufacturer, in no condition water is to be used except for external surfaces. Further, prior to opening of gas compartment, the same shall be thoroughly cleaned externally. The vacuum cleaning of the installation area shall also be done specially the immediate vicinity of the flanges to be connected.
- 24.15. All Civil Work inside building including internal cable trench shall be completed before GIS installation.
- 24.16. Installation of flanges shall be done immediately after removal of transport covers. Transport covers, O-rings and other packing material of GIS shall be taken out immediately after

- removal.
- 24.17. O Rings shall be properly stored and taken out only before installation. O Rings are also to be cleaned before use with manufacturer authorized cleaning agent.
 - 24.18. At all points of time during installation authorized personnel shall use suitable gloves to avoid contamination.
 - 24.19. Cable termination work shall commence only after completion of GIS equipment erection, as during GIS installation period laying and termination of cables interferes with the GIS erection work and affects cleanliness.
 - 24.20. Approved Field Quality Plan shall be followed during site work.
 - 24.21. Proper power supply shall be ensured by installing DG Set of proper rating and frequency if required prior to commencement of erection work so that assembly work is not interrupted in the middle which is critical for GIS installation.

25. ON SITE TESTING

After the GIS Switchgear has been fully installed at site and SF6 gas filled at rated filling density, the complete assembly shall be subjected to the site tests as per IEC-62271-203 and with the test voltages specified below:-

- 25.1. Application of Power Frequency voltage test for duration of 1 minute with the value as per IEC 62271-203.
- 25.2. Directly after the above test at 25.1, Switching impulse test with three impulses of each polarity and with the value (80 % of the rated switching Impulse withstand level) as per IEC 62271-203.
- 25.3. In case of a disruptive discharge in the gas as outlined in clause no: C.6.2.2 Procedure b), Annexure-C of IEC 62271-203 during the AC voltage test and a repeat test is performed due to this failure, then the repeat test shall be carried out at Specified voltage.
- 25.4. In case of a disruptive discharge in the gas as outlined in clause no: C.6.2.2 Procedure b) Annexure-C of IEC 62271-203 during Oscillating Switching Impulse Test and a repeat test is performed due to this failure then the repeat test shall be carried out at a value equal to 90 % of the rated switching Impulse withstand level.
- 25.5. Method statement/ procedure of ON SITE high voltage testing, PD measurement and Switching Impulse test shall be submitted by contractor in advance. The adequacy of number of UHF sensors and their location shall be verified as per recommendations of CIGRE task force **TF 15/33.03.05 (Task force on Partial discharge detection system for GIS: Sensitivity verification for the UHF method and the acoustic method)**. In case during site testing additional UHF sensors are required, the same shall also be supplied and installed to complete the technical requirement.
- 25.6. Application of AC voltage equal to 1.2 times the service voltage in order to condition the GIS whilst at the same time permitting measurement of Partial discharge and detection of conductive particles by UHF method.
- 25.7. In case of a disruptive discharge in the gas as outlined in clause no: C.6.2.2 Procedure b) annexure – C of IEC : 62271-203 , and a repeat test is performed due to failure during the AC voltage test , then the test shall be carried out at 1.2 times the service voltage .
- 25.8. The analysis of PD measured during High voltage test shall be done very carefully and presence of PD measured by any sensor shall be attended and HV test shall be repeated after the rectification work. Calibration of PD sensors shall be completed before start of HV test to establish reference for detection of PD above 5 pc.
- 25.9. Method statement/ procedure of onsite high voltage testing and PD measurement shall be submitted by contractor in advance.

26. VENTILATION SYSTEM FOR GIS HALL

- 26.1. 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.

- 26.2. 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:
- i. Pre Filters: To remove dust particles down to 10 micron in size with at least 95% efficiency.
 - ii. 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.
- 26.3. The ventilation of the GIS hall shall be of a positive pressure type with minimum 4 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.
- 26.4. In case of extension of GIS hall is covered under the present contract, separate ventilation system shall be provided meeting the functional requirement as specified above and the same shall be integrated with existing ventilation system.

27. MANDATORY SPARE

Design, engineering, manufacture, testing, supply on FOR destination site basis including transportation & insurance, storage at site of Mandatory spares for the GIS(As specified in BPS).

28. TESTING & MAINTENACE EQUIPMENT

Testing & Maintenance equipment shall be offered, as per relevant schedule of BPS.

28.1. SF6 Gas leakage detector.

28.2. The technical specification of SF6 Gas leakage detector shall be as per **Annexure-8**

28.3. Gas filling and evacuating plant : (Gas Processing unit)

- I. The plant necessary for filling and evacuating the SF6 gas in the switchgear shall be supplied to enable any maintenance work to be carried out. This shall include all the necessary gas cylinders for temporarily storing the evacuated SF6 gas. The capacity of the temporary storage facilities shall at least be sufficient for storing the maximum quantity of gas that could be removed from at least one phase of one complete bay (switchgear and associated equipment).
- II. Where any item of the filling and evacuating plant is of such a weight that it cannot easily be carried by maintenance personnel, it shall be provided with lifting hooks for lifting and moving with the overhead cranes.
- III. The minimum capacity parameters of evacuation plant will be as under :

Oil Free Suction (Recovery) Pump:	30 M ³ /Hour
Compressor (Two Stage):	15 M ³ /Hour
Oil Free Vacuum Pump:	100 M ³ /Hour
- IV. The evacuation equipment shall be provided with all the necessary pipes, couplings, flexible tubes and valves for coupling up to the switchgear for filling or evacuating all the gases.
- V. Details of the filling and evacuating plant that will be supplied, as well as the description of the filling and evacuating procedures shall be furnished

28.3. SF6 gas analyzer: The technical specification of SF6 gas analyzer shall be as per(As per Annexure-9)

28.4. Portable Partial Discharge(PD) monitoring system (Shall generally applicable for

220kV,66kV & 33 kV)

- I. The equipment shall be used for detecting different types of defects in Gas Insulated Stations (GIS) such as Particles, Loose shields and Partial Discharges as well as for detection of Partial discharges in other types of equipment such as Cable Joints, CTs and PTs.
- II. It shall be capable for measuring PD in charged GIS environment as EHV which shall have bandwidth in order of 100 MHz–2GHz with possibility to select a wide range of intermediate bandwidths for best measurement results. The principle of operation shall be based on UHF principle of detection. The instrument should also be able to detect partial discharges in cable joints and terminations.
- III. Detection and measurement of PD and bouncing particles shall be displayed on built in large LCD display and the measurement shall be stored in the instrument and further downloadable to a PC for further analysis to locate actual source of PD such as free conducting particles, floating components, voids in spacers, particle on spacer surfaces etc. Software for display and diagnosis of PD signals and an expert software system for accurate interpretation of cause of PD shall also be supplied and installed by the contractor.
- IV. The equipment shall meet the following requirements
 1. Measurement shall be possible in noisy environment.
 2. Stable reading shall be possible in presence of vibrations within complex GIS assemblies, which can produce signals similar to PD.
 3. Equipment should have necessary synchronizing circuits to obtain PD correlation with power cycle and power frequency.
 4. The equipment shall be battery operated with built-in-battery charger. It shall also be suitable for 230V AC/50 Hz input.
 5. Measurement shall be possible in the charged switchyard in the presence of EMI/EMC. Supplier should have supplied similar detector for GIS application to other utilities. Performance certificate and the list of users shall be supplied along with the offer.
 6. Instrument shall be supplied with standard accessories i.e., re-locatable sensors with mounting arrangements, connecting cables (duly screened) to sensors, Lap-top PC, diagnostic and expert interpretation software, carrying case, rechargeable battery pack with charger suitable for 230V AC, 50Hz supply connecting cables (duly screened) to view in storage.
 7. The function of software shall be covering the following:
 - a) Data recording, storage and retrieval in computer
 - b) Data base analysis
 - c) Template analysis for easy location of fault inside the GIS
 - d) Evaluation of PD measurement i.e, Amplitude, Phase Synchronization etc.
 - e) Evaluation of bouncing/loose particles with flight time and estimation on size of particle.
 - f) Expert software system for accurate interpretation of cause of PD.
 - g) Report generation.
 8. To prove the suitability in charged switchyard condition, practical demonstration shall be conducted before acceptance.
 9. Supplier shall have “Adequate after sales service” facility in India and shall provide the document in support of this.
 10. Necessary training may be accorded to personnel to make use of the kit for locating PD sources inside the GIS
 11. Instrument shall be robust and conform to relevant standard.

- IV. **Calibration/Sensitivity verification:** The UHF Couplers have to be first calibrated as per CIGRE Document No.654 as part of factory acceptance tests to guarantee detection sensitivity of 5pC or better. The GIS of same design shall be used as test specimen during the coupler calibration. The pulse injection level determined through above factory calibration tests shall only be used as reference for site sensitivity checks during commissioning of PDM system. The data sheet/frequency response characteristics shall be submitted for reference.
- V. Pulse generator, same type as that of used during factory testing for UHF sensor sensitivity test shall be supplied as a standard accessory.

28.5. Online Partial Discharge Monitoring System (Applicable 400 kV GIS)

- a) GIS equipment shall be designed so as to minimize partial discharge or other electrical discharge. A state-of-the-art Partial Discharge Monitoring system shall be provided to monitor the entire GIS installation.
- b) An on-line continuous Partial Discharge Monitoring (PDM) system shall be designed to provide an automatic facility for the simultaneous collection of PD data at multiple points on the GIS & its associated GIB ducts and Voltage Transformers adopting UHF technique. The data stored shall provide a historical record of the progress of PD sources and shall identify the areas of maximum activity.
- c) On-line continuous Partial Discharge Monitoring (PDM) system shall be capable for measuring PD in charged GIS environment as EHV which shall have bandwidth in order of 100 MHz–2GHz with possibility to select a wide range of intermediate bandwidths for best measurement results. The principle of operation shall be based on UHF principle of detection.
- d) The scope shall cover Engineering, supply, installation, testing and commissioning of partial discharge continuous monitoring system, with all necessary auxiliaries and accessories to make a complete system as per technical specification, including site demonstration of successful operation. Any items/accessories necessary to make the system fully functional for the trouble free online PD monitoring of complete GIS installation shall be considered as included in the scope.

The PDM system shall be provided with all its hardware and software, with readily interfacing to the UHF PD couplers installed in the GIS of present bays and future bays as shown in SLD plus 20% additional as extra. Details of this shall be submitted during engineering stage for approval.

The integration of UHF PD coupler in future GIS bays shall be done in respective package. The number of UHF PD coupler for future bays shall be decided based on GIS layout finalized under present scope (considering present GIS equipment with future provision).

The PD Monitoring PC Work Station shall be housed in a lockable cabinet with duplicate keys and shall be located in the control room of the GIS substation. Workstation PCs shall be pre-loaded with all necessary Hardware & Software. The PCs shall have each Combo drive & Retrievable disk drive (1 TB), Ethernet port 100Mbps, printer. The workstation PC shall be powered by suitable dedicated UPS and same is included in the present scope.

- e) Design of on-line PDM System
 - 1. The technical proposal for PDM system along with detailed design documentation shall be submitted for EMPLOYER'S approval during engineering stage.
 - 2. To guarantee that sufficient coverage is available for complete GIS installation to monitor PD activity all design details shall be submitted as part of the above for review.
 - 3. The sensitivity of the offered system shall be in accordance with CIGRE Document No. 654 that will be verified as part of site sensitivity tests.

4. UHF attenuation data of GIS shall be submitted for the switching devices, spacers, bends etc.
 5. The signal attenuation level of co-axial cable per meter length and justification for the length of cable connection between the couplers and detector units shall be furnished.
 6. The overall sensitivity of PD detection system shall take into account the spacing between couplers and the associated cabling, filters, amplifiers, etc.
 7. The Sub-station GIS layout as a separate drawing indicating position of spacers, spread over of PD sensors with distance, sensor identification, the detector unit identification etc. shall be submitted during engineering stage for approval.
 8. The PD sensors shall be identified / coordinated with the corresponding detector unit etc. with proper identification labeling and indicated in the substation PDM SLD.
 9. Internal arrangement/wiring diagram is to be submitted for detector units/control cabinet etc. All internal items are to be identified / labeled to facilitate troubleshooting.
 10. Supply requirement (AC & DC) to be specified for the complete monitoring system.
 11. Power supply to PDM PC shall have protection against surges, overload and short circuit. A dedicated on-line UPS system shall also be provided as a backup during supply interruption, to ensure trouble-free & reliable running of the PDM System for a minimum of 15 minutes duration. Ratings of UPS shall be proposed for the approval of EMPLOYER'S. The UPS shall have enough capacity to initiate a 'safe' shut down of the PDM PC and the peripherals after this 15-minute period if normal supply fails to resume. The PDM PCs shall restart automatically on resumption of normal supply. The UPS shall not generate spikes during changeover of supply. UPS shall automatically give indication / alarm when it requires battery replacement. Potential Free Contacts shall be generated to signal these events. These contacts shall be wired out to Annunciation / Monitoring systems. Alternately, inverter of suitable capacity is also acceptable. Critical Process and Status alarms of the PDM system shall be displayed.
 12. PDM System shall be provided with a user security for accessing the system with a log-on and password entry procedure. The user levels shall be defined as a Master User and other users for the modification of system, update, and entry of parameters or manual operation. System shall be able to generate 3D point on wave pattern whenever any PD activity detected by the system. System shall be able to give online 3D point on wave pattern, online PRPD (phase resolved PD) and online short time trend etc. System shall be able to generate the all the logs related to system fault, system access, PD event, and any changes in system setting etc.
 13. Method of electrical isolation/protection provided between PD sensor and detector circuitry in case of flashover/high potential stress inside GIS should be furnished.
 14. The selected mode of propagation of PD signal (electromagnetic wave) inside GIS for the design of sensors shall be furnished.
 15. The protection available for electronics against transient over voltages caused by switching operations shall be furnished.
 16. The capacity of each detector unit to be specified to accommodate as many numbers of PD sensors signal.
 17. The applicable standards to meet IEC & IEEE requirements for electromagnetic compatibility shall be specified. The offered system should have been tested for the same for working in a 400kV & above substation environment. The necessary documentation has to be submitted in this regard.
 18. Guaranteed technical particulars & data sheet for various components used in the system shall be submitted.
- f) **Calibration:** The UHF Couplers have to be first calibrated as per CIGRE procedure TF15/330305 as part of factory acceptance tests to guarantee detection sensitivity of 5pC or better. The GIS of same design shall be used as test specimen during the coupler calibration.

The pulse injection level determined through above factory calibration tests shall only be used as reference for site sensitivity checks during commissioning of PDM system. The data sheet/frequency response characteristics shall be submitted for reference.

- g) **Every Day Use & Maintenance :** The system shall be designed suitable for an unmanned s/s and operate automatically. The system shall generate alarms if suspected partial discharge activity is noticed or the system itself is in failure, thereby eliminating the necessity of periodic system access by the user and one such alarm shall be connected to Substation automation system (SAS). The alarms shall be configured coupler wise.
- h) **Computers and Peripherals:** The PC operating system shall be the latest version of MS Windows. It should be suitable for continuous process application and should have been tested for the same. The hardware configuration of PC should be the latest available in the market of industrial type subject to EMPLOYER'S / Engineer approval. For storing the historical PD database, sufficient storage facility in the form of hard disc and retrievable hard disk drive of 1TB as specified shall be available in the substation. The PC monitor shall be 21" LCD type of reputed make.
- i) **Filtering Facility:** The filtering facility has to be provided in order to distinguish real PD from internal/external noise such as switching operations, self-test signal, radio, communication signal etc. The PDM system itself shall be able to discriminate the noise from real PD. The exposed gas barriers of the GIS shall be shielded effectively against noise interference & tested. The gas barrier shields/belts shall be suitable for outdoor use also & able to withstand high ambient temperature. Site measurements have to be performed after installation of the PDM system in order to identify the various sources of external noise to incorporate the same in the filtering facility. This filtering will preferably be through software by band pass, which can be manually activated (as an option) to filter out noise signals in the trend plot display. If hardware filtering is employed then adequate measures have to be taken to avoid masking of other signals, which may lie in the same frequency range. The method adopted for the above shall be specified taking into account the sensitivity requirement of PDM system as per CIGRE document. The noise filters shall be selectable individually coupler-wise.
- j) **Self-Test (Diagnostic) Facility:** Built-in self-checking facility shall be incorporated in the control system which will continuously verify the correct operation of the whole monitoring system with the simulated PD signal viz. checking of the sensitivity of individual detector units, response of PD sensors in addition to the checking of the system functioning. The periodicity of such self-check operation shall be specified. In case of system failure this shall trigger an alarm for communication to SAS. External check facility: Propose the arrangement/device available for externally checking the healthiness of PD sensors by pulse injection in addition to built-in monitoring facility.
- k) **Detector Units:** The sensitivity of each detector unit shall be furnished. The sensitivity level of individual detector units shall be selectable depending on the site background noise level.
- l) **Trend Plot:** The trend plot facility shall be available with the update period of hourly/daily/weekly/monthly/yearly. It shall be possible to view the historical trends for the complete archived data accumulated over several years.
- m) **PD Monitoring modes:** There shall be two different modes of system operation viz. a dedicated Continuous PD Monitoring mode for the normal day today operation of the system & a dedicated HV commissioning test mode which is exclusively for PD monitoring during HV commissioning test. The HV commissioning mode shall also operate as an independent feature.
In the HV Commissioning mode the real time display shall be possible for a minimum of two complete bays with associated bus bars and at with one second update period. The HV test software shall automatically record the HV voltage information along with PD so as to check PD inception & extinction voltages precisely. The complete HV & PD data recorded during HV test shall be possible to be reviewed in replay mode after the HV test.
- n) **Alarm Facility:** The PDM system shall generate alarm when action is required; viz. a)

PDalarm (abnormal PD activity indicating a risk of failure) & b) PD system fail alarm to be connected to SAS.

- o) **Real Time Display:** The PDM system should have the facility of Real Time display, which will give an instant indication of PD activity coupler wise, with one-second-update period. The PDM system shall be able to capture the PD data triggered by associated switching operations of CBs & isolators.
- p) **Schematics:** The PDM system should have GIS schemes bay-wise incorporating PD sensor identification and location along with spacer location. The sectional view of typical bay arrangement of GIS showing active parts shall also be included as part of the PDM software.
- q) **Print Option/Facility:** PDM system should have the option/facility of printing all trendplots/reports/POW patterns/displays, etc. Laser Colour printer shall be provided for this purpose at substation.
- r) **Data Archives:** This is to provide access to historical data and file storage with date and time stamp. Sufficient storage facility shall be available to review historical data updated for the lifetime of switchgear. The substation & headquarters PCs shall have a backup device in the form of a retrievable disk drive of 1TB capacity for this purpose.
- s) **PD Fault Identification & Location/Pattern Recognition/Predictive Maintenance**
Diagnostic Software: In order to interpret various types of PD defects, intelligent diagnostics software (expert system) shall be built-in as part of the PDM software capability. This is mainly to reduce the dependence on PD specialist. The bidder shall also make available typical point-on-wave patterns as library pictures to train the user.
Software Updates: It shall be possible to upgrade / update the system software throughout the lifetime of the system with the ongoing development / refinement in PD technology.
- t) **Fault investigation :** In case of any indication of suspected PD activity by the on line system, further investigation has to be carried out by the contractor for the PD defect identification and location during the warranty period
- u) **Special Tools / equipment, Spare Parts, software packages**
 - i. **Special Tools:** Special tools for cutting and crimping of coaxial cable with 'N Connectors' shall be supplied.
 - ii. **Spare parts:** The contractor has to supply critical spares with replacement procedure for the trouble free operation of the system during its expected lifetime as part of the contract. A detailed list shall be included in the tender and also submitted for EMPLOYER'S approval during the detailed engineering stage.
 - iii. **Software Packages:** The complete software package shall be supplied as part of a back-up facility in the form of DVD/CDs viz. Windows operating system with end user license, PDM Software including HV Test, Drivers for modems etc., software for remote access, printer etc. The list shall be submitted for reference.
 - iv. **Pulse generator for UHF sensor sensitivity test** shall also be supplied as a standard accessory.
- v) **Operation & Maintenance Manual :** A complete O&M manual covering all aspects of trouble shooting of PDM system in six sets in original shall be provided & also in CD's. For diagram references colour pictures shall be provided. A step-by-step procedure for spare parts replacement shall also be included.
- w) **Factory / Site Test Formats:** The factory & site tests format to be submitted for approval. The format shall cover all possible tests to confirm healthiness of the system and to record the test values.
- x) **List of References:** The bidder shall provide a reference list of PD monitoring system, which is supplied by them and in successful operation worldwide in a power utility.

29.0 Training

The successful bidder shall arrange free of cost training to engineers of the purchaser/purchaser's representative in design, manufacture and testing of GIS being supplied for 120 man days.

- Four weeks on site and on-job training during erection.
- Two weeks training on GIS at principle manufacturer's works as per

curriculum specified below :

Curriculum for GIS Training

The curriculum of GIS training should at least cover the following aspects. Any other specific area may be brought to notice and included.

1. General Explanation for GIS
2. Layout and Architecture of GIS
3. Gas Sectionalisation of GIS
4. Construction of CB
5. Operating Mechanism of CB
6. Maintenance of CB
7. Overhaul of CB (Interrupting chamber)
8. Overhaul of CB (Operating Unit)
9. Construction of DS/ES
10. Maintenance of DS/ES
11. Overhaul of DS/ ES
12. Construction of Bus/ Cable head/ SF6 – air bushing
13. Maintenance of Bus/ Cable head/ SF6 – air bushing
14. Overhaul of Bus/ Cable head
15. Overhaul of various transformer connections
16. Operation of GIS with SCADA
17. Construction & Maintenance of Lightning Arrester
18. Construction & Maintenance of VT/CT
19. Construction & Maintenance of Local control panel
20. Erection of GIS at site.
21. Installation & Testing of GIS at site
22. Type tests of GIS
23. Routine tests of GIS.
24. Faults simulation of GIS
25. Localization of GIS fault.

30. Service conditions

The equipment and the accessories to be supplied against this technical specification shall be suitable for satisfactory continuous operation under the following tropical conditions.

1. Temperature:		
The reference ambient temperature be taken as 43.3 ° C as per IS 9676.		
a.	Maximum ambient air temperature	50°C
b.	Maximum daily average ambient temp	40°C
c.	Maximum indoor ambient temp	35° C
2. Relative Humidity:		
a.	Maximum Relative Humidity	100%
b.	Minimum Relative Humidity	10%

3.	Average annual rainfall	750 mm
4.	Average no. of rainy day	50
5.	Average no. of thunderstorm days per annum	40
6.	Altitude	Not exceeding 300 meters
7.	Rain months	June to Oct.
8.	Wind pressure as per IS 875	195 Kg/Sq. meters up to 30 meters
9	Seismic Level	Zone-IV, as per IS-1893, Year-2002
10	Pollution class/creepage distance	31 mm/kV

The atmosphere is generally laden with mild acid and dust in suspension during the dry months and is subjected to fog in cold months. Heavy lightening occurs in the area during rainy months (June to October).

All equipment shall be designed to withstand seismic forces, corresponding to an acceleration of 0.3 g horizontal.

ANNEXURE-1

Technical parameters of Circuit Breaker shall be as follows:

S.No.	Details	Unit	400kV	220kV	66kV	33kV
1.	Rated current	A	3000/2000 A (3000 for bus-coupler breaker & I/C bay)/ As per scheme	1600/2500 (2500 for bus-coupler breaker & I/C bay)/ As per scheme	2000/2500 (2500 for bus-coupler breaker & I/C bay)/ As per scheme	1250/2500 (2500 for bus-coupler breaker & I/C bay)/ As per scheme
2.	Operating mechanism		Spring/ hydraulic	Spring/ hydraulic	Spring/ hydraulic	Spring
3.	Rated fault current & its duration	kA	63 (1 sec.)	50 (1 sec.)	31.5 (1 sec.)	31.5 (1 sec.)
4.	Rated short circuit making current	kA	158	125	80	80
5.	Rated operating duty cycle:					
5a)	For auto-reclosing type		O-0.3 sec- CO-3 min- CO	O-0.3 sec- CO-3 min- CO	O-0.3 sec- CO-3 min- CO	NA
5b)	For non-auto reclosing type		-----	-----	-----	CO-15sec-CO
6)	Lightning (Full wave) impulse withstand voltage (1.2/50 μ s)					
6a)	Between line terminals and ground	kVp	± 1425	± 1050	± 325	± 170
6b)	Between terminals with circuit breaker contacts open:	kVp	± 1425 kVp impulse on one terminal & 240 kVp of opposite polarity on the other terminal	± 1200	± 375	± 195
6c	-Lightning impulse voltage applied to one terminal	kVp	1425	---	---	---
6d	-Power frequency voltage applied to opposite terminal	kVp	240	---	----	----
7.	Switching impulse withstand voltage					

S.No.	Details	Unit	400kV	220kV	66kV	33kV
	(250/2500 s) dry & wet					
7a)	Between line terminals and ground	kVp	1050	---	---	---
7b)	Between terminals with circuit breaker contacts open:		900	--	---	---
7c	-Switching impulse voltage applied to one terminal	kVp	900	---	---	---
7d	-Power frequency voltage applied to opposite terminal	kVp	345			
8	One minute power frequency withstand voltage					
8a)	Between line terminals and ground	kV rms	As per IEC			
8b)	Between terminals with circuit breaker contacts open	kV rms	As per IEC			
9)	Minimum corona extinction voltage in open and close position	kV rms	320	156	105	---
10.	Maximum radio interference voltage for frequency between 0.5 to 2MHz in open and close position	Micro-volt	1000 (at 320 kVrms)	1000 (at 156 kVrms)	500 (at 92 kVrms)	---
11.	First pole to clear factor		1.3	1.3	1.3	---
12.	Maximum line charging current (rms)(5)	A	600	125	50	10
13.	Rated cable charging breaking current capacity (rms)	A	400	250	160	50
14.	Break time: -Total break time up to rated breaking current -Rated break time	ms	45 40	65 60	65 60	105 100
15.	Making time (closing time)	ms	<150	<200	<200	<200
16.	Difference in instants of closing/opening of contacts(6)					
	-within a pole	ms	2.5	2.5	--	--
	-Between poles (for opening)	ms	3.3	3.3	--	--
	-Between poles (for	ms	5	5	---	--

S.No.	Details	Unit	400kV	220kV	66kV	33kV
	closing)					
17.	Maximum noise level (7)	dB	140	140	140	140
18.	Maximum over –voltage on switching of transformer on no load	p.u.	<2.3	---	---	---
19.	Closing time	msec	100	100	100	100
20.	DC control voltage	V	220	220	220	220
21.	Auxiliary contacts continuous current rating	A	10	10	10	10
22.	Auxiliary contacts breaking capacity (for circuit time constant >20 ms)	A	2	2	2	2

Annexure-2

The major technical parameters of Disconnector and Earthing Switches for various voltage levels shall be as follows:

S.No.	Details	Unit	400kV System	220kV System	66kV System	33kV System
1.	Nominal/Rated voltage	kV	400	220	66	33
2.	Highest system voltage	kV	420	245	72.5	36
3.	Rated current	A	3150/2000 A (3000 for bus-coupler breaker & I/C bay)/ As per scheme	1600/2500 (2500 for bus-coupler breaker & I/C bay)/ As per scheme	2000/2500 (2500 for bus-coupler breaker & I/C bay)/ As per scheme	1250/2500 (2500 for bus-coupler breaker & I/C bay)/ As per scheme
4.	Rated fault current and its duration	kA	63 (1 sec)	50 (1 sec)	31.5 (1 sec)	31.5 (1 sec)
5.	Rated dynamic short circuit current	kAp	158	125	80	62.5
6.	Operating mechanism		AC motor operated & manual	AC motor operated & manual	AC motor operated & manual	Manual
7.	Lightning (Full wave) Impulse withstand voltage (1.2/50 μ s)					
7a)	Rated insulation Between line terminals and ground(+ve or –ve polarity	kVp	1425	1050	325	170
7b)	Between terminals with disconnector contacts open:	kVp	1425	1200	375	195
	-Lightning impulse voltage applied to one terminal	kVp	1425	--	--	--
	-Power frequency coltage of opposite polarity applied to other terminal	kVp	240	--	--	--
8.	Switching impulse withstand voltage (250/2500 μ s) dry & wet					
8a)	Between line terminals and ground	kVp	1050	--	--	--
8b)	Between terminals with circuit breaker contacts open:	kVp	900	--	--	--

	-Switching impulse voltage applied to one terminal	kVp	900			
	-Power frequency voltage of opposite polarity applied to other terminal	kVp	345			
9.	One minute power frequency withstand voltage:					
9a)	Between line terminals and ground	kVrms	650	460	275	70
9b)	Between terminals with disconnecter contacts open	kVrms	815	530	315	80
10.	Operating time	Sec	<12	<12	<12	<12
12.	Maximum radio interference voltage for frequency between 0.5 to 2 MHz in open and close position	μ-volt	1000 (at 320 kVrms)	1000 (at 156 kV rms)	500 (at 92 kV rms)	--
13.	Total operating time	Sec	<12	<12	<12	<12
15.	DC control voltage	V	220	220	220	220
16.	Auxiliary contacts continuous current rating	A	10	10	10	10
17.	Auxiliary contacts breaking capacity (for circuit time constant >20ms)	A	2	2	2	2

The major technical parameters of Current Transformer

S.No.	Details	Unit	400kV System	220kV System	66kV System	33kV System
1.	Nominal /Rated system voltage	kV	400	220	66	33
2.	Highest system voltage	kV	420	245	72.5	36
3	Rated fault current and duration	kA	63(1 sec)	50(1 sec)	31.5(1 sec)	31.5(1 sec)
4	Rated dynamic short circuit current	kA0	157.5	125	78.75	62.5
5	Lightning (Full wave) impulse withstand voltage (1.2/50 μ s) -between line terminals and ground	kVp	1425	1050	650	170
6	Switching impulse withstand voltage (250/2500 μ s) -between line terminals ground (dry& wet)	kVp	1050	--	--	--
7	One minute power frequency withstand voltage -between line terminals and ground	kVrms	630 (dry only)	460	275	75
8	One minute power frequency withstand voltage of secondary winding	kV	5	5	5	5
9	Minimum corona extinction voltage	kVrms	320	156	105	--
10	Maximum radio interference voltage for frequency between 0.5 to 2 MHz	μ -volt	1000 (at 320 kVrms)	1000 (at 156 kVrms)	500 (at 92 kVrms)	--
11	Maximum partial discharge level	pC	10	10	10	10
12	Cantilever	kg.	500	350	350	350

TABLE-3A**REQUIREMENTS FOR 420 kV CURRENT TRANSFORMER**

No. of cores	Core No.	Application	Current ratio	Output Burden (VA)	Accuracy Class as Per IEC: 61869	Min. Knee pt Voltage V_k	Max CT Sec. Wdg. Resistance (ohm)	Max Excitation current at V_k in mA)
5	1	BUS DIFF CHECK	3000-2000-1000/1	-	-	$V_k > K.I_s .(R_{ct} + R_b) V$	15/10/5	20 on 3000/1 tap. 30 on 2000/1 tap. 60 on 1000/1 tap.
	2	BUS DIFF MAIN	3000-2000-1000/1	-	-	$V_k > K.I_s .(R_{ct} + R_b) V$	15/10/5	20 on 3000/1 tap. 30 on 2000/1 tap. 60 on 1000/1 tap.
	3	METERING	3000-2000-1000/1	20 20 20	0.2s 0.2s 0.2s	-	-	-
	4	TRANS. BACK UP/ LINE PRTN	3000-2000-1000/1			$V_k > K.I_s .(R_{ct} + R_b) V$	15/10/5	20 on 3000/1 tap. 30 on 2000/1 tap. 60 on 1000/1 tap.
	5	TRANS. DIFF/ LINE PRTN	3000-2000-1000/1			$V_k > K.I_s .(R_{ct} + R_b) V$	15/10/5	20 on 3000/1 tap. 30 on 2000/1 tap. 60 on 1000/1 tap.

Note:

- The Bidder will ensure compatibility of CT and numerical relay in respect of knee-point voltage as well as operating time of relay to avoid malfunctioning or damage to the numerical relay.
- Protection cores shall be of accuracy class PX as per IEC 61869.
- Metering Core shall be of accuracy class 0.2S as per IEC: 61869

TABLE-3B
REQUIREMENTS FOR 245 kV CURRENT TRANSFORMER

No. of cores	Core No.	Application	Current ratio	Output Burden (VA)	Accuracy Class as Per IEC: 44-1	Min. Knee pt Voltage V_k	Max CT Sec. Wdg. Resistance (ohm)	Max Excitation current at V_k in mA)
5	1	BUS DIFF CHECK	1600-800/1	-	-	1600/800	8/4	25on1600/1tap 50 on800/1 tap.
	2	BUS DIFF MAIN	1600-800/1	-	-	1600-800/1	8/4	25on1600/1ta 50 on800/1 tap.
	3	METE-RING	1600-800/1	20	0.2S	-	-	-
	4	TRANS. BACK UP/ LINE PRTN.	1600-800/1	-	-	1600-800/1	8/4	25on1600/1tap 50 on800/1 tap.
	5	TRANS. DIFF/ LINE PRTN.	1600-800/1	-	-	1600-800/1	8/4	25on1600/1tap 50 on800/1 tap.

NOTE:-

- 220kV C.T ratio of 1600-800/1-1-1-1 A for all bays
- The Bidder will ensure compatibility of CT and numerical relay in respect of knee-point voltage as well as operating time of relay to avoid malfunctioning or damage to the numerical relay.
- Protection cores shall be of accuracy class PX as per IEC 61869.
- Metering Core shall be of accuracy class 0.2S as per IEC: 61869

TABLE-3C
REQUIREMENTS FOR 72.5 kV CURRENT TRANSFORMER

No. of Cores	Core no.	Application	Current ratio	Output Burden (VA)	Accuracy Class as Per IEC: 44-1	Min.Knee pt. Voltage V_k	Instrument security factor
4	1	METERING	*	20	0.2S	-	Less than 5
	2	Differential Protection	*	-	*	$V_k > K.I.(R_c + R)V$	
	3	Back-up Protection(O/C and E/F)	*	-	*	$V_k > K.I.(R_c + R)V$	
	4	REF Protection	*	-	*	$V_k > K.I.(R_c + R)V$	

*** NOTE:-**

- i) Protection cores shall be of accuracy class PX as per IEC 61869.
Metering Core shall be of accuracy class 0.2S as per IEC: 61869
- ii) 66kV C.T. of ratio 2000/1-1-1-1 A for incoming from 160 MVA Trf and 2000/1-1-1 for bus coupler (with core one for metering and core 2 for back-up protection)
- iii) 66kV C.T. ratio 1000 /1-1-1 A for Feeder Protection with core 1 for metering, core 2 for Line protection and core 3 for back-up protection with above accuracy class.

TABLE-3D
REQUIREMENTS FOR 36kV CURRENT TRANSFORMER

No. of cores	Core no.	Application	Current ratio	Output Burden (VA)	Accuracy Class as Per IEC: 44-1	Min.Knee pt. Voltage V_k	Instrument security factor
3	1	METERING	*	10	0.2S	-	Less than 5
	2	PROTECTION/O/C & E/F	*	-	*	$V_k > K.I.(R_c + R)V$	
	3	Back-up Protection	*	-	*	$V_k > K.I.(R_c + R)V$	

*** NOTE:-**

- i) Protection cores shall be of accuracy class PX as per IEC 61869.
Metering Core shall be of accuracy class 0.2S as per IEC: 61869
- ii) 33kV C.T. of ratio 2000/1-1-1-1 A for incoming from 100 MVA Trf. and for bus coupler.
- iii) 33kV C.T. ratio 800-4001-1-1 A for feeder protection.

The major technical parameters of voltage Transformer

S.No.	Details	Unit	400kV System	220kV System	66kV System	33kV System
1.	Nominal /Rated voltage	kV	400	220	66	33
2.	Highest system voltage	kV	420	245	72.5	36
3.	Fault current and duration	kA	63 (1 sec)	50 (1 sec)	31.5 (1 sec)	31.5 1 sec
4.	Rated primary voltage	kV	420/ $\sqrt{3}$	245/ $\sqrt{3}$	145/ $\sqrt{3}$	36/ $\sqrt{3}$
5.	Rated secondary voltage(1)	V	110/ $\sqrt{3}$	110/ $\sqrt{3}$	110/ $\sqrt{3}$	110/ $\sqrt{3}$
6.	Accuracy class					
	-protection		3P	3P	3P	3P
	-metering(2)		0.2	0.2	0.2	0.2
7,	Lightning (Full wave) impulse withstand voltage (1.2/50 μ s) -between line terminals and ground	kVp	1425	1050	650	170
8.	Switching impulse withstand voltage (250/2500 μ s) - between line terminals and ground(dry & wet)	kVp	1050	--	--	--
9.	One minute power frequency withstand voltage -between line terminals and ground	kVrms	630 (dry only)	460	275	75
10.	Minimum corona extinction voltage	kVrms	320	156	105	--
11.	Maximum Radio interference voltage for frequency between 0.5 to 2 MHz	Micro-volt	1000 (at 320 kV rms)	1000 (at 156kV rms)	500 At 92 kVrms)	--
12.	Standard reference range of frequencies for which the accuracies are valid					
	-protection	%	96 to 102	96 to 102	96 to 102	NA
	-measurement	%	99 to 101	99 to 101	99 to 101	NA
13.	High frequency capacitance for	%	80 to 150% of rated	80 to 150% of rated	80 to 150% of rated	NA

S.No.	Details	Unit	400kV System	220kV System	66kV System	33kV System
	entire carrier frequency range		capacitance	capacitance	capacitance	
14.	Equivalent resistance over entire carrier frequency range	Ω	<40	<40	<40	--
15.	Stray capacitance and stray conductance of LV terminal over entire carrier frequency range		As per IEC 60358	As per IEC 60358	As per IEC 60358	--
16.	One minute power frequency withstand voltage (LV side)					
16a)	Between LV (HF) terminal and earth					
	-for exposed terminals	kVrms	10	10	10	10
	-for terminals enclosed in weather proof enclosure	kVrms	4	4	4	4
16b)	For secondary winding	kVrms	3	3	3	3
17.	Rated voltage factor					
	-continuous		1.2	1.2	1.2	1.2
	-for 30 seconds		1.5	1.5	1.5	1.5
18.	Maximum partial discharge level	pC	10	10	10	10
19.	Rated capacitance	pF	4400 (+10,-5%)	4400 (+10,-5%)	4400 (+10,-5%)	--
20.	Cantilever strength	Kg	500	350	350	350

TABLE-4A
REQUIREMENT OF 400kV VOLTAGE TRANSFORMERS

Sl. No.	PARTICULARS	400kV		
1	Rated primary voltage	420/ $\sqrt{3}$ kV		
2	Type	Electromagnetic, or Single phase capacitor VT		
3	No. of secondaries	3		
4	Rated voltage factor	1.2 continuous		
		1.5-30 seconds		
5	Phase angle error	± 20 minutes		
		Sec.1	Sec II	Sec III
6	Rated voltage (V)	110/ $\sqrt{3}$	110/ $\sqrt{3}$	110/ $\sqrt{3}$
		3		
7	Application	Protection	Protection	Metering
8	Accuracy	3P	3P	0.2
9	Output burden (VA) (minimum)	50	50	50

TABLE-4B
REQUIREMENT OF 220kV VOLTAGE TRANSFORMERS

S. N	PARTICULARS	220kV		
1	Rated primary voltage	245/ $\sqrt{3}$ kV		
2	Type	Electromagnetic		
3	No. of secondaries	3		
4	Rated voltage factor	1.2 continuous		
		1.5-30 seconds		
5	Phase angle error	± 20 minutes		
		Sec.1	Sec II	Sec III
6	Rated voltage (V)	110/ $\sqrt{3}$	110/ $\sqrt{3}$	110/ $\sqrt{3}$
7	Application	Protection	Protection	Metering
8	Accuracy	3P	3P	0.2
9	Output burden (VA) (minimum)	50	50	50

TABLE-4C
REQUIREMENT OF 72.5kV VOLTAGE TRANSFORMERS

S. N.	PARTICULARS	66 kV		
1.	Rated primary voltage	72.5/ $\sqrt{3}$ kV		
2.	Type	Electromagnetic		
3.	No. of secondary	3		
4.	Rated voltage factor	1.2 continuous		
		1.5-30 seconds		
5.	Phase angle error	± 20 minutes		
		Sec I	Sec II	Sec III
6.	Rated voltage (V)	110/ $\sqrt{3}$	110/ $\sqrt{3}$	110/ $\sqrt{3}$
7.	Application	Metering	Protection	Protection
8.	Accuracy	0.2	3P	3P
9.	Output burden (VA) (minimum)	50	50	50

TABLE-4D

REQUIREMENT OF 33kV VOLTAGE TRANSFORMERS

Sl. No.	PARTICULARS	33 kV		
1.	Rated primary voltage	36/ $\sqrt{3}$ kV		
2.	Type	Electromagnetic		
3.	No. of secondaries	3		
4.	Rated voltage factor	1.2 continuous		
		1.5-30 seconds		
5.	Phase angle error	± 20 minutes		
		Sec I	Sec II	Sec III
6.	Rated voltage (V)	110/ $\sqrt{3}$	110/ $\sqrt{3}$	110/ $\sqrt{3}$
7.	Application	Metering	Protection	Protection
8.	Accuracy	0.2	3P	3P
9.	Output burden (VA) (minimum)	20	20	20

The major technical parameters of Surge Arresters

S.No.	Details	Unit	400kV System	220kV System	66kV System	33kV System
1.	Rated SYSTEM voltage	kV	400	220	66	33
2.	Highest system voltage	kV	420	245	72.5	36
3.	Rated arrester voltage	kV	336	216	120	30
4.	Continuous operating voltage (COV) at 50°C	kVrms	267	168	102	25
5.	Discharge current (8/20µs wave)					
5a)	Nominal discharge current	kAp	20	10	10	10
5b)	Discharge current at which insulation coordination will be done	kAP	20	10	10	10
6.	Minimum discharge capability (1)	kJ/kV	12	5	5	5
7,	Maximum residual voltage for					
7a)	Lightning impulse current					
	-20kA	kVp	850	--	--	--
	-10kA	kVp	800	600	330	90
	-5kA	Micro-volt	--	560	310	85
7b)	Switching impulse current					
	-at 2kA	kVp	670	--	--	NA
	-at 1kA	kVp		500	280	NA
	-at 500A		650	--	--	NA
7c)	Steep current impulse at nominal discharge current		925	650	380	110
8.	Long duration discharge class (as per IEC)		Class 4	Class 3	Class 3	Class 3
9.	Perspective symmetrical fault current for pressure relief test (for 0.2 Sec)	kA(rms)	63	50	31.5	25
10.	Low current long duration test value		As per IEC (2400µs)	As per IEC (2400µs)	As per IEC (2400µs)	As per IEC (2400µs)

11.	High current impulse test value (4/10 micro sec.)	kAp	100	100	100	100
12.	Minimum corona extinction voltage	kVrms	320	156	105	NA
13.	Maximum radio interference voltage for frequency between 0.5 to 2 MHz	Micro-Volt	500 At 320 kV rms)	500 (at 156 kVrms)	500 (at 92 kVrms)	---
14.	Full wave impulse withstand voltage (1.2/50 μ s)-between line terminals and ground	kVp	1425	1050	650	170
15.	Switching impulse withstand voltage (250/250 μ s)-between line terminals and ground (Dry & wet)	kVp	1050	NA	NA	NA
16.	One minute power frequency withstand voltage between line terminals and	kV(rms)	630	460	275	70
17.	Maximum Partial Discharge for arrester at (1.05 x COV)	pC	50	50	50	50
18.	Cantilever strength	Kg	500	350	350	350

SYSTEM PARAMETERS

(Annexure -6)

S.No.	Details	Unit	400kV system	220kV System	66kV system	33kV system
1.	Nominal/rated voltage	kVrms	400	220	66	33
2.	Highest system voltage	kVrms	420	245	72.5	36
3.	Phase	nos.	3	3	3	3
4.	Rated frequency	Hz	50	50	50	50
5.	Ambient temperature	°C	50	50	50	50
6.	Specific creepage distance	mm/kV	31	31	31	31
7.	Rated fault current and its duration	kA	63 1 sec.	50 1 sec.	31.5 1 sec.	31.5 1 sec.
8.	Minimum corona extinction voltage	kVrms	320	156	105	NA
9.	Maximum radio interference voltage (RIV) for frequency between 0.5 & 2.0 MHz	-volt	1000 (at 320kV rms)`	1000 (at 156 kV rms)	500 (at 92 kV rms)	NA
10.	Seismic acceleration Zone-IV, as per IS-1893,Year-2002	G	0.3	0.3	0.3	0.3
11.	System neutral earthing		Effectively earthed	Effectively earthed	Effectively earthed	Effectively Earthed
12.	Auxiliary AC supply (3Ph,2wire,50 Hz)	V	415 ±10%			
13.	Auxiliary DC supply (2 wire ungrounded)	V	220 ±10%			

TECHNICAL PARAMETERS FOR SF6/AIR BUSHING

Sl. No.	Particular	400 kV	220 kV	66kV	33kV
1	Rated Voltage (kV) (rms)	420 kV (rms)	245 kV (rms)	72.5 kV (rms)	36
2	Rated Current (Amp)	As per scheme	As per scheme	As per scheme	As per scheme
3	1.2/50 micro second impulse voltage (Lightning impulse withstand voltage)	1425 kVp	±1050 kVp	±325 kVp	±170 kVp
4	250/2500 micro second switching impulse voltage	1050 kVp	NA	NA	NA
5	One minute power frequency withstand voltage(kV R.M.S)	±650	±460	±140	±70
6	Minimum total Creepage distance in mm	31 mm/kV			
7	Minimum Cantilever strength (kN)	10	8	5	

Technical Specifications for SF6 Gas Leak Detector Equipment along with Standard Accessories:

1. General Requirements

- 1.1 The testing equipment shall be type tested and shall be subjected to acceptance and routine tests in accordance with the requirements of relevant national/international standards with latest version.
- 1.2 The instrument should have been proven for repeatability of test result in charged switchyard of EHV substations. Documentary evidence for this should be furnished along with the bid.
- 1.3 The acceptance of the equipment is subject to the successful demonstration to the satisfaction of DTL at prescribed site of DTL including 400KV switchyard/site during technical evaluation.
- 1.4 Under very high/low ambient temperatures, high humidity, equipment shall be able to carry out measurement under these conditions.

2. Functional Requirement:

- 2.1. The meter shall be capable of detecting leakage of SF6 from 400/220kV Circuit Breakers/GIS equipments. Instrument shall work in induced condition of charged switchyard up to 400kV level. The equipment shall not be sensitive to moisture or other gases in atmosphere and water vapour.
- 2.2. It shall be Microprocessor controlled, with advanced digital signal processing, visual LED display Audible signal for progressive leak-size indication having following features:
 - a. easy and tactile keypad control, battery test function, battery low voltage indication etc;
 - b. Cordless and portable, Battery operated,
 - c. Immediate response time for quick leak detection and quick return to zero - position even after detection of large leaks.
 - d. The sensing probe shall be such that it can reach all the points on the switchgear where leakage is to be sensed.
- 2.3. The equipment and accessories shall be robust and rugged enough, so that it can be transported safely at different locations. The transportation case and packing of the equipment shall be such that the transportation from one station to other will not affect the performance, repeatability and accuracy of measurement of equipment.
- 2.4. The test results should have repeatability consistency & immunity to electromagnetic, electrostatic interference in live switch yard up to 400kV.
- 2.5. Safety, EMC/EMI, Environment, Enclosure, and Interference limit shall be as per national/international standards with latest revision.

2.6. Accessories:

Set of batteries, Battery Charger, Manual, Hard Carrying case, Spare sensor tip etc, Software CD and other mandatory accessory.

SPARES: Filter Tips 5 nos, Infra red cell or any other consumable as required/Mandatory for operations of kit during guarantee period, Optional spares shall be quoted separately.

3. Technical Parameters:-

S.No.	Parameter	Specification
1.	Method of operation and principle	Continuous leak detection and leak measurement operation during leak check without limitation with audible and visual indication.(Infrared technology)
2.	Range of SF6 leak measurement during leak detection	0-1000 and more PPMv by volume with accuracy of $\pm 5\%$ or better
3.	Sensitivity	3.5 gm SF6/year or less. No cross sensitive to other gases
4.	Response Time	Immediately
5.	Alarm	Visual as well as Audio
6.	Power supply	Li-Ion batteries powered / equivalent power supply with charger.
7.	Batteries voltage indication/test function	To be displayed
8.	Spares	Mandatory for operation of equipment during guarantee period
9.	Operating Temperature & Relative Humidity	0 to 50°C & RH 95%

4. Calibration certificate:-

The instrument shall be supplied with proper Calibration certificate from NABL or internationally accredited lab. It is the responsibility of the supplier to provide the Calibration services of the instrument after the calibration interval is over. Date of Calibration Certificate shall not be older than three month from the date of supply of kit.

5. Demonstration:-

The bidder will have to demonstrate the equipment for accuracy and repeatability under stringent field conditions at prescribed site of DTL including 400kV switchyard/site up to the satisfaction of DTL at their own cost and ***this will be the part of technical evaluation.*** Successful demonstration of equipment shall be the pass / fail criteria for further evaluation / rejection of bid. The instrument failed during demonstration shall be rejected.

6. Warranty/Guarantee Period:

Min 05 years from the date of successful & complete commissioning at DTL sub-station.

The warranty shall include:

- a) Calibration of instrument (annually),
- b) As much as visit for repairs to site, along with all the materials, including accessories etc. are to be covered under warranty/guaranty period. If the equipment needs to be shifted to supplier's works for repairs within warranty/guaranty period, suppliers will have to bear the cost of spares, software, and transportation of equipment for repair at test lab / works.

7. Services after sale:

Bidder will have to submit the documentary evidences of having established mechanism for prompt services as and when required by DTL. Bidder need to submit their organization service chart along with bid.

8. Commissioning, Training and Handling Over of the Instrument

Successful bidder will have to commission the instrument to the satisfaction of DTL. The instrument failed during the demo shall be rejected and no repairs are allowed.

Bidder will have to provide training to DTL engineers for safe operation and maintenance of the instrument before handing over the same at DTL site in batches.”

9. Guaranteed technical particulars SF6 Gas Leak Detector Test Equipment along with Standard Accessories

Sr.No	Item	Description (To be filled in and signed by the Bidder)
1.	Mfg.Name/Model No.	
2.	Method of Operation and principle	
3.	Range of Sf6 leak measurement during leak detection	
4.	Sensitivity	
5.	Response Time	
6.	Alarm	
7.	Power Supply	
8.	Spares	
9.	Operating temperature	
10.	Accessories	
11.	Warranty	
12.	Calibration certificate	
13.	Services after Sale	
14.	Safety,EMC/EMI,Environment, Enclosure, and Interference applicable standards	

Technical specifications of SF6 gas analyzer**1. General Requirements**

- 1.1 The testing equipment shall be type tested and shall be subjected to acceptance and routine tests in accordance with the requirements of relevant national/international standards with latest version.
- 1.2 The instrument should have been proven for repeatability of test result in charged switchyard of EHV substations. Documentary evidence for this should be furnished along with the bid.
- 1.3 The kit and accessories shall be robust and rugged enough, so that it can be transported safely to different locations. The transportation and packing cases of the kit shall be such that the transportation from one station to other will not affect the performance and accuracy of measurement of kit. Further, the instrument shall be robust enough to sustain the jerks during the transportation in local condition.
- 1.4 Bidder will have to submit the documentary evidences of having established mechanism for prompt services in India as and when required by DTL. Bidder need to submit their organization service chart along with bid.

2. Functional Requirement

- 2.1. The instrument should be suitable for online measurement of Moisture (Dew point & ppm), Purity, SO₂ content of SF₆ Gas in gas insulated EHV equipments and GIS (Gas insulated switchgear), in live switchyard upto 400 kV level.
- 2.2. The measurement principle shall be based upon zero gas loss i.e. the gas will be returned back to original compartment of the GIS after performing the measurement without being exposed to the atmosphere.
- 2.3. The instrument shall be able to measure the pressure of the compartment under Test in bar, kPa, MPa.
- 2.4. The measurement should be possible at standard pressure/system pressure.
- 2.5. The test results should have repeatability consistency & immunity to electromagnetic, electrostatic interference in live switch yard up to 400kV.
- 2.6. It should have facility for Data Storing in the kit & down loading to PC. It should have USB / Ethernet Interface.

3. Technical Parameters:-

Item	Specification
Measurement Parameters	1. SF6 purity – Range: 0-100 % , Accuracy: +/- 0.5 % 2. Dew point - Range : -60 to +20 deg C, Accuracy: +/-4 deg C 3. SO2 - Range : 0-100 ppm, Accuracy : +/- 3 ppm 4. HF-Range :-10ppm & Accuracy : +/- 10 %
Input Pressure	0.5 to 9 Bar
Re-circulation/ Pumping Back of SF6 gas	The kit shall have the inbuilt facility of pumping back the measured SF6 gas to the equipment being tested.
Test Leads and accessories	Complete set of Hoses, pipes, coupling, valves etc. for measurement (min 10 m length) with suitable adaptors for connection with Equipment (Areva, CGL,ABB,Hyosung, BHEL, Siemens make GIS/CBs etc).
Design/Engg.	The complete equipment along with complete accessories must be designed/engineered by Original Equipment Manufacturer.
Power Supply	150 – 240 V AC at 50 Hz and Inbuilt battery with charger/adaptor etc.
Operating Temperature	-10 to +50 °C
Relative humidity	Max. 90 % non-condensing
IP Class	It should be housed in a robust IP67 case with wheels
Display/Control	LCD/Keypads.
Environment	The test kit shall be compatible for EMI/EMC/safety environment requirement as per IEC.

4. Calibration certificate:-

As per requirement of ISO-9001, calibration certificate for each testing instrument covering entire range shall be supplied with the test kit at the time of supply.

Calibration certificate from NABL accredited lab or internationally reputed lab, shall be submitted. Date of calibration shall not be older than two month from the date of supply of kit.

5. Demonstration:-

The bidder will have to demonstrate the kit for accuracy and repeatability under stringent field conditions at prescribed site of DTL including 400kV switchyard/site upto the satisfaction of DTL at their own cost and ***this will be the part of technical evaluation***. Successful demonstration of equipment shall be the pass / fail criteria for further evaluation / rejection of bid. The instrument failed during demonstration shall be rejected.

6. Warranty/Guarantee Period:

Min 03 years from the date of successful & complete commissioning at DTL sub-station. All the materials, including accessories etc. are to be covered under warranty/guaranty period. If the kit needs to be shifted to supplier's works for repairs within warranty/guaranty period, suppliers will have to bear the cost of spares, software, and transportation of kit for repair at test lab / works.

7. Commissioning, Training and Handling Over of the Instrument

Successful bidder will have to commission the instrument to the satisfaction of DTL. The instrument failed during the demo shall be rejected and no repairs are allowed.

Bidder will have to provide training to DTL engineers for safe operation and maintenance of the instrument before handing over the same at DTL site in batches.”

8. Guaranteed technical particulars SF6 Gas Quality Analyzer Test Kit along with Standard Accessories

Sr. No.	Particulars	Filled by bidder
1.	Name & Country of Manufacturer	
2.	Type / Model No.	
3.	SF6 Purity Measurement method	
4.	Pumpback of SF6 gas back in to breaker after measurement	
5.	Measurement parameter as per IEC60480 & CIGRE B3.02.01	
6.	SF6 Purity range with accuracy	
7.	Dew Point measurement range with accuracy	
8.	SO2 measurement range with accuracy	
9.	User selectable Inbuilt standards a) IEC60480 b) IEC60376	
10.	Measurement Cycle Selection	
11.	Direct Input Gas pressure	
12.	Vacuum purging for hose pipes	
13.	Quantum of SF6 gas used for measurement	
14.	Data storage	
15.	Display	
16.	Power input	
17.	Battery operation	
18.	Casing Protection class	
19.	Weight	
20.	Accessories	
21.	Service life	

SECTION-III

GENERAL TECHNICAL **REQUIREMENTS**

SECTION : III

GENERAL TECHNICAL REQUIREMENTS (GTR)

1.0 FOREWORD

- 1.1 The provisions under this section are intended to supplement general requirements for the materials, equipments and services covered under other sections of tender documents and is not exclusive. However in case of conflict between the requirements specified in this section and requirements specified under other sections, the requirements specified under respective sections shall prevail.

2.0 GENERAL REQUIREMENT

- 2.1 The bidders shall submit the technical requirements, data and information as per the technical data sheets provided in the Volume III of bid documents.
- 2.2 The bidders shall furnish catalogues, engineering data, technical information, design documents, drawings etc., fully in conformity with the technical specification.
- 2.3 It is recognized that the Contractor may have standardized 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 the Purchaser's. Unless brought out clearly, the Bidder shall be deemed to conform to this specification scrupulously. All deviations from the specification shall be clearly brought out in the respective schedule of deviations. Any discrepancy between the specification and the catalogues or the bid, if not clearly brought out in the specific requisite schedule, will not be considered as valid deviation.
- 2.4 Except for lighting fixtures, 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. For lighting fixtures, makes shall be as defined in Section- Lighting System
- 2.5 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 not specifically stated in the specification but 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.
- 2.6 The contractor shall design the system maintaining all the statutory clearances for both indoor and outdoor equipments as per relevant standards and norms. Contractor shall also design the building with sufficient working space for ease of operation and maintenance activities.

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 to be furnished under this specification shall conform to latest issue with all amendments (as on the date of bid opening) of standard specified under Annexure-C of this section, unless specifically mentioned in the specification.
- 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.
- 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.
- 3.5 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.
- 3.6 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 in additional information schedule of Vol III 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 Purchaser's approval.
- 3.7 The bidder shall clearly indicate in his bid the specific standards in accordance with which the works will be carried out.

4.0 SERVICES TO BE PERFORMED BY THE EQUIPMENT BEING FURNISHED

- 4.1 The equipment furnished under this specification shall perform all its functions and operate satisfactorily without showing undue strain, re-strike 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 bidder shall design terminal connectors of the equipment taking into account various forces that are required to withstand.
- 4.5 The equipment shall also comply to the following:
a) All outdoor EHV equipments except marshalling kiosks shall be suitable for hot line washing.
b) To facilitate erection of equipment, all items to be assembled at site shall be “match marked”.
c) 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 Operating times of circuit breakers and protective relays have been specified in respective sections. However, the bidder is allowed to have minor variations on the individual equipment timings subject to the condition that overall fault clearing time remains within 160 milli seconds at 220 kV level under comparable conditions.
- 4.7 EHV equipments and system shall be designed to meet the following major technical parameters as brought out hereunder.

4.7.1 System Parameter

S. No	Description of parameters	220 kV System	66kV System	33 kV System
1.	System operating voltage	220kV	66kV	33kV
2.	Rated frequency	50Hz	50Hz	50Hz
3.	No. of phase	3	3	3
4.	Rated Insulation levels			
	i) Full wave impulse withstand voltage (1.2/50 μ s)	1050 kVp	325kVp	170 kVp
	ii) One minute power frequency dry and wet withstand voltage (rms)	460kV	140kV	70kV
5.	Corona extinction voltage	156kV	-	-
6.	Max. radio Interference voltage for frequency b/w 0.5MHz and 2 MHz at 156kV rms for 220kV system	1000 μ V	-	-
7.	Minimum creepage distance	25 mm/kV (6125 mm)	25 mm/kV (1812.5 mm)	25 mm/kV (900 mm)
8.	Min. clearances			
i)	Phase to phase	2100mm	630mm	320mm
ii)	Phase to earth	2100mm	630mm	320mm
iii)	Sectional clearances (These clearances are mentioned for air clearance)	5000 mm	3000mm	3000mm
9.	Rated short circuit current for 1 sec. duration	40 kA	31.5kA	31.5 kA
10.	System neutral earthing	Effectively earthed	Effectively earthed	Effectively earthed

Note : The insulation and RIV levels of the equipments shall be as per values given in the respective chapter of the equipments.
Bidder is required to maintain the clearances as per relevant IEC/IS and shall adhere to safety guidelines.

4.7.2 Major Technical Parameters

The major technical parameters of the equipments are given below. For other parameters and features respective technical sections should be referred.

(A)-I For 220/66/11 kV Power Transformer

Voltage ratio (kV)	220/66/11
Rated frequency (Hz)	50

Max. Design Ambient Temp. (°C) 50

Windings	HV	IV	LV
(i) System Fault level (kA)	40	31.5	18.35
(ii) 1.2/50 micro sec. impulse withstand voltage kVp	±1050	±325	±170
(iii) One minute power frequency voltage kV(rms)	±460	±140	±70
(iv) Winding connection	Star	Star	delta
(v) Neutral	- Solidly grounded -		
(vi) Insulation	- Solidly grounded -		
(vii) Vector Group	- YN yn0 d11 -		

(A)-II For 220/33/11 kV Power Transformer

Voltage ratio (kV) **220/33/11**
 Rated frequency (Hz) 50
 Max. Design Ambient Temp. (°C) 50

Windings	220kV	33kV	11kV
(i) System Fault level (kA)	40	31.5	18.35
(ii) 1.2/50 µsec. impulse withstand voltage kVp	±1050	±170	±170
(iii) One minute power frequency voltage kV rms	±460	±70	±70
(iv) Winding connection	Star	Star	delta
(v) Neutral	- Solidly grounded -		
(vi) Insulation	- Solidly grounded -		
(vii) Vector Group	- YN yn0 d11 -		

(B) For 245 kV, 72.5kV & 36kV Circuit Breaker and Isolator

Rated voltage kV (rms)	245	66	36
Rated frequency (Hz)	50	50	50
No. of Poles	3	3	3
Design ambient temperature (°C)	50	50	50

Rated insulation levels :

1) Full wave impulse withstand voltage (1.2/50 µsec.)

- between line terminals and ground	± 1050 kVp	±325 kVp	±170 kVp
- between terminals with circuit breaker open	± 1200 kVp	±375 kVp	±195 kVp
- between terminals with isolator open	± 1200 kVp	±375 kVp	±195 kVp

2) One minute power frequency dry and wet withstand voltage

- between line terminals and ground	460 kV (rms)	±140 kVp	±70kV (rms)
- between terminals with circuit breaker open	530 kV (rms)	As per IEC	As per IEC
- between terminals with Isolator open	530 kV (rms)	As per IEC	As per IEC

3) Max. radio interference voltage (µV) for frequency between 0.5 MHz and 2 MHz in all positions of the equipments. 1000 (at 156 kV rms) - -

4) Minimum creepage distance :-

Phase to ground (mm)	6125	1812.5	900
Between CB Terminals (mm)	6125	1812.5	900

5) System neutral earthing Effectively Effectively Effectively

	earthed	earthed	earthed
6) Seismic acceleration	-	0.3g horizontal	-
7) Rating of Auxiliary Contacts	-	10 A at 220 V DC	-
8) Breaking capacity of Auxiliary contacts	2 A DC with circuit time constant of not less than 20 ms.		

Auxiliary Switch shall also comply with other clauses of this chapter.

(C) FOR 245 kV, 72.5kV & 36kV CT/CVT/SA

Rated voltage kV (rms)	245	72.5	36
Rated frequency (Hz)	50	50	50
No. of poles	1	1	1
Design ambient temperature (°C)	50	50	50

Rated insulation levels :

1) Full wave impulse withstand voltage (1.2/50 micro sec.)			
- between line terminals and ground	± 1050 kVp	±325 kVp	±170 kVp
- for CT and CVT			
- for arrester housing	± 1050 kV peak	±325 kVp	±170 kVp
2) One minute power frequency dry and wet withstand voltage			
- between line terminals and ground	±460 kV rms	±140 kVp	±70 kV rms
- for CT and CVT			
- for arrester housing	±460 kV rms	±140 kVp	± 70kV rms
3) Max. radio interference voltage (µV) for frequency between 0.5 MHz and 2 MHz in all positions of the equipment	1000 for CT/CVT 500 500 for SA (at 156 kV rms)		
4) Minimum creepage distance :-			
- Phase to ground (mm)	6125	1812.5	900
5) System neutral earthing	- Effectively earthed -		
6) Seismic acceleration	- 0.3g horizontal -		
7) Partial discharge for :-			
- Surge arrester at 1.05 COV	- Not exceeding 50 pc. -		
- for CT/CVT	- Not exceeding 10 pc. -		

(D) Technical Parameters of Bushings/Hollow Column insulators/support insulators:

	220 kV	66kV	33 kV
(a) Rated Voltage (kV)	245	72.5	36
(b) Impulse withstand voltage (Dry & Wet) (kVp)	±1050	±325	±170
(c) Power frequency withstand voltage (dry and wet) (kV rms)	±460	±140	±70
(d) Total creepage distance (mm)	6125	1812.5	900

(e) Pollution Class-III Heavy (as per IEC 71) and as specified Section-2 for all class of equipment

(f) Insulator shall also meet requirement of and IEC-815 for 220 kV system, as applicable having alternate long & short sheds.

(E) Technical Data Sheet for 66kV Bus Post Insulator

66kV	Technical Specification	Party's offer
a) Solid Core	Solid Core	
b) Voltage class (kV)	72.5	
c) Dry and wet one minute power frequency withstand voltage (kV) rms	150	

d)	Dry lightning impulse withstand voltage (kVp)	±325
e)	Wet switching surge withstand voltage (kVp)	--
f)	Max. radio interference voltage (in microvolts)- Dry	200 at 54kV
g)	Corona Extinction voltage (kV rms) (min)	54
h)	Cantilever Strength	
i)	Total minimum cantilever strength (Kg)	600
j)	Minimum torsional moment	As per IEC-60273
j)	Total height of insulator (mm)	770
k)	P.C.D. Top (mm)	127
	Bottom (mm)	127
l)	No. of bolts	
	Top	4
	Bottom (mm)	4
m)	Diameter of bolt/holes (mm)	
	Top	M16
	Bottom dia	16
n)	Pollution level as per IEC-60815	Heavy (III)
o)	Minimum creepage distance for Heavy Pollution (mm)	1815

(F) Specific Technical Requirement of 11kV Surge Arrester

S.No.	Particulars	Requirement
1.	Type of Arrester	Non-linear metal oxide resistors type surge arresters without spark gaps designed to limit voltage surges on a.c. power circuits
2.	Applicable standard	IEC 60099-4
3.	Arrester class and Designation	Distribution High (DH)
4.	Nominal System Voltage	11 kV
5.	Highest System Voltage	12 kV
6.	Rated Voltage	9 kV
7.	Nominal Discharge Current	10 kA
8.	Rated Short Circuit Current	10 kA
9.	Rated frequency	50 Hz
10.	Line Discharge Class	1
11.	Continuous Operating Voltage, Maximum	7.65 KV
12.	Insulation withstand level (BIL)	11 kV

(G) Technical Specification of 11kV PT

S.No.	Particulars	Requirement
1.	System Voltage (3 Phase, 50 Hz)	11 kV
2.	Insulation Level	
3.	System highest Voltage	12 kV
4.	Power frequency withstand voltage (primary)	28 kV
5.	Power frequency withstand voltage (secondary)	2.5 kV
6.	Lightening Impulse withstand voltage	75 kVp
7.	Insulation Class	12 kV/28 kVrms/75 kVp
8.	Continuous Over Voltage factor	1.2 continuous & 1.9 for 8 hours
9.	Insulation class	B or better
10.	Winding 1 accuracy/burden	50VA / 0.5/3P
11.	Ambient Air Temperature	-5°C (min.) & 50°C (max.)
12.	Relative humidity	10 % min. & 95 % max.
13.	Height above MSL	≤ 1000 meters (consider suitable altitude correction factor in Impulse withstand for height more than 1000 mtrs)
14.	Pollution severity	Heavily polluted & highly corrosive environment
15.	Seismic Coefficient	0.3g
16.	Design Ambient Temp.	50°C

5.0 ENGINEERING DATA AND DRAWINGS

- 5.1** The engineering data shall be furnished by the Contractor in accordance with the Schedule for each set of equipment as specified in the Technical Specifications.
- 5.2** The list of drawings/documents which are to be submitted to the Purchaser shall be discussed and finalised by the Purchaser at the time of award. The Contractor shall necessarily submit all the drawings/ documents unless anything is waived. The Contractor shall submit 4 (four) sets of drawings/ design documents /data/ test reports as may be required for the approval of the Purchaser.
- 5.3 Drawings**
- 5.3.1** All drawings submitted by the Contractor including those submitted at the time of bid 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** Each drawing submitted by the Contractor shall be clearly marked with the name of the Purchaser, the unit designation, the specifications title, the specification number and the name of the Project. If standard catalogue pages are submitted, the applicable items shall be indicated therein. All titles, noting, markings and writings on the drawing shall be in English. All the dimensions should be in metric units.
- 5.3.3** Further work by the Contractor shall be in strict accordance with these drawings and no deviation shall be permitted without the written approval of the Purchaser, if so required.
- 5.4** The review of these data by the Purchaser 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 Purchaser 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 purchaser 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 Purchaser. Approval of Contractor's drawing or work by the Purchaser 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 Purchaser 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 Purchaser in Writing.
- 5.7 Approval Procedure**
The scheduled dates for the submission of the drawings as well as for, any data/information to be furnished by the Purchaser would be discussed and finalised at the time of award. The following schedule shall be followed generally for approval and for providing final documentation.
- | | | |
|------|---|--|
| i) | Approval/comments by Purchaser on initial submission | As per agreed schedule |
| ii) | Resubmission (whenever from date of Comments required including both ways postal time). | Within 3 (three) weeks |
| iii) | Approval or comments | Within 3 weeks of receipt of resubmission. |
| iv) | Furnishing of distribution copies in bound volume (5 copies per substation and one copy for Corporate Centre) | 2 weeks from the date of final approval |
| v) | Furnishing of distribution copies of test reports | |

(a)	Type test reports (one copy per substation plus one copy for corporate centre)	2 weeks from the date of final approval
(b)	Routine Test Reports (one copy for each substation)	-do
vi)	Furnishing of instruction/operation manuals (4 copies per substation and two copies for corporate centre)	As per agreed schedule
vii)	RTFs of drawings (one set substation and one set for corporate centre)	-do
(viii)	Video Cassette (VHS-PAL) - highlighting installation and maintenance techniques/ requirements of circuit breaker & isolators (one per substation plus one for corporate centre)	-do
(ix)	As built drawings & RTFs (Two sets per substation plus one set for corporate centre)	On completion of entire works
(x)	ROM optical disks for all As built drawings (one per substation plus one for corporate)	-do

NOTE:

- (1) The contractor may please note that all resubmissions must incorporate all comments given in the earlier submission by the Purchaser or adequate justification for not incorporating the same must be submitted failing which the submission of documents is likely to be returned.
 - (2) The drawings which are required to be referred frequently during execution should be submitted on cloth lined paper. The list of such drawings shall be finalised with the Contractor at the time of Award.
 - (3) All major drawings should be submitted in Auto Cad Version 12 or better.
 - (4) 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.
 - (5) 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 Purchaser.
 - (6) The Contractor shall furnish to the Purchaser catalogues of spare parts.
- 5.8 The list of major drawings and General Technical Parameters 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 Incase where the equipment, materials or components are indicated in the specification as “similar” to any special standard, the Purchaser shall decide upon the question of similarity. When required by the specification or when required by the Purchaser 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 being 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 Purchaser.

- 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, leveling, 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 in the proposal, where such oil or grease is available. He shall help Purchaser in establishing equivalent Indian make and Indian Contractor. The same shall be applicable to other consumables too.
- 6.1.8 A cast iron or welded steel base plate shall be provided for all rotating equipment which are to be installed on a concrete base unless otherwise agreed to by the Purchaser. Each base plate shall support the unit and its drive assembly, shall be of design with pads for anchoring the units, shall have a raised up all around and shall have threaded in air connections, if so required.
- 6.1.9 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 B respectively.

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 240 V ac 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.

6.2.1.3 Suitable anti condensation heaters with the provision of thermostat shall be provided.

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. Outdoor compartment openings shall be provided with shutter type blinds and suitable provision shall be made so as to avoid any communication of air / dust with any part in the enclosures of the Control Cabinets, Junction boxes and Marshalling Boxes, panels etc.

6.2.4 Degree of Protection

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

- a) Installed 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:13947 (Part-I)/ IEC-947 (Part-I)/ IS 12063 / IEC 529. Type test report for degree of protection test, on each type of the box 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, 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 Purchaser. The rating plate of each equipment shall be according to IEC requirement.

6.3.2 All such nameplates, instruction plates, rating plates of transformers, reactors, CB, CT, CVT, SA, Isolators and C & R panels 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 successful 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 note that the equipment offered by him in the bid only shall be accepted for supply. However, the Purchaser or the Contractor may propose changes in the specification of the equipment or quality thereof and if the Purchaser & contractor 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, subassemblies 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 Purchaser. 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 Purchaser (if any) during the period of Contract. The Contractor shall attend such meetings at his own cost at New Delhi 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 Purchaser's site or at any other place of Work are in accordance with the specifications, the Contractor shall adopt suitable quality assurance programme to control such activities at all points necessary. Such programme shall be broadly outlined by the contractor and finalised after discussions before the award of contract. The detailed programme shall be submitted by the contractor after the award of contract and finally accepted by DTL after discussion. However, in case detailed valid programme approved by DTL for the equipment already exist, same would be followed till its validity. A quality assurance programme of the contractor shall generally cover the following:

- (a) His organization structure for the management and implementation of the proposed quality assurance program;
- (b) Documentation control system;
- (c) Qualification data for 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 and fabrication and assembly control;
- (f) Control of non-conforming items and system for corrective actions;
- (g) Inspection and test procedure both for manufacture and field activities.
- (h) Control of calibration and testing of measuring instruments and field activities;
- (i) System for indication and appraisal of inspection status;
- (j) System for quality audits;
- (k) System for authorising release of manufactured product to the Purchaser.
- (l) System for maintenance of records;
- (m) System for handling storage and delivery; and
- (n) A quality plan detailing out the specific quality control measures and procedures adopted for controlling the quality characteristics relevant to each item of equipment furnished and/or services rendered.

The Purchaser 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 would be required to submit all the Quality Assurance Documents as stipulated in the Quality Plan at the time of purchaser's inspection of equipment/material

9.0 TYPE TESTING, INSPECTION, TESTING & INSPECTION CERTIFICATE

9.1 All equipment being supplied shall conform to type tests including additional type tests as per technical specification and shall be subject to routine tests in accordance with requirements stipulated under respective sections. Purchaser reserves the right to witness any or all the type tests. The Contractor shall intimate the Purchaser the detailed program about the tests atleast three (3) weeks in advance in case of domestic supplies & six (6) weeks in advance in case of foreign supplies.

9.2 The reports for all type tests and additional type tests as per technical specification shall be furnished by the Contractor alongwith equipment / material drawings as per relevant IEC with latest amendments. The type tests conducted 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 the representative(s) of DTL or Utility. The test reports submitted shall be of the tests conducted within last 10 (ten) years prior to the date of bid opening.

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

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

9.3 Bidder shall conduct type tests on equipments other than GIS if required in their respective section.

9.4 The Purchaser, his duly authorised representative and/or outside inspection agency acting on behalf of the Purchaser shall have at all reasonable times free access to the Contractor's/sub-vendors premises or Works and shall have the power at all reasonable times to inspect and examine the materials and workmanship of the Works during its manufacture or erection if part of the Works is being manufactured or assembled at other premises or works, the Contractor shall obtain for the Engineer 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. Inspection may be made at any stage of manufacture, despatch or at site at the option of the Purchaser and the equipment if found unsatisfactory due to bad workmanship or quality, material is liable to be rejected.

9.5 The Contractor shall give the Purchaser /Inspector thirty (30) days written notice of any material being ready for joint testing including contractor and DTL. Such tests shall be to the Contractor's account except for the expenses of the Inspector. The Purchaser / inspector, unless witnessing of the tests is virtually waived, will attend such tests within thirty (30) days of the date of which the equipment is notified as being ready for test/inspection, failing which the Contractor may proceed alone with the test which shall be deemed to have been made in the Inspector's presence and he shall forthwith forward to the Inspector duly certified copies of tests in triplicate.

9.6 The Purchaser or Inspector shall, within fifteen (15) days from the date of inspection as defined herein give notice in writing to the Contractor, of any objection to any drawings and all or 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 Purchaser /Inspector giving reasons therein, that no modifications are necessary to comply with the Contract.

9.7 When the factory tests have been completed at the Contractor's or Sub-Contractor's works, the Purchaser/inspector shall issue a certificate to this effect within fifteen (15) days after completion of tests but if the tests are not witnessed by the Purchaser /Inspector, the certificate shall be issued within fifteen (15) days of receipt of the Contractor's Test certificate by the Engineer/Inspector. Failure of the Purchaser /Inspector 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 Purchaser to accept the equipment should, it, on further tests after erection, be found not

to comply with the Contract. The equipment shall be dispatched to site only after approval of test reports and issuance of CIP by the Purchaser.

- 9.8 In all cases where the Contract provides for tests whether at the premises or at the 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 Purchaser /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 Purchaser /Inspector or to his authorised representative to accomplish testing.
- 9.9 The inspection by Purchaser 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.
- 9.10 The Purchaser 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.
- 9.11 The Purchaser reserves the right for getting any field tests not specified in respective sections of the technical specification conducted on the completely assembled equipment at site. The testing equipments for these tests shall be provided by the Purchaser.

10. 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 Purchaser 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 testing equipments required for testing and commissioning shall be arranged by the Contractor.
- 10.2.2 The specific tests requirement on equipment have been brought out in the respective chapters of the technical specification.
- 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 DTL 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 Purchaser, the Contractor shall also submit packing details/associated drawing for any equipment/material under his scope of supply, to facilitate the Purchaser 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. Purchaser 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. High tensile steel nuts & bolts and spring washers shall be electro galvanized to service condition 4. 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 thickness of coating shall be 85 microns for all items thicker than 6mm. 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.
- 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 treatment shall be provided to avoid formation of white rust after hot dip galvanization.
- 12.2.4 The galvanized steel shall be subjected to six 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 zinc rich paint at site shall not be allowed.

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 swarf 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 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 colour of the paint shall be as per shade no: 697 (for outdoor) & 692 (for indoor) of IS-5 and inside shall be glossy white for all equipment, marshalling boxes, junction boxes, control cabinets, panels etc. unless specifically mentioned under respective sections of the equipments. 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 Bidder 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 alongwith the Bids for Purchaser'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
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Fire Protection System			
1	Hydrant and Emulsifier system pipeline	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 System			
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

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 Purchaser 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 In case of any doubt/misunderstanding as to the correct interpretation of manufacturer's drawings or instructions, necessary clarifications shall be obtained from the Purchaser. Contractor shall be held responsible for any damage to the equipment consequent to not following manufacturer's drawings/instructions correctly.
- 13.4 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 necessary 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.
- 13.5 Contractor shall be responsible for examining all the shipment and notify the Purchaser immediately of any damage, shortage, discrepancy etc. for the purpose of Purchaser's information only. The Contractor shall submit to the Purchaser 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.
- 13.6 The Contractor shall be fully responsible for the equipment/material until the same is handed over to the Purchaser 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 Purchaser, as well as protection of the same against theft, element of nature, corrosion, damages etc.

- 13.7 Where material / equipment is unloaded by Purchaser before the Contractor arrives at site or even when he is at site, Purchaser 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.
- 13.8 The Contractor shall be responsible for making suitable indoor storage facilities, to store all equipment which requires indoor storage.
- 13.9 The words 'erection' and 'installation' used in the specification are synonymous.
- 13.10 Exposed live parts shall be placed high enough above ground to meet the requirements of electrical and other statutory safety codes.
- 13.11 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 as given in clause 4.7.1 the Contractor shall immediately proceed to correct the discrepancy at his risks and cost.

13.12 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 Purchaser. 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.

14.0 TOOLS AND TACKLES

The Contractor shall supply with the equipment one complete set of all special tools and tackles for the erection, assembly, dis-assembly and maintenance of the equipment. However, these tools and tackles shall be separately, packed and brought on to Site.

15.0 AUXILIARY SUPPLY

- 15.1 The sub-station auxiliary supply is normally met through a system indicated under section "Electrical & Mechanical Auxiliaries" having the following parameters. 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 shall also conform the parameters as indicated in the following.

Normal Voltage connection	Variation in Voltage	Frequency in HZ	Phase /Wire	Neutral
415V	+/- 10%	50 +/- 5%	3/ 4 Wire	Solidly Earthed
240V	+/- 10%	50 +/- 5%	1/ 2 Wire	Solidly Earthed
220V System	190V to 240V	DC	-	Isolated 2 wire
50V (+) earthed	—	DC	—	2 wire system

Combined variation of voltage and frequency shall be limited to +/-10%.

16.0 SUPPORT STRUCTURE

The Contractor is required to supply standard structures of various equipments. Bidder may also refer relevant Clauses of Section (Civil) in this regard.

17.0 CLAMPS AND CONNECTORS INCLUDING TERMINAL CONNECTORS

- 17.1 All power clamps and connectors shall conform to IS:5561 & NEM CC1 and shall be made of materials listed below :

- a) For connecting
ACSR conductors

Aluminum alloy casting,
conforming to designation A6
of IS:617 and all test shall
conform to IS:617

- | | |
|---|---|
| b) For connecting equipment terminals made of copper with ACSR conductors | Bimetallic connectors made from aluminum alloy casting, conforming to designation A6 of IS 617 with 2mm thick bimetallic liner and all test shall conform to IS:617 |
| c) For connecting G.I wire | Galvanised mild steel shield |
| i) Bolts, nuts & Plain, washers | i) Electro galvanised for sizes below M12, for others hot dip galvanised. |
| ii) Spring washers for items 'a' to 'c' | ii) Electro-galvanised mild steel suitable for atleast service condition-3 as per IS:1573 |

- 17.2 Each equipment shall be supplied with the necessary terminals and connectors, as required by the ultimate design for the particular installation. The conductor terminations of equipment shall be either expansion, sliding or rigid type suitable for 4" IPS (OD : 114.2 mm, ID: 97.18 mm) aluminum tube or suitable for Quad/Twin ACSR / AAAC Conductor (250 mm Sub- Conductor spacing for 220 kV). The requirement regarding external corona and RIV as specified for any equipment shall include its terminal fittings and the equipment shall be factory tested with the connectors in position. 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. The design details of the joint shall be furnished to the Purchaser by the Contractor.
- 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 of minimum 2 mm thickness shall be cast integral with aluminum body 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 4" 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 Clamp shall be designed to carry the same current as the conductor and the temperature rise shall be equal or less than that of the conductor at the specified ambient temperature. The rated current for which the clamp/connector is designed with respect to the specified reference ambient temperature, shall also be indelibly marked on each component of the clamp/connector, except on the hardware.
- 17.9 All current carrying parts shall be designed and manufactured to have minimum contact resistance.
- 17.10 Clamps and connectors shall be designed to be corona controlled. Corona extinction voltage for 220 kV class clamps shall not be less than 156 kV and R.I.V. level shall not be more than 1000 micro volts at the test voltage specified in respective sections.

17.11 Tests

- 17.11.1 Clamps and connectors should be type tested as per IS:5561 and shall also be subjected to routine tests as per IS:5561. Following type test reports on three samples of similar type shall be submitted for approval as per clause 9.2 above except for sl. no.(ii) & (iii) for which type test once

conducted shall be applicable (i.e. the requirement of test conducted within last five 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 220 KV and above voltage level clamps)
- iv) Resistance test and tensile test

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-5039/IS-8623, IEC-439, as applicable, and the clauses given below:
- 18.2 Control cabinets, junction boxes, Marshalling boxes & terminal boxes shall be made of sheet steel or aluminum enclosure and shall be dust, water and vermin proof. Sheet steel used shall be atleast 2.0 mm thick cold rolled or 2.5 mm hot rolled. The box shall be properly braced to prevent wobbling. There shall be sufficient reinforcement to provide level surfaces, resistance to vibrations and rigidity during transportation and installation. 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.
- 18.3 Cabinet/boxes shall be free standing floor mounting type, wall mounting type or pedestal mounting type as per requirements. 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 shall be provided with double hinged doors with padlocking arrangements. The distance between two hinges shall be adequate to ensure uniform sealing pressure against atmosphere. The quality of the gasket shall be such that it does not get damaged/cracked during the operation of the equipment.
- 18.5 All doors, removable covers and plates shall be gasketed all around with suitably profiled EPDM gaskets. The gasket shall be tested in accordance with approved quality plan. The quality of gasket shall be such that it does not get damaged/cracked during the ten years of operation of the equipment or its major overhaul whichever is earlier. All gasketed surfaces shall be smooth straight and reinforced if necessary to minimize distortion and to make a tight seal. Ventilating Louvers, if provided, shall have screen and filters. The screen shall be fine wire mesh made of brass.
- 18.6 All boxes/cabinets shall be designed for the entry of cables from bottom by means of weather proof and dust-proof connections. Boxes and cabinets shall be designed with generous clearances to avoid interference between the wiring entering from below and any terminal blocks or accessories mounted within the box or cabinet. Suitable cable gland plate projecting at least 150 mm above 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. The gland shall project at least 25mm above gland plate to prevent entry of moisture in cable crutch. Gland plate shall have provision for some future glands to be provided later, if required. 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 For illumination of a 20 Watts flourscent tube or 15 watts CFL shall be provided. The switching of the fittings shall be controlled by the door switch.
- 18.9 All control switches shall be of rotary switch type and Toggle/piano switches shall not be accepted. However, Spring return type actuator switch for ON/Off control are acceptable.

- 18.10 Positive 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/earthing by pasting the same on the inside of the door.
- 18.12 a) The following routine tests along with the routine tests as per IS:5039 shall also be conducted:
 i) Check for wiring
 ii) Visual and dimension check
 b) The enclosure of bay marshalling kiosk, junction box, terminal box shall conform to IP-55 as per IS:13947 including application of, 2.5 KV rms for 1 (one) minute, insulation resistance and functional test after IP-55 test.

19.0 Auxiliary Switches (Applicable for isolators and circuit breakers)

The following type test reports on auxiliary switches shall be submitted for approval:

- (a) Electrical endurance test - A minimum of 2000 operation for 2A D. C. with a time constant greater than or equal to 20 millisecond with a subsequent examination of mV drop/visual defects/temperature rise test.
- (b) Mechanical endurance test. A minimum of 1,00,000 operations with a subsequent checking of contact pressure test/visual examination.
- (c) Heat run test on contacts.
- (d) IR/HV test etc.

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 650 V grade and have continuous rating to carry the maximum expected current on the terminals. 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 preferably the terminal blocks shall be non disconnecting stud type equivalent to Elmex type CATM4, Phoenix cage clamp type of Wago or equivalent.
- 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.
- 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 Minimum of two of 2.5 sq mm CT circuits copper flexible.
- b) All CT 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. Also 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.
- 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

21.0 LAMPS AND SOCKETS

21.1 Lamps

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

21.2 Sockets

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.

21.3 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.

21.4 Switches and Fuses:

21.4.1 Each panel shall be provided with necessary arrangements for receiving, distributing, isolating and fusing of DC and AC supplies for various control, signalling, lighting and space heater circuits. The incoming and sub-circuits shall be separately provided with 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.

21.4.2 All fuses shall be of HRC cartridge type 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.

22.0 Bushings, Hollow Column Insulators, Support Insulators:

22.1 Bushings shall be manufactured and tested in accordance with IS: 2099 & IEC: 137 while hollow column insulators shall be manufactured and tested in accordance with IEC 233/IS 5621. The support insulators shall be manufactured and tested as per IS 2544/IEC 168 and IEC 273. The insulators shall also conform to IEC 815 as applicable. The bidder may also offer composite silicon insulator, conforming to IEC-61109.

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 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. The type test reports shall be submitted for approval.
- 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 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-online 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 rate 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 specialties of the items as per the field Q.P./Instructions of the equipment Contractor or Purchaser without any extra cost to the Purchaser. The Contractor shall arrange all instruments required for conducting these tests along with calibration certificates and shall furnish the list of instruments to the Purchaser 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.

24.0 TECHNICAL REQUIREMENT OF EQUIPMENTS

24.1 Circuit Breakers

- a. The manufacturer(s) whose Circuit Breaker are offered should have designed, manufactured tested as per IEC/IS or equivalent standard supplied the same for the specified system voltage and which are in satisfactory operation for at least 2 (two) years as on the date of bid opening.

Or

- b. The manufacturer(s) whose Circuit Breaker are offered who have recently established production line in India for the specified system voltage or above class, based on technological support of a parent company or collaborator for the respective equipment(s) can also be considered provided the parent company (Principal) or collaborator meets qualifying requirements stipulated under clause no 24.1.a given above.

And

Furnishes (jointly with parent company or collaborator) a legally enforceable undertaking to guarantee quality, timely supply, performance and warranty obligations as specified for the equipment(s)

And

Furnishes a confirmation letter from the parent company or collaborator alongwith the bid stating that parent company or collaborator shall furnish performance guarantee for an amount of 10% of the cost of such equipment(s). This performance guarantee shall be in addition to contract performance guarantee to be submitted by the Bidder

24.2 Isolators

The manufacturer whose isolators are offered, should have designed, manufactured, tested as per IEC/IS or equivalent standard and supplied the isolator for the specified system voltage and fault level and should be in satisfactory operation for at least 2 (two) years as on the date of bid opening.

24.3 Instrument Transformers

The manufacturer whose instrument transformers are offered, should have designed, manufactured & tested as per IS/IEC or equivalent standard and supplied the same for the specified system voltage for CT & CVT and fault level in case of CT. These equipment should be in satisfactory operation for at least 2 (two) years as on the date of bid opening.

24.4 Surge Arresters

The manufacturer whose Surge Arresters are offered should have designed, manufactured and tested as per IEC/IS or equivalent standard and supplied the Surge Arrester for the specified energy capability with rated system voltage and which are in satisfactory operation for at least 2 (two) years as on the date of bid opening.

24.5 1.1 kV Grade Power & Control Cables

24.5.1 Applicable for PVC Control Cable

The manufacturers, whose PVC control cables are offered, should have designed, manufactured, tested and supplied in a single contract at least 100 Kms of 1.1 kV grade PVC insulated control cables as on the date of bid opening. Further the manufacturer should also have designed,

manufactured, tested and supplied at least 1 km of 27C x 2.5 Sq.mm or higher size as on the date of bid opening.

24.5.2 Applicable for PVC Power Cable

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

24.5.3 Applicable for XLPE Power Cables

The Manufacturer, whose XLPE Power cables are offered, should 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 bid opening . Further the manufacturer should also have designed, manufactured, tested and supplied at least 1 km of 1C x 630 Sq. mm or higher size as on the date of bid opening.

24.6 LT Switchgear

24.6.1 The Manufacturer whose LT Switchgear are offered, should be a manufacturer of LT Switchboards of the type and rating being offered. He should have designed, manufactured, tested and supplied at least 50 nos. draw out circuit breaker panels, out of which at least 5 nos. should have been with relay and protection schemes with current transformer. He should have also manufactured at least 50 nos. motor control center panels of the type and rating being offered which should be in successful operation as on date of bid opening.

24.6.2 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. At least one hundred circuit breakers of the make and type being offered shall be operating satisfactory as on date of bid opening.

24.7 Battery and Battery Charger

24.7.1 Requirements for Battery Manufacturers

The manufacturer whose Batteries are offered should have designed, manufactured and supplied DC Batteries of the type specified and being offered, having a capacity of at least 600 AH and these shall be operating satisfactorily for two years in power sector and/or industrial installations as on date of bid opening.

24.7.2 Requirements for Battery Charger Manufacturers

The manufacturer, whose Battery Chargers are offered, should 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 should be in successful as on the date of bid opening.

24.8 LT Transformers

The manufacturer, whose transformers are offered should have designed, manufactured, type tested including short circuit test as per IEC/IS or equivalent standards and supplied transformers of at least 33 kV class of 800 kVA or higher. The transformer should have been in successful operation for at least 2 years as on the date of bid opening.

24.9 Fire Fighting System

Nitrogen Injection Fire Prevention and Extinguishing System shall be used for fire protection of Transformer. In addition fire protection wall shall be erected between the two transformers which have adjacent base. Portable Fire Extinguishers shall also be provided.

24.10 Control and Relay Panels

24.10.1 The manufacturer whose C&R panels and protective relay are offered should have designed, manufactured, tested, installed and commissioned C&R panels including protection relays which must be in satisfactory operation on 220 kV system for atleast 2 (two) years on the date of bid opening.

24.10.2 The C&R Panel from a manufacturer whose have designed, manufactured, tested, installed and commissioned C&R panels which are in satisfactory operation on 220 kV system for atleast 2 (two) years on the date of bid opening can also be offered, provided the protective relay schemes should be offered from a Contractor who fully meets the requirements stipulated under clause 24.10.1 above. Further, in such an event the manufacturer shall furnish an undertaking jointly executed by him and his protective relay schemes Supplier, as per the format enclosed in the bid documents for successful performance of the protection system offered.

CORONA AND RADIO INTERFERENCE VOLTAGE (RIV) TEST**1. General**

Unless otherwise stipulated, all equipment (except Auto Transformer) 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%, 115% and 130% of the specified RIV test voltage for all equipment unless otherwise specified. The specified RIV test voltage for 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.

4.0 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 130% of RIV test voltage and maintained there for five minutes. In case corona inception does not take place at 130 %, 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%, 115% and 130%. 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.

- 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 interference sources detected at each step.
- e) Test voltage shall be recorded when measured RIV passes through 100 microvolts in each direction.
- f) Onset and extinction of visual corona for each of the four tests required shall be recorded.

SEISMIC WITHSTAND TEST PROCEDURE

The seismic withstanding test on the complete equipment (except Auto Transformer) shall be carried out alongwith supporting structure. The Bidder shall arrange to transport the structure from his Contractor's premises/DTL 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 Purchaser. 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 Purchaser.

LIST OF SPECIFICATIONS**GENERAL STANDARDS AND CODES**

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	-	Insulation Coordination.
P2:1983		
IS-3043	-	Code of Practice for Earthing
IS-6103	-	Method of Test for Specific Resistance(Resistivity) of Electrical
	-	Insulating Liquids
IS-6104	-	Method of Test for Interfacial Tension of Oil against Water by
	-	the Ring Method
IS-6262	-	Method of test for Power factor & Dielectric
	-	Constant of Electrical Insulating Liquids.
IS-6792	-	Method for determination of electric strength
	-	of insulating oils.
IS-5578	-	Guide for marking of insulated conductors.
IS-11353	-	Guide for uniform system of marking &
	-	identification of conductors & apparatus terminals.
IS-8263	-	Methods for Radio Interference Test on High
	-	voltage Insulators.
IS-9224 (Part 1,2&4)	-	Low Voltage Fuses
IEC-60060 (Part 1 to P4)	-	High Voltage Test Techniques
IEC 60068	-	Environmental Test
IEC-60117	-	Graphical Symbols
IEC-60156,	-	Method for the Determination of the Electrical
	-	Strength of Insulation Oils.
IEC-60270,	-	Partial Discharge Measurements.
IEC-60376	-	Specification and Acceptance of New Sulphur
	-	Hexafluoride
IEC-60437	-	Radio Interference Test on High Voltage
	-	Insulators.
IEC-60507	-	Artificial Pollution Tests on High Voltage
	-	Insulators to be used on AC Systems.
IEC-60694	-	Common Specification for High Voltage
	-	Switchgear & Controlgear Standards.
IEC-60815	-	Guide for the Selection of Insulators in respect
	-	of Polluted Conditions.
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,	-	Specification for Electromagnetic Noise and
C63.3	-	Field Strength Instrumentation 10 KHz to 1 GHZ
C36.4/ANSI-C68.1	-	Techniques for Dielectric Tests
ANSI-C76.1/IEEE21	-	Standard General Requirements and Test Procedure for Outdoor
	-	Apparatus Bushings.
ANSI-SI-4	-	Specification for Sound Level Metres
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 Part 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
ANSI-CG,1EEE-4	-	Standard Techniques for High Voltage Testing

CIRCUIT BREAKERS

IEC-62271-100	-	High Voltage Alternating Current Breakers
IEC-60427	-	Synthetic Testing of High Voltage alternating current circuit Breakers.
IEC-61264	-	Pressurised Hollow Column Insulators

CURRENT TRANSFORMERS, VOLTAGE TRANSFORMERS AND COUPLING CAPACITOR VOLTAGE TRANSFORMERS

IS-2705	-	(P1 to P4) - Current Transformers.
IS:3156	-	(P1 to P4) - Voltage Transformers.
IS-4379	-	Identification of the Contents of Industrial Gas Cylinders
IEC-60044-1	-	Current transformers.
IEC-60044-2	-	Voltage Transformers.
IEC-60358	-	Coupling capacitors and capacitor dividers.
IEC-60044-4	-	Instrument Transformers : Measurement of Partial Discharges
IEC-60481	-	Coupling Devices for power Line Carrier Systems.
ANSI-C5713	-	Requirements for Instrument transformers
ANSIC92.2	-	Power Line Coupling voltage Transformers
ANSI-C93.1	-	Requirements for Power Line Carrier Coupling
Capacitors		
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	-	IEEE Standards for S A for AC Power Circuits

CUBICLES AND PANELS & OTHER RELATED EQUIPMENTS

IS-722, IS-1248, IS-3231, 3231 (P-3)	-	Electrical relays for power system 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 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-60129	-	Alternating Current Disconnectors (Isolators) and Earthing switches
IEC-1129	-	Alternating Current Earthing Switches Induced Current switching
IEC-60265 (Part 1 & Part 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 part 23) - IEC-60297	-	Electrical relays.

(P1 to P4)	-	Dimensions of mechanical structures of the 482.6mm (19 inches) 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	-	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

IEC-60068 (P1 to P5)	-	Environmental testing
IEC-60326 (P1 to P2)	-	Printed boards Material and workmanship standards
IS-1363 (P1 to P3)	-	Hexagon headbolts, 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 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-60233	-	Tests on Hollow Insulators for use in electrical equipment.
IEC-60273	-	Characteristics of indoor and outdoor post insulators for systems with nominal voltages greater than 1000V.
IEC-60305	-	Insulators for overhead lines with nominal voltage above 1000V-ceramic or glass insulator units for a.c. systems Characteristics of String Insulator Units of the cap and pintype.
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

IEC-60433	-	voltage above 1000 V.
IEC-60471	-	Characteristics of string insulator units of the long rod type.
ANSI-C29	-	Dimensions of Clevis and tongue couplings of string insulator units.
ANSI-C29.1	-	Wet process porcelain insulators
ANSI-C92.2	-	Test methods for electrical power insulators
ANSI-C29.8	-	For insulators, wet-process porcelain and toughened glass suspension type
ANSI-G.8	-	For wet-process porcelain insulators apparatus, post-type
CISPR-7B	-	Iron and steel hardware
ASTM A-153	-	Recommendations of the CISPR, tolerances of form and of Position, Part 1
Strain and rigid bus-conductor	-	Zinc Coating (Hot-Dip) on iron and steel hardware

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
ASTM-B 231-81	-	Concentric - lay - stranded, aluminum 1350 conductors
ASTM-B 221	-	Aluminum - Alloy extruded bar, rod, wire, shape
ASTM-B 236-83	-	Aluminum bars for electrical purpose (Busbars)
ASTM-B 317-83	-	Aluminum-Alloy extruded bar, rod, pipe and structural shapes for electrical purposes(Bus Conductors)

Batteries and batteries charger Battery

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

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
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 controlgear.
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.
IS:1753	-	Part (2) for working voltage from 3.3 kV upto and including 11kV.
IS:2982	-	Aluminium conductor for insulated cables
IS-3961 (P1 to P5)	-	Copper Conductor in insulated cables.
IS-3975	-	Recommended current ratings for cables.
IS-5831	-	Mild steel wires, formed wires and tapes for armouring of cables.
IS-6380	-	PVC insulating and sheath of electric cables.
IS-7098	-	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-8130	-	Cross-linked polyethylene insulated PVC sheathed cables for working voltage from 3.3kV upto and including 33 kV.
IS-1753	-	Conductors for insulated electrical cables and flexible cords.
IS-10418	-	Aluminum Conductors for insulated cables.
IEC-60096 (part 0 to p4)	-	Specification for drums for electric cables.
IEC-60183	-	Radio Frequency cables.
IEC-60189 (P1 to P7)	-	Guide to the Selection of High Voltage Cables.
IEC-60227 (P1 to P7)	-	Low frequency cables and wires with PVC insulation and PVC sheath.
IEC-60228	-	Polyvinyl Chloride insulated cables of rated voltages up to and including 450/750V.
IEC-60230	-	Conductors of insulated cables
IEC-60287 (P1 to P3) cables (100% load factor).	-	Impulse tests on cables and their accessories.
IEC-60304	-	alculation of the continuous current rating of
IEC-60331	-	Standard colours for insulation for low frequency cables and wires.
IEC-60332 (P1 to P3)	-	Fire resisting characteristics of Electric cables.
IEC-60502	-	Tests on electric cables under fire conditions.
IEC-754 (P1 and P2)	-	Extruded solid dielectric insulated power cables for rated voltages from 1 kV upto to 30 kV
	-	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.

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:469	-	Degree of protection provided by enclosures for rotating electrical machinery
IS:7572	-	Guide for testing single-phase a.c. 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-A123	-	Specification for zinc (Hot Galvanizing) Coatings, on products Fabricated from rolled, pressed and forged steel shapes, plates, bars and strips.
ASTM-A-121-77	-	Zinc-coated (Galvanized) steel barbed wire

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
IS:5120	-	Technical requirement – Roto dynamic 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, utilising 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:78	-	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
IS:5290	-	Landing valves (internal hydrant)
IS:5312	-	Swing check type reflex (non-return) valves (Part-I)
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:472	-	Rotating electrical machines
IS:4729	-	Measurement and evaluation of vibration of rotating electrical machines
IS:5572	-	Classification of hazardous areas for electrical (Part-I) installations (Areas having gases and vapours)
IS:6362	-	Designation of methods of cooling for rotating electrical machines
IS:6381	-	Construction and testing of electrical apparatus with type of protection 'e'
IS:7816	-	Guide for testing insulation for rotating machine
IS:4064	-	Air break switches
IEC DOCUMENT 2 (Control Office) 432	-	Three Phase Induction Motor
VDE 0530 Part I/66	-	Three Phase Induction Motor
IS:9224 (Part-II)	-	HRC Fuses
IS:6875	-	Push Button and Control Switches
IS:694	-	PVC Insulated cables
IS:1248	-	Indicating instruments

IS:375	-	Auxiliary wiring & busbar markings
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 (Latest Edition)	-	Standard on Automatic Fire Detectors Fire Protection Manual by TAC
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

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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.
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 headbolts, 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

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 hotdipped, zinc coated welded and seamless
ASTM-A106	-	Seamless carbon steel pipe for high temperature service
ASTM-A284	-	Low and intermediate tensile strength carbonsilicon steel plates for machine parts and general construction.
ASTM-A234	-	Pipe fittings of wrought carbon steel and alloy steel for moderate and elevated temperatures
ASTM-S181	-	Specification for forgings, carbon steel for general purpose piping
ASTM-A105	-	Forgings, carbon steel for piping components
ASTM-A307	-	Carbon steel externally threaded standard fasteners
ASTM-A193	-	Alloy steel and stainless steel bolting materials for high temperature service
ASTM-A345	-	Flat rolled electrical steel for magnetic applications
ASTM-A197	-	Cupola malleable iron
ANSI-B2.1	-	Pipe threads (Except dry seal)
ANSI-B16.1	-	Cast iron pipe 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

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-drawn 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-drawn steel wire fabric for concrete reinforcement.
IS-1742	- Code of Practice for Building drainage.
IS-1785	- Plain hard-drawn steel wire for prestressed 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 prestressed 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) rammer and 18-in. (457 mm) Drop.
ASTM-D1586	- Penetration Test and Split-Barrel (1967) - Sampling of Soils
ASTM-D2049-69	- Test Method for Relative Density of Cohesionless Soils
ASTM-D2435	- Test method for Unconsolidated, (1982)
BS-5075	- Undrained Strengths of Cohesive Soils in Triaxial Compression.
CPWD	- Specification for accelerating Part I Admixtures, Retarding Admixtures and Water Reducing Admixtures.
	- Latest CPWD specifications

ACSR MOOSE CONDUCTOR

IS:6745	Methods for Determination of BS:443-1969
IS:8263	Mass of zinc coating on zinc coated Iron and Steel Articles
	Methods for Radio Interference IEC:437-1973
	Test on High Voltage Insulators
	NEMA:107-1964
	CISPR
IS:209	Zinc Ingot BS:3436-1961
IS:398	Aluminum Conductors for IEC:209-1966
Part – V	Overhead Transmission Purposes
BS:215(Part-II)	Aluminium Conductors galvanized IEC:209- forced extra high

BS:215(Part-II)	voltage (400 kV and above)
IS:1778	Reels and Drums for BS:1559-1949
	Bare Conductors
IS:1521	Method for Tensile Testing ISO/R89-1959
	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	Hot dip galvanised coatings on round steel wires ASTM-472-729

GALVANISED STEEL EARTHWIRE

IS:1521	Method for Tensile Testing ISO/R:89-1959
	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	Hot dip Galvanised Coatings ASTM:A
	475-72 a on Round Steel Wires BS:443-1969
IS:6745	Method for Determination BS:443-1969 of mass of Zinc Coating on Zinc
	coated Iron and Steel Articles.
IS:209	Zinc ingot BS:3463-1961
IS:398(Pt. I to	Aluminum Conductors for BS:215 (Part-II)
P5:1992)	overhead transmission purposes.

Lighting Fixtures and Accessories

(i)	IS:1913	General and safety requirements for electric lighting fittings.
(ii)	IS:3528	Water proof electric lighting fittings.
(iii)	IS:4012	Dust proof electric lighting fittings.
(iv)	IS:4013	Dust tight proof electric lighting fittings.
(v)	IS:10322	Industrial lighting fittings with metal reflectors.
(vi)	IS:10322	Industrial lighting fittings with plastic reflectors.
(vii)	IS:2206	Well glass lighting fittings for use under ground in mines (non-flameproof type).
(viii)	IS:10322	Specification for flood light.
(ix)	IS:10322	Specification for decorative lighting outfits.
(x)	IS:10322	Luminaires for street lighting
(xi)	IS:2418	Tubular fluorescent lamps
(xii)	IS:9900	High pressure mercury vapour lamps.
(xiii)	IS:1258	Specification for Bayonet lamp fluorescent lamp.
(xiv)	IS:3323	Bi-pin lamp holder tubular fluorescent lamps.
(xv)	IS:1534	Ballasts for use in fluorescent lighting fittings.
	(Part-I)	
(xvi)	IS:1569	Capacitors for use in fluorescent lighting fittings
(xvii)	IS:2215	Starters for fluorescent lamps.
(xviii)	IS:3324	Holders for starters for tubular fluorescent lamps
(xix)	IS:418	GLS lamps
(xx)	IS:3553	Water tight electric fittings
(xxi)	IS:2713	Tubular steel poles
(xxii)	IS:280	MS wire for general engg. purposes

Conduits, Accessories and Junction Boxes

(1)	IS:9537	Rigid steel conduits for electrical wiring
(2)	IS:3480	Flexible steel conduits for electrical wiring
(3)	IS:2667	Fittings for rigid steel conduits for electrical wiring
(4)	IS:3837	Accessories for rigid steel conduits for electrical wiring
(5)	IS:4649	Adaptors for flexible steel conduits.
(6)	IS:5133	Steel and Cast Iron Boxes
(7)	IS:2629	Hot dip galvanising of Iron & Steel.

Lighting Panels

(1)	IS:13947	LV Switchgear and Control gear(Part 1to 5)
(2)	IS:8828	Circuit breakers for over current protection for house hold and similar installations.
(3)	IS:5	Ready mix paints
(4)	IS:2551	Danger notice plates
(5)	IS:2705	Current transformers
(6)	IS:9224 650V(Part-2)	HRC Cartridge fuse links for voltage above
(7)	IS:5082	Wrought aluminium and Al. alloys, bars, rods, tubes and sections for electrical purposes.
(8)	IS:8623	Factory built Assemblies of Switchgear and Control Gear for voltages upto and including 1000V AC and 1200V DC.
(9)	IS:1248	Direct Acting electrical indicating instrument

Electrical Installation

(1) IS:1293	3 pin plug
(2) IS:371	Two to three ceiling roses
(3) IS:3854	Switches for domestic and similar purposes
(4) IS:5216	Guide for safety procedures and practices in electrical work.
(5) IS:732	Code of practice for electrical wiring installation (system voltage not exceeding 650 Volts.)
(6) IS:3043	Code of practice for earthing.
(7) IS:3646	Code of practice of interior illumination part II & III.
(8) IS:1944	Code of practice for lighting of public through fares.
(9) IS:5571	Guide for selection of electrical equipment for hazardous areas.
(10) IS:800	Code of practice for use of structural steel in general building construction.
(11) IS:2633	Methods of Testing uniformity of coating on zinc coated articles.
(12) IS:6005	Code of practice for phosphating iron and steel.
(13)	INDIAN ELECTRICITY ACT
(14)	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
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

LIST OF DRAWINGS/DOCUMENTS

1. Single Line Diagram
2. Electrical Layout – Plan and Sections
3. Switchyard structural Layout and Section
4. DSLP Calculation and drawing
5. Earthmat Design
6. Short circuit Force and Critical Span Calculations
7. Busbar Design calculations
8. Cantilever Strength calculations
9. Design calculation for Sag – Tension stringing chart
10. GTP and drawings for Bus-Post Insulator
11. Tension/suspension string insulator and Hardware Assembly GTP and drawing
12. Structure Layout (Plan & Section) drawing
13. Soil Investigation Report

14. **Circuit Breakers (220kV and 33kV)**
 - GA drawing
 - GTP
 - Type test Reports
15. **CTs (220kV and 33kV)**
 - GA drawing
 - GTP
 - Type test Reports
16. **Surge Arrestors (216kV and 30kV)**
 - GA drawing
 - GTP
 - Type test Reports
17. **Isolators (220kV and 33kV)**
 - GA drawing
 - GTP
 - Type test Reports
18. **220kV Transformers (220/33/11kV)**
 - Outline GA drawings
 - Foundation Plan
 - Data Sheet
 - OLTC GA drawing/schematic
 - RTCC GA drawing/schematic
 - OGA and Data sheets for Bushing
 - GA and schematic of Marshalling Kiosk
 - Rating and Diagram Plate
 - Type test Reports
19. **Control and Relay Panels**
 - GTP and technical literature
 - Type test report of Relays/Relays/Equipments
20. **Civil Works**
 - Boundary wall**
 - Control Room Building**
 - Structure Design, Foundation Design & Drg., Plinth Beam Design & Drg. and column Design & Drg. upto G.F. Level
 - Transformer foundation design/drawings
 - 220kV Tower foundation design/drawings.

SECTION-IV

SPECIAL EQUIPMENTS

SECTION: IV

SPECIAL EQUIPMENTS

A. Technical Specification of “Automatic Transformer Turn Ratio Meter”

1.0 Functional requirement

- 1.1 The equipment offered shall be used for automatic measurement of turns ratio (3phase simultaneously), exciting current, ratio error, and phase angle deviation, tap position for power transformers, instrument transformers and distribution transformers and CT and PT's by directly connecting the instrument to equipment. The instrument should have the provision for measurement for single phase also.
- 1.2 It should measure actual turn ratio of different, vector groups, phase, tap-position, ratio and deviation, phase angle and deviation, in three phase transformers without conversion and should also give magnetizing current indication.
- 1.3 Kit should have facility for operator to enter the ratio of the transformer and all of it's taps to the operator to know immediately when a tap is outside the acceptable limits. It should also have facility to enter pass/fail limit so problem taps can be easily flagged.
- 1.4 It should easily portable.
- 1.5 Automatic range selection and self-calibration for each test.

2.0 Display

Digital LCD display with backlight viewable in bright sunlight.

3.0 Ratio measuring range and accuracy

1-10000:1 minimum with accuracy of 0.1% to 0.5% maximum at different ranges

4.0 Test Voltage

8 to 80V rms minimum, automatically or manually selected

5.0 Magnetising Current

1mA to 2000mA @ 0.1mA and Accuracy = ± 5 mA

6.0 Phase angle Range

$\pm 90^\circ$ @ resolution 0.1° and accuracy $\pm 0.5^\circ$

7.0 Data Entry

Through instrument mounted key board/front panel/external key board.

8.0 Power Supply

It shall work on single-phase $230 \pm 10\%$ V, $50 \pm 5\%$ Hz, supply with variations in voltage and frequency respectively.

9.0 Protection of Kit

Kit should have all necessary protections against transient surges, over voltages, induction, short circuits etc.

10.0 **Storage**

Internal, nonvolatile memory for storing up to minimum 100 sets of three-phase measured and calculated ratio, exciting current, phase, ratio error, and name plate details of transformer.

11.0 **Repeatability**

It should offer repeatability of test results in 220 kV/400 kV charged area.

12.0 **Software**

The kit should have facility to connect with windows based computer for exporting the test data. The software should be suitable for data storage, report printout, and download of data etc. The original software in CD shall be handed over to DTL during the commissioning.

13.0 **Interfacing PC**

The kit shall be provided with necessary ports (RS232/USB/ equivalent) to interface the other peripheral devices such as printers, portable drive, etc.

14.0 **Accessories**

Complete set of test leads (min. 20 meter) with clamps and connectors, PC cables, Licensed OS software, Licensed software of the testing kit, combination plugs, power-supply cables, original hard carrying case for main kit and cables (which should be robust/ rugged enough for proper safety of the kit during transportation), manual (both in soft copy & hard copies) etc, required for carrying out all types of testing.

15.0 **Cooling arrangement**

Necessary in built cooling arrangement should be provided to dissipate the heat generated during testing. No external coolant/accessory shall have to be required.

16.0 **Printer**

Thermal/Normal printer, inbuilt or external.

17.0 **Calibration certificate**

Kit should have automatic self calibration feature. However party will have to submit the calibration certificate from/traceable to, NABL accredited lab or internationally reputed lab, shall be submitted. Date of calibration shall not be older than two months from the date of supply of Kit.

18.0 **Environment**

- a. The test kit shall be compatible for EMI/EMC/safety environment requirement as per IEC 61000.
- b. Temp 0 to 50Deg.C,
- c. Humidity not condensing-upto90%,

19.0 **Warranty**

Kit shall have Warranty for minimum 5 years for smooth and reliable operation of the kit. The warranty includes:

- i. Calibration of instrument (annually till completion of 5 years)

- ii. As much as visits for repairs to site.
- iii. If the kit needs to be shifted to suppliers works for repairs, supplier will have to bear the cost of spares, softwares, transportation, transit insurance (To & Fro), etc of kit for repair at test lab/works. Kit after repairs need to be returned within thirty days from the date of despatch.
- iv. All the expenses for maintaining the supplied instrument “**Healthy and in working condition**” is to be borne by Successful bidder as per LOA.

20.0 **Transit Case**

The kit and accessories shall be robust and rugged enough, so that it can be transported safely at different locations. The transportation and packing cases of the kit shall be such that the transportation from one station to other will not affect the performance and accuracy of measurement of kit.

21.0 **Services after Sales**

Bidder will have to submit the documentary evidences of having established mechanism for prompt services as and when required by DTL. Bidder need to submit their organisation service chart along with bid.

22.0 **Demonstration and Handing over of Instruments**

The contractor shall have to demonstrate the instrument to the satisfaction of DTL. The Supplier shall have to ensure the kit is made user friendly apart from the detailed demonstrations at each site. The instrument failed during the demonstration shall be rejected and no repairs are allowed.

B. “CIRCUIT BREAKER OPERATIONAL ANALYSER WITH DCRM”

1.0 General:

- 1.1 This instrument shall be used for testing functioning of EHV circuit breakers in live/charged switchyards.
- 1.2 The operation analyzer should be able to measure, record and print graphically the operation timings, mechanism travel and velocity, trip and close coil current rise and fall, dynamic contact resistance (DCRM) and functioning of auxiliary contacts of CB.
- 1.3 The testing equipment shall be type tested and shall be subjected to acceptance and routine tests in accordance with the requirements of relevant national/international standards with latest version.
- 1.4 The kit and accessories shall be robust, rugged enough and easily portable so that it can be transported safely to different locations. The transportation and packing cases of the kit shall be such that the transportation from one station to other will not affect the performance and accuracy of measurement of kit. Further, the instrument shall be robust enough to sustain the jerks during the transportation in local condition.
- 1.5 The bidder will have to demonstrate the kit for accuracy and repeatability under stringent field conditions at prescribed site of DTL including 400kV switchyard/site upto the satisfaction of DTL at their own cost and this will be the part of technical evaluation. Successful demonstration of equipment shall be the pass / fail criteria for further evaluation / rejection of bid. The instrument failed during demonstration shall be rejected.

- 1.6 The kit should be capable of operating and storing data at temperature from 0 degree C to 50 degree C and humidity up to 90%.

2.0 Functional Requirement:

- 2.1 The Computer Aided CB Analyzer system comprising of CB operation unit, programme unit, travel analyzer unit & analysis software should be capable to perform close, open ,close-open, open-close, open-close, open operation on CB under test, with a facility to introduce time delays between composite operation.
- 2.2 The instrument should be suitable for measuring the Operation timing of main and auxiliary contacts (wet & dry) as well as coil currents.
- 2.3 The CB Analyzer should be able to measure and record current rise and fall of tripping coils as well as of closing coils for at least two breaks of Circuit Breaker poles simultaneously.
- 2.4 It should measure the Dynamic Contact Resistance of main & arcing contacts as well as travel measurement (with external travel transducer) of operating mechanism.
- 2.5 The instrument should be suitable for testing the CBs up to 400 kV as per applicable standards and testing procedure of DTL.
- 2.6 The test results should have repeatability, consistency & Immunity to electromagnetic interference in live switchyard upto 400 kV levels.
- 2.7 The CB Analyzer should be capable to measure pole discrepancy timing.
- 2.8 The CB Analyzer should be capable to calculate and print all contact closing & opening tuning in tabular form also.

3.0 Technical Parameters:

S. No	Description		
1.	Functional Requirement The operation analyzer must have availability of minimum no. of following channels:		The operation analyzer must have availability of minimum no. of following channels:
			400kV 220kV
		1.	Main Contact Channels:6 (2 per pole on 3 pole simultaneously) Main Contact Channels:3 (1 per pole on 3 pole simultaneously)
		2.	DCRM/Test Current Channels:6 DCRM/Test Current Channels:3
		3.	Travel Channel:03 Travel Channel:03
		4.	Coil Current Channel:06 Coil Current Channel:06
		5.	Aux. Contact Channel:06 Aux. Contact Channel:06
2.	Sampling Speed	≥20 kHz	
3.	Accuracy	1.	Timing: ± 1 % of reading
		2.	Coil Current: ± 1 % of reading
		3.	R: ± 2 % of reading
		4.	Travel: ± 1 % of reading
4.	Measurement	1.	Timing: 0-4 s

	Range:	2.	R: 0-8 m Ω .
		3.	Coil Current:0-25 A
5.	Resolution	Timing: 0.1 ms	
6.	DCRM Test Current	100 Amp (Minimum)	
7.	PC Interface	It shall include supply of one laptop PC of Dell/Lenovo/HP make with latest specifications such as Core i5 Intel Processor, 4 GB RAM, 320GB or better HDD, 15'' TFT screen, Combo 24xCD R/W Drive ie having CD read / write facility complete with required cables and connectors with preloaded operating MS Window 7 professional or better with latest version application software require for storage analysis and record management.	
8.	Power Supply	It shall work on single phase 230 Volts ± 10 %, 50 Hz ± 5 % supply with standard socket.	
9.	Operating Temperature	0 to +50 deg C	
10.	Relative humidity	Max. 90% non-condensing.	
11.	Environment	The test kit shall be compatible for EMI/EMC/Safety environment.	

4.0 System Operation hardware/software, peripherals and analysis software for CB Analyzer

- 4.1 The test report for recording motion should provide test results both in form of curve and tables. The tables should consist of calculated CB parameters such as closing/opening speed etc.
- 4.2 The entry of various data/parameters (pertaining to CB) be possible built in display of menu.
- 4.3 The battery backup and real time clock should be provided for automatic date and time functions.
- 4.4 The analyzer should be capable to record transient phenomenon for duration at least 500 ms.
- 4.5 The binary channel accuracy and analogue channel accuracy should be suitable meet all desired functions (stated above).
- 4.6 The CB analyzer should be provided with facility of down loading data to PC.
- 4.7 The printer provided with CB analyzer should be preferably a plain paper printer.
- 4.8 The computer aided CB analysis software should be supported with suitable report generation.
- 4.9 It should be possible to change scale factor of time axis to enable enlarged view of part of diagram.
- 4.10 It should be possible to change amplitude scale to make best use of available space.

- 4.11 It should be possible to study on speed curve, the damping and speed variations at CB opening and closing time.
- 4.12 The CB analyzer should be supplied with portable memory bank to store test result taken by test kit to enable further down loading to centrally located PC.
- 4.13 Window based PC down loading software should be provided with CB analyzer to facilities downloading test result from memory bank to PC where it can be analyzed and stored in proper directory/file.
- 4.14 It should be possible to compare present results with previous one. The feature of Zooming the graph and moving the cursors on graph, thereby indicating instantaneous values of test parameters should also be provided.
- 4.15 The latest version of CB analyzer system (hardwares and softwares) to be supplied and time to time updating of software should be offered.
- 4.16 As and when required, technical support for analysis of critical test result to be offered, on regular basis.
- 4.17 The software should be suitable for automatic testing & report generation, signature as well as trend analysis. The kit should have facility to store and communicate with windows based computer for exporting the test data.

5.0 Other Essential Requirements.

5.1 Protection/ Control

Against short circuit, over voltage, improper ground connection, over load & transient surges, the kit should have alarm/cut-off features to protect the instrument. Also the kit should have facility of stopping automatically on power failure.

5.2 Cooling Arrangement

Necessary in built cooling arrangement should be provided to dissipate the heat generated during testing. No external coolant/ accessory shall have to be required.

5.3 Test Leads and accessories

One complete set of cables of sufficient length (min 20metre) with suitable clamps & connectors, compatible with the instruments should be provided for successfully carrying out the test in DTL S/Stn. Additionally all the required accessories should be provided for the smooth functioning of kit. Further hard carrying case (which should be robust/ rugged enough) for ensuring proper safety of the kit during transportation shall have to be provided.

5.4 Travel Transducers

One set of travel transducers along with clamp/fixtures to suit 400/220 kV CBs of ABB/AREVA/ALSTOM/BHEL/CGL/ SIEMENS etc (wherever applicable) make for AIS and for GIS Stations, CB details shall be provided by DTL and the supplier shall have to develop & supply the transducers within delivery schedule. The voltage class and make shall be intimated along with the order.

5.5 Calibration Certificate

Unit shall be duly calibrated before supply and the date of calibration shall not be older than two month from the date of supply of Kit.

5.6 Training

Supplier shall have to ensure that the kit is made user friendly. Apart from the detailed demonstration at site, the supplier shall also have to arrange necessary training to DTL engineers, where kit is being supplied.

5.7 Weight

It should be portable and trolley mounted for smooth movement in live switchyard.

GUARANTEED TECHNICAL PARTICULARS FOR CIRCUIT BREAKER OPERATION ANALYSER WITH DCRM

(To be filled in and signed by the Bidder)

1.	Name of manufacturer	
2.	Type and Model	
3.	Applicable standards	
4.	Logic	
5.	Maximum Configuration	
6.	Time measurement	
	(i)Range	
	(ii)Resolution	
	(iii)Accuracy	
7.	No. of current channels	
8.	No. of travel channels	
9.	Binary channels	
10.	Sampling speed	
11.	Plot length	
12.	Printer	
13.	Paper type	

14.	Display of test results		
15.	Test leads		
	(i)	Type of leads	
	(ii)	No. of leads	
	(iii)	Length	
16.	Power supply		
17.	Weight		
18.	Details of type tests		
19.	No. of cases		
20.	Case type & size		
21.	Transducer (i) Voltage (ii) Speed.		
22.	Particulars of Dynamic contact resistance		
	(i)	Working current	
	(ii)	Range Full scale	
	(iii)	Operation • Battery • Mains	
	(iv)	Resolution • Minimum • Maximum	
	(iv) Accuracy		
23.	Environmental/service conditions:		

C. Technical Specification of “Fully Automatic Capacitance and Tan Delta Kit”

1. General Requirements

- 1.1 The testing equipment shall be type tested and shall be subjected to acceptance and routine tests in accordance with the requirements of relevant national/international standards with latest version.
- 1.2 Kit should be able to measure capacitance and tan delta/ power factor automatic without balancing any decade and also interference suppression shall be automatic.

- 1.3 The instrument should have been proven for repeatability of test result in charged switchyard of EHV substations. Documentary evidence for this should be furnished along with the bid.
- 1.4 The kit and accessories shall be robust, rugged enough and easily portable so that it can be transported safely to different locations. The transportation and packing cases of the kit shall be such that the transportation from one station to other will not affect the performance and accuracy of measurement of kit. Further, the instrument shall be robust enough to sustain the jerks during the transportation in local condition
- 1.5 The acceptance of the kit is subject to the successful demonstration to the satisfaction of DTL at prescribed site of DTL including 400KV switchyard/site during technical evaluation.
- 1.6 Bidder will have to submit the documentary evidences of having established mechanism for prompt services in India as and when required by DTL. Bidder need to submit their organization service chart along with bid.
- 1.7 The kit should be capable of operating and storing data at temperature from 0 degree C to 50 degree C and humidity up to 90%.

2. Functional Requirements

- 2.1 The instrument shall be suitable for automatic offline measurement of Capacitance and Tan delta of EHV class transformers (1/2/3 winding), Bushings, CTs, Bus & Line CVTs and Grading Capacitors of CB's as well as excitation current of transformer/reactor at site in charged switchyard up to 400 kV AC.
- 2.2 The test results should have repeatability consistency & immunity to electromagnetic, electrostatic interference in live switch yard up to 400kV.
- 2.3 The kit shall be capable of measuring capacitance and tan-delta of each winding up to 500 MVA transformers in suitable switching mode so that capacitance of other winding does not affect the reading etc.
- 2.4 The test voltage should be independent of input voltage & frequency so that no variation in frequency is there during testing.
- 2.5 The test kit should be capable of performing tests on all ungrounded and grounded specimens in various modes such as UST, GST-g, GST without changing the leads always.
- 2.6 The kit shall be capable of measuring excitation current of transformer winding at 10 kV. The kit shall be able to measure the ambient temperature and relative humidity with inbuilt/external arrangement.
- 2.7 The optional arrangements, if available, for measurement of inductance, transformer turns-ratio, transformer leakage reactance and loss etc, may be included in the offer. However, the tech/financial evaluation will be made for the basic kit, which have the facility of measurement of tan-delta and capacitance with induction suppression feature as detailed above.
- 2.8 Display should be LCD/LED (readable in sunlight), Front Panel/ Key Pad mounted on Control unit (with built-in microprocessor/computer) and providing external industrial grade Laptop PC preloaded with application software of reputed brand with latest specifications such as Intel core i5, 4GB RAM, 500 GB or higher HDD, Integrated Graphics & Audio, DVD-RW Drive, 13 inch Display, Touch pad,Wifi-802.11 a/b/g, 1gbps

NIC, Bluetooth, 1xVGA, windows-7 professional or higher version latest with antivirus, Original CDs etc.

- 2.9 It should have facility for Data Storing in the kit & down loading to PC. It should have USB / Ethernet Interface.
- 2.10 It should have indications like HV Supply ON, Ground Open, Power Supply ON etc.
- 2.11 Protection against short circuit, over voltage, improper ground connection over load & transit surges, the kit should have alarm/cut-off features to protect the instrument. Also the kit should have facility of stopping automatically on power failure as well as interlock for HV.
- 2.12 Necessary inbuilt cooling arrangement should be provided to dissipate the heat generated during testing. No external coolant/accessory shall have to be required.

2.13 Cables & Accessories:

The equipment shall be complete with measuring bridge, HV power supply unit of 12kV, standard Capacitor, Laptop (of latest specifications, built-in display screen and all standard accessories including cables, hard carrying case(box) and fitted with trolley (if applicable) etc. Brief description of cables is as below:

- HV/LV screened Cable set – 20 Meters (Min.) with Clamps and connector
 - Power Supply Cable
 - Grounding Cable with Clamps
 - One set of Interconnecting Cables
 - Other cables and accessories required for carrying out measurement including temperature sensing probe.
 - One set of Fuses and Indicating Lamps and other consumables shall be supplied with the kit.
- 2.14 It should have Data Analysis Software with the features of:
- Storing and downloading of files in data base for further analysis in PC
 - Facility of drawing Graphs of $\tan \delta$ (with and without temperature correction of $\tan \delta$ values), frequencies etc. between voltages.
 - Comparing of different value of same parameter at different period/time (trending).
 - The data format shall be XML/CSV open with excel for easy transfer to data base applications.
 - Facility to make reports in word/excel/pdf formats

3. Technical Parameters

Output voltage	0-12 kV (AC)(Continuously variable)
Output current	100 mA (Min) continuous & 200 mA (Min) intermittent
Output frequency	45Hz to 70Hz
Tan delta (DF)	Range: 0 to 200% Min.

	Accuracy : 1% of reading \pm 0.0005 Resolution : 0.01% or better
Power Factor	Range: 0 to 100% Min. Accuracy : 1% of reading \pm 0.0005 Resolution : 0.01% or better
Capacitance	Range: 10pF to 1 μ F Accuracy: 0.5% of reading \pm 1 pF Resolution : \pm 1pF
Power Supply (input)	240 V \pm 10% AC, 50 Hz \pm 5%
Operating & Environment Conditions	Temp.- 0 to 50°C Humidity- 90% not condensing The kit shall be compatible for EMI/EMC requirements as per relevant IEC.

4. Calibration certificate:-

As per requirement of ISO-9001, calibration certificate for each testing instrument covering entire range shall be supplied with the test kit at the time of supply. Calibration certificate from NABL accredited lab or internationally reputed lab shall be submitted. Date of calibration shall not be older than three (03) month from the date of supply of kit.

5. The bidder will have to demonstrate the kit for accuracy and repeatability under stringent field conditions at prescribed site of DTL including 400kV switchyard/site upto the satisfaction of DTL at their own cost and **this will be the part of technical evaluation**. Successful demonstration of equipment shall be the pass / fail criteria for further evaluation / rejection of bid. The instrument failed during demonstration shall be rejected.

6. Warranty/Guarantee Period:

Min 03 years from the date of successful & complete commissioning at DTL sub-station. All the materials, including accessories, cables, laptops etc. are to be covered under warranty/guaranty period. If the kit needs to be shifted to supplier's works for repairs within warranty/guaranty period, suppliers will have to bear the cost of spares, software, and transportation of kit for repair at test lab / works.

7. Commissioning, Training and Handling Over of the Instrument

Successful bidder will have to commission the instrument to the satisfaction of DTL. The instrument failed during the demonstration at site shall be rejected and no repairs are allowed.

Bidder will have to provide training to DTL engineers for safe operation and maintenance of the instrument before handing over the same at DTL site in batches.

GUARANTEED TECHNICAL PARTICULARS FOR TAN DELTA KIT

(To be filled in and signed by the Bidder)

1	Name of manufacturer	
2	Type and Model	
3	Output voltage	
4	Output current	
5	Output frequency	

6	Tan delta (DF) i. Range ii. Accuracy iii. Resolution	
7	Power Factor i. Range ii. Accuracy iii. Resolution	
8	Capacitance i. Range ii. Accuracy iii. Resolution	
9	Power Supply (input)	
10	Operating & Environment Conditions	
i	Temp	
ii	Humidity	
11	Weight	
12	Cable & Accessories	

D. TECHNICAL SPECIFICATION OF “TRANSFORMER WINDING RESISTANCE METER”

1.0 Functional requirement

1. The instrument should be suitable for offline measurement of winding resistance of transformer, including OLTC and reactors etc. up to 400KV in live switchyards up to 400KV level, as per applicable standards/testing procedure.
2. The instrument shall be able to provide the current vs time plot of OLTC from one tap to another.
3. The test kit shall be able to withstand inductive kicks from transformer winding and shall be capable of working in inductive atmosphere of 400kV Substation.
4. It should employ four wire methods and no lead compensation shall be required for the measurement.
5. It should have m i n. 06 No. measuring channels.
6. The test results should have repeatability, consistency & immunity to interference in live switchyard up to 400KV levels.

2.0 Test Current

Up to 50 A DC continuous in suitable steps.

3.0 Resistance Measurement

Resolution: 0.1 $\mu\Omega$ up to 500 $\mu\Omega$ range and 0.02% of FS above 500 $\mu\Omega$ range. Accuracy value 0.5 % \pm 5 count.

4.0 Measurement Range

0 to 1000 Ω or above auto ranging.

5.0 Demagnetization

The equipment shall have built-in demagnetization circuitry which shall allow the operator to manually/automatically de-magnetize the transformer core, either before or upon completion of resistance testing, or as a standalone feature.

6.0 OLTC Testing

The kit should be capable of checking the current v/s time characteristics during the tap change. It should be able to display the magnitude of current variation during tap change operation in %. The kit should present the transition time from one tap to the next tap in the test results.

7.0 Open Circuit Voltage

50 V DC or more

8.0 Temperature Correction

The kit should have the facility to have correction of resistance value to a reference temp. i.e. provide temp compensated reading of resistance (for Copper & Aluminum).

9.0 Test Lead/Accessories

One complete set of cable of sufficient length (Min 20 Mtr) with suitable clamps & connectors, compatible with the instruments should be provided for successfully carrying out the test in DTL substation. Additionally all the required accessories should be provided for the smooth functioning of kit. Further hard carrying case (which should be robust/rugged enough) for proper safety of the kit during transportation shall have to be provided. All the standard accessories for desired monitoring, operation & control of instrument shall have to be provided.

10.0 Key board

Front panel, interactive

11.0 Power Supply

It shall work on input supply variations, Voltage: $230 \pm 10\%$, Frequency: $50\text{Hz} \pm 5\%$ on standard sockets.

12.0 Protection of Kit

Kit should have all necessary protections against transient voltages, induction, short circuits etc, Built-in-discharge circuit should be provided to discharge the specimen when test is completed or when current lead accidentally disconnects or when instrument power supply is lost.

13.0 Operating Temperature

Temp 0 to 50 Deg.C

14.0 Relative Humidity

Maximum 90%, non condensing

15.0 Protection/Control

Against short circuit, over load, transient surges etc. The instrument should have facility of discharging the specimen when test is completed or when current cable is accidentally disconnected or when instrument power supply is lost. The kit should have built in rapid discharge circuit for automatically discharging the stored energy in the transformer at the end of each test.

16.0 Cooling arrangement

Necessary in built cooling, if required, arrangement should be provided to dissipate the heat generated during use. No external coolant/accessory shall have to be required.

17.0 Weight

It should be easily portable.

18.0 Software

The software should be suitable for automatic testing & report generation including temperature compensation. The kit should have facility to connect with windows based computer for exporting the test data.

19.0 Display/Control

Digital LCD display with backlight viewable in bright sunlight.

20.0 Printer

Inbuilt printer.

21.0 Memory

Internal, Non-volatile memory to store minimum 1000 measurement.

22.0 Environment

The test kit shall be compatible for EMI/EMC/safety environment requirement as per IEC.

23.0 Calibration certificate

The Calibration certificate from/traceable to, NABL accredited lab or internationally reputed lab, shall be submitted. Date of calibration shall not be older than two month from the date of supply of Kit.

24.0 Demonstration

The bidder will have to demonstrate the offered kit for accuracy and repeatability under stringent field conditions at prescribed site of DTL including 400kV switchyard/site up to the satisfaction of DTL at their own cost and this will be the part of technical evaluation. Successful demonstration of equipment shall be the pass / fail criteria for further evaluation / rejection of bid. The instrument failed during demonstration shall be rejected.

25.0 Training

Supplier shall have to ensure that the instrument is made user friendly. Apart from the detailed demonstration at site the supplier shall also have to arrange necessary training to DTL engineers.

26.0 Commissioning, demonstration and Handing over of Instruments

The Successful Bidder will have to commission the instrument to the satisfaction of DTL. The instrument failed during the demo shall be rejected and no repairs are allowed. The acceptance of the kit shall be subjected to the successful demonstration and repeatability of test results by supplier to the satisfaction of DTL at prescribed site.

27.0 Services after Sales

Bidder will have to submit the documentary evidences of having established mechanism for prompt services in India as and when required by DTL. Bidder need to submit their organisation service chart along with bid.

28.0 Warranty/Guarantee Period

Min 03 years from the date of successful & complete commissioning at DTL sub-station. All the materials, including accessories etc. are to be covered under warranty/guaranty period. If the kit needs to be shifted to supplier's works for repairs within warranty/guaranty period, suppliers will have to bear the cost of spares, software, and transportation of kit for repair at test lab / works.

E. Technical Specification of “10kV Digital Insulation Tester”:-

Functional Requirement	<ol style="list-style-type: none"> 1. The instrument should be suitable for measuring insulation resistance and PI, in live switchyard up to 400 kV level, as per applicable standard testing procedure of DTL. 2. The test results should have repeatability, consistency & immunity to electromagnetic interference in live switchyard up to 400 kV level. 3. The instrument should automatically discharge the energy transferred to test specimen at the end of test. 4. The instrument should have Guard Terminal to eliminate the effect of surface leakages etc. (with accuracy of $\pm 2\%$)
Output	Voltage: 0-10kV in several steps (Digital) with range of 1 kV (or lower) to 10 kV (or higher).in 25V steps.
Short Circuit Current	Not less than 5mA
Accuracy	<ol style="list-style-type: none"> 1. IR : $\pm 05\%$ of reading 2. Voltage: $\pm 05\%$ of reading
Measurement Range:	Insulation Resistance : 0-5T Ω (or higher) (Auto Ranging & Digital) Capacitance : up to 50 μ F
Test Modules	Auto IR, PI, DAR
Voltage measurement	0 to 600V AC or DC, $\pm 3\%$ accuracy
Leakage current measurement	0.01 nA to 5 mA
Test Leads and accessories	Two complete set of screened cables, each of 3m and 15m with suitable clamps & connectors, compatible with the instruments should be provided for successfully carrying out the test in DTL S/S. Additionally all the required accessories should be provided for the smooth functioning of kit. Further hard carrying case (which should be robust / rugged enough) for ensuring proper safety of the kit during transportation shall have to be provided.
Design/Engg.	The complete equipment along with complete accessories must be designed / engineered by Original Equipment Manufacturer.
Power Supply	It shall work on single phase 230 Volts $\pm 10\%$, 50 Hz $\pm 5\%$ supply with standard socket along with Internal Chargeable Battery.
Operating Temperature	0 to ± 50 deg C
Relative humidity	Max. 90% non-condensing
Protection/	Against short circuit, over voltage, improper ground connection
Control	Over load & transient surges, the kit should have alarm/ cut-off features to protect the instrument.

Weight	It should be easily portable
Display/control	Digital LCD/Keypad
Data storage	Data stored: selected voltage, test time elapsed, voltage applied, leakage current, and insulation resistance. The PI, DAR, capacitance, time constant and Dielectric Discharge (DD) values are also stored if available at the end of the test. Suitable Software may be used to transfer this data to a PC.
Environment & safety	The test kit shall be compatible for EMI/EMC/Safety environment requirement as per relevant IEC.
Applicable standards	As per relevant IS/IEC
Guarantee	Warranty/Guarantee period: Min 01 year from the date of successful & complete commissioning at DTL sub-station. All the materials, including accessories, cables etc. are to be covered under warranty/guaranty period. If the kit needs to be shifted to supplier's words for repairs within warranty/guaranty period, suppliers will have to bear the cost of spares, software, and transportation of kit for repair at test lab / works.
Demonstration	The bidder will have to demonstrate the kit for accuracy and repeatability under stringent field conditions at prescribed site of DTL including 400kV switchyard/site upto the satisfaction of DTL at their own cost and this will be the part of technical evaluation. Successful demonstration of equipment shall be the pass / fail criteria for further evaluation / rejection of bid. The instrument failed during demonstration shall be rejected.
Calibration Certificate	Calibration certificate from NABL accredited lab or internationally reputed lab, shall be submitted. Date of calibration shall not be older than one month from the date of supply of kit.
Commissioning, handing over the Instrument	Successful bidder will have to commission the instrument to the satisfaction of DTL. The supplied instrument, failed during the demonstration at site shall be rejected and no repairs are allowed.

Guaranteed Technical Particulars for 10kV Digital Insulation Tester:-

Sr. No.	Description	To be submitted by Bidder
1.	Name of manufacturer	
2.	Type & Model	
3.	Input Supply (A.C.)	
4	Output	
5	Short Circuit Current	
6	Accuracy	
7	Measurement Range:	
8	Test Modules	
9	Voltage measurement	
10	Leakage current measurement	
11	Test Leads and accessories	
12	Operating Temperature/ Relative humidity	
14	Protection/ Control	

16	Display/ Weight	
17	Data storage	
18	Environment & safety	
19	Applicable standards	
20	Guarantee	
21	Calibration Certificate	

F. Technical Specifications for “Automatic Transformer Oil Breakdown Voltage (BDV) Tests along with Standard Accessories”:-

1) General Requirements

- 1.1 The testing equipment shall be type tested and shall be subjected to acceptance and routine tests in accordance with the requirements of relevant national/international standards with latest version
- 1.2 Kit should be able to measure Transformer Oil Breakdown Voltage (BDV) Tests along with Standard Accessories automatic without balancing any decade and also interference suppression shall be automatic.
- 1.3 The instrument should have been proven for repeatability of test result in charged switchyard of EHV substations.
- 1.4 The kit and accessories shall be robust and rugged enough, so that it can be transported safely to different locations. The transportation and packing cases of the kit shall be such that the transportation from one station to other will not affect the performance and accuracy of measurement of kit. Further, the instrument shall be robust enough to sustain the jerks during the transportation in local condition.
- 1.5 Bidder will have to submit the documentary evidences of having established mechanism for prompt services in India as and when required by DTL. Bidder need to submit their organization service chart along with bid.
- 1.6 The kit should be capable of operating and storing data at temperature from 0 degree C to 50 degree C and humidity up to 95%.

2. Functional Requirement

- 2.1 The equipment offered shall be suitable for determination of electrical strength (Break Down Voltage) of insulating oil conforming to IS-335 and IS-1866 upto 100KV, when measured in accordance with IS:6792.
- 2.2 The test cell shall be as per IS: 6792 and IEC 156-1995 suitable for BDV upto 100kV without external flash over.
- 2.3 The unit shall be automatic type having control unit and high voltage transformer in a common cabinet with necessary partition.
- 2.4 HV chamber interlocking and zero start interlocking shall be provided.
- 2.5 The unit shall have motorized drive to increase voltage linearly as per the rate specified in IS: 6792. Provision shall also be available for manual increase of voltage
- 2.6 The unit shall be complete with test cell stirrer, calibrator and necessary gauges for adjusting the gap.
- 2.7 The equipment shall be suitable for operation at 240 volts +/- 10% 50Hz +/- 5% single phase AC supply.

- 2.8 The instruments should be capable of storing the test results. The results should be easily down loadable to a PC through RS232 and USB interface
- 2.9 The instrument should have a built-in printer for getting a hard copy of test results with and without the need for downloading to a PC but provision of RS-232/USB interface must be present.
- 2.10 The test set should be either magnetic stirring or propeller stirring facility.

3.0) Technical Parameters:-

S.No.	Parameters	Technical Specifications
1	Applicable Indian / International standards for the equipment	ASTM D 877B-02, IS 6792
2	Environment	The test kit shall be compatible for EMI/EMC/Safety environment as per LATEST IS/IEC
3	Power Supply voltage in volts.	240V \pm 10%, 50Hz \pm 5% on a standard socket
4	Measurement standard	IEC 60156-95, IEC-156-1995 & ASTM method
5	Protection provided to equipments.	1. HV Chamber interlocking. 2. Zero starts interlocking.
6	Display.	LCD/LED with alphanumeric keypad to facilitate entry of test ID notes etc
7	Test output voltage.	Suitable for BDV up to 100KV without external flashover. 0.1kV \pm 1% \pm 2 digits. (Rate of rise :2 kV/sec)
8	Standard Accessories	1. Test cell 400ml with lockable gap setting, test cell stirrer, calibrator. 2. Flat electrode gap gauge – 1mm & 2.5mm. 3. Electrodes should be supplied as per IEC60156 4. Printer should be in-built. 5. Hard carrying case
9	Additional features of equipments.	1. The Unit shall be fully automatic type having control unit & high voltage transformer in common cabinet with necessary partition. 2. Automatic oil temp. measurements with a resolution of 1°C 3. Large, easy clean test chamber with oil drain. High visibility of test chamber.
10	Operating temp. range of equipment in degree C.	0 to 50°C

11	<p>A) Breakdown detection should perform in terms of both “Voltage” and “Current” Trip time should be less then 10mSec.</p> <p>B) The short-circuit current of the transformer and associated trip time Required as per IEC156 shall be 4mA for 5ms and 1ms in case of Silicon oils. Normal breakdown detection speed shall be within 10msec.</p> <p>C) The HV switch off time shall be <10μs automatically if an established arc of 4mA occurs for 5ms as per IEC156.</p>	
13	Non condensing operating humidity range for equipment in %.	5 to 95%
14	The equipments shall be work in presence of high interference / high voltage.	
15	Service life of the equipments in years.	Should be specified by supplier.
16	Whether the kit has USB port facility.	Yes, for printing data and requirement of software for downloading data & inter prediction of test result. Software should be window base.

4) Calibration certificate:-

As per requirement of ISO-9001, calibration certificate for each testing instrument covering entire range shall be supplied with the test kit at the time of supply.

Calibration certificate from NABL accredited lab or internationally reputed lab, shall be submitted. Date of calibration shall not be older than one month from the date of supply of kit.

- 5)** Supplier shall have to ensure that the kit is made user friendly. Apart from the detailed demonstration at site, the supplier shall also have to arrange necessary training to DTL engineers.

The bidder will have to demonstrate the kit for accuracy and repeatability under stringent field conditions at prescribed site of DTL including 400kV switchyard/site upto the satisfaction of DTL at their own cost and this will be the part of technical evaluation. Successful demonstration of equipment shall be the pass / fail criteria for further evaluation / rejection of bid. The instrument failed during demonstration shall be rejected.

6) Warranty/Guarantee Period:

Min 05 years from the date of successful & complete commissioning at DTL sub-station. All the materials, including accessories, cables, laptops etc. are to be covered under warranty/guaranty period. If the kit needs to be shifted to supplier's works for repairs within warranty/guaranty period, suppliers will have to bear the cost of spares, software, and transportation of kit for repair at test lab / works.

7) Commissioning, Training and Handling Over of the Instrument

Successful bidder will have to commission the instrument to the satisfaction of DTL. The instrument failed during the demo shall be rejected and no repairs are allowed.

Bidder will have to provide training to DTL engineers for safe operation and maintenance of the instrument before handing over the same at DTL site in batches.”

Guarantee Technical particular Automatic Transformer Oil Breakdown Voltage (BDV) Test Kit along with Standard Accessories:-

S.No	Parameters	Technical Specifications
1	Applicable Indian / International standards for the equipment	
2	Environment	
3	Power Supply voltage in volts.	
4	Measurement standard	
5	Protection provided to equipments.	
6	Display.	
7	Test output voltage.	
8	Standard Accessories	
9	Additional features of equipments.	
10	Operating temp. range of equipment in degree C.	
11	Non condensing operating humidity range for equipment in %.	
12	Service life of the equipments in years.	
13	Whether the kit has USB port facility.	

G. Technical Specification of “Automatic Water Content Measurement (PPM) instrument in Insulating Oil Using Coulometric Karl Fisher Titration Method”

1.0 General :

- 1.1 The testing instrument covered in this specification is generally meant for carrying out testing and maintenance at site/Laboratory and shall be complete with all material and accessories. These shall be robust in design, so that they give accurate results even in adverse site conditions.
- 1.2 Design, Manufacture, Testing at factory; Supply, Installation and commissioning of Water Content Measurement Kit of given specifications.
- 1.3 The intended use of Automatic Water Content Measurement Kit in insulating oil is to measure moisture content in insulating oil as per (IS-13567-2003, IEC-60814). As such the range and accuracy of the kit shall be sufficient to meet these testing requirements.
- 1.4 The equipment should be microprocessor controlled for determination of water in insulating oil by ‘Coulometric Karl Fischer Titration’ Method.
- 1.5 The equipment shall be robust, have automatic test sequences, automatic control with digital display and option to interface with computer to download test results.
- 1.6 The testing equipment shall be type tested and shall be subjected to acceptance and routine tests in accordance with the requirements of relevant national/international standards with latest version.
- 1.7 The instrument should be complete in all respects & ready to use with all accessories as supplied with the instruments.

2.0 Functional Requirements:

- 2.1 The kit should have fully automatic EHV electrostatic and electromagnetic interference suppression. The kit shall be compatible for EMI/EMC environment as per IEC 61000.
- 2.2 Under very high/low ambient temperatures, high humidity, equipment shall be able to carry out measurement under these conditions.
- 2.3 Instrument should be designed on Coulometric Karl Fischer Titration method for measuring moisture contents in PPM or micrograms or Percentage.
- 2.4 Instrument should have facility to automatic compensate Error generated due to change in electrolysis cell resistance so that calibration of reagent is not required.
- 2.5 All accessories and reagents should be supplied with equipments.
- 2.6 Latest windows based application software CD (Original) should be provided with the equipment for evaluation of test results.
- 2.7 Should be free from effect of humidity, parasitic reaction and inherent drift of circuitry.
- 2.8 Should have back up indication for mains on, instrument error, stirrer moving and titration over
- 2.9 Titrators offer a broad range of options for handling test results data. Choose whether to export as CSV, PDF or XML files. Devices such as printers or memory sticks can be connected via the USB port and are automatically recognized
- 2.10 **Solvent extraction unit:**

The kit should have the provision of extraction & addition of titration solvent to titration vessel by motorized automatic mechanism.

2.11 SAFETY:

Shock proof, Vibration proof, EMC compliant & Safety requirements as per relevant International Standards.

2.12 Technical Requirements:

Sr.No	Description	Details
i)	Method of Measurement	Microprocessor Controlled Determination of Water in Insulating Oil by Coulometric Karl Fischer Titration Method.
ii)	Water Concentration	Above 2mg/Kg and Viscosity less than 100 mm ² /s at 40 ⁰ .C.
iii)	Iodine Production	Pulse of variation length and current density
iv)	Titration Speed	2.0 mg H ₂ O/min.
v)	Measuring Range	10µg to 10mg H ₂ O
vi)	Moisture Range	1 ppm to 100% of water
vii)	Resolution	0.1 µg H ₂ O
viii)	Precision/ Accuracy	Upto 3 µg for water of 100 µg or better; For more water 0.5% or better
ix)	Drift Compensation	Automatic
x)	Keypad/ User controls	Should be capable of carrying out all operational functions

xi)	Stirrer Control	The speed of the stirrer shall be microprocessor controlled. The speed of stirrer should preferably be controllable.
xii)	Modes	Standard/ Preset as well as User programmable
xiii)	Report Output	In Display as well as Printer, Result in ppm, %, µg, mg/kg formats
xiv)	Diagnostics	Should have error messages/ indications for any defects in vessel, solution, electrodes etc. as well as instrument error, mains on, stirrer moving etc.
xv)	Interface	Interface for balance and printer/ PC
xvi)	Power Supply	AC Voltage 230 V ± 10 % Frequency 50 Hz ± 5 %
xvii)	Printer	Built in printer or facility to connect external printer via USB/Serial Port/Ethernet/Bluetooth. Suitable Printer for printing the results
xviii)	05 ml Glass Syringe	02 Nos. 05 ml Hamilton Glass syringes
xix)	Display/ Key Board	Alpha numeric LCD/LED Display and key board

3.0 Auxiliary Spares: Apart from the standard supplied kit one set of Complete Titration Vessel assembly is also to be supplied by the supplier.

Should have 3 nos of syringes required for measurement and 6 nos of reagent bottle.

4.0 Supply of spares:

The Vendor shall ensure supply of spares/services for at least 7 years.

5.0 MANUAL: The supplier has to supply Instrument's Operation & Maintenance manual with circuit diagrams and troubleshooting guidelines...Operating / User's Manual in English.

6.0 Calibration certificate:-

Calibration certificate for each testing instrument covering entire range shall be supplied with the test kit at the time of supply.

The instrument shall be supplied with proper Calibration certificate from NABL accredited lab or internationally reputed lab. Calibration certificate traceable to national/international standards from an international accredited laboratory with uncertainty calculations shall be provided. It is the responsibility of the supplier to provide the Calibration services to the instrument after the calibration interval is over. Date of Calibration Certificate shall not be older than three month from the date of supply of kit.

7.0 The bidder will have to demonstrate the kit for accuracy and repeatability shall be established at prescribed site of DTL/any other site/Lab including 400/220kV switchyard/site up to the satisfaction of DTL at bidder cost and this will be the part of technical evaluation. Successful demonstration of equipment shall be the pass / fail criteria for further evaluation / rejection of bid. The instrument failed during demonstration shall be rejected.

8.0 Warranty/Guarantee Period:

Min 03 years from the date of successful & complete commissioning at DTL sub-station. All the materials, including accessories, cables, laptops etc. are to be covered under warranty/guaranty period. If the kit needs to be shifted to supplier's works for repairs within warranty/guaranty period, suppliers will have to bear the cost of spares, software, and transportation of kit for repair at test lab / works.

9.0 After sales-service: The supplier should have adequate "After Sales Service" in India so that repair / calibration of the testing kit can be done in the short period of time.

10.0 Commissioning, Training and Handling Over of the Instrument

Successful bidder will have to commission the instrument to the satisfaction of DTL. The instrument failed during the demo shall be rejected and no repairs are allowed.

Supplier shall arrange exhaustive classroom training with the theory and practical session on the usage of the instrument by the technical expert of the Principal Company in our premises without any extra cost to DTL

Guarantee Technical particular "Automatic Water Content Measurement instrument in Insulating Oil Using Coulometric Karl Fisher Titration Method" (To be submitted by bidder)

S.No.	Parameters	(To be submitted by bidder)
1	Titration Method	
2	Electrolysis Control	
3	End Point Detection	
4	End Point Indication	
5	Measuring Range	
6	Moisture Range	
7	Resolution	
8	Drift Compensation	
9	Precision	
10	Method storage	
11	Display Format	
12	Print Format	
13	Start Delay	
14	Min. Titration time	
15	Stirrer Speed	
16	Stirring method	
17	Keypad/user Control	
18	Printer	
19	Carry case	
20	Power Supply	
21	Dimensions	
22	Weight	
23	Screen	
24	Instrument manuals	
25	Accessories/ Auxiliary Spares	

H. Technical Specification of "Thermo Vision Scanning Camera"

Item	Specification
Functional Requirement	1. The instrument shall be thermal imaging system based on principle of infra-red radiation detection. It should be suitable for following measurement in live substations and

	<p>transmission lines up to 400 kV level.</p> <ol style="list-style-type: none"> I. The Absolute value of Hot spot temperature. II. Color thermal as well as visual image of focused object III. Isotherm <ol style="list-style-type: none"> 2. The test results should have repeatability, consistency & immunity to electromagnetic interference in live switchyard upto 400 kV levels. 3. The measurement of ambient temperature.
Measurement Range	Temperature:0-500 ° C
Detector Type / Infrared Pixels	320 x 240 pixels (Uncooled) Infrared Pixels to be captured by the camera and not enhanced after image capturing
Accuracy	T: ± 2 ° C or 2 % of Reading
IFOV or Spatial Resolution	Standard Lens: 1.4 mrad or better Telephoto Lens: 0.7mrad or better
Min. focus distance	50 cm
Focus	Auto / manual
Text annotation	Predefined by user and should be stored with image
Digital Video	1.3 MP (min.) color
Spectral Range	8 μ m to 13 μ m (min)
Sensitivity	Min 0.1 °C at 30 °C or better
Emissivity Correction	Automatic temp. correction for emissivity (Variable from 0.1 to 1.0)
Accessories	One complete set of lens i.e. normal as well as telephoto lens, removable memory card (Min. 1 GB), PC communication cable, windows based software, battery set with adapter (02 set) etc, compatible with the instruments should be provided for successfully carrying out the test in DTL S/S and transmission line. Additionally, all the required accessories, drawing & documents including Operating/Maintenance instruction manual, tools etc. should be provided for the smooth functioning of kit. Further hard carrying case (which should be robust/ rugged enough) for ensuring proper safety of the kit during transportation shall have to be provided.
Design/Engg.	The complete equipment along with complete accessories must be designed/engineered by Original Equipment Manufacturer.
Power Supply	It shall work on single phase 230 Volts ± 10 %, 50 Hz ± 5 % supply with standard socket and Rechargeable Battery.
Rechargeable battery (1 battery capacity)	4 hours continuous operation
Operating Temperature	0 to +50 deg C
Degree of Protection	IP 54 (Min)
Relative humidity	Max. 90 % non-condensing
Protection/ Control	Against short circuit, over voltage, improper ground connection over load & transient surges, the instrument should have alarm/cut-

	off features to protect the instrument.
Mounting Arrangement	The necessary tripod mounting arrangement should be provided for long distance measurement.
Weight	The weight should be preferably less than 2.5Kg for easy portability.
Software	The software should be provided free of cost & suitable for report generation and temperature analysis on windows based platform. The instrument should have facility to store, in standard formats, and communicate with windows based computer for exporting the test data. USB port or any other arrangement shall be provided for downloading the images, etc via USB port.
Display/Control	3.5" LCD Display (Min)
Environment	The test kit shall be compatible for EMI/EMC/safety environment requirement as per IEC.
Guarantee	Warranty/Guarantee Period: Min 01 year from the date of successful demonstration of supplied equipment at DTL sub-station. All the materials, including accessories, cables etc. are to be covered under warranty/guaranty period. If the kit needs to be shifted to supplier's works for repairs within warranty/guaranty period, suppliers will have to bear the cost of spares, software, transportation of kit for repair at test lab/ works.
Calibration Certificate	Unit shall be duly calibrated before supply and the date of calibration shall not be older than two month from the date of supply of Kit.
Training	Supplier shall have to ensure that the kit is made user friendly. Apart from the detailed demonstration at site, the supplier shall also have to arrange necessary training to DTL engineers.
Commissioning, handing over the Instrument	Successful bidder will have to supply and demonstrate the instrument to the satisfaction of DTL. The instrument failed during the demonstration shall be rejected and no repairs are allowed.
After sales service	Bidder will have to submit the documentary evidence of having established mechanism in India for prompt after sale services.

Note: For substation purpose, only thermo scanning camera without telephoto lens is required whereas for lines purpose thermo scanning camera with telephoto lens is required.

I. Technical Specification of "Digital Earth Resistance Meter"

1.0 General:

Digital Earth Resistance Meter shall be used to measure earth resistance of substations, power transmission towers, building rods, primary cabins etc. & soil-resistivity at 220kV and 400kV Substations.

1.0 General Requirements:

- 2.1 The calibration certificate should be supplied with test kit (for entire range).
- 2.2 If supplier is not the manufacturer, maintenance facility should be available with the supplier.
- 2.3 The earth testing kit should be supplied complete in all respect i.e. with suitable spikes and

test leads etc.

- 2.4 The meter should have synchronous internal Generator to inject AC current.
- 2.5 The meter should have suitable circuit to regulate the current automatically.
- 2.6 The meter should comply with IP54 class for Environmental protection.
- 2.7 The Instrument should meet safety class requirements as per IEC 61010-1/1990 or equivalent.
- 2.8 The Instrument should meet IEC 61326-1 or equivalent for EMC.
- 2.9 The Instrument should have CE marking.
- 2.10 The meter should weigh not more than 3 kg.

2.0 Functional Requirements:

- 1.0 Suitable to measure resistance of earth electrode and resistivity of soil.
- 2.0 Comply with testing requirements set by international standards.
- 3.0 Measurement should not be influenced by electrostatic/electromagnetic interference present in EHV switchyards.
- 4.0 Indication for condition of battery should be provided e.g. “Low-Battery” OR “Replace-Battery” OR “Charge-Battery” etc.

4.0 Range and Accuracy:

- 4.1 Earth Resistance Range : 0 Ω to 1.99 K Ω (in multiple ranges)
- 4.2 Accuracy : $\pm 2.0\% + 3$ digits or better
- 4.3 Resolution : 0.01
- 4.4 Maximum output voltage : ≈ 50 Volts
- 4.5 Test current : ≈ 30 mA

4.6 Environmental conditions:

- 4.6.1 Operating Temp : Up to 50°C
- 4.6.2 Operating R.H. : Up to 90% (at 40°C) non condensing

4.7 Power supply:

- 4.7.1 Rechargeable battery/cells.
- 4.7.2 Charger : Internal/external

4.7.3 Charger : Suitable for 230 Volts Single phase
50 Hz AC supply.

Guaranteed Technical Particulars:

1. Name and country of Manufacturer:
2. Make / Model offered :
3. **Range and Accuracy**
 - (i) Earth Resistance Range :
 - (ii) Accuracy :
 - (iii) Resolution :
 - (iv) Maximum output voltage :
 - (v) Test current :
4. **Environmental conditions**
 - (i) Operating Temp :
 - (ii) Operating R.H. :
5. **Power supply**
 - (i) Rechargeable battery/cells. :
 - (ii) Charger (Internal / External) :
 - (iii) Charger

J. Technical Specification of “Online Leakage Current Measurement (LCM) Kit”

Technical Specification for Leakage Current Meter for Lightning Arrestors

1. Online leakage Current Monitor for Metal Oxide Surge Arrestors- complying to B2 Method of IEC 60099-5 Edition-1.1
2. The Leakage Current Monitor instrument system should be portable equipment for in-service measurement of the resistive current of Gap-less metal oxide surge arrestors (MOSA). The leakage Current Meter should be able to measure Metal Oxide surge arrestor Leakage current installed at a height of approximate six meters from the ground.
3. Environmental: - Weather proof environmental enclosure.
4. Operating Temperature: - 0 to 50°C with 95%RH (Non condensing) under typical EHV switchyard condition.
5. Measured parameters & Direct display of:-
 - i. Total leakage current

- ii. Resistive leakage current
 - iii. Corrected value of resistive leakage current. (70% of surge arrestor's rated voltage and 20°C)
6. Measurement range
 - a. For total leakage current 100μA to 10mA
 - b. For resistive leakage current 1μA to 10mA
 - c. Field probe current 10μA to 1mA
 7. Resolution: 1 micro Amps for all currents.
 8. Accuracy: +/- 5% of the measured value.
 9. Repeatability: Instrument should offer repeatability of test results in 220kV/400kV charged sub-station.
 10. The instrument should have a clamp-on type CT, suitable for all types of earth strap generally found on a surge arrestor.
 11. The instrument should have a field probe to pick up the 3rd current component due to harmonics in the system voltage.
 12. The instrument should have built in standard calibration source so that self calibration check can be performed at site also.
 13. The instrument should have built in Temperature measurement facility which should enable calculation of temperature compensated leakage currents.
 14. Compensation: The equipment must have compensation for harmonics in system voltage & noise.
 15. Results must be displayed on LCD display & can also be print on in-built thermal paper printer at site and can be stored in the in-built memory of the instrument. The instrument should have in-built memory for storing test results up to 500 measurements. The results must be stored in the proper folder against the pre-loaded ID at on-board memory of the instrument.
 16. The instrument should be rechargeable battery operated (240V, 50Hz AC). Battery back-up should be at least 8 hours in idle condition.
 17. Certificates: Manufacturer's test & calibration certificates are to be supplied.
 18. Manuals: 2 set of manuals describing details of equipment and its functions are to be supplied in hard copy as well as in soft form.
 19. Data Port: The equipment must have communication port to transfer data to PC & windows-based data management software.
 20. Carrying Case: Suitable carrying case to be supplied.
 21. The equipment must be supplied along with the suitable accessories such as clamp on CT, Field probe, set of test leads suitable for testing of 400KV & 220KV LA's, thermal paper rolls, data software, battery charger, one set of spare rechargeable batteries.
 22. Supplier shall have adequate after sale service facility in India. Documentary evidence of the same shall be submitted at the time of bid.
 23. All the accessories including Probes and connecting leads should be properly screened to nullify the effect of interference of switchyard. Moreover, the equipment should have inherent processing capabilities and should not require any add-on like notepad/laptop for measurement in switchyard environment.
 24. Demonstration: The party have to carry out complete live demonstration and installation of the supplied LCM kit along with its software capabilities, report generation and all features of LCM kit at any 400KV AIS Sub-Station of DTL on different manufacturers lightening arrestors. The instrument failed during the demonstration shall be rejected and

no repair shall be allowed.

25. The equipment should bear a warranty of Eighteen month after receipt. Any defect within the guarantee period has to be rectified free of cost by manufacturer.
26. Supplier has to give a training of two days to DTL personnels on use of equipment.
27. Any software required for working of equipment and maintaining of measured data base have to be supplied by the supplier in the form of CD free of cost for any no. Of use. It should be valid & genuine software.

The bidders have to provide item wise confirmation for all the technical specification mentioned above.

K. TECHNICAL SPECIFICATION OF “REVISION OF STATIC CONTACT RESISTANCE METER”

1.0 General

The instrument should be suitable for automatic offline measurement of contact resistance of the Switchyard equipments i.e, CB, Isolator, clamps/connector, joints in live switchyards up to 400 kV having high electrostatic and electromagnetic interference. The size (cross sectional area) of test lead should be suitable to carry 100 Amp or more current continuously without appreciable rise in temp. The clamp and connectors should also be suitable for accurate measurement of contact resistance of specimen.

2.0 Functional Requirement:

- (a) The instrument should provide direct reading of the resistance of specimen and test current.
- (b) Test current of 100 A (or more), with provision of continuous variation; regular or in steps.
- (c) Resistance

Sl. No.	Range	Resolution	Accuracy
(a)	Up to 199 μ ohm	0.1 μ ohm	$\pm 2 \%$
(b)	200 μ ohm to 1.99 milli ohm	1 μ ohm	$\pm 2 \%$

3.0 Test lead and accessories:

One complete set of cables of sufficient length (Min 20Metre) with suitable clamps & connectors, compatible with the instruments should be provided for successfully carrying out the test in DTL S/S. Additionally all the required accessories should be provided for the smooth functioning of kit. Further hard carrying case (which should be robust/ rugged enough) for ensuring proper safety of the kit during transportation shall have to be provided.

4.0 Power Supply

It shall work single phase AC 230 V, 50Hz $\pm 5\%$ nominal supply with standard sockets.

5.0 Operating Temperature

Temp 0 to 50 Deg C

6.0 Relative Humidity

Maximum 90%, non condensing

7.0 Protection/Control

Kit should have all necessary protections against short circuits and over voltage.

8.0 Weight

The kit should be portable/light weight to facilitate easy movement at site.

9.0 Display/Control

Digital Readout.

10.0 Environment

The test kit shall be compatible for EMI/EMC/safety environment requirement as per IEC.

11.0 Calibration certificate

The Calibration certificate from/traceable to, NABL accredited lab or internationally reputed lab, shall be submitted. Date of calibration shall not be older than two month from the date of supply of Kit.

12.0 Demonstration

The bidder will have to demonstrate the offered kit for accuracy and repeatability under stringent field conditions at prescribed site of DTL including 400kV switchyard/site up to the satisfaction of DTL at their own cost and this will be the part of technical evaluation. Successful demonstration of equipment shall be the pass / fail criteria for further evaluation / rejection of bid. The instrument failed during demonstration shall be rejected.

13.0 Training

Supplier shall have to ensure that the instrument is made user friendly. Apart from the detailed demonstration at site the supplier shall also have to arrange necessary training to DTL engineers.

14.0 Services after Sales

Bidder will have to submit the documentary evidences of having established mechanism for prompt services in India as and when required by DTL. Bidder need to submit their organisation service chart along with bid.

15.0 Warranty/Guarantee Period

Min 12 month from the date of successful & complete demonstration after receipt of kit at DTL site.

All the materials, including accessories, cable etc. are to be covered under warranty/guaranty period. If the kit needs to be shifted to supplier's works for repairs within warranty/guaranty period, suppliers will have to bear the cost of spares, software, and transportation of kit for repair at test lab / works.

Guaranteed Technical Particulars

S. No	Description		To be filled by the Bidders	
1.	Mfg.Name/Model No.			
2.	Test current			
3.	Resistance			
	Range	Resolution		Accuracy
a.	Up to 199 μohm			
b.	200 μohm to 1.99 milli ohm			
4.	Protection/Control			
5.	Operating Temperature			
6.	Relative Humidity			
7.	Power Supply			
8.	Weight			
9.	Display/Control			
10.	Environment			
11.	Calibration certificate			
12.	Demonstration			
13.	Training			
14.	Services after Sales			
15.	Warranty/Guarantee Period			

SECTION-V

FIRE PROTECTION SYSTEM

SECTION: V

FIRE PROTECTION SYSTEM

1.0 INTENT OF SPECIFICATION

This section covers the design and performance requirements of the following type of fire protection systems:

- a) **Portable Fire Extinguishers**
- 1.1 It is not the intent to completely specify all details of design and construction. Nevertheless, the system design and equipment shall conform in all respects to high standard of engineering, design and workmanship and shall be capable of performing in continuous commercial operation in a manner acceptable to the Owner. The system design shall also conform to TAC/ NFPA norms.
- 1.2 The scope of work includes complete installation of fire protection system wherever it is required.
- 1.3 The equipment offered shall comply with the relevant IEC. The equipment conforming to any other approved international standards shall meet the requirement called for the latest revision of relevant Indian Standard or shall be superior.
- 1.4 Ambient temperature for design of all equipment shall be considered as 50⁰ C.
- 1.5 The successful bidder shall prepare detailed layout and piping drawing and also other drawing such as road, drainage, cable trench, switch yard layout, etc. as furnished by the Employer during detailed engineering.

2.0 PORTABLE FIRE EXTINGUISHERS

2.1 Intent of Specification

This specification lays down the requirement regarding fire extinguishers of following types:

Portable fire extinguishers.

- a) Dry chemical powder type
- b) Carbon Dioxide type
- 2.2 All the extinguishers offered by the Bidder shall be of reputed make and should have been approved by Tariff Advisory Committee of India or any other international authorities like FOC - London/NFPA-USA. Certificates to this effect shall be furnished by the Bidder. All extinguishers shall be ISI marked.
- 2.3 Adequate number of smoke detector and Portable Fire Extinguishers of Dry Chemical Powder and Carbon dioxide shall be provided in suitable location in control room building, GIS Hall and DG set room. These extinguishers will be used during the early phases of fire to prevent its spread and costly damage.
- 2.4 **Design and Construction**
- 2.4.1 All the portable extinguishers shall be of freestanding type and shall be capable of discharging freely and completely in upright position.
- 2.4.2 Each extinguisher shall have the instructions for operating the extinguishers on its body itself.
- 2.4.3 All extinguishers shall be supplied with initial charge and accessories as required.
- 2.4.4 Portable type extinguishers shall be provided with suitable clamps for mounting on walls or columns.
- 2.4.5 All extinguishers shall be painted with durable enamel paint of fire red colour conforming to relevant Indian Standards.
- 2.4.6 Dry chemical powder type extinguisher shall conform to IS: 2171.
- 2.4.7 Carbon Dioxide type extinguisher shall conform to IS: 2878.

2.5 Tests and Inspection

- 2.5.1 Particulars of shop tests and procedure shall be submitted to the Employer before hand for his approval.
- 2.5.2 A performance demonstration test at site of five (5) percent or one (1) number whichever is higher, of the extinguishers shall be carried out by the Contractor. All consumable and replaceable items require for this test would be supplied by the Contractor without any extra cost to Employer.
- 2.5.3 Performance testing of extinguisher shall be in line of applicable Indian Standards. In case where no Indian Standard is applicable for a particular type of extinguisher, the method of testing shall be mutually discussed and agreed to before placement of order for the extinguishers.

2.6 Performance Guarantee

The contractor shall guarantee all equipment supplied by him against any defect due to faulty design, material and workmanship. The equipment shall be guaranteed to operate satisfactorily at the rated conditions at site.

2.7 Painting

Each fire extinguisher shall be painted with durable enamel paint of fire red colour conforming to relevant Indian Standards

SECTION-VI

LT SWITCHGEAR

SECTION: VI

LT SWITCHGEAR

1.1 CONSTRUCTIONAL DETAILS OF SWITCHBOARD AND DISTRIBUTION BOARDS

- 1.1.1 All boards shall be of metal enclosed, indoor floor mounted, compartmentalized construction and freestanding type.
- 1.1.2 All board frames, shall be fabricated using suitable mild steel structural sections or pressed and shaped cold-rolled sheet steel of thickness not less than 2.0 mm. Frames shall be enclosed in cold-rolled sheet steel of thickness not less than 1.6mm. Doors and covers shall also be of cold rolled sheet steel of thickness not less than 1.6 mm. Stiffeners shall be provided wherever necessary.
- 1.1.3 All panel edges and cover/door edges shall be reinforced against distortion by rolling, bending or by the addition of welded reinforcement members.
- 1.1.4 The complete structures shall be rigid, self-supporting free from flaws, twists and bends. All cut-outs be true in shape and devoid of sharp edges.
- 1.1.5 All boards shall be of dust and vermin proof construction and shall be provided with a degree of protection of IP:42 as per IS 2147. However, the busbar chambers having a degree of protection of IP:42, in accordance with IS:2147, are also acceptable where continuous busbar rating exceeds 1000 Amp. Provision shall be made in all compartments for providing IP:42 degree of protection, when Circuit breaker or module trolley, has been removed. All cut-outs shall be provided with neoprene/Synthetic rubber gaskets.
- 1.1.6 Provision of louvers on boards would not be preferred. However, louvers backed with metal screen are acceptable on the busbar chambers where continuous busbar rating exceeds 1000 Amps.
- 1.1.7 All boards shall be uniform height not exceeding 2450 mm.
- 1.1.8 Boards shall be easily extendible on both sides, by the addition of the vertical sections after removing the end covers.
- 1.1.9 Boards shall be supplied with base frames made of structural steel sections, alongwith all necessary mounting hardware required for welding the base frames to the insert plates.
- 1.1.10 All boards shall be divided into distinct vertical sections, each comprising of :
- i) A completely enclosed busbar compartment for running horizontal and vertical busbars. Busbar chamber shall be completely enclosed with metallic portions. Bolted covers shall be provided for access to horizontal and Vertical bus bars and all joints for repair maintenance, which shall be feasible without disturbing feeder compartment.
 - ii) Completely enclosed switchgear compartment(s) one for each circuit for housing circuit breaker or MCCB or motor starter.
 - iii) A compartment or alley for power and control cables. Cable alley door shall preferably be hinged. Cable alley shall have no exposed live parts, and shall have no communication with busbar chamber. It shall be of atleast 350mm width.
 - iv) A compartment for relays and other control devices associated with a circuit breaker.

- 1.1.11 Sheet steel barriers shall be provided between two adjacent vertical panels running to the full height of the switchboard, except for the horizontal busbar compartment. Each shipping section shall have full metal sheets at both ends for transport and storage.
- 1.1.12 All equipments associated with a single circuit except MCB circuits shall be housed in a separate compartment of the vertical section. The Compartment shall be sheet steel enclosed on all sides with the withdrawal units in position or removed. The front of the compartment shall be provided with the hinged single leaf door, with locking facilities.
- In case of circuits controlled by MCBs, group of MCB feeders can be offered in common compartment. In such case number of MCB feeder to be used in a common compartment shall not exceed 4 (four) and front of MCB compartment, shall have a viewing port of toughen glass sheet for viewing and sheet steel door of module shall be lockable with star knob/panel key.
- 1.1.13 After isolation of power and control circuit connections it shall be possible to safely carryout maintenance in a compartment with the busbar and adjacent circuit live. Necessary shrouding arrangement shall be provided for this purpose over the cable terminations located in cable alley.
- 1.1.14 The minimum clearance in air between phases and between phase and earth for the entire run of horizontal and vertical busbars, shall be 25mm. For all other components, the clearance between “two live parts”, “A live part and an earthed part” and isolating distance shall be atleast ten (10) mm throughout. Wherever it is not possible to maintain these clearances, insulation shall be provided by sleeving or barriers. However, for horizontal run of busbar minimum clearance of 25mm should be maintained even if they are sleeved.
- 1.1.15 The temperature rise of horizontal & vertical busbars when carrying rated current along its full run shall in no case exceed 55⁰C, with silver plated joints and 40⁰C with all other type of joints over an outside ambient temperature of 50⁰C.
- 1.1.16 All single front boards shall be provided with removable bolted covers at the rear. The covers shall be provided with danger labels.
- 1.1.17 All identical circuit breakers and module chasis of same test size shall be fully interchangeable without having to carryout modifications.
- 1.1.18 All Circuit breaker boards shall be of Single Front type, with fully drawout circuit breakers, which can be drawn out without having to unscrew any connections. The circuit breakers shall be mounted on rollers and guides for smooth movement between SERVICE, TEST and ISOLATED positions and for withdrawal from the Switchboard. Testing of the breaker shall be possible in the TEST position.
- 1.1.19 Wherever two breaker compartments are provided in the same vertical section, insulating barriers and shrouds shall be provided in the rear cable compartment to avoid accidental touch with the live parts of one circuit when working on the other circuit.
- 1.1.20 All disconnecting contacts for power circuits shall be of robust design and fully self aligning. Fixed and moving contacts of the power drawout contact system shall be silver plated. Both fixed and moving contacts shall be replacement.
- 1.1.21 All AC & DC boards shall be of single Front type.
- 1.1.22 All module shall be fixed type except air circuit breaker module, which shall be drawout type.
- 1.1.23 The connections from busbars to the main switch shall be fully insulated/shrouded, and securely bolted. The partition between the feeder compartment and cable alley may be

non-metallic and shall be such construction as to allow cable cores with lugs to be easily inserted in the feeder compartment for termination.

- 1.1.24 All equipment and components shall be neatly arrangement and shall be easily accessible for operation and maintenance. The internal layout of all modules shall be subject to Owner's approval. Bidder shall submit dimensional drawings showing complete internal details of Busbars and module components for each type and rating for approval.
- 1.1.25 The tentative power and control cable entries shall be from bottom. However, Owner reserves the right to alter the cable entries, if required, during detailed engineering, without any additional commercial implications.
- 1.1.26 Adaptor panels and dummy panels required to meet the various busbar arrangements and layouts required shall be included in Bidder's scope of work.
- 1.1.27 All sheet work shall be pre-treated, in tanks, in accordance with IS:6005. Degreasing shall be done by alkaline cleaning. Rust and scale shall be removed by pickling with acid. After pickling the parts shall be washed in running water. Then these shall be rinsed in slightly alkaline hot water and dried. The phosphate coating shall 'Class-C' as specified in IS:6005. The phosphated surfaces shall be rinsed and passivated prior to application of stoved lead oxide primer coating after primer application, two coats of finishing synthetic enamel paint on panels shall be applied, Electrostatic painting shall also be acceptable.
- 1.1.28 Finishing paint on panels shall be shade 692 (Smoke grey) of IS:5 unless required otherwise by the OWNER. The inside shall be properly stoved. The paint thickness shall be coated by peelable compound by spraying method to protect the finished surfaces from scratches grease dirt and oily spots during testing, transportation, handling and erection.

1.2 DERATING OF EQUIPMENTS

- 1.2.1 The current ratings of all equipments as specified in the 'Bill of Materials are the minimum standards current ratings at a reference ambient temperature of 50⁰C as per relevant Indian Standards.
- 1.2.2 The Bidder shall indicate clearly the derating factors employed for each component and furnish the basis for arriving at these derating duly considering the specified ambient temperature of 50⁰C.

1.3 POWER BUS BARS AND INSULATORS

- 1.3.1 All AC Distribution Boards shall be provided with three phase buses and a neutral bus bars and the DC Distribution Boards shall be provided with two busbars.
- 1.3.2 It busbars and jumper connections shall be high conductivity aluminium/copper of adequate size the bus bar size calculations shall be submitted for approval.
- 1.3.3 The Cross-Section of the busbars shall be uniform through out the length of Switchgear and shall be adequately supported and braced to withstand the stresses due to the specified short circuit currents.
- 1.3.4 All busbars shall be adequately supported by Non-hygroscopic, non-combustible, track resistant & high strength type Polyester fibre glass Moulded Insulators. Separate supports shall be provided for each phase and neutral busbar. If a busbar support is provided anti-tracking barriers shall be provided between the supports.
- 1.3.5 All busbars joints shall be provided with high tensile steel bolts. Belleville/sprint washers and nuts, so as to ensure good contacts at the joints. Non-silver plated Busbars joints shall be thoroughly cleaned at the joint locations and a suitable contact grease shall be applied just before making a joint.
- 1.3.6 All busbars shall be colour coded as per IS:375.

- 1.3.7 The Bidder shall furnish calculations alongwith the bid, establishing the adequacy of busbar sizes for specified current ratings, on the basis of short circuit current and temperature rise consideration at specified ambient temp.

1.4 EARTH BUS

- 1.4.1 A galvanised steel earthing shall be provided at the bottom of each panel and shall extend throughout the length of each switchboard. It shall be welded/bolted to the frame work of each panel and beaker earthing contact bar vertical bus shall be provided in each vertical section which shall in turn be bolted/welded to main horizontal ground bus.
- 1.4.2 The earth bus shall have sufficient cross-section to carry the monetary short circuit and short time fault currents to earth as indicated in 'Bill of Material's without exceeding the allowable temperature rise.
- 1.4.3 Suitable arrangements shall be provided at each end of the horizontal earth bus for bolting to Owner's earthing conductors. The horizontal earth bus shall project out the switchboard ends and shall have predrilled holes for this connection. A joint spaced and taps to earth bus shall be made through at least two bolts.
- 1.4.4 All non-current metal work of the Switchboard shall be effectively bonded to the earth bus. Electrical conductivity of the whole switchgear enclosures frame work and the truck shall be maintained even after painting.
- 1.4.5 The truck and breaker frame shall get earthed while the truck is being inserted in the panel and positive earthing of the truck and breaker frame shall be maintained in all positions. SERVICES & ISOLATED, as well as through out the intermediate travel.
- 1.4.6 Each module frame shall get engaged to the vertical earth bus. Before the disconnecting contacts on these module are engaged to the vertical busbar.
- 1.4.7 All metallic cases of relays, instruments and other panel mounted equipments shall be connected to earth by independent standard copper wires of size not less than 2.5mm². Insulation colour code of earthing wires shall be green. Earthing wires shall be connected to terminals with suitable clamp connections and soldering is not acceptable. Looping of earth connections which would result in loss of earth connection to the devices when a device is removed is not acceptable. However, looping of earth connections between equipment to provide alternative paths or earth bus is acceptable.
- 1.4.8 VT and CT secondary neutral point earthing shall be at one place only, on the terminal block. Such earthing shall be made through links so that earthing on one secondary circuit shall be removed without disturbing the earthing of other circuit.
- 1.4.9 All hinged doors shall be earthed through flexible earthing braid.
- 1.4.10 Caution nameplate 'Caution-Live Terminals' shall be provided at all points where the terminals are like to remain live and isolation is possible only at remote end.

1.5 AIR CIRCUIT BREAKERS

- 1.5.1 Circuit breakers shall be three-pole air break horizontal drawout type and shall have inherent fault making and breaking capacities as specified in "Technical Parameters". The circuit breakers which meet specified parameter only after provision of releases or any other devices shall not be acceptable.
- 1.5.2 Circuit breakers shall be mounted along with operating mechanism on a wheeled carried. Suitable guides shall be provided to minimise misalignment of the breaker.
- 1.5.3 There shall be 'Service', 'Test' and 'Fully withdrawn positions for the breakers. In "Test" position the circuit breaker shall be capable of being tested for operation without

energising the power circuits i.e. the power contacts shall be disconnected while Control circuits shall remain undisturbed. Locking facilities shall be provided so as to prevent movement of the circuit breaker from the 'SERVICE', 'TEST' or FULLY WITHDRAWN' position. It shall be possible to close the door in TEST position.

- 1.5.4 All circuit breakers shall be provided with 4 NO and 4 NC potential free auxiliary contacts. These contacts shall be addition to those required for internal mechanism of the breaker. Separate limit switches each having required number of contacts shall be provided in both 'SERVICE & 'TEST' position of the breaker. All contacts shall be rated for making continuously carrying and breaking 10 Amps at 240 V AC and 1 Amp (Inductive) at 220 DC.
- 1.5.5 Suitable mechanical indications shall be provided on all circuit breakers to show 'OPEN', 'CLOSE', 'SERVICE', TEST' and 'SPRING CHARGED' positions.
- 1.5.6 Main poles of the circuit breakers shall operate simultaneously in such a way that the maximum difference between the instants of contacts touching during closing shall not exceed half cycle of rated frequency.
- 1.5.7 All circuit breakers shall be provided with the interlocks as explained in further clauses.
- 1.5.8 Movement of a circuit breaker between SERVICE AND TEST positions shall not be possible unless it is OPEN position. Attempted with drawl of a closed circuit breaker shall trip the circuit breaker.
- 1.5.9 Closing of a circuit breaker shall not be possible unless it is SREVICE, TEST POSITION or in FULLY WITHDRAWN POSITION.
- 1.5.10 Circuit breaker cubicles shall be provided with safety shutters operated automatically by the movement of the circuit breaker carriage to cover the stationery isolated contacts when the breaker is withdrawn. It shall however, be possible to open the shutters intentionally, against spring pressure for testing purpose.
- 1.5.11 A breaker of particular rating shall be prevented from insertion in a cubicle of a different rating.
- 1.5.12 Circuit breakers shall be provided with electrical anti-pumping and trip feature, even if mechanical antipumping feature is provided.
- 1.5.13 Mechanical tripping shall be possible by means of front mounted RED 'TRIP' push-button. In case of electrically operated breakers these push buttons shall be shrouded to prevent accidental operation.
- 1.5.14 Breaker controlled motors shall operate satisfactorily under the following conditions :-
- i) Direct on-line starting of Induction Motors rated 110kW to 220 kW with a locked rotor current of seven times the rated current, and starting time of up to 30 seconds.
 - ii) Breaking on-load, full load and locked motor currents of Induction Motors for rated 100 kW to 220kW.
- 1.5.15 Means shall be provided to slowly close the circuit breaker in withdrawn position. If required for inspection and setting of Contacts, in service position slow closing shall not be possible.
- 1.5.16 Power operated mechanism shall be provided with a universal motor suitable for operation 220V DC Control supply with voltage variation from 90% to 110% rated voltage. Motor insulation shall be class 'E' or better.

- 1.5.17 The motor shall be such that it requires not more than 30 seconds for fully charging the closing spring.
- 1.5.18 Once the closing springs are discharged, after the one closing operation of circuit breaker, it shall automatically initiate, recharging of the spring.
- 1.5.19 The mechanism shall be such that as long as power is available to the motor, a continuous sequence of closing and opening operations shall be possible. After failure of power supply at least one open-close open operation shall be possible.
- 1.5.20 Provision shall be made for emergency manual charging and as soon as this manual charging handle is coupled, the motor shall automatically get mechanically decoupled.
- 1.5.21 All circuit breakers shall be provided with closing and trip coils. The closing coils shall operate correctly at all values of Voltage between 85% to 110% at rated control voltage. The trip coil shall operate satisfactorily under all values of supply voltage between 70% to 110% of rated control voltage.
- 1.5.22 Provision for mechanical closing of the breaker only in 'TEST' and 'WITHDRAWN' positions shall be made.
- 1.5.23 PROTECTION CO-ORDINATION**
- 1.5.23.1 It shall be the responsibility of the Contractor to fully co-ordinate the overload and short circuit tripping of the circuit breakers with the upstream and down stream circuit breakers/fuses/motor starters, to provide satisfactory discrimination.
- 1.6 MOULDED CASE CIRCUIT BREAKER (MCCB) and MCB**
- 1.6.1 MCCB shall in general conform to IS:13949 Part-2, All MCCB shall be P2 duty.
- 1.6.2 MCCB shall be flush mounted on the AC/DC distribution boards.
- 1.6.3 MCCBs shall be provided with thermo-magnetic type release for over current and short circuit protection. The setting of the thermal release shall be adjustable between 75% to 100% of the rated current. The MCCB shall have breaking capacity not less than 20kA.
- 1.6.4 MCCBs used for ACDB incomers and Bus coupler shall be equipped with stored energy mechanism for electrical closing and tripping. All other MCCBs shall be manually operated. The operating handle should give a clear trip indication.
- 1.6.5 Miniature circuit breaker (MCB) shall conform to IEC:898-1998 and IS:8928.
- 1.7 RELAYS**
- 1.7.1 All relays and timers in protective circuits shall be flush mounted on panel front with connections from the inside. They shall have transparent dust tight covers removable from the front. All protective relays shall have a drawout construction for easy replacement from the front. They shall either have built-up test facilities, or shall be provided with necessary test blocks and test switches located immediately below each relay. The auxiliary relays and timers may be furnished in non-drawout cases.
- 1.7.2 All AC relays shall be suitable for operation, at 50 Hz with 110 Volts secondary and 1 amp or 5 amp CT secondary.
- 1.7.3 All protective relays and timers shall have at least two potentially free output contacts. Relays shall have contacts as required for protection schemes. Contacts of relays and timers shall be silver faced and shall have a spring action. Adequate number of terminals shall be available on the relay cases for applicable relaying schemes.
- 1.7.4 All protective relays auxiliary relays and timers shall be provided with hand rest operation indicators (flags) and analysing the case of operation.

- 1.7.5 All relays shall withstand a test voltage of 2 KV (rms) for one minute.
- 1.7.6 Motor starters shall be provided with three element, ambient temperature compensated, time lagged, hand reset type overload relays with adjustable settings. The setting ranges shall be properly selected to suit the motor ratings. These relays shall have a separate black coloured hand reset push button mounted on compartment door and shall have at least one changeover contact.
- 1.7.7 All fuse-protected contractor-controlled motors shall have phasing protection, either as a distinct feature in the overload relays (by differential movement of bimetallic strips), or as a separate device. The single phasing protection shall operate even with 80% of the set current flowing in two of the phases.
- 1.8 CONTACTORS**
- 1.8.1 Motor starter contactors shall be air break, electromagnetic type rated for uninterrupted duty as per IS:13957 (Part 4).
- 1.8.2 Contactors shall be double break, non-gravity type and their main contacts shall be silver faced.
- 1.8.3 Direct on line starter contactors shall be utilisation category AC2. These contactors shall be as IS:13947 (Part 4).
- 1.8.4 Each contactor shall be provided with two (2) normally open (NO) and two (2) normally close (NC) auxiliary contacts.
- 1.8.5 Operating coils of contactors shall be of 240V AC Unless otherwise specified elsewhere. The Contactors shall operate satisfactorily between 85% to 110% of the rated voltage. The Contactor shall drop out at 70% of the rated voltage.
- 1.9 INSTRUMENT TRANSFORMERS**
- 1.9.1 All current and voltage transformers shall be completely encapsulated cast resin insulated type suitable for continuous operation at the temperature prevailing inside the switchgear enclosure, when the switchgear is operating at its rated condition and the outside ambient temperature is 50°C.
- 1.9.2 All instrument transformers shall be able to withstand the thermal and mechanical stresses resulting from the maximum short circuit and momentary current ratings of the associated switchgear.
- 1.9.3 All instrument transformer shall have clear indelible polarity markings. All secondary terminals shall be wired to a separate terminal on an accessible terminal block where star-point formation and earthing shall be done.
- 1.9.4 Current transformers may be multi or single core type. All voltage transformers shall be single phase type. The bus VTs shall be housed in a separate compartment.
- 1.9.5 All VTs shall have readily accessible HRC current limiting fuses on both primary and secondary sides.
- 1.10 INDICATING INSTRUMENTS**
- 1.10.1 All indicating and integrating meters shall be flush mounted on panel front. The instruments shall be of at least 96 mm square size with 90 degree scales, and shall have an accuracy class of 2.5 or better. The covers and cases of instrument and meters shall provide a dust and vermin proof construction.

- 1.10.2 All instruments shall be compensated for temperature errors and factory calibrated to directly read the primary quantities. Means shall be provided for zero adjustments without removing or dismantling the instruments.
- 1.10.3 All instruments shall have white dials with black numerals and lettering. Black knife edge pointer with parallax free dials will be preferred.
- 1.10.4 Ammeters provided on Motor feeders shall have a compressed scale at the upper current region to cover the starting current.
- 1.10.5 Watt-hour meters shall be of 3 phase three element type, Maximum demand indicators need not be provided.

1.11 CONTROL & SELECTOR SWITCHES

- 1.11.1 Control & Selector switches shall be of rotary type with escutcheon plates clearly marked to show the function and positions. The switches shall be of sturdy construction suitable for mounting on panel front. Switches with shrouding of live parts and sealing of contacts against dust ingress be preferred.
- 1.11.2 Circuit breaker selector switches for breaker controlled motor shall have three stay put positions marked 'Switchgear', 'Normal' and 'Trial' respectively. They shall have two contacts of each of the three positions and shall have black shade handles.
- 1.11.3 Ammeter and voltmeter selector switches shall have four stay out position with adequate number of contacts for three phase 4 wire system. These shall have oval handles Ammeter selector switches shall have make before break type contacts to prevent open circuiting of CT secondaries.
- 1.11.4 Contacts of the switches shall be spring assisted and shall be of suitable material to give a long trouble free service.
- 1.11.5 The contact ratings shall be at least the following :

i) Make and carry continuously	10 Amp.
ii) Breaking current at 220V DC	1 Amp (Inductive)
iii) Breaking current at 240V DC	5 Amp (at 0.3 pf lagging)

1.12 AIR BREAK SWITCHES

- 1.12.1 Air breaker switch shall be of the heavy duty, single throw group operated, load break, fault make type complying with IS:4064.
- 1.12.2 The Bidder shall ensure that all switches are adequately rated so as to be fully protected by the associated fuses during all abnormal operating conditions such as overload, locked motor, short circuit etc.
- 1.12.3 Switch operating handles shall be provided with padlocking facilities to lock them in 'OFF' position.
- 1.12.4 Interlocks shall be provided such that it is possible to open the cubicle door only when the switch is in 'OFF' position and to close the switch only when the door is closed. However suitable means shall be provided to intentionally defeat the interlocks explained above.
- 1.12.5 Switches and fuses for AC/DC control supply and heater supply wherever required shall be mounted inside and cubicles.

1.13 PUSH BUTTONS

- 1.13.1 Push-buttons shall be of spring return, push to actuate type. Their contacts shall be rated to make, continuously carry and break 10A at 240V and 0.5A (inductive) at 220V DC.

- 1.13.2 All push-buttons shall have one normally open and one normally closed contact, unless specified otherwise. The contact faces shall be of silver or silver alloy.
- 1.13.3 All push-buttons shall be provided with integral escutcheon plates marked with its function.
- 1.13.4 The colour of the button shall be as follows :-
- | | | |
|------------|---|--------------------------------|
| i) GREEN | : | For motor START, Breaker CLOSE |
| ii) RED | : | For motor TRIP, Breaker OPEN |
| iii) BLACK | : | For overload rest |
- 1.13.5 All push-buttons on panels shall be located in such a way that Red-push-buttons shall always be to the left green push-buttons.
- 1.14 INDICATING LAMPS**
- 1.14.1 Indicating lamps shall be of the panel mounting cluster LED type. The lamps shall have escutcheon plates marked with its function, wherever necessary.
- 1.14.2 Lamps shall have translucent lamp-covers of the following colours, as warranted by the application :
- | | | |
|------------|---|--|
| i) RED | : | For motor ON, Breaker CLOSED |
| ii) GREEN | : | For motor OFF, Breaker OPEN |
| iii) WHITE | : | For motor Auto-trip |
| iv) BLUE | : | For all healthy conditions (e.g. control supply, and also for 'SPRING CHARGED') |
| v) AMBER | : | For all alarm conditions (e.g. overload) Also for 'SERVICE' and 'TEST' positions indicators. |
- 1.14.3 Lamps shall be easily replaceable from the front of the cubicle.
- 1.14.4 Indication lamps should be located just above the associated push buttons/control switches. Red Lamps shall invariable be located to the right of green lamps. In case a white lamp is also provided, it shall be placed between the red and green lamps along with the centre line of control switch/push button pair. Blue and Amber lamps should normally be located above the Red and Green Lamps.
- 1.14.5 When associated with push-buttons, red lamps shall be directly above the green push button, and green lamps shall be directly above the red push-button. All indicating lamps shall be suitable for continuous operation at 90 to 110% of their rated voltage.
- 1.15 FUSES**
- 1.15.1 All fuses shall be of HRC cartridge fuse link type. Screw type fuses shall not be accepted. Fuses for AC Circuits shall be of class 2 type, 20 kA (RMS) breaking current at 415 AC, and for DC circuits Class 1 type 5 kA breaking current.
- 1.15.2 Fuses shall have visible operation indicators.
- 1.15.3 Fuses shall be mounted on fuses carriers, which are mounted on fuse bases, wherever it is not possible to mount fuses on carriers fuses shall be directly mounted on plug in type of bases, In such cases one set of insulated fuse pulling handles shall be supplied with each switchgear.
- 1.15.4 Fuse rating shall be chosen by the Bidder depending upon the circuit requirements and these shall be subject to approval of OWNER.

1.16 TERMINAL BLOCKS

- 1.16.1 Terminal blocks shall be of 1100 volts grade and have continuous rating to carry the maximum expected current on the terminals. It shall be complete with insulating barriers, clip-on-type/stud type terminals for Control Cables and identification strips. Making on terminal strip shall correspond to the terminal numbering on wiring on diagrams. It shall be similar to 'ELEMEX' standard type terminals, cage clamp type of Phoenix or WAGO or equivalent.
- 1.16.2 Terminal blocks for CT and VT secondary leads shall be provided with test links and isolating facilities. CT secondary leads shall be provided distributed on all terminal circuiting and earthing facilities. It shall be similar to 'Elem', 'CATD' – Type.
- 1.16.3 In all circuit breaker panels at least 10% spare terminals for external connections shall be provided and these spare terminals shall be uniformly distributed on all terminal blocks. Space for adding another 10% spare terminals shall also be available.
- 1.16.4 All terminals blocks shall be suitable for terminating on each side, two (2) nos. of 2.5mm square size standard copper conductors.
- 1.16.5 All terminals shall be numbered for identification and grouped according to the function. Engraved white-on-black labels shall be provided on the terminal blocks.
- 1.16.6 Wherever duplication of a terminal block is necessary it shall be achieved by solid bonding links.
- 1.16.7 Terminal blocks shall be arranged with at least 100 mm clearance between two sets of terminal block. The minimum clearance between the first row of terminal block and the associated cable gland plate shall be 250 mm.

1.17 NAME PLATES AND LABELS

- 1.17.1 All switchgears AC/DC distribution boards shall be provided with prominent, engraved identification plates. The module identification plate shall clearly give the feeder number and feeder designation. For single front switchboards, similar panel and board identification labels shall be provided at the rear also.
- 1.17.2 All name plates shall be of non-rusting metal or 3-ply lamicaid with white engraved lettering on black back ground. Inscriptions and lettering sizes shall be subject to OWNER approval.
- 1.17.3 Suitable plastic sticker labels shall be provided for easy identification of all equipments, located inside the panel/module. These labels shall be positioned so as to be clearly inside visible and shall give the device number as mentioned in the module wiring drawings.

1.18 SPACE HEATER

- 1.18.1 Space heater shall be provided in all the boards for preventing harmful moisture condensation.
- 1.18.2 The space heaters shall be suitable for continuous operation on 240V, AC, 50 Hz, single phase supply, and shall be automatically controlled by thermostats. Necessary isolating switches and fuses shall also be provided.

1.19 CONTROL AND SECONDARY WIRING

- 1.19.1 All switchboards shall be supplied completely wired internally upto the terminal blocks ready to receive Owner's control cables.
- 1.19.2 All inter cubicle and inter panel wiring and connections between panels of same switchboard including all bus wiring for AC and DC supplies shall be provided by the bidder.

- 1.19.3 All internal wiring shall be carried out with 1100V grade, single core, 2.5 square mm or larger standard copper wires having colour coded, PVC insulation. CT circuits shall be wired with 2.5 square mm copper wires. Voltages and insulation shall be same as above.
- 1.19.4 Extra-flexible wires shall be used for wiring to device mounted on moving parts such as hinged doors.
- 1.19.5 All wiring shall be properly supported, neatly arranged, readily accessible and securely connected to equipment terminals and terminals blocks.
- 1.20 POWER CABLES TERMINATION**
- 1.20.1 Cable termination compartment and arrangement for power cables shall be suitable for standard aluminium conductor, armoured XLPE/PVC insulated and sheathed, single core/three core, 1100V grade cables.
- 1.20.2 All necessary cable terminating accessories such as Gland plates, supporting clamps and brackets, power cable lugs, hardware etc., shall be provided by successful bidder, suit the final cable sizes which would be advised later.
- 1.20.3 The gland plate shall be removable type and shall cover the entire cable alley. Bidder shall also ensure that sufficient space is provided for all cable glands. Gland plates shall be factory-drilled according to the cable gland sizes and number which shall be informed to the Contractor later. For all single core cables, gland plates shall be of non-magnetic Material.
- 1.21 TYPE TESTS**
- 1.21.1 Type test reports of Panels (Switchgear and Control gear assemblies) as per IS 8623 Part-I shall be submitted for the following tests in line with clause 9.0 of Section GTR before the fabrication of switchgear is started :
- i) Verification of temperature rise limits
 - ii) Verification of the dielectric properties
 - iii) Verification of short circuit strength
 - iv) Verification of the continuity of the protective circuit
 - v) Verification of clearances and creepage distances
 - vi) Verification of mechanical operation
 - vii) Verification of degree of protection
- 1.21.2 Contractor shall submit type test reports for the following Switchgear and Control gears before the fabrication of switchgear is started :
- 1. Circuit breakers / MCCB as per IS 13947 Part-II
 - 2. Protective Relays as per IEC:60255
- for the above equipments test conducted once are acceptable (i.e. The requirement of test conducted within last five years shall not be applicable).
- 1.22 ERECTION, TESTING AND COMMISSIONING**
- 1.22.1 The Contractor shall unload, erect, install, test and put into commercial use all electrical equipment included in this specification.
- 1.22.2 Equipment shall be installed in a neat, workman like manner so that it is level, plumb, square and properly aligned and oriented. Tolerance shall be as established in Contractor's drawings or as stipulated by Owner. No equipment shall be permanently bolted down to foundations until the alignment has been checked and found acceptable by the Owner.
- 1.22.3 Contractor shall furnish all supervision, labour tools equipment rigging materials, bolts, wedges, anchors, concrete inserts etc. in proper time required to completely install, test and commission the equipment.

- 1.22.4 Manufacturer's and Owner's instructions and recommendations shall be correctly followed in handling, setting, testing and commissioning of all equipment.
- 1.22.5 Contractor shall move all equipment into the respective from through the regular door or openings specifically provided for this purpose. No part of the structure shall be utilized to lift or erect any equipment without prior permission of Owner.
- 1.22.6 All boards shall be installed in accordance with Indian Standards IS:3072 and at Owner's instructions. All boards shall be installed on finished surfaces, concrete or steel stills. Contractor shall be required to install and align any channel sills which form part of foundations. In joining shipping sections of switchboards together adjacent housing of panel sections or flanged throat sections shall be bolted together after alignment has bee complete. Power bus, enclosures ground and control splices of conventional nature shall be cleaned and bolted together being drawn up with torque spanner of proper size or by other approved means.
- 1.22.7 All boards shall be made completely vermin proof.
- 1.22.8 Contractor shall take utmost care in holding instruments, relaying and other delicate mechanism wherever the instruments and relays are supplied separately they shall be mentioned only after the associated panels have been erected and aligned. The packing materials employed for safe transit of instrument and relays shall be removed after ensuring that panel have been completely installed and to further movement of the same should be necessary. Any damage shall be immediately reported to Owner.
- 1.22.9 Equipment furnished with finished coats of paint shall be touched by up Contractor if their surface is specified or marred while handling.
- 1.22.10 After installation of panels, power and control wiring and connections, Contractor shall perform operational tests on all switchboards, to verify proper operation of switchboards/panels and correctness of all equipment in each and every respect. The cable opening and cables entries for cables terminating to the panels shall be sealed with fire sealing materials.

1.23 COMMISSIONING CHECK TESTS

The contractor shall carry out the following commissioning checks, in addition to the other checks and tests recommended by the manufacturers.

1.23.1 General

- 1.23.1.1 Check name plate details according to the specification.
- 1.23.1.2 Check for physical damage.
- 1.23.1.3 Check tightness of all bolts, clamps, joints connecting terminals.
- 1.23.1.4 Check earth connections
- 1.23.1.5 Check cleanliness of insulators and bushings
- 1.23.1.6 Check all moving parts for proper lubrication
- 1.23.1.7 Check settings of all the relays

1.23.2 Circuit Breakers

- 1.23.2.1 Check alignment of breaker truck for free movement
- 1.23.2.2 Check correct operation of shutters
- 1.23.2.3 Check control wiring for correctness of connections, continuity and IR values
- 1.23.2.4 Manual operation of breaker completely assembled
- 1.23.2.5 Power closing/opening operation, manually and electrically
- 1.23.2.6 Breaker closing and tripping time
- 1.23.2.7 Trip free and anti-pumping operation
- 1.23.2.8 IR values, minimum pick up voltage and resistance of coils
- 1.23.2.9 Contact resistance
- 1.23.2.10 Simultaneous closing of all the three phases
- 1.23.2.11 Check electrical & mechanical interlocks provided

- 1.23.2.12 Check on spring charging motor, correct operation of limit switches and time of charging.
- 1.23.2.13 All functional checks
- 1.23.3 Current Transformers**
- 1.23.3.1 Meggar between winding and winding terminals to body
- 1.23.3.2 Polarity test
- 1.23.3.3 Ratio identification checking of all ratios on all cores by primary injection of current.
- 1.23.3.4 Spare CT cores, if available, to be shorted and earthed.
- 1.23.4 Voltage Transformer**
- 1.23.4.1 Insulation resistance test
- 1.23.4.2 Ratio test on all cores
- 1.23.4.3 Polarity test
- 1.23.4.4 Line connections as per connection diagram
- 1.23.5 Cubicle Wiring**
- 1.23.5.1 Check all switch developments
- 1.23.5.2 Each wire shall be traced by continuity tests and it should be made sure that the wiring is as per relevant drawing. All interconnections between panels/equipment shall be similarly checked.
- 1.23.5.3 All the wires shall be megged to earth
- 1.23.5.4 Functional checking of all control circuit e.g. closing, tripping control, interlock, supervision and alarm circuit.
- 1.23.6 Relays**
- 1.23.6.1 Check connections and wiring
- 1.23.6.2 Meggar all terminals to body
- 1.23.6.3 Meggar AC to DC terminals
- 1.23.6.4 Check operating characteristics by secondary injection
- 1.23.6.5 Check minimum pick up voltage of DC coils
- 1.23.6.6 Check operation of electrical/mechanical targets
- 1.23.6.7 Relays settings
- 1.23.6.8 Check CT and VT connections with particular reference to their polarities for directional relays wherever required.
- 1.23.7 Meters**
- 1.23.7.1 Check calibration by comparing it with a sub-standard.
- 1.23.7.2 Megger all insulated portions.
- 1.23.7.3 Check CT and VT connections with particulars reference to their polarities for power type meters.
- 1.24 SPECIAL TOOLS AND TACKLES**
- 1.24.1 The Bidder shall include in his proposal any special tools and tackles required for erection, testing commissioning and maintenance of the equipments offered.
- 1.24.2 The list of these special tools and tackles shall be given in the bid proposal sheets along with their respective prices.
- 1.24.3 The total price of the special tools and tackles shall be included in proposal sheets.
- 1.25 EQUIPMENT TO BE FURNISHED**
- 1.25.1 The Bidder shall quote for various AC/DC distribution boards as given in Bill of Materials and in accordance with this specification.
- 1.25.2 Standard scheme of interconnection of switchboards and distribution boards along with tentative feeder disposition for each board is indicated in Standard SLD of A/C & DC system enclosed bid documents. The bidder shall quote board prices on the basis of standard SLD and their estimation of feeders for entire present and future bays

requirement. Any other feeder required as per system requirement for efficient and reliable operation shall be deemed to be included in bidder's scope.

1.25.3 The Bill of Materials for each type of module shall be as under. These are minimum indicative requirement of the system. The necessary auxiliary relays, push buttons and indicating lamps shall be provided as per scheme requirement. Any other item / component required with in a module for efficient and reliable operation shall be deemed to be included in bidder's scope. The scheme shall have provision for remote annunciation for the followings :

- a) Station LT (415V) AC incomer supply unhealthy.
- b) 220V DCDB U/V, O/V & Earth leakage relay operated.
- c) DG set start
- d) DG set protection

1.25.4 **Module Type AE (Electrically controlled circuit breaker for incoming and Bus Coupler Circuit).**

- i) One (1) Triple pole air circuit breaker complete with all accessories and power operated mechanism as specified.
- ii) Two (2) Neutral Link.
- iii) Three (3) Current Transformer for metering.
- iv) One (1) Ammeter with selector switch.
- v) Three (3) Current Transformer for relaying.
- vi) One (1) Triple pole instantaneous over-current relay having the setting range of 200-800% or 500-2000% of CT secondary and adjustable definite minimum time.
- vii) One (1) Instantaneous earth fault relay having and adjustable setting range of 10-40% or 20-80% of CT secondary current and adjustable definite minimum time. The earth fault relay shall be provided with a stabilizing resistor.

1.25.5 **Module Type – M1 (Circuit Breaker Controlled Motor Feeder)**

- i) One (1) Triple pole Air Circuit Breaker complete with accessories, and power operated mechanism as specified.
- ii) One (1) Three position 6 pole selector switch 'SWITCHGEAR / NORMAL / TRIAL'.
- iii) Three (3) Current Transformer for meeting.
- iv) One (1) Ammeter with Ammeter Selector Switch.
- v) Three (3) Current Transformer for relaying.
- vi) One (1) Triple pole instantaneous over-current relay for providing positive sequence current protection in all the three phases. The relay setting range shall be continuously adjustable between 200-800% or 400-1600% of CT secondary rated current as required.
- vii) One (1) Double pole inverse definite minimum time over current relays connected in R&B phases for over current protection of motor rated 110kw – 200kw. The relay shall have an adjustable setting range of 50%-200% of CT Secondary current and time setting range of 0-30 Second. The relay shall be CDGM-22 of EE or equivalent.

- viii) One (1) Single pole adjustable definite time delay for motor overload alarm connected in Y-phase only. The relay shall have resetting ratio of not less than 90%. The relay shall have continuously adjustable time delay range of 2.5 to 25 Sec.
 - ix) One (1) Instantaneous earth fault relay having an adjustable setting range of 10-40% or 20-80% of CT secondary current. The earth fault relay shall be provided with a stabilizing resistor.
- 1.25.6 **Module Type E**
- i) One (1) Four pole MCCB
- 1.25.7 **Module G-1 (VT Module with under Voltage Relay)**
- i) Three (3) 415/ $\sqrt{3}$ /110/ $\sqrt{3}$ volts single phase voltage transformer star / star connect with star point solidly earthed mounted on common draw out chassis. Accuracy Class 0.5 for protection and metering with 50VA Burden.
 - ii) HRC Fuses mounted on the above chassis.
 - iii) One (1) Four Position voltmeter selector switch.
 - iv) One (1) Voltmeter (0-500V)
 - v) One (1) Double pole instantaneous under voltage relays with continuous variable setting range of 40-80% of 110 Volts.
 - vi) One (1) Time delay pick up relay having a time setting range of 0.5 to 3 secs. With 3 'No'. Self reset contacts, suitable for 220V DC.
 - vii) One (1) Auxiliary relay 220V DC with 2 No. self reset contacts.
 - viii) Three (3) Indicating lamps with series resistor and colour lenses (Red, Blue & Yellow).
- 1.25.8 **Module Type G-2**
- i) Three (3) HRC Fuse
 - ii) One (1) Voltmeter (0-500V)
 - iii) One (1) Voltmeter selector switch four position (R-Y, Y-B, B-R OFF).
 - iv) Three (3) Indication lamps (Red, Blue & Yellow)
- 1.25.9 **Module Type H & H (BC) (Isolating Switch Controlled Incoming Circuit)**
- i) One (1) Four pole MCCB
 - ii) One (1) Red Indicating lamp to indicate isolating switch closed position.
- 1.25.10 **Module Type S : (DC Metering and Protection Module)**
- i) One (1) Voltmeter 300-0-300V DC for 220V DC DB.
 - ii) One (1) Three (3) position voltmeter selector switch
 - iii) One (1) Instantaneous under voltage relay with 95% of 220V DC. The resetting ratio of relay should not be more than 1.25. the relay shall be provided with a series resistor and a push button across it for resetting (pick up) the relay at about 105% of the drop out voltage.

- iv) One (1) Instantaneous over voltage relay with setting range of 110% of 220V DC. The resetting ratio of relay should not be less than 0.8. the relay shall have a push button in series of resetting the relay at about 95% of the operating voltage.
 - v) One (1) Earth leakage relay only for 220V DC system having adjustable pick up range between 3 to 7 milliamps the relay shall be suitable for 220V DC/240V AC Auxiliary supply.
- 1.25.11 **Module Type X**
One (1) Double pole 250V MCB
- 1.25.12 **Module Type-DC (Incomer from Battery & Chargers)**
- i) One (1) Double pole 250V DC MCCB for incomer from Battery.
 - ii) One (1) DC ammeter with shunt and range of 90-0-400 Amps. For 220V DC DB.
 - iii) Two (2) Double pole 250V DC MCCB / MCB.
 - iv) One (1) Double pole single throw 250V DC air Break switch connecting battery & charger sections to DC DB.
- 1.25.13 **Module Type DG-1 (Electrically Controlled Circuit Breaker for Incomer from DG Set)**
- a) One (1) Triple pole circuit breaker complete with all accessories and power operated mechanism as specified.
 - b) One (1) Frequency meter.
 - c) One (1) Voltmeter with selector switch.
 - d) One (1) Remote/Local Selector switch.
 - e) Three (3) Current Transformer for Metering.
 - f) Six (6) Current Transformers for differential protection (out of this 3 Nos. will be supplied loose for mounting in DG set panel).
 - g) Three (3) Current Transformer for relaying.
 - h) One (1) Ammeter Selector Switch.
 - i) One (1) Ammeter
 - j) One (1) Wattmeter of range 0-300 KW
 - k) One (1) Three pole voltage controlled definite time delay relay having current setting range of 50-200% of CT secondary current and adjustable time delay 0.3 to 3 secs.
 - l) One (1) Watt hour meter with six (6) digits and minimum count of one (1) kwh.
 - m) One (1) Single pole definite time over current relay having a continuous setting range of 50-200% of CT secondary current and a time delay of 2.5-25 secs connected in CT of Y phase for overload alarm. The relay shall have a setting ratio of not less than 90%.

	n) One (1)	Three pole differential protection relay having an operating current setting range of 10-40% of generator full load current. The relay shall be high impedance type, with necessary stabilizing resistors.
	o) Two (2)	Push Buttons for Remote starting & stopping of DG Set (Red, Green).
1.25.14	Module Type H1	
	One (1)	Double pole DC Switch with pad locking facility in off position.
1.25.15	Module Type EL	
	i) One (1)	Four pole MCCB
	ii) One (1)	Contactor
	iii)	Electronic Timer suitable for continuous operation, push button and selector switch be as per scheme requirement.
1.26	PARAMETERS	
1.26.1	Power Supply	
1.26.1.1	AC System	3 phase, 4 wire, solidly earthed
	a) Voltage	415 Volts, $\pm 10\%$
	b) Frequency	50 Hz $\pm 5\%$
	c) Combined variation	$\pm 10\%$ Absolute Sum in Voltage & frequency
	d) fault Level	20 kA (rms)
1.26.1.2	DC System	2 Wire, unearthed
	a) System Voltage	220V $\pm 10\%$
	b) Fault Level	5 kA
1.26.2	Control Supply Voltage	
	a) Trip and closing coils	220V DC Unearthed
	b) Spring charging	220V DC Unearthed
1.26.3	Cubicle Data	
1.26.3.1	Busbar Rating	
	a) Continuous for Vertical panels	As specified in 'Bill of Materials'
	b) Short time (1 sec.)kA (rms)	20 kA
	c) Momentary (kA)	45 kA
	d) Ambient Temperature	50°C
	e) One Minute Power Frequency Withstand	
	I. Power Circuit	2500 Volts (rms)
	II. Control Circuit	2500 Volts (rms)
1.26.3.2	Cubicle Colour Finish	
	a) Interior	Glossy White
	b) Exterior	Smoke Grey shade No. 692 of IS:5
1.26.4	Circuit Breaker	
	a) Type	Air break
	b) No. of Poles	3

c) Voltage & Frequency	415 \pm 10%, 50 HZ + 5%
d) Rated Operating Duty	B-3 Min, M-B-3 Min. MB
e) Symmetrical Interrupting rating	20 kA (RMS)
f) Short Circuit making current	45 kA (Peak)
g) Short time withstand Current for 1 sec. Duration	20 kA (RMS) for 1 Sec.
h) Operating Mechanism Current for 1 sec. Duration	20 kA (RMS) for 1 Sec.
i) No. of auxiliary contacts	4 NO & 4 NC contacts for Owner's use on fixed portion of the cubicle
j) Short Circuit breaking current	
I. AC Component	20 kA (RMS)
II. DC Component	As per IS:13947 (Part 2)

1.26.5 MOULDED CASE CIRCUIT BREAKER

	<u>AC System</u>	<u>DC System</u>
a) No. of poles	4	2
b) Voltage & Frequency	415 \pm 10% 50 HZ \pm 5%	250 V
c) Rated Operating Duty	P2	P2
d) Symmetrical interrupting rating	20 kA (RMS)	5 KA
e) Short Circuit making current	45 kA (Peak)	--
f) No. of auxiliary contacts	2 NO & 2 NC	2 NO & 2 NC
g) Short Circuit breaking current		
I. AC Component	20 kA (RMS)	As per IS
II. DC Component	As per IS 13947	As per IS 13947

1.26.6 Meters

a) Accuracy Class	0.5
b) One minute power frequency withstand test voltage	2.0kV

1.26.7 Current Transformers

a) Type	Cast resin, Bar primary
b) Voltage class & frequency	650 V, 50 Hz
c) Class of Insulation	E or better
d) Accuracy class metering CT	Class 1, VA adequate for application but not less than 7.5 VA
e) Accuracy class protection CT	5P 15, VA adequate for application, but not less than 7.5 VA
f) Accuracy class differential protection	PS, KPV = 300 V
g) Short Time Current rating (for CTs Associated with circuit breakers)	
I. Current	20 kA (RMS)
II. Duration	One second
III. Dynamic Rating	45 kA (Peak)
IV. One minute Power frequency Withstand test Voltage	2.5 kv (rms)

1.26.8 Voltage Transformer

a) Type	Cast Resin
b) Rated Voltage	

Primary	415/ $\sqrt{3}$ V
Secondary	110/ $\sqrt{3}$ V
c) Method of connection	
Primary	Star
Secondary	Star
d) Rated Voltage Factor	1.1 continuous, 1.5 for seconds
e) Class of insulation	E or better
f) One minute power frequency withstand voltage	2.5 KV (RMS)
g) Accuracy class	0.5, not less than 20 VA

1.26.9 **Relay**

One minute power frequency withstand test	2 kV (rms)
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1.27 **AUTOMATIC CONTROL OF OUTDOOR LIGHTING**

1.27.1 EL-type module of 415 V Main lighting distribution board and Emergency lighting distribution board and shall be controlled by timer and contactor module to facilitate its operation automatically.

1.28 **AUTOMATIC SUPPLY CHANGEOVER**

Automatic changeover between Incomer I, Income II and DG set is to be carried out during the failure of supply in one/or both the incomers. After the restoration of the supply, system shall be restored to normal condition automatically. The requirements of changeover under various conditions are as below:-

- i) Under normal conditions i.e. when supply is available in both the incomers, incomers I&II of 415 V Main switchboard, ACDB shall be in closed condition and Bus couplers and DG set breaker shall be in open condition.
- ii) In case of failure of either of the sources, the incomer of that source shall trip and Bus coupler shall get closed. On restoration of supply, normal conditions described above are to be established automatically.
- iii) In case of failure of supply in both the sources, both incomers, incomers of ACDBs and ACDB Bus coupler shall trip and DG Set breaker switched on.

One restoration of one or both sources, DG Set breaker shall trip, DG set stopped and conditions described in paragraph (i)/(ii) shall be restored.

To avoid unnecessary operation of switchgear for momentary disturbances all changeovers from one state to another shall be intimated after a time delay, after the conditions warranting such change has been detected.

SECTION-VII

BATTERY & BATTERY **CHARGER**

SECTION: VII

BATTERY & BATTERY CHARGER

1.1 GENERAL TECHNICAL REQUIREMENTS

1.1.1. All the material used in the manufacture of stationary valve regulated lead acid battery banks shall be the best of their respective kind , free from flaws and defects and shall conform to the latest edition of the relevant Indian Standard. There shall be no impurities that be harmful to the performance or life of a cell or battery bank.

1.1.2. Bidder shall select number of cells to achieve following system requirement:

System Voltage	Maximum Voltage during Float operation	Minimum voltage available when no charger working and battery fully discharged up to 1.85V per cell.
220 Volt	242 Volt	198 Volt

1.2 Battery

1.2.1 Type

The DC Batteries shall be **VRLA (Valve Regulated Lead-Acid)** type and shall be Normal Discharge type. These Batteries are intended to be used in air-conditioned atmosphere and shall be suitable for a long life under continuous float operations and occasional discharges. The 220 V DC system is unearth.

The AH rating of the battery bank can be 200AH, 300AH ,400AH, 500AH, 600AH and shall be as per the requirement of DC load in the scheme/ scope.

1.2.2 Constructional Requirements

The design of battery shall be as per field proven practices. Partial plating of cells is not permitted. Paralleling of cells externally for enhancement of capacity is not permitted. Protective transparent front covers with each module shall be provided to prevent accidental contact with live module/electrical connections.

1.2.3 Containers

The container shall be made of polypropylene co-polymer, acrylonitrile butadiene styrene, styrene-acrylonitrile or any other acid resistant plastic material and shall have chemical and electro-chemical compatibility. The material shall meet all the requirements of VRLA batteries and be consistent with the life of battery. The container shall be fire retardant and shall have an Oxygen Index of at least 28% and **shall also comply with the**

provisions of UL 94- V2/V0. The other requirement of plastic container shall be as per IS-1146. The porosity of the container shall be such as not to allow any gases to escape except from the regulation valve. The tensile strength of the material of the container shall be such as to handle the internal cell pressure of the cells in the worst working condition.

Cell shall not show any deformity or bulge on the sides under all working conditions. The container shall be capable of withstanding the rigors of transport, storage and handling. The containers shall be enclosed in a steel tray.

1.2.4 Cell Covers

The cell covers shall be made of suitable material compatible with the container material and permanently fixed with the container. It shall be capable to withstand internal pressure without bulging or cracking. It shall also be fire retardant. Fixing of Pressure Regulation Valve & terminal posts in the cover shall be such that the seepage of electrolyte, gas escapes and entry of electro-static spark are prevented.

1.2.5 Separators

The separators used in manufacturing of battery cells, shall be of glass mat having high acid absorption capability, resistant to sulphuric acid and good insulating properties. The design of separators shall ensure that there is no misalignment during normal operation and handling.

1.2.6 Pressure Regulation Valve

Each cell shall be provided with a pressure regulation valve. The valve shall be self re-sealable and flame retardant. The valve unit shall be such that it cannot be opened without a proper tool. The valve shall be capable to withstand the internal cell pressure specified by the manufacturer.

Each valve regulating venting device shall be provided with flame arrestor capable of preventing the ingress of moisture/flame in to the cell interior when the valve release the gas mixture.

The opening and closing pressure shall be within \pm 1psi variation and the manufacturer shall declare the closing and opening pressure values.

1.2.7 Terminal Posts

Both the +ve and –ve terminals of the cells shall be capable of proper termination and shall ensure its consistency with the life of the battery. The surface of the terminal post extending above the cell cover including bolt hole shall be coated with an acid resistant and corrosion

retarding material. Terminal posts or any other metal part which is in contact with the electrolyte shall be made of the same alloy as that of the plates or of a proven material that does not have any harmful effect on cell performance. Both +ve and –ve posts shall be clearly and unambiguously identifiable.

Terminal posts shall be suitably sealed at the lid to prevent leakage of any gas. Any gas escape shall be only through the venting device provided.

1.2.8 Connectors, Nuts & Bolts, Heat Shrinkable Sleeves

Where it is not possible to bolt the cell terminals directly to assemble a battery, separate non-corroding lead or copper connectors of suitable size shall be provided to enable connection of the cells. Copper connections shall be suitably lead coated to withstand corrosion due to sulphuric acid at a very high rate of charge or discharge.

Nuts and bolts for connecting the cells shall be made of copper, brass or stainless steel. Copper or brass nuts and bolts shall be effectively lead coated to prevent corrosion. **The lead plating on copper connectors shall not be less than 25 micron.** Stainless steel bolts and nuts can be used without lead coating. All inter cell connectors shall be protected with heat shrinkable silicon sleeves for reducing the environmental impact including a corrosive environment.

1.2.9 Flame Arrestors

Each cell shall be equipped with a Flame Arrestor to defuse the Hydrogen gas escaped during charge and discharge. Material of the flame arrestor shall not affect the performance of the cell.

1.2.10 Battery Bank Stand

All batteries shall be mounted in a suitable metallic stand/frame. The frame shall be properly painted with the acid resistant paint. The suitable insulation shall be provided between stand/frame and floor to avoid the grounding of the frame/stand.

1.2.11 Capacity Requirements

When the battery is discharged at 10 hour rate, it shall deliver 80% of **its C-Rate** (rated capacity, corrected at 27° Celsius) before any of the cells in the battery bank reaches 1.75V/cell.

The battery shall be capable of being recharged from the fully exhausted condition (1.75V/cell) within 10 hrs up to 90% state of charge. All the cells in a battery shall be designed for continuous float operation at the specified float voltage throughout the life. The capacity (corrected at 27°Celsius) shall also not be less than **the C-Rate** and not more than 120% of **the C-Rate** before any cell in the battery bank reaches 1.75V/cell. The battery voltage shall not be less than the following values, when a fully charged battery is put to discharge at C/10 rate:

- (a) After Six minutes of discharge : 1.98V/cell
- (b) After Six hours of discharge : 1.92V/cell
- (c) After **10 hours** of discharge : **1.75V/cell**

Loss in capacity during storage at an average ambient temperature of 35° Celsius for a period of 6 months shall not be more than 60% and the cell/battery shall achieve 85% of its rated capacity within 3 charge/discharge cycles and full rated capacity within 5 cycles, after the storage period of 6 months. Voltage of each cell in the battery set shall be within $\pm 0.05V$ of the average voltage throughout the storage period. Ampere hour efficiency shall be better than 90% and watt hour efficiency shall be better than 80%.

1.2.12 Expected Battery Life

The battery shall be capable of giving 1200 or more charge/discharge cycles at 80% Depth of discharge (DOD) at an average temperature of 27° 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.

1.2.13 Routine Maintenance of Battery system

For routine maintenance of battery system, the contractor shall supply 1 set of following tools:

- a) Torque wrench.
- b) Tool for opening/closing of Pressure regulation valve of battery
- c) Hand held digital multi-meter for measurement of resistance, AC/DC Voltage

1.2.14 Type Tests

The bidder shall submit all the applicable type test reports of the battery bank in line with latest edition of IS-15549:2005 and validity of the type test reports shall be as per latest CEA guidelines. The type test reports shall be submitted along with the bid.

If any applicable type test has not been conducted by the bidder, then the same shall be conducted by the bidder free of cost and without affecting the completion period of the project/tender.

Further if different capacities of cells are made using the same size of standard plate, than relevant clauses of IS-15549:2005 shall be applicable for type test requirement.

1.2.15 Routine and Acceptance Tests:

All routine tests shall be carried out on the battery bank during manufacturing and all acceptance tests shall be carried out on the battery bank during inspection in line with latest edition of IS-15549:2005.

1.3 Battery Charger

The DC system for 220 V DC is unearth. The Battery Chargers as well as their automatic regulators shall be of static type and shall be compatible with offered VRLA batteries. All battery chargers shall be capable of continuous operation at the respective rated load in float charging mode, i.e. Float charging the associated DC Lead-Acid Batteries at 2.15 to 2.25 Volts per cell while supplying the DC load. The chargers shall also be capable of Boost charging the associated DC Battery at 2.3 +/- 0.02 volts per cell at the desired rate. Charger shall regulate the float/boost voltage in case of prescribed temperature rise of battery as per manufacturers recommendation to avoid thermal runaway. Necessary temperature sensors shall be provided in mid location of battery banks and shall be wired up to the respective charger for feedback control. The manufacturer shall demonstrate this feature during testing of each charger. Battery charger should be thyristor controlled.

- 1.3.1 All Battery Chargers shall be provided with facility for both automatic and manual control of output voltage and current. A selector switch shall be provided for selecting the mode of output voltage/current control, whether automatic or manual. When on automatic control mode during Float charging, the Charger output voltage shall remain within $\pm 1\%$ of the set value, for AC input voltage variation of $\pm 10\%$, frequency variation of $\pm 5\%$, a combined voltage and frequency variation of $\pm 10\%$, and a DC load variation from zero to full load.
- 1.3.2 All battery chargers shall have a constant voltage characteristics throughout the range (from zero to full load) at the floating value of the voltage so as to keep the battery fully charged but without harmful overcharge.
- 1.3.3 All chargers shall have load limiters having drooping characteristic, which shall cause, when the voltage control is in automatic mode, a gradual lowering of the output voltage when the DC load current exceeds the Load limiter setting of the Charger. The Load-limiter characteristics shall be such that any sustained overload or short circuit in DC System shall not damage the Charger, nor shall it cause blowing of any of the Charger fuses. The Charger shall not trip on overload or external short circuit.
- 1.3.4 Uniform and step less adjustments of voltage setting (in both manual and automatic modes) shall be provided on the front of the Charger panel covering the entire float charging output range specified. Step less adjustments of the Load-limiter setting shall also be possible from 80% to 100% of the rated output current for Charging mode.
- 1.3.5 During Boost Charging, the Battery Charger shall operate on constant current mode (when automatic regulator is in service). It shall be possible to adjust the Boost charging current continuously over a range of 50 to 100% of the rated output current for Boost charging mode.
- 1.3.6 The Charger output voltage shall automatically go on rising, when it is operating on Boost mode, as the Battery charges up. For limiting the output voltage of the Charger, a potentiometer shall be provided on the front of the panel, whereby it shall be possible to set the upper limit of this voltage any where in the output range specified for Boost Charging mode.

- 1.3.7 The Charger manufacturer may offer an arrangement in which the voltage setting device for Float charging mode is also used as output voltage limit setting device for Boost charging mode and the Load-limiter of Float charging mode is used as current setting device in boost charging mode.
- 1.3.8 Suitable filter circuits shall be provided in all the chargers to limit the ripple content (Peak to Peak) in the output voltage to 1%, irrespective of the DC load level, when they are not connected to a Battery.

1.3.9 MCCB

All Battery Chargers shall have 2 Nos. MCCBs on the input side to receive cables from two sources. Mechanical interlock should be provided such that only one shall be closed at a time. It shall be of P2 duty and suitable for continuous duty. MCCB's should have auxiliary contacts for annunciation.

1.3.10 Rectifier Transformer

The rectifier transformer shall be continuously rated, dry air cooled (A.N) and of class F insulation type. The rating of the rectifier transformer shall have 10% overload capacity.

1.3.11 Rectifier Assembly

The rectifier assembly shall be fully/half controlled bridge type and shall be designed to meet the duty as required by the respective Charger. The rectifier shall be provided with heat sink having their own heat dissipation arrangements with natural air cooling. Necessary surge protection devices and rectifier type fast acting HRC fuses shall be provided in each arm of the rectifier connections.

1.3.12 Instruments

One AC voltmeter and one AC ammeter alongwith selector switches shall be provided for all chargers. One DC voltmeter and DC ammeter (with shunt) shall be provided for all Chargers. The instruments shall be flush type, dust proof and moisture resistant. The instruments shall have easily accessible means for zero adjustment. The instruments shall be of 1.5 accuracy class. In addition to the above a centre zero voltmeter with selector switch shall also be provided for 220V chargers for testing purpose.

1.3.13 Air Break Switches

One DC output switch shall be provided in all chargers. They shall be air break type suitable for 500 volts AC/ 250 DC. The contacts of the switches shall open and close with a snap action. The operating handle of the switch shall be fully insulated from circuit. 'ON' and 'OFF' position on the switch shall be clearly indicated. Rating of switches shall be suitable for their continuous load. Alternatively, MCCB's of suitable ratings shall also acceptable in place of Air Break Switch.

1.3.14 Fuses

All fuses shall be HRC Link type. Fuses shall be mounted on fuse carriers which are in turn mounted on fuse bases. Wherever it is not possible to mount fuses on carriers, fuses shall be directly mounted on plug-in type base. In such case one insulated fuse pulling handle shall be supplied for each charger. Fuse rating shall be chosen by the Bidder depending on the circuit requirement. All fuses in the chargers shall be monitored. Fuse failure annunciation shall be provided on the failure of any fuse.

1.3.15 Blocking Diode

Blocking diode shall be provided in the positive pole of the output circuit of each charger to prevent current flow from the DC Battery into the Charger.

1.3.16 Annunciation System

Audio-visual indications through bright LEDs shall be provided in all Chargers for the following abnormalities :

- a) AC power failure
- b) Rectifier/chargers fuse blown.
- c) Over voltage across the battery when boost charging.
- d) Abnormal voltage (High/Low)
- e) Any other annunciation if required.

Potential free NO Contacts of above abnormal conditions shall also be provided for common remote indication "CHARGER TROUBLE" in Owner's Control Board.

Indication for charger in float mode and boost mode through indication lamps shall be provided for chargers. A potential free contact for float/boost mode shall be provided for external interlocks.

1.3.17 Name Plates and Marking

The name plates shall be white with black engraved letters. On top of each Charger, on front as well as rear sides, larger and bold name plates shall be provided to identify the Charger. Name plates with full and clear inscriptions shall also be provided on and inside of the panels for identification of the various equipments and ease of operation and maintenance.

1.3.18 Charger Construction

The Chargers shall be indoor, floor-mounted, self-supporting sheet metal enclosed cubicle type. The Contractor shall supply all necessary base frames, anchor bolt and hardware. The Chargers shall be fabricated from 2.0mm cold rolled sheet steel and shall have folded type of construction. Removable gland plates for all cables and lugs for power cables shall be supplied by the Contractor. The lugs for power cables shall be made of electrolytic copper with tin coat. Power cable sizes shall be advised to the Contractor at a later date for provision of suitable lugs and drilling of gland plates. The Charger shall be tropicalised and vermin proof. Ventilation louvers, if provided shall be backed with screens. All doors and covers shall be fitted with synthetic rubber gaskets. The chargers shall have hinged double leaf doors provided on front and on backside for adequate access to the Charger's internals. All the charger cubicle doors shall be properly earthed. The degree of protection of Charger enclosure shall be at least IP-42 as per IS: 13947 Part I.

1.3.18.1. All indicating instruments, control switches and indicating lamps shall be mounted on the front side of the Charger.

1.3.18.2 Each Charger shall be furnished completely wired upto power cable lugs and terminal blocks and ready for external connections. The control wiring shall be carried out with PVC insulated, 1.5 sq.mm. stranded copper wires. Control terminals shall be suitable for connecting two wires, with 2.5 sq.mm stranded copper conductors. All terminals shall be numbered for ease of connections and identification. Each wire shall bear a ferrule or tag on each end for identification. At least 20% spare terminals shall be provided for control circuits.

1.3.18.3 The insulation of all circuits, except the low voltage electronic circuits shall withstand test voltage of 2 KV AC for one minute. An air clearance of at least ten (10) mm shall be maintained throughout for such circuits, right up to the terminal lugs. Whenever this clearance is not available, the live parts shall be insulated or shrouded.

1.3.19 Painting

All sheet steel work shall be pre-treated, in tanks, in accordance with IS:6005. Degreasing shall be done by alkaline cleaning. Rust and scale shall be removed by pickling with acid. After pickling, the parts shall be washed in running water. Then these shall be rinsed in slightly alkaline hot water and dried. The phosphate coating shall be 'Class-C' as specified in IS:6005. Welding shall not be done after phosphating. The phosphating surfaces shall be rinsed and passivated prior to application of

staved lead oxide primer coating. After primer application, two coats of finishing synthetic enamel paint of shade-631 of IS:5 shall be applied, unless required otherwise by the Owner. The inside of the chargers shall be glossy white. Each coat of finishing synthetic enamel paint shall be properly stoved. The paint thickness shall not be less than fifty (50) microns.

1.3.20 TESTS

1.3.20.1. Battery chargers shall conform to all type tests as per relevant Indian Standard. Performance test on the Chargers as per Specification shall also be carried out on each Charger as per specification. Rectifier transformer shall conform to all type tests specified in IS: 4540 and short circuit test as per IS:2026. Following type tests shall be carried out for compliance of specification requirements:

- i) Voltage regulation test
- ii) Load limiter characteristics test
- iii) Efficiency tests
- iv) High voltage tests
- v) Temperature rise test
- vi) Short circuit test at no load and full load at rated voltage for sustained short circuit.
- vii) Degree of protection test
- viii) Measurement of ripple by oscilloscope.

1.3.20.2. The Contractor may be required to demonstrate to the OWNER that the Chargers conform to the specification particularly regarding continuous rating, ripple free output, voltage regulation and load limiting characteristic, before dispatch as well as after installation at site. At site the following tests shall be carried out :

- i) Insulation resistance test
- ii) Checking of proper annunciation system operation.

1.3.20.3. If a Charger fails to meet the specified requirements, the Contractor shall replace the same with appropriate Charger without affecting the commissioning schedule of the Sub-station, and without any extra cost to the OWNER.

1.3.20.4. The Contractor shall present for inspection, the type and routine test certificates for the following components whenever required by the OWNER.

- (i) Switches.
- (ii) Relays/MCCBs
- (iii) Instruments.
- (iv) DC fuses.
- (v) SCR.
- (vi) Diodes.
- (vii) Condensers.
- (viii) Potentiometers.
- (ix) Semiconductor
- (x) Annunciator.
- (xi) Control wiring
- (xii) Push buttons and contactors.

Makes of above equipment shall be subject to Owner's approval.

1.4 THE POWER SUPPLY SYSTEM FOR SCADA SYSTEM

The tele-communication/SCADA equipments shall be suitable to operate on 220V DC power supply available in the substation.

SECTION-VIII

LIGHTING SYSTEM

SECTION: VIII

LIGHTING SYSTEM

1.0 LIGHTING SYSTEM

1.1 The scope of work comprises of design, engineering, testing, supply, installation, testing and commissioning of various lighting fixtures complete with lamps, supports and accessories, ceiling fans complete with electronic regulators, exhaust fans for toilets, pantry and battery room, lighting panels, lighting poles complete with distribution boxes, galvanized rigid steel conduits, lighting wires, G.I. Earthwire, receptacles, tag block & telephone socket, switchboards, switches, junction boxes, pull out boxes complete with accessories, lighting transformer. The lighting system shall be as per Energy Conservation Act. (Latest).

1.2 SYSTEM DESCRIPTION

A typical arrangement of lightening system shall comprise of the following:

1.2.1 AC Normal Lighting

AC lights will be connected to AC lighting panels. All the lights connected to the AC lighting system in different areas will be connected to the main lighting distribution boards.

1.2.2 AC Emergency Lighting

This system will be available in control room building, DG Set building & switchyard. AC lighting load will be connected to this system, which will be normally 'ON'. The lighting panels of this system will be connected to the Emergency lighting board, which is fed from diesel generator during the emergency. 50% of lighting fixtures shall be connected on AC emergency lighting.

1.2.3 D.C. Emergency Lighting

A few DC emergency lighting fixtures operated on the DC system will be provided in the strategic locations including staircase, corridors, electrical rooms, Battery charger room, LT switchgear room in control room building, and DG Set building so that the operating personnel can safely find their way even during emergency of a total AC failure. These lights will be normally 'OFF' and will be switched 'ON' automatically when under voltage occurs in the AC main lighting distribution board. GLS lamp down lighters in false ceiling area and Bulkhead fixtures in non-false ceiling area to be used.

1.2.4 Portable Fixtures

Three numbers of battery operated, portables fixtures will be provided in the Control room building and one number shall be provided in DG Set Building.

These fixtures will be provided at important locations in the above-mentioned areas.

1.3 The Lux levels to be maintained in the switchyard shall be as per following :

S.No.	Area	Average Lux Level
1)	Switchyard	Average Lux level 50 Lux on main Equipments (i.e Transformer, ISO) at first level (Equipment Connection level.) 20 Lux on balance area of switchyard and Road at ground level

The minimum Lux level to average Lux level ratio should not be less than 0.3 (i.e. $E_{min}/E_{avg} > 0.3$). the maintenance factor for outdoor illumination design shall be considered as 0.65.

For achieving the specified Lux levels in the switchyard, the contractor can provide luminaries of 1x400W/ 1x250W and 2x 400W/ 250 W flood light as per requirement.

The contractor shall submit detailed calculation for reaching the above Lux level. Contractor shall conform the Lux levels at different locations of the switchyard and lighting by measurement.

In addition to the normal lighting provided in the switchyard area to maintain the desired Lux levels, few high beam fixtures on swivel support shall be provided in strategic locations near equipments, which shall be kept normally OFF, and these shall be switched ON in case of maintenance work.

- 1.4 Adequate nos. of Ceiling fans (1400mm sweep, AC 230 volts) shall be provided in DG set building and all the rooms in the control room building. Wall mounted fans shall be provided in the conference room, shift manager and substation in charge rooms in control room building. In addition exhaust fans shall be provided in toilets, pantry and battery room.
- 1.5 One no. of aluminium ladder of each size shall be supplied by the contractor for maintenance purpose.
- 1.6 The following specific areas are included in the scope of lighting:
- (i) GIS cum Control Room building.
 - (ii) Switchyard outside GIS cum Control Room Building.
 - (iii) DG Set
 - (iv) Landscape lighting around GIS cum Control Room building
 - (v) Roads in the substation.
- 1.7 Street lighting shall be provided through HP sodium vapour lamps.
- 1.8 **For Outdoor Illumination**
Switchyard design, detailed drawings showing the lighting layout and Electrical distribution diagram shall be prepared by the Contractor and submitted for approval. The above layout drawings will include disposition and location of lighting fixtures, receptacles, etc.
- High Mast Lighting System**
The High Mast shall be provided for outdoor illumination. The bidders shall design the proper height of High Mast, control panels and average illumination level for outdoor switchyard as per IS:3646 (part-2) and subjected to the Employer approval. The required quantity and rate shall be filled by the bidder in relevant BPS (Vol-III). The Mast shaft shall be provided with hot dip galvanised and suitable for wind velocity as per IS 875. It shall also include accessories for high mast including head frame, steel wire rope, trailing cable, double drum winch, galvanised Lantern carriage arrangement suitable for luminaries symmetrically & its control gear boxes and lightning finial etc. The mast shall have an integral power motor installed inside the base compartment for its operation.
- The control panel housing shall be contactor circuit for the automatic control of luminaries, outgoing terminals and control circuit for the power motor.
- For Indoor Illumination**
The conduit layout for substation buildings based on the tender drawings, Electrical distribution diagram for substation buildings & for landscape lighting cable schedule for substation yard etc. shall be prepared by the Contractor. All wiring including telephone wiring (tinned two pair copper) shall be in concealed conduit. Concealed MS junction boxes for sockets and light points shall be provided in all the rooms of GIS cum Control Room Building, DG Set Building etc.
- 1.9 Each cable and conduct run shall be tagged with number that appears in the cable and conduit schedules. Cables and conduits shall be tagged at their entrance and / or exit from any piece of equipment, junction or pull box, floor opening etc.
- 1.10 The tag shall be made up of aluminium with the number punched on it and securely attached to the cables by not less than two turns of G.I. wire Cable tags shall be rectangular in shape for power cables and circular shape for control cables.
- 1.11 Location of cables laid directly under ground shall be indicated clearly by cable marker made of galvanized iron plate embedded in concrete book.
- 1.12 The location of under ground cable joints if any, shall be clearly indicated with cable marker with an additional inscription "cable joint".
- 1.13 The marker, which is a concrete block, shall project 150mm above ground and shall be spaced at an interval of 30 meters and at every change of direction. It shall also be located on both sides of the road or drain crossing.

2.0 DESCRIPTION OF ITEMS

The Contractor shall supply and install the following equipment and accessories in accordance with the specification.

2.1
2.1.1

LIGHTING PANELS

Outdoor

415 V AC lighting panel with 415V, 63A, 3 Phase 4 wire bus and one no. 63A, TPN, MCB with neutral unit as incomer and 20A, MCB as outgoing feeders, the details are as follows.

Type	Description	Details of outgoing Feeders
ACP-2	Outdoor	6 nos. 32A Tripple pole MCB with Neutral suitable timer & contactor for automotive switching.
ACP-3	Outdoor	3 nos., 32A Tripple pole MCB with Neutral Lighting with suitable timer & contractor for automatic switching.

Note: The number of outgoing feeders indicated above are the minimum.

2.1.2

Indoor

415 V Indoor AC lighting panel, 63A, 3 phase, 4 wire bus and one number 63 AMP, TPN, MCB with 300ma 63 A, RCCB. Flush Mounted with per phase isolation and indication lamps din mounted. The DB will be flush mounted.

ACP-1 Indoor 18 nos. outgoing 16-32 amp SPMCB

2.2.

220V DC indoor type change over board and 220V DC 32A two wire bus and one 32A contactor backed up by 32A double pole MCB as incomer. The panel shall have local push button controls. Following are the various types of panels required with control timer.

Type	Description	Details of Outgoing Feeders
DCP	Indoor	6 Nos. – 16A DPMCB Unit.

2.3.

Sub-Lighting Panels

Type	Description
SLD	4 pole 32A Isolator suitable for 415V, 50 cycles AC Supply, with LILO Facility using 8 nos. terminal blocks suitable for cable upto 16m sq cable Enclosure shall be suitable for outdoor use with IP-55 degree of protection as per IS: 13947 (Part-I)

2.4.

Lighting Fixtures and Receptacles

Lighting Fixtures

Type	Description
IF	CFL/Metal Halide in recessed down light having high purity aluminum reflector electrochemically brightened and anodized. Stainless steel leaf springs and pressure die cast ceiling similar to Philips Cat. No. DN-622 Crompton greaves cat DDLV 10-BC
SF1	Whether proof integral Floor Lighting with housing made of corrosion resistant die cat aluminum painted black. Grey powder coated outside suitable for 150W SON-T lamp complete with all accessories and suitable for termination with conduits/flexible Cat. No. F69045 (C). Similar to Philips Cat. No. SWF230/150/Bajaj Cat. No. BGEMF-150WSV Crompton Greaves Cat No. FAD 11151H
SF2	2 x 400 / 2 x 250 W HP Sodium vapour lamps in high flood lighting fixture suitable for outdoor mounting with aluminum enclosure: similar to Phillips Cat. No. SNT001/Bajaj Cat. No. DJEF-22CA/Crompton Greaves Cat. No. FHD1324
SF3	1 x 250 W/ 1 x 400 HP Sodium vapour lamps in high flood lighting fixture suitable for outdoor mounting with aluminum enclosure and integral control gear: similar to Phillips cat. No. SWF 330/CGL Cat. No. FAD 1114/Bajaj Cat. No. BJEF T14CA.

PF	1x11 W CFL/Metal Halide lamp emergency light with Battery operated portable fixture with built in chargeable Batteries and battery charger suitable for a lighting period of six hours similar to ALPHA DELUX of M/s DELTA FLASH LITE/MICRO LITE OF M/s MICRO / BPL MAKE
FB	9W CFL /Metal Halide lamp in Bulkhead fixtures with Cat Aluminium alloy body, suitable for column, wall, and ceiling mounting finished stove enameled silver grey outside white inside, to be supplied complete (with front cover, wire guard, tropicalised gasket and lamp holder taped ¾" E.T. for conduit entry) similar to Phillips Cat. No. FXC 101/Bajaj Cat. No. BJB-19/Crompton Greaves.
MP	125 HP MV CFL/Metal Halide in weather proof post top lantern with case aluminium canopy, mounting piece, opal acrylic cover tropicated gasket and all other accessories for mounting on pole top similar to Phillips Cat. No. HPC-101/Bajaj/Crompton Greaves. Cat No. MPT12IH/BC
IB	60/100W CFL/Metal Halide in Bulkhead fixtures with cast Aluminium alloy, body, suitable for column, wall and ceiling mounting finished stove enameled silver grey outside white inside, to be supplied complete (with front glass, wire guard, tropicalised, gasket and E.S. Porcelain, lamp holder taped ¾" E.T. for conduit entry) similar to Phillips Cat. No. NXC101/Crompton Greaves IBH1110/BC
BL	2x9 or 1x18 W, CFL bollard light for landscape lighting FRP/LLDPE housing similar to Phillips FGC202/Crompton Greaves Cat No. CFBL1129
DLR	2x18 W, CFL Down light for recess mounting lighting having similar to Phillips FBH225/2x18 / Crompton Greaves Cat No DDLH218TG
DSM	1x13 WTT surface mounted CFL similar to Art Light Make Cat No. RL 3146
HL	2x18 CFL Decorative hanging down Light Similar no. Cat No Art light RL 3166/HL
CL	1x18 WATT Decorative ceiling mounted luminaries similar to Phillips Dixie Cat FL 343/118

2.5

RECEPTACLES

RO	15A, 240V, Outdoor Receptacle 3 Pole, 3 pin type
R1	5/15A, 240V Indoor receptacle 3-in type
RP	63A, 415V, Interlocked switch socket, outdoor receptacle

2.6

SWITCH BOARDS

Modular type switches, 5/15 Amp. Receptacles

2.7

CONDUITS AND ACCESSORIES

Galvanised Rigid Steel Conduits of 19mm/25mm/32mm/40mm dia

2.8

JUNCTION BOXES with 5 nos. of terminal blocks

2.9

LIGHTING POLES – Adequate nos. of lighting pole shall be provided.

2.10

CEILING FANS – 1400mm Sweep with Electronic regulator

2.11

MAINTENANCE EQUIPMENT

- i) A type Aluminium ladder of 3 mtr. vertical height.
- ii) Cartwheel mounted aluminium ladder Vertical Height 7.5 Mtrs. when extended.

2.12

LIGHTING TRANSFORMER

Supply, erection, testing and commissioning of 100 KVA or above (in case the capacity of transformer required is higher than 100 KVA as per approved calculations), 415/415 V, 3

Phase, 50 Hz Dry type natural air cooled lighting transformers. The technical parameters of these lighting transformers are as follows:-

Technical Parameters of Lighting Transformer

Type of transformer	:	Dry Type natural air
Cooled Rating	:	100 KVA
Voltage Ratio	:	415/415 Volts
No. of Phases	:	Three
Frequency	:	50 Hz
Winding connection	:	Dyn – 1
Class of insulation	:	'B' Class
Impedance	:	4% \pm 10%
No. of taps & steps	:	5, \pm 5% in steps of 2.5%
Ref. Standard	:	IS:2026

The enclosure for the above transformer shall have degree of protection not less than IP-42. The rating of lighting transformer should be suitable for lighting load. The contractor shall submit the supporting calculation for the rating of lighting transformer.

3.0 LIGHTING FIXTURES AND ACCESSORIES

3.1 General

All lighting fixtures and accessories shall be designed for continuous operation under atmospheric conditions existing at site, without reduction in the life or without any deterioration of materials, internal wiring.

3.2 Temperature Rise

All lighting Fixtures and accessories shall be designed to have a low temperature rise according to the relevant Indian Standards. The design ambient temperature shall be taken as 50 deg.C.

3.3 Supply Voltage

3.3.1 Lighting fixtures and accessories meant for 240V A.C. operation shall be suitable for operation on 240V A.C. 50Hz, supply voltage variation of \pm 10%, frequency variation of \pm 5% and combined voltage and frequency variation of \pm 10%.

3.3.2 Lighting fixture and accessories meant for 220V DC operation shall be suitable for operation on 220V DC with variation between 190 to 240 Volts.

3.4 Lighting Fixtures

The lighting fixtures shall be Philips or Bajaj or Crompton Greaves make only except for fixtures type 'DSM' & 'HI' for which make has been specified elsewhere in this section. The different types of lighting fixtures are also indicated elsewhere in this Section.

3.4.1 All Fixtures shall be designed for minimum glare. The finish of the fixtures shall be such that no bright spots are produced either by direct light source or by reflection.

3.4.2 All lighting fixtures shall be complete with CFL /mercury vapour/sodium vapour/metal halide lamps as specified and shall be suitably wired up.

3.4.3 High beam Fixtures shall be suitable for pendant mounting and flood lights shall have suitable base plate / frame for mounting on steel structural member. Hook mounted high beam fixtures are not acceptable.

3.4.4 Each lighting Fixture shall be provided with an earthing terminal suitable for connection to 16 SWG GI earthing conductors.

3.4.5 All light reflecting surfaces shall have optimum light reflecting co-efficient such as to ensure the overall light output as specified by the manufacturer.

3.4.6 Height of fixtures should be such that it is easy to replace the lamps with normal ladder/stool. In case the ceiling height is very high, the fixtures may be placed on the walls for ground lighting.

3.5 ACCESSORIES

3.5.1 Reflectors

The reflectors shall be manufactured from sheet steel or aluminium as applicable. They shall be securely Fixed to the captive type.

3.5.2 Lamp holders and Starter Holders

Lamp holders/starter for CFL, Metal Halide Lamp and HPMV/HPSV lamps shall be of screwed type, manufactured in accordance with relevant standard and designed to give long and satisfactory service.

3.5.3 Ballasts

- a) The Ballasts shall be designed, manufactured and supplied in accordance with relevant standard and function satisfactorily under site condition specified. The ballasts shall be designed to have a long service life and low power loss.
- b) Ballasts shall be mounted using self locking anti-vibration fixing and shall be easy to remove without dismantling the fixtures. They shall be totally enclosed units.
- c) The ballasts shall be of the inductive, heavy duty type, filled with thermosetting insulating moisture repellent polyester compound filled under pressure or vacuum. The ballast wiring shall be of copper wire. They shall be free from hum. Ballasts which produce humming sound shall be replaced free of cost by the Contractor. Ballasts for high pressure mercury vapour/ HPSV lamps shall be provided with suitable tapings to set the voltage within the range specified. End connections and taps shall be brought out in a suitable terminal block, rigidly fixed to the ballast enclosure.
- d) Separate ballast for each lamp shall be provided in case of multi-lamp fixtures.

3.5.4 Starters

Starters shall have bimetal electrodes and high mechanical strength. Starters shall be replaceable without disturbing the reflector or lamps and without the use of any tool. Starters shall have brass contacts and radio interference suppressing capacitor.

3.5.5 Capacitors

- a) The capacitors shall have a constant value of capacitance and shall be connected across the supply of individual lamp circuits.
- b) The capacitors shall be suitable for operation at supply voltage as specified and shall have a value of capacitance so as to correct the power factors of its corresponding lamp circuit to the extent of 0.98 lag.
- c) The capacitors shall be hermetically sealed in a metal enclosure.

3.6 Lamps

General Lighting Services (GLS) lamps shall be provided with screwed caps and shall be of 'clear' type unless otherwise specified.

Mercury vapour lamps, sodium vapour lamps shall be colour corrected type, with screwed caps.

The Bidder shall furnish typical wiring diagram for CFL/Metal Halide lamps, HPMV & HPSV fitting including all accessories. The diagram shall include technical details of accessories i.e. starters, Electronic Chokes, capacitors etc.

Flexible conduits if required, for any fixture shall be deemed to be included in Contractor's scope.

4.0 RECEPTACLES

- a) All receptacles shall be of cast steel/aluminium, heavy duty type, suitable for fixing on wall/column and complete with individual switch.
- b) In general the receptacles to be installed are of the following types
 - i) **Type RO** -15A, 240V, 2 pole, 3 pin type with third pin grounded, metal dad with gasket having cable gland entry suitable for 2Cx6 sq.mm. PVC/aluminium armoured cable and a metallic cover tied to it with a metallic chain and suitable for installation in moist location and or outdoor. The switch shall be of rotary type. Receptacles shall be housed in an enclosure made out of 2 mm thick GI sheet with hinged doors with padlocking arrangements. Door shall be lined with good quality gasketing. This shall conform to IP-55.
 - ii) **Type RI** - The 5/15 amp 6 pin receptacles with switches will be of Modular type with flush type switches and electroplated metal enclosures of approved make

iii) **Type RP** - 63A, 415V, 3 phase, 4 pin interlocked plug and switch with earthing contacts. Other requirements shall be same as type RO. The receptacle shall be suitable for 3.5C x 35/3.5Cx70 sq.mm. aluminium conductor cable entry and shall also be suitable for loop-in and loop out connection of cables of identical size. Receptacle shall be suitable for outdoor application. Receptacles shall be housed in a box made out of 2mm thick G.I. sheet, with hinged door with padlocking arrangement. Door shall be lined with good quality gasketing. This shall conform to IP-55.

5.0 SWITCH AND SWITCHBOARD

- (a) All Switch board/boxes, 5/15 Amp Receptacles and electronic fan regulators located in office/building areas shall be modular flush mounted type or brick wall with only the switch knob projecting outside.
- (b) Switch boards/boxes shall have conduit knock outs on all the sides. Adequate provision shall be made for ventilation of these boxes.
- (c) The exact number of switches including regulator for fans and layout of the same in the switchboard shall be to suit the requirement during installation.
- (d) The maximum number of luminaries controlled by one no 6 amp switch would 4 nos. For DC fixtures there will be no switch and the same shall be controlled from DC LP
- (e) The luminaries shall be wired in such a fashion that luminaries on each phase are evenly distributed all over the room.

6.0 CONDUITS & CONDUIT ACCESSORIES

- 6.1 The conduits shall conform to IS:9537. All conduits shall be seamed by welding, shall be of heavy gauge and shall be hot dip galvanised.
- 6.2 Flexible conduits wherever required shall be made with bright, cold rolled annealed and electro-galvanised mild steel strips.
- 6.3 All conduits accessories shall conform to relevant IS and shall be hot dip galvanised.

7.0 JUNCTION BOXES

- 7.1 The junction boxes shall be concealed type for indoor lighting and suitable for mounting on columns, lighting poles, structures etc., for outdoor lighting.
- 7.2 Junction boxes shall be of square/rectangular type of 1.6 mm sheet steel with minimum 6 mm thick pressure die cast aluminium material LM-6 and shall have bolted cover with good quality gasket lining.
- 7.3 The junction box and cover shall be hot dip galvanised.
- 7.4 The junction boxes shall be complete with conduit knockouts/threaded nuts and provided with terminal strips. The junction boxes shall be suitable for termination of conduit/glands of dia 20 mm, 25 mm, 32 mm, 40 mm on all sides. The junction boxes shall be provided with 4 way terminals suitable for two numbers 10 sq. mm. wire & for switchyard lighting suitable for 2 numbers 4C x 16 Sq.mm Al. cable.
- 7.5 The junction boxes shall have the following indelible markings
 - (i) Circuit Nos. on the top.
 - (ii) Circuit Nos. with ferrules (inside) as per drawings.
 - (iii) DANGER sign in case of 415 volt junction box.
- 7.6 The junction boxes shall be weather proof type with gaskets conforming to IP-55 as per IS: 13947 (Part 1). The conduit connections shall also be properly sealed to prevent entry of water.

8.0 TERMINAL BLOCKS

- 8.1 Each terminal shall be suitable for terminating upto 2 Nos. 10 sq.mm. stranded Aluminium Conductors without any damage to the conductors or any looseness of connections.

9.0 PULL OUT BOXES

- 9.1 The pull out boxes shall be concealed type for indoor lighting and suitable for mounting on column, structures etc., for outdoor lighting. The supply of bolts, nuts and screws required for the erection shall be included in the installation rates.

- 9.2 The pull out boxes shall be circular of cast iron or 16 SWG sheet steel and shall have cover with good quality gasket lining.
- 9.3 The pull out boxes and cover shall be hot dip galvanized.
- 9.4 The pull out boxes shall be completed with conduit knock outs/threaded hubs and provided at approximately 3 meters intervals in a conduit run.
- 10.0 LIGHTING PANELS (L.P.)**
- 10.1 Each panel shall be provided with one incoming triple pole MCB with neutral link and outgoing miniature circuit breakers as per clause 2.0. The panels shall conform to IS-8623.
- 10.2 Constructional Features**
- 10.2.1 Panels shall be sheet steel enclosed and shall be dust, weather and vermin proof. Sheet steel used shall be of thickness not less than 2.00 mm (cold rolled) or 2.5 mm (hot rolled) smoothly finished, leveled and free from flaws. Stiffeners shall be provided wherever necessary. The indoor lighting panels will be ready made DB of minimum 20 swg sheet thickness.
- 10.2.2 The panels shall be of single front construction, front hinged and front connected, suitable for either floor mounting on channels, sills or on walls/columns by suitable M.S. brackets.
- 10.2.3 Panels shall have a dead front assembly provided with hinged door(s) and out door panels will be with padlocking arrangement with single key supplied in duplicate.
- 10.2.4 All out door panels, removable covers, doors and plates shall be gasket all around with neoprene gaskets.
- 10.2.5 The panels shall be suitable for cable/conduit entry from the top and bottom. Suitable removable cable gland-plate shall be provided on the top and bottom of panels. Necessary number of double compression cable gland shall be supplied, fitted on to this gland plate. The glands shall be screwed on top and made of tinned brass.
- 10.2.6 The panels shall be so constructed as to permit free access to connection of terminals and easy replacement of parts.
- 10.2.7 Each panel shall have a caution notice fixed on it.
- 10.2.8 Each panel will be provided with directory holder in which printed and laminated as built circuit directory would be kept
- 10.2.9 Each Outdoor lighting panel shall be provided with one no. 'ON' indicating lamp for each phase along with fuses. For indoor lighting panels din mounted phase indication lamps will be provided, mounted along side of the MCB
- 10.3 Main Bus Bars**
- 10.3.1 Bus bars shall be of aluminium alloy conforming to IS:5082 and shall have adequate cross-section to carry the rated continuous and withstand short circuit currents. Maximum operating temperature of the bus bars shall not exceed 85 deg. C. The bus bars shall be able to withstand a fault level of 9 kA for 1 sec. for AC panels and 4 KA for 1 sec. for DC panels. The Indoor lighting panels shall have copper bus bar.
- 10.4 Residual Current Circuit Breakers (RCCB)**
- 10.4.1 For indoor panels 63A 4pole 300 ma conforming IS 12640 will be provided along with incomer
- 10.5 Miniature Circuit Breaker (MCB)**
- a) The miniature circuit breakers shall be suitable for manual closing, opening, automatic tripping under overload and short circuit. The MCBs shall also be trip free.
- b) Single pole as well as three pole versions shall be furnished as required in the Schedule of Lighting Panels.
- c) The MCBs and panel MCCB together shall be rated for full fault level. In case the MCB rating is less than the specified fault level the bidder shall co-ordinate these breaker characteristics with the back up MCCB in such a way that if fault current is higher than

breaker rating, the MCCB should blow earlier than the breaker. If the fault current is less than MCB breaking capacity, MCB shall operate first and not the incomer MCCB.

- d) The MCBs shall be suitable for housing in the lighting panels and shall be suitable for connection with stranded copper wire connection at both the incoming and outgoing side by copper lugs or for bus bar connection on the incoming side.
- e) The terminals of the MCBs and the 'open' 'close' and 'trip' conditions shall be clearly and indelibly marked.
- f) The tenderer shall check and co-ordinate the ratings of MCBs with respect to starting characteristics of discharge lamps. The vendor has to furnish overload and short circuit curve of MCB as well as starting characteristics curves of lamps for Employer's approval.
- g) The MCB shall generally conform to IS:8828.

10.6

Contactors

Contactors shall be of the full voltage, direct-on line air break, single throw, electro-magnetic type. They shall be provided with atleast 2-'NC' and 2-'NO' auxiliary contacts. Contactor shall be provided with the three element, positive acting, ambient temperature compensated time lagged, hand reset type thermal overload relay with adjustable settings to suit the rated current. Hand reset button shall be flush with the front of the cabinet and suitable for resetting with starter compartment door closed. The Contactor shall be suitable for switching on Tungsten filament lamp also. The bidder shall check the adequacy of the Contactors rating wire with respect to lighting load.

10.7

Push Buttons

All push buttons shall be of push to actuate type having 2 'NO' and 2 'NC' self reset contacts. They shall be provided with integral escutcheon plates engraved with their functions. Push buttons shall be of reputed make.

10.8

Labels

- a) The lighting panels shall be provided on the front with panel designation labels on a 3 mm thick plastic plate of approved type. The letter shall be black engraved on white back ground.
- b) All incoming and outgoing circuits shall be provided with labels. Labels shall be made of non-rusting metal or 3 ply lamicol. Labels shall have white letters on black or dark blue background.

10.9

Earthing Terminals

Panels shall be provided with two separate and distinct earthing terminals suitable to receive the earthing conductors of size 50x6 G.S. Flat.

10.10

Type test reports for following tests on all lighting panels shall be submitted for approval.

- (i) Wiring continuity test
- (ii) High voltage (2.5 KV for 1 minute) and insulation test
- (iii) Operational test
- (iv) Degree of protection (not less than IP-55 test on outdoor Lighting Panels and IP-52 test on indoor Lighting Panels as per IS 13947 (part 1)
- (v) Heat run test

10.11

Lighting Transformer

Lighting transformer shall be located in MCC room, in separate enclosure. Enclosure shall have degree of protection not less than IP-42 as per IS-13947 (Part-1).

11.0

Emergency Portable Lighting Fixtures

11.1

The portable fixtures shall have a built in battery rated for six hours, battery chargers and solid state inverters. These shall be of approved make.

11.2

The portable fixtures shall be of a single unit, completely tropicalised and suitable for prolonged use with no maintenance.

11.3

The portable fixtures shall be supplied and necessary supporting brackets of galvanized steel suitable for wall/column mounting shall also be supplied.

11.4

The portable fixture shall come up automatically in the event of failure of normal supply.

- 12.0 LIGHTING POLES**
- 12.1 In front of GIS cum control room building and DG Set building decorative post top lantern poles and Bollards shall be installed.
- 12.2 Lighting poles shall be complete with fixing brackets and junction boxes. Junction boxes should be mounted one meter above ground level.
- 12.3 The lighting poles shall be coated with bituminous preserving paint on the inside as well as on the embedded outside surface. Exposed outside surface shall be coated with two coats of metal primer (comprising of red oxide and zinc chromate in a synthetic medium).
- 12.4 Wiring from junction box at the bottom of the pole to the fixture at the top of the pole shall be done through 2.5 sq. mm wire.
- 12.5 Earthing of the poles should be connected to the switchyard main earth mat wherever It is available and the same should be earthed through 3M long, 20 mm dia, earth electrode.
- 13.0 CEILING & WALL MOUNTED FANS AND REGULATORS**
- 13.1 The contractor shall supply and install 1400 mm sweep ceiling fans complete with electronic regulator and switch, suspension rod, canopy and accessories. The wall-mounted fans shall be of 400 mm sweep
- 13.2 The contractor shall supply and install the switch, electronic regulator and board for mounting switch and electronic regulator for ceiling fans.
- 13.3 Winding of the fans and regulators shall be insulated with Class-E insulating material. Winding shall be of copper wire.
- 13.4 Electronic regulator with smooth control shall be provided.
- 13.5 One fan for approx 100 sq. feet area shall be provided.
Fans and electronic regulators shall be of Alstom / Crompton Greaves / Bajaj Electricals / Usha Electricals make.
- 14.0 LIGHTING WIRES**
- 14.1 The wiring used for lighting shall be standard products of reputed manufacturers.
- 14.2 The wires shall be of 1100 V grade, PVC insulated product of reputed manufacturers.
- 14.3 The conductor sizes for wires used for point wiring beyond lighting panels shall be single core 4 sq. mm., 6 sq.mm and 10 sq.mm stranded aluminium wires and 2.5 sq.mm, 4 sq.mm, 6 sq.mm and 1.5 sq.mm stranded copper wire.
- 14.4 The wires used for connection of a lighting fixture from a nearest junction box or for loop-in loop-out connection between two CFL/Metal Halide lamps fluorescent fixtures shall be single core copper stranded conductor, 1100V grade flexible PVC insulated cords, unsheathed, conforming to IS:694 with nominal conductor cross sectional areas of 2.5 sq. mm.
- 14.5 The wires shall be colour coded as follows:
Red for R – Phase
Yellow for Y - Phase
Blue for B - Phase
Black for Neutral
White for DC (Positive)
Grey for DC (Negative)
- 15.0 PAINTING OF SHOP MADE ITEMS**
- 15.1 All sheet steel work shall be phosphated in accordance with the following procedure and in accordance with IS:6005 'Code of Practice for Phosphating Iron and Steel'.
- 15.2 Oil grease and dirt shall be thoroughly removed by emulsion cleaning.

- 15.3 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.
- 15.4 After phosphating through rinsing shall be carried out with clean water, followed by final rinsing with diluted dichromate solution and oven drying.
- 15.5 The phosphate coating shall be sealed by the application of two coats of ready mixed stoving type metal primer (comprising of red oxide and Zinc chromate in a synthetic medium). The first coat may be 'flash dried' while the second coat shall be stoved.
- 15.6 After application of the primer, two coats of finishing synthetic enamel paint shall be applied with each coat followed by stoving. The second finishing coat for the external of panels shall be applied after completion of tests. The panels can also be powder coated instead of painting after surface treatment as given above.
- 15.7 Both outside and inside of lighting panel, sheet metal fabricated junction boxes etc. and outside of lighting fixtures shall be finished in light grey (IS-5 shade 631). Inside of lighting fixtures shall be finished in white. The colour of indoor lighting panels should match with colour of wall.
- 15.8 Each coat of primer and finishing paint shall be of slightly different shade so as to enable inspection of the painting.
- 15.9 The final finished thickness of paint film on steel shall not be less than 100 microns and shall not be more than 150 microns. The final thickness of powder coating will not be less than 50 microns. For indoor lighting panels the painting will be as per approved manufacturers specification.
- 15.10 Finished painted appearance on equipment shall present on aesthetically pleasing appearance, free from dents and uneven surfaces.

16.0 LIGHTING SYSTEM INSTALLATION WORKS

16.1 General

- 16.1.1 In accordance with the specified installation instructions as shown on manufacturer's drawings or as directed by Employer, Contractor shall unload, erect, install, test and put into commercial use all the electrical equipment included in the contract. Equipment shall be installed in a neat, workmanship manner so that it is level, plumb square and property aligned and oriented. Tolerances shall be as established in manufacturers drawing or as stipulated by Purchaser.

- 16.1.2 All apparatus, connections and cabling shall be designed so as to minimise risk of fire or any damage which will be caused in the event of fire.

16.2 Conduit System

- 16.2.1 Contractor shall supply, store and install conduits required for the lighting installation as specified. All accessories/fittings required for making the installation complete, including but not limited to pull out boxes (as specified in specification ordinary and inspection tees and elbow, check nuts, male and female bushings (brass or galvanised steel), caps, square headed make plugs, nipples, gland sealing fittings, pull boxes, conduits terminal boxes, glands, gaskets and box covers, saddle terminal boxes, and all steel supporting work shall be supplied by the Contractor. The conduit fittings shall be of the same material as conduits. The contractor shall also supply 19 mm PVC conduit and accessories for telephone wiring.
- 16.2.2 All un-armoured cables shall run within the conduits from lighting panels to lighting fixtures, receptacles, etc.
- 16.2.3 Size of conduit shall be suitably selected by the Contractor.
- 16.2.4 Conduit support shall be provided at an interval of 750 mm for horizontal runs and 1000 mm for vertical runs.
- 16.2.5 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 masonry or concrete for conduit support is not acceptable.

- 16.2.6 Where conduits are alongwith cable trays they shall be clamped to supporting steel at an interval of 600 mm.
- 16.2.7 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.
- 16.2.8 For long conduit run, pull boxes shall be provided at suitable intervals to facilitate wiring.
- 16.2.9 Conduit shall be securely fastened to junction boxes or cabinets, each with a lock nut inside and outside the box.
- 16.2.10 Conduits joints and connections shall be made through 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.
- 16.2.11 The entire metallic conduit system, shall be embedded, electrically continuous and thoroughly grounded. Where slip joints are used, suitable bounding shall be provided around the joint to ensure a continuous ground circuit.
- 16.2.12 Conduits and fittings shall be properly protected during construction period against mechanical injury. Conduit ends shall be plugged or capped to prevent entry of foreign material.
- 16.3 **Wiring**
- 16.3.1 Wiring shall be generally carried out by PVC insulated wires in conduits. All wires in a conduit shall be drawn simultaneously. No subsequent drawings of wires is permissible.
- 16.3.2 Wires shall not be pulled through more than two equivalent 90 deg. bends in a single conduit run. Where required, suitable junction boxes shall be used.
- 16.3.3 Wiring shall be spliced only at junction boxes with approved type terminal strip.
- 16.3.4 For lighting fixtures, connection shall be teed off through suitable round conduit or junction box, so that the connection can be attended without taking down the fixture.
- 16.3.5 For vertical run of wires in conduit, wires shall be suitably supported by means of wooden/hard rubber plugs at each pull/junction box.
- 16.3.6 Maximum two wires can be terminated to each way of terminal connections.
- 16.3.7 Separate neutral wires are to be provided for each circuit.
- 16.3.8 AC and DC wiring should not run through the same conduit.
- 16.4 **Lighting Panels**
- 16.4.1 The lighting panels shall be erected at the locations to be finalised during detailed engineering.
- 16.4.2 Suitable foundations/supporting structures for all outdoor type lighting panels shall be provided by the Contractor.
- 16.5 **Foundation & civil works**
- 16.5.1 Foundation for panel foundation and transformer foundation shall be done by the Contractor..
- 16.5.2 All final adjustment of foundation levels, chipping and dressing of foundation surfaces, setting and grouting of anchor bolts, sills, inserts and fastening devices shall be carried out by the Contractor including minor modification of civil works as may be required for erection.
- 16.5.3 Any cutting of masonry / concrete work, which is necessary shall be done by the Contractor at his own cost and shall be made good to match the original work.

SECTION-IX

LT TRANSFORMER

Technical specification of Distribution transformers of 33/0.415kV and 11/0.415kV voltage class and various kVA ratings

1. SCOPE:

- 1.1 This specification covers design, engineering, manufacture, assembly, inspection and testing before supply and delivery at site of oil immersed, naturally cooled 3 phase wound and outdoor type **33kV/0.415kV and 11 kV/0.415kV** distribution transformers, for providing auxiliary power supply to DTL S/stn. only.
- 1.2 The equipment shall conform in all respects to high standards of engineering, design and workmanship and shall be capable of performing in continuous commercial operation, in a manner acceptable to the purchaser, who will interpret the meanings of drawings and specification and shall have the power to reject any work or material which, in his judgment is not in accordance therewith. The offered equipment shall be complete with all components necessary for their effective and trouble free operation. Such components shall be deemed to be within the scope of bidder's supply irrespective of whether those are specifically brought out in this specification and / or the commercial order or not.
- 1.3 The transformer and accessories shall be designed to facilitate operation, inspection, maintenance and repairs. The design shall incorporate every precaution and provision for the safety of equipment as well as staff engaged in operation and maintenance of equipment.
- 1.4 All outdoor apparatus, including bushing insulators with their mountings, shall be designed so as to avoid any accumulation of water.
- 1.5 The short circuit level of 33kV and 66kV system is 31.5kA for 01 second. Short circuit level of distribution transformer for tertiary loading shall be accordingly considered.

2. STANDARD RATINGS:

- 2.1 The standard ratings for distribution transformers are as under:

S.No.	Voltage Rating (In kV)	Capacity (In kVA)
1	11/0.415kV	250, 315, 400, 500, 630, 800, 1000, 1250, 1600, 2000 and 2500
2	33/0.415kV	250, 315, 400, 500, 630, 800, 1000, 1250, 1600, 2000 and 2500

3. STANDARDS:

- 3.1 The materials shall conform in all respects to the relevant Indian/International Standards, with latest amendments thereof unless otherwise specified herein. Some of them are listed

below:

Standard	Title
IS -2026 IEC 60076	Specification for Power Transformers
IS-1180 (Part-I)	Outdoor type oil immersed distribution transformers up to and including 2500kVA, 33kV (Latest revision)
IS 12444	Specification for Copper wire rod
IS-335 IEC 296	Specification for Transformer Oil
IS - 5	Specification for colors for ready mixed paints
IS - 104	Ready mixed paint, brushing zinc chromate, priming
IS – 2099	Specification for high voltage porcelain bushing
IS - 649	Testing for steel sheets and strips and magnetic circuits
IS – 4257 Part-I	Dimensions for clamping arrangements for bushings
IS - 7421	Specification for Low Voltage bushings
IS – 3347 Part-I	Specification for Outdoor Bushings
IS – 9335 IEC 554	Specification for Insulating Kraft Paper
IS – 1576 IEC 641	Specification for Insulating Press Board
IS – 6600 IEC76	Guide for loading of oil Immersed Transformers
IS - 2362	Determination of water content in oil for porcelain bushing of transformer
IS - 6160	Rectangular Electrical conductor for electrical machines
IS - 5561	Electrical power connector
IS - 6103	Testing of specific resistance of electrical insulating liquids
IS - 6262	Method of test for power factor and dielectric constant of electrical insulating liquids
IS - 6792	Determination of electrical strength of insulating oil
IS - 10028	Installation and maintenance of transformers.
IS 3401	Specification of silica gel
IS 6600	Guide for loading of oil immersed transformer
IS 5082	Wrought Aluminium and Aluminium alloy bars, Rods, tubes, sections and sheets for electrical applications.

- 3.2 Material conforming to other internationally accepted standards, which ensure equal or better quality than the standards mentioned above, would also be acceptable. In case the bidders who wish to offer material conforming to other standards, the bidder shall clearly bring out the salient points of difference between the standards adopted and the specific standards in

relevant schedule. Four copies of such standards with authentic English translations shall be furnished along with the offer.

4. CLIMATIC CONDITIONS:

The equipment covered under this specification is for outdoor installation and the climatic conditions that are prevailing in Delhi.

1. Temperature:		
The reference ambient temperature be taken as 43.3 ° C as per IS 9676.		
a.	Maximum ambient air temperature	50°C
b.	Maximum daily average ambient temp	40°C
2. Relative Humidity:		
a.	Maximum Relative Humidity	100%
b.	Minimum Relative Humidity	10%
3.	Average annual rainfall	750 mm
4.	Average no. of rainy day	50
5.	Average no. of thunderstorm days per annum	40
6.	Altitude	Not exceeding 300 meters
7.	Rain months	June to Oct.
8.	Wind pressure as per IS 875	195 Kg/Sq. meters up to 30 meters

The atmosphere is generally laden with mild acid and dust in suspension during the dry months and is subjected to fog in cold months. Heavy lightening occurs in the area during rainy months (June to October).

All equipment shall be designed to withstand seismic forces, corresponding to an acceleration of 0.3 g horizontal.

5. PRINCIPAL PARAMETERS:

- 5.1 The transformers shall be suitable for outdoor installation with three phases, 50 Hz systems in which the neutral is effectively earthed and they should be suitable for service with fluctuations in supply voltage up to +12.5%.
- 5.2 The transformers shall conform to the following specific parameters :

S.No.	Item	11 kV Distribution Transformers	33 kV Distribution Transformers
1.	System voltage (max.)	12 kV	36 kV
2.	Rated voltage HV	11 kV	33 kV
3.	Rated voltage LV	415-240 V	415-240 V
4.	Frequency	50 Hz +/- 5%	50 Hz +/- 5%
5	No. of Phases	Three	Three

6	Connection HV	Delta	Delta
7	Connection LV	Star (Neutral brought out)	Star (Neutral brought out)
8.	Vector group	Dyn-11	Dyn-11
9.	Type of cooling	ONAN	ONAN
10	LV Neutral Earthing	The Neutral point of the secondary (LV) winding shall be brought out in a separate insulated terminal and shall be solidly earthed.	The Neutral point of the secondary (LV) winding shall be brought out in a separate insulated terminal and shall be solidly earthed.

Audible sound levels (decibels) at rated voltage and frequency for liquid immersed distribution transformers shall be as per NEMA Standards.

6. Core Material

- 6.1 The core shall be of high grade cold rolled grain oriented annealed steel lamination having low loss and good grain properties, coated with hot oil proof insulation, bolted together and to the frames firmly to prevent vibration or noise. The core shall be stress relieved by annealing under inert atmosphere if required. The complete design of core must ensure permanency of the core loss with continuous working of the transformers. The maximum flux density in any part of the cores and yoke at **rated** voltage and frequency shall be such that the flux density with + **12.5% combined voltage and frequency variation** from the rated voltage and frequency shall not exceed 1.9 Tesla.
- 6.2 The bidder should offer the core for inspection and approval by the purchaser during manufacturing stage.
- 6.3 The transformers core shall be suitable for over fluxing (due to combined effect of voltage and frequency) up to 12.5% without injurious heating at full load conditions and shall not get saturated. The bidder shall furnish necessary design data in support of this situation.
- 6.4 No-load current shall not exceed **2%** of full load current and shall be measured by energising the transformer at 415 volts, 50 Hz on the secondary. Increase of voltage of 415 volts by 12.5% shall not increase the no-load current by **5%** (maximum) of full load current.

7. WINDINGS:

7.1 Material:

- 7.1.1 HV and LV windings shall be wound from Super Enamel covered / Double Paper covered copper conductor.
- 7.1.2 LV winding shall be such that neutral formation will be at top.
- 7.1.3 The winding construction of single HV coil wound over LV coil is preferable.
- 7.1.4 Inter layer insulation shall be Epoxy dotted/ Kraft Paper.

- 7.1.5 Proper bonding of inter layer insulation with the conductor shall be ensured. Test for bonding strength shall be conducted.
- 7.1.6 Dimensions of winding coils are very critical. Dimensional tolerances for winding coils shall be within limits as specified in Guaranteed Technical Particulars.
- 7.1.7 Current density for HV and LV winding should not be more than 2.5 Ampere per sq mm.
- 7.1.8 The core/coil assembly shall be securely held in position to avoid any movement under short circuit conditions.
- 7.1.9 Joints in the winding shall be avoided. However, if jointing is necessary the joints shall be properly brazed and the resistance of the joints shall be less than that of parent conductor

8. TAPS:

- 8.1.1 The standard tapping ranges shall be as follows:

Winding tapped: HV

No. of Tap positions: 5

Voltage variations: +5% to -5% in steps of 2.5% for variation of HV.

- 8.1.2 Tap changing shall be carried out by means of an externally operated self position switch and when the transformer is in de-energized condition. Switch position No.1 shall correspond to the maximum plus tapping. Each tap change shall result in variation of 2.5% in voltage. Provision shall be made for locking the tapping switch handle in position. Suitable aluminium anodized plate shall be fixed for tap changing switch to know the position number of tap.

9. OIL:

- 9.1 The insulating oil shall comply with the requirements of IS 335 / IEC 60296. Use of recycled oil is not acceptable. The specific resistance of the oil shall not be less than 2.5×10^{12} ohm-cm at 27 °C when tested as per IS 6103.
- 9.2 Oil shall be filtered and tested for break down voltage (BDV) and moisture content before filling. The dielectric strength and water content shall meet as under:

BDV (min in kV): Minimum **30kV (new unfiltered oil) / 70 kV (after treatment)**

Water content ppm (max): **05**

- 9.3 The oil shall be filled under vacuum.
- 9.4 The design and all materials and processes used in the manufacture of the transformer, shall be such as to reduce to a minimum the risk of the development of acidity in the oil.

10. INSULATION LEVELS:

Sl. No.	Voltage (kV)	Impulse Voltage (kV Peak)	Power Frequency Voltage (kV)	Usage
1	0.415	-	3	LV of transformer
2	11	75	28	HV of transformer for station usage
3	11 (Tertiary loading)	170	70	HV of transformer for tertiary loading of 220kV voltage class power transformers
4	33 (Tertiary loading)	250	95	HV of transformer for tertiary loading of 400kV voltage class auto transformers

11. Losses:

- 11.1 The bidder shall also guarantee the total losses at 50% and 100% load condition (at rated voltage and frequency and at 75 °C) as per IS-1180 part-01.
- 11.2 The maximum allowable losses at rated voltage and rated frequency permitted at 75°C for 11/0.415 kV transformers shall be as per **minimum Energy Efficiency Level-02** specified in IS 1180 (Part-1):2014 with latest amendment and up to date, for all kVA ratings of **11./0.415kV** distribution transformers.
- 11.3 For 33/0.415 kV transformers the permissible total loss values shall not exceed by 7.5% of the maximum total loss values mentioned in Table-06 of IS 1180 (Part-I):2014 with latest amendment and up to date revision.
- 11.4 Further providing of cooling tubes / fans to distribution transformer should be calculated (Bidder shall submit the calculation sheet during detailed engineering) to the Maximum losses as per **minimum energy Efficiency Level -2** as per IS 1180 (Part-I) with latest revision.

12. TOLERANCES:

- 12.1 No positive tolerance shall be allowed on the maximum losses displayed on the label for both 50% and 100% loading values.

13. PERCENTAGE IMPEDANCE:

The value of percentage impedance for various kVA ratings shall be as per IS-1180 (Part-I).

14. Temperature rise:

The temperature rise over ambient shall not exceed the limits given below when tested in accordance with IS 2026 (Part-2).

- 14.1 Top oil temperature rise measured by thermometer : 35°C

14.2 Winding temperature rise measured by resistance method: 40°C

14.3 The transformer shall be capable of giving continuous rated output without exceeding the specified temperature rise. Bidder shall submit the calculation sheet in this regard.

15. INSULATION MATERIAL:

15.1 Electrical grade insulation epoxy dotted/ Kraft Paper and pressboard of standard make shall be used.

15.2 All spacers, axial wedges / runners used in windings shall be made of pre-compressed Pressboard-solid, conforming to type B 3.1 of IEC 641-3-2. In case of cross-over coil winding of HV all spacers shall be properly sheared and dovetail punched to ensure proper locking. All axial wedges / runners shall be properly milled to dovetail shape so that they pass through the designed spacers freely. Insulation shearing, cutting, milling and punching operations shall be carried out in such a way, that there should not be any burr and dimensional variations.

16. TANK:

16.1 The internal clearance of tank shall be such, that it shall facilitate easy lifting of core with coils from the tank without dismantling LV bushings.

16.2 All joints of tank and fittings shall be oil tight and no bulging should occur during service.

16.3 Inside of tank shall be painted with varnish/hot oil resistant paint.

16.4 The top cover of the tank shall be slightly sloping to drain rain water.

16.5 The tank plate and the lifting lugs shall be of such strength that the complete transformer filled with oil may be lifted by means of lifting shackle.

16.6 Manufacturer should carry out all welding operations as per the relevant IS/IEC and submit a copy of the welding procedure and welder performance qualification certificates to the customer.

16.7 PLAIN TANK:

16.7.1 The transformer tank shall be of robust construction rectangular/octagonal/round/ elliptical in shape and shall be built up of electrically tested welded mild steel plates of thickness of 6 mm for bottom & top and 4 mm for sides . Tolerances as per IS1852 shall be applicable.

16.7.2 In case of rectangular tanks the corners shall be fully welded at the corners from inside and outside of the tank to withstand a pressure of 0.8 kg/cm² for 30 minutes.

16.7.3 Under operating conditions the pressure generated inside the tank should not exceed 0.4 kg/sq. cm positive or negative. There must be sufficient space from the core to the top cover to

take care of oil expansion. The space above oil level in the tank shall be filled with dry air or nitrogen conforming to commercial grade of IS 1747.

- 16.7.4 The tank shall be reinforced by welded flats on all the outside walls on the edge of the tank.
- 16.7.5 Permanent deflection: The permanent deflection, when the tank without oil is subjected to a vacuum of 525 mm of mercury for rectangular tank and 760 mm of mercury for round tank, shall not be more than as specified in relevant IS. The tank shall further be capable of withstanding a pressure of 0.8 kg/ sq.cm (g) and a vacuum of 0.7 kg/sq.cm (g) without any deformation.
- 16.7.6 The radiators can be tube type or fin type or pressed steel type to achieve the desired cooling to limit the specified temperature rise.

17. CONSERVATOR:

- 17.1 When a conservator is provided, oil gauge and the dehydrating breathing device shall be fitted to the conservator which shall also be provided with a drain plug and a filling hole [32 mm (1¼")] normal size thread with cover. In addition, the cover of the main tank shall be provided with an air release plug.
- 17.2 The dehydrating agent shall be silica gel. The moisture absorption shall be indicated by a change in the colour of the silica gel crystals which should be easily visible from a distance. Volume of breather shall be suitable for 1 kg of silica gel conforming to IS 3401 for transformers.
- 17.3 The capacity of a conservator tank shall be designed keeping in view the total quantity of oil and its contraction and expansion due to temperature variations. The total volume of conservator shall be such as to contain 10% quantity of the oil. Normally 3% quantity the oil shall be contained in the conservator.
- 17.4 The cover of main tank shall be provided with an air release plug to enable air trapped within to be released, unless the conservator is so located as to eliminate the possibility of air being trapped within the main tank.
- 17.5 The inside diameter of the pipe connecting the conservator to the main tank should be within 20 to 50 mm and it should be projected into the conservator so that its end is approximately 20 mm above the bottom of the conservator so as to create a sump for collection of impurities. The minimum oil level (corresponding to -5 °C) should be above the sump level.

18. SURFACE PREPARATION AND PAINTING:

18.1 GENERAL

- 18.1.1 All paints, when applied in a normal full coat, shall be free from runs, sags, wrinkles, patchiness, brush marks or other defects.
- 18.1.2 All primers shall be well marked into the surface, particularly in areas where painting is evident and the first priming coat shall be applied as soon as possible after cleaning. The

paint shall be applied by airless spray according to manufacturer's recommendations. However, where ever airless spray is not possible, conventional spray be used.

18.2 CLEANING AND SURFACE PREPARATION:

- 18.2.1 After all machining, forming and welding has been completed, all steel work surfaces shall be thoroughly cleaned of rust, scale, welding slag or spatter and other contamination prior to any painting.
- 18.2.2 Steel surfaces shall be prepared by shot blast cleaning (IS9954) to grade Sq. 2.5 of ISO 8501-1 or chemical cleaning including phosphating of the appropriate quality (IS 3618).
- 18.2.3 Chipping, scraping and steel wire brushing using manual or power driven tools cannot remove firmly adherent mill-scale. These methods shall only be used where blast cleaning is impractical.

18.3 PROTECTIVE COATING:

As soon as all items have been cleaned and within four hours of the subsequent drying, they shall be given suitable anti-corrosion protection.

18.4 PAINT MATERIAL:

- 18.4.1 Following are the types of paint which may be suitably used for the items to be painted at shop and supply of matching paint to site:

Heat resistant paint (Hot oil proof) for inside surface

- 18.4.2 For external surfaces one coat of thermo setting powder paint or one coat of epoxy primer followed by two coats of synthetic enamel/polyurethane base paint. These paints can be either air drying or stoving.
- 18.4.3 For highly polluted areas, chemical atmosphere or for places very near to the sea coast, paint as above with one coat of high build micaceous iron oxide (MIO) as an intermediate coat may be used.

18.5 PAINTING PROCEDURE:

- 18.5.1 All prepared steel surfaces should be primed before visible re-rusting occurs or within 4 hours, whichever is sooner. Chemical treated steel surfaces shall be primed as soon as the surface is dry and while the surface is still warm.
- 18.5.2 Where the quality of film is impaired by excess film thickness (wrinkling, mud cracking or general softness) the supplier shall remove the unsatisfactory paint coating and apply another coating. As a general rule, dry film thickness should not exceed the specified minimum dry film thickens by more than 25%.

18.6 DAMAGED PAINTWORK:

- 18.6.1 Any damage occurring to any part of a painting scheme shall be made good to the same standard of corrosion protection and appearance as that was originally applied.
- 18.6.2 Any damaged paint work shall be made good as follows:
- 18.6.2.1 The damaged area, together with an area extending 25 mm around its boundary, shall be cleaned down to bare metal.
- 18.6.2.2 A priming coat shall be immediately applied, followed by a full paint finish equal to that originally applied and extending 50 mm around the perimeter of the original damage.
- 18.6.2.3 The repainted surface shall present a smooth surface. This shall be obtained by carefully chamfering the paint edges before and after priming.

18.7 DRY FILM THICKNESS:

- 18.7.1 To the maximum extent practicable the coats shall be applied as a continuous film of uniform thickness and free of pores. Overspray, skips, runs, sags and drips should be avoided. The different coats may or may not be of the same color.
- 18.7.2 Each coat of paint shall be allowed to harden before the next is applied as per manufacturer's recommendation.
- 18.7.3 Particular attention must be paid to full film thickness at the edges.
- 18.7.4 The requirements for the dry film thickness (DFT) of paint and the materials to be used shall be as given below:

Sl.No.	Paint type	Area to be painted	No. of coats	Total dry film thickness(min.) (microns)
1.	Thermo setting powder paint	inside outside	01 01	30 60
2.	Liquid paint a)Epoxy (primer) b)P.U. Paint(Finish coat) c) Hot oil paint/ Varnish	outside outside inside	01 02 01	30 25 each 35/10

18.8 TESTS FOR PAINTED SURFACE:

- 18.8.1 The painted surface shall be tested for paint thickness.
- 18.8.2 The painted surface shall pass the cross hatch adhesion test and impact test as acceptance tests.

Note: Supplier shall guarantee the painting performance requirement for a period of not less than 5 years.

19. BUSHINGS:

19.1 The bushings shall conform to the relevant standards specified and shall be of outdoor type. The bushing rods and nuts shall be made of brass material 12 mm diameter for both HT and LT bushings. The bushings shall be fixed to the transformers on side with straight pockets and in the same plane or the top cover. The tests as per latest IS 2099 and IS 7421 shall be conducted on the transformer bushings.

19.2 For 33kV 52kV class bushings, for 11 kV, 17.5 kV class bushings and for 0.415 kV, 1.1 kV class bushings shall be used. Creepage distance shall be 31mm/kV for each type.

19.3 Bushing can be of porcelain/epoxy material. Polymer insulator bushings conforming with relevant IEC can also be used.

19.4 Bushings of plain shades as per IS 3347 shall be mounted on the side of the Tank and not on top cover.

19.5 Dimensions of the bushings of the voltage class shall conform to the Standards specified and dimension of clamping arrangement shall be as per IS 4257.

19.6 Minimum external phase to phase and phase to earth clearances of bushing terminals shall be as under:

as under:					
Voltage(kV)	Medium	Clearance for phase to phase(mm)terminal chamber open closed		Clearance for phase to earth(mm) terminal chamber open closed	
For 11/0.415kV transformer					
0.415	Air	40	25	40	20
11	Air	255	127	140	76
For 33/0.415kV transformer					
0.415	Air	75	45	40	20
33	Air	530	---	480	---

19.7 Arcing horns shall be provided on HV bushings.

19.8 Brazing of all inter connections, jumpers from winding to bushing shall have cross section larger than the winding conductor. All the Brazes shall be qualified as per relevant standard.

19.9 The bushings shall be of reputed make supplied by those manufacturers who are having manufacturing and testing facilities for insulators.

- 19.10 The terminal arrangement shall not require a separate oil chamber not connected to oil in the main tank.

20. TERMINAL CONNECTORS:

The LV and HV bushing stems shall be provided with suitable terminal connectors as per IS 5082 so as to connect the jumper without disturbing the bushing stem. Connectors shall be with eye bolts so as to receive conductor for HV. Terminal connectors to be supplied should have been type tested as per IS 5561.

21. CABLE BOXES

In case HV/LV terminations are to be made through cables the transformer shall be fitted with suitable cable box on 33 or 11 kV side (As applicable as per scope) to terminate cable of suitable size as per the requirement.

The bidder shall ensure the arrangement of HT Cable box so as to prevent the ingress of moisture into the box due to rain water directly falling on the box. The cable box on HT side shall be of the split type with faces plain and machined and fitted with Neo-k-Tex or similar quality gasket and complete with brass wiping gland to be mounted on separate split type gland plate with nut-bolt arrangement and MS earthing clamp. The bushings of the cable box shall be fitted with nuts and stem to take the cable cores without bending them. The stem shall be of copper with copper nuts. The cross section of the connecting rods shall be stated and shall be adequate for carrying the rated currents. On the HV side the terminal rod shall have a diameter of not less than 12 mm. The material of connecting rod shall be copper. HT Cable support clamp should be provided to avoid tension due to cable weight.

The transformer shall be fitted with suitable LV cable box having non-magnetic material gland plate with appropriate sized single compression brass glands on LV side to terminate 1.1 kV/single core XLPE armoured cable (Size as per requirement).

22. TERMINAL MARKINGS:

High voltage phase windings shall be marked both in the terminal boards inside the tank and on the outside with capital letter 1U, 1V, 1W and low voltage winding for the same phase marked by corresponding small letter 2u, 2v, 2w. The neutral point terminal shall be indicated by the letter 2n. Neutral terminal is to be brought out and connected to local grounding terminal by an earthing strip.

23. FITTINGS:

The following standard fittings shall be provided:

- i. Rating and terminal marking plates, non-detachable.

- ii. Earthing terminals with lugs - 2 Nos.
- iii. Lifting lugs for main tank and top cover
- iv. Terminal connectors on the HV/LV bushings (For bare terminations only).
- v. Thermometer pocket with cap - 1 No.
- vi. Air release device
- vii. HV bushings - 3 Nos and 1 no spare
- viii. LV bushings - 4 Nos and 1 no spare
- ix. Pulling lugs
- x. Stiffener
- xi. Radiators - No. and length may be mentioned (as per heat dissipation calculations)/ corrugations.
- xii. Arcing horns - 3 No.
- xiii. Prismatic oil level gauge.
- xiv. Drain cum sampling valve.
- xv. Top filter valve
- xvi. Oil filling hole having p. 1- ¼" thread with plug and drain plug on the conservator.
- xvii. Silicagel breather
- xviii. Base channel 100 mmx50 mm, 460 mm long with holes to make them suitable for fixing on a platform or plinth.
- xix. 4 No. rollers.
- xx. Pressure relief device or explosion vent.

24. FASTENERS:

- 24.1 All bolts, studs, screw threads, pipe threads, bolt heads and nuts shall comply with the appropriate Indian Standards for metric threads, or the technical equivalent.
- 24.2 Bolts or studs shall not be less than 6 mm in diameter except when used for small wiring terminals.
- 24.3 All nuts and pins shall be adequately locked.
- 24.4 Wherever possible bolts shall be fitted in such a manner that in the event of failure of locking resulting in the nuts working loose and falling off, the bolt will remain in position.
- 24.5 All ferrous bolts, nuts and washers placed in outdoor positions shall be treated to prevent corrosion, by hot dip galvanizing, except high tensile steel bolts and spring washers which shall be electro-galvanized/plated. Appropriate precautions shall be taken to prevent electrolytic action between dissimilar metals.

- 24.6 Each bolt or stud shall project at least one thread but not more than three threads through the nut, except when otherwise approved for terminal board studs or relay stems. If bolts and nuts are placed so that they are inaccessible by means of ordinary spanners, special spanners shall be provided.
- 24.7 The length of the screwed portion of the bolts shall be such that no screw thread may form part of a shear plane between members.
- 24.8 Taper washers shall be provided where necessary.
- 24.9 Protective washers of suitable material shall be provided front and back of the securing screws.

25. OVERLOAD CAPACITY:

The transformers shall be suitable for loading as per IS 6600.

26. TESTS:

The design of transformer should have been fully type tested by the bidder as per the relevant standards including the additional type and special tests as mentioned below. The type test must have been conducted on a transformer of similar design* (of same BIL) as per relevant standards with validity of tests as per CEA guidelines. The bidder shall submit the tests reports for review.

In case, the design of offered transformer is not type tested, the bidder will conduct the type test as per the relevant standards including the additional type and special tests, as detailed below, at his own cost in CPRI/ NABL accredited laboratory in the presence of employer's representative(s) without any financial liability to employer in the event of order placed on him.

**Definition of similar transformer as per relevant IS/IEC*

26.1 Type Tests:

- 26.1.1 Lightning Impulse test (IS-2026 (Pat-3)).
- 26.1.2 Temperature rise test (IS-2026 (Pat-2)).
- 26.1.3 Pressure Test

26.2 Additional / Special Type tests:

- 26.2.1 Determination of sound levels. (IS-2026 (Pat-10)).
- 26.2.2 Short circuit withstand test (IS-2026 (Pat-2)).
- 26.2.3 Measurement of zero phase sequence impedance.
- 26.2.4 Measurement of harmonics of no load current.
- 26.2.5 No load current at 112.5% voltage.

26.2.6 Unbalanced current test.

26.3 Routine Tests:

26.3.1 Ratio, polarity, phase sequence and vector group.

26.3.2 No Load current and losses at service voltage and normal frequency.

26.3.3 Load losses at rated current and normal frequency.

26.3.4 Impedance voltage test.

26.3.5 Resistance of windings at each tap, cold (at or near the test bed temperature).

26.3.6 Insulation Resistance.

26.3.7 Induced over voltage withstand test.

26.3.8 Separate source voltage withstand test.

26.3.9 Neutral current measurement-The value of zero sequence current in the neutral of the star winding shall not be more than 2% of the full load current.

26.3.10 Measurement of no load losses and magnetizing current at rated frequency and 90%, 100% and 110% rated voltage.

26.3.11 Pressure and vacuum test for checking the deflection.

26.3.12 Measurement of short circuit impedance.

26.3.13 Oil leakage test.

26.4 Before dispatch each of the completely assembled transformers shall be subjected to the routine tests at the manufacturer's works.

GUARANTEED AND OTHER PARTICULARS FOR DISTRIBUTION TRANSFORMERS

(To be furnished by the Manufacturer)

Sl. No. Description

1. Make
2. Name of Manufacturer
3. Place of Manufacture
4. Voltage Ratio
5. Rating in kVA
6. Short circuit level (In kA):
7. Core Material used and Grade:
 - a) Flux density
 - b) Over fluxing without saturation
(Curve to be furnished by the Manufacturer in support of his claim)
8. Maximum temperature rise of:
 - a) Windings by resistance method
 - b) Oil by thermometer
9. Magnetizing (no-load) current at:
 - a) 90% Voltage
 - b) 100% voltage
 - c) 110% Voltage
10. Energy Efficiency level as per IS-1180:
11. Core loss in watts:
 - a) Normal voltage
 - b) Maximum voltage
12. Resistance of windings at 20 C
(with 5% tolerance):
 - a. HV Winding (ohms)
 - b. LV Winding (ohms)
13. Full load losses (watts) at 75 deg C
14. Total Losses at 100% load at 75 deg C
15. Total Losses at 50% load at 75 deg C
16. Current density used for : (Ampere/sq mm)
 - a) HV Winding
 - b) LV Winding
17. Clearances : (mm)
 - a) Core and LV
 - b) LV and HV
 - c) HV phase to phase
 - d) End insulation clearance to earth
 - e) Any point of winding to tank
18. Efficiency at 75 deg C:
 - a) Unity P.F. and

- b) 0.8 P.F.
 - 1) 125% load
 - 2) 100% load
 - 3) 75% load
 - 4) 50% load
 - 5) 25% load
- 19. Regulation at:
 - a) Unity P.F.
 - b) 0.8 P.F. at 75 deg C
- 20. % Impedance at 75 deg C
- 21. Power frequency withstand voltage test:
 - i) HV winding (kV) for 1 minute
 - ii) LV winding (kV) for 1 minute
- 22. Over potential Test (Double Voltage and Double frequency for 1 minute)
- 23. Impulse test
- 24. Mass of :(kg)
 - a) Core lamination (minimum)
 - b) Winding (minimum)
 - c) Tank and fittings
 - d) Oil
 - e) Oil quantity (minimum) (litre)
 - f) Total weight
- 25. Oil Data:
 - 1. Quantity for first filling (minimum) (litre)
 - 2. Grade of oil used
 - 3. Maker's Name
 - 4. BDV at the time of filling (kV)
- 26. Transformer:
 - 1) Overall length x breadth x height (mm x mm x mm)
 - 2) Tank length x breadth x height
 - 3) Thickness of plates for
 - a) Side plate (min)
 - b) Top and bottom plate (min)
 - 4) Conservator Dimensions
- 25. Radiation:
 - 1. Heat dissipation by tank walls excluding top and bottom
 - 2. Heat dissipation by cooling tune
 - 3. Diameter and thickness of cooling tube
 - 4. Whether calculation sheet for selecting cooling

Area to ensure that the transformer is capable of giving continuous rated output without Exceeding temperature rise is enclosed.

26. Inter layer insulation provided in design for:
- 1) Top and bottom layer
 2. In between all layer
 - 3) Details of end insulation
 - 4) Whether wedges are provided at 50% turns of the HV coil
27. Insulation materials provided
- a) For Conductors
 - 1) HV
 - 2) LV
 - b) For Core
28. Material and size of the wire used
1. HV Dia (mm) (SWF)
 2. LV a) strip size
 - b) No. of Conductors in parallel
 - c) Total area of cross section (sq mm)
29. Whether the name plate gives all particulars as required in Tender
30. Particulars of bushings HV/LV
- 1) Maker's name
 - 2) Type IS-3347/IS-2099/S7421
 - 3) Rating as per IS
 - 4) Dry power frequency voltage withstands test (As applicable)
 - 5) Wet power frequency voltage withstand test (As applicable)

SECTION-X

DIESEL GENERATOR SET

Technical Specifications of 250/125kVA Generator set

1.0 TECHNICAL REQUIREMENTS

- 1.1 Capacity of Gen set to be taken as 250kVA or 125kVA as per requirement of scope/scheme.
- 1.2 The Alternator shall be self excited and self regulated of 250/125 kVA rating in three phase at 415 Volt, 50 Hz, 1500 RPM and shall conform to latest edition of IS: 13364 (Part 2). The alternators shall be of brush less type only with VG-3 grade of voltage regulation. The alternators shall be screen-protected drip proof with Min.IP-23 degree of protection as per IS: 4691/85.
- 1.3 The GEN set shall be with a nominal rating of 250/125kVA, 1500RPM, 0.8 PF, 415V, 3 phase, 50Hz with class A-2 Governing or better for alternator to deliver specified continuous KVA output. The diesel engine shall conform to BS ISO 3046/ ISI marking IS: 10002 and its latest amendments.
- 1.4 GEN sets shall also be rated for 110% of full load for (01) hour in every 12 hours of continuous running.
- 1.5 The output voltage, frequency and limits of variation from open circuit to full load shall be as follows :
 - a)Voltage variation $\pm 5\%$ of the set value. Provision shall exist to set adjust the value between 90% to 110% of nominal Generator voltage of 415V.
 - b)Frequency 50Hz $\pm 3\%$
 - c) Waveform Distortion As per IS:13364 (Part-2)
 - d) Harmonic Distortion As per IS:13364 (Part-2)
- 1.6 The Generator and other auxiliary motor shall be of H class with temp rise limited to class-F for temperature rise consideration.
- 1.7 The day tank shall be provided on a suitable fabricated steel platform. The tank shall be complete with level indicator marked in liters, filling inlet with removable screen, an outlet, a drain plug, an air vent, an air breather and necessary piping. The tank shall be

painted with oil resistant paint and shall be erected in accordance with Indian explosive act of 1932.

- 1.8 Six (6) output terminals shall be provided in alternator box. The neutral shall be formed in AMF panel. The generator terminal box shall be suitable to house necessary cables and should be made of non-magnetic material.
- 1.9 Engine instrument Panel consisting of starting switch with Key, Lube Oil temperature and water temperature gauge in case of water cooled engines and RPM indicator and hour meter.
- 1.10 Safety controls to shut down the engine in the event of high water temperature in case of water-cooled engines.
- 1.11 For transferring oil to Day tank transfer pumps are envisaged. The capacity of transfer pump shall be adequate to fill the day tank in about 30 minutes.
- 1.12 The Gen set shall preferably follow emissions norms and limits as per latest MoEFCC and CPCB directives and guidelines applicable for Delhi & NCR region. Alternatively the GEN set shall be dual fuel system (70% gas and 30% diesel) and fitted with an emission control device/equipment having a minimum specified particulate matter capturing efficiency as per CPCB guidelines. The emission control device/equipment must have been tested for equivalent KVA rating at any of the CPCB approved laboratories. Testing certificate to be submitted by bidder.
- 1.13 Earthing: The Generator Set is to be utilized in 400/220kV grid substations of DTL. As such suitable earthing shall be provided at all locations in the set and must be finally connected to the earth mat of the grid.

2.0 SYSTEM DESIGN:

- 2.1 Suction of air can be from indoor or outdoor as per site requirement and exhaust will be let out to outside atmosphere, Condensate traps shall be provided on the exhaust pipe.
- 2.2 The fuel used shall be:
 - a. High Speed Diesel Oil (HSD)/ Light Diesel Oil (LDO) suitable for new engines in line with emission norms as prescribed in latest MoEFCC and CPCB directives and guidelines.

OR

- b. Dual fuel {PNG and High Speed Diesel Oil (HSD)/ Light Diesel Oil (LDO)} with ECD as per norms.

OR

- c. PNG as per applicable Indian Standard

- 2.3 The Engines shall be directly water/liquid cooled. Cooling of water through radiator and fan as envisaged.
- 2.4 The engine shall have closed loop lubricating system. No moving parts shall require lubrication by hand prior to the start of engine or while it is in operation.

3.0 PLANT DESIGN

- 3.1 The equipment shall be safe and proper and without undue vibration or stores for continuous operation at all loads up to rated output at operating and test conditions.
- 3.2 The equipment shall have provision for easy maintenance, overhaul, cleaning and inspection and replacement of parts. All tools for operation and maintenance of equipment shall be supplied.
- 3.3 Engine shall be turbo charged multi-cylinder V-type/ in line type with mechanical/electronic fuel injection system as applicable.
- 3.4 Automatic electric starting by DC starter motor shall be provided. The batteries with automatic battery charger shall be provided. Each battery shall have sufficient capacity to give 10 nos. successive starting impulse to the diesel engine.

4.0 CONTROL AND INSTRUMENTATION

- 4.1 Each Gen Set shall be provided with suitable instruments, interlock and protection arrangement, suitable annunciation and indications etc. for proper start up, control, monitoring and safe operation of the unit. One local automatic failure (AMF) control panel along with each Gen set shall be provided by the Supplier to accommodate these instruments, protective relays, indication lamps etc. The AMF Panel shall have IP-55 degree of Protection as per IS: 12063.

- 4.2 The Gen sets shall be provided with automatic start facility to make it possible to take full load within 30 seconds of Power Supply failure.
- 4.3 Testing facility for automatic operation of Gen Set shall be provided in AMF panel.
- 4.4 A three attempt starting facility using two impulse timers and summation timer for engine shall be provided and if the voltage fails to develop within 40 sec. from receiving the first impulse, the set shall block and alarm to this effect shall be provided in the AMF panel.
- 4.5 Following instruments shall be provided with the Engine.
- a) Lube. oil Pressure gauge (engine panel).
 - b) Lube. oil temperature thermometers (both on engine and at local panel)
 - c) Water temperature thermometers (both on engine and at local panel)
 - d) Exhaust gas pyrometer with temp, switch (at local panel)
 - e) Engine tachometer and HR meter (engine panel)
 - f) Any other instruments necessary for GEN Set operation shall be provided
- 4.6 GEN set shall be capable of being started/ stopped manually from remote as well as local. (Remote START/STOP push button shall be provided in 415V ACDB). However, interlock shall be provided to prevent shutting down operation as long as generator Circuit breaker is closed.
- 4.7 The generator shall commence a shutdown sequence whenever any of the following conditions appear in the system :
- a) Over speed
 - b) Over load
 - c) High temperature of engine and cooling water.
 - d) High temperature inside enclosure
 - e) Low lube oil pressure
 - f) Generator differential protection
 - g) Short circuit protection
 - h) Under voltage
 - i) Over voltage
 - j) Further interlocking of breaker shall be provided to prevent parallel operation of GEN set with normal station supply.
- 4.8 A suitable battery charger using semi-conductor rectifier shall be provided for quick and trickle charging the battery. AMF panel shall consist of complete battery charging scheme suitable for 24V/12V DC, 25 A operation. Battery charger shall have input

switch, transformer, Rectifier unit, choke, control fuses, necessary filters and suitable characteristic for charging the battery and keeping it in fully charged state. The charger shall be provided with suitable DC voltmeter, Ammeter and output voltage control facility mounted on the control cubicle and shall be suitable for connection to single phase 240V Ac supply with $\pm 10\%$ voltage variation.

- 4.9 Following indication lamps for purposes mentioned as under shall be provided in AMF panel.

Pilot indicating lamp for the following:

- a) Mains ON
- b) Alternator ON
- c) Charger ON/OFF
- d) Breaker ON/OFF
- e) Main LT Supply ON/OFF

- 4.10 Visual annunciation shall be provided for set shut down due to :

- a) engine overheating
- b) low oil pressure
- c) lack of fuel
- d) Set failed to start in 40 sec. after receiving the first start impulse
- e) high cooling water temperature
- f) Low level in daily service fuel tank
- g) Over speed trip
- h) Audio & visual Annunciation for alternator fault.

- 4.11 Thermostatically controlled space heaters and cubicle illumination operated by Door Switch shall be provided in AMF panel. Necessary isolating switches and fuses shall also be provided.

- 4.12 Automatic mains failure (AMF) control panel shall be able to start up the GEN set and transfer the loads on to the GEN sets on mains failure without requiring any human intervention. Similarly on restoration of mains supply it shall be able to transfer the load to mains supply and switch off the GEN set automatically. The AMF Control Panel shall have the following instruments:

Microprocessor based relay with composite meter for digital display of:

- a) Generator voltage/AC Mains voltage.
- b) Generator Current.
- c) Load Current.
- d) Power Factor.

- e) Frequency
- f) Energy
- g) Three attempts engine start / engine cranking relay.
- h) On -delay timer for load change over
- i) On-delay timer for engine shut off

4.13 AMF panel shall have facility for adjustment of speed and voltage including fine adjustments in remote as well as in local mode. Following shall also be provided in AMF panel:

- a) Frequency meter
- b) 3 Nos. single phase CT's for metering
- c) 3 Nos. (Provided by LT switchgear manufacturer) single phase CT's with KPV 300V & RCT 0.25 ohm for differential protection of GEN Set on neutral side.
- d) One (1) DC Ammeter (0-40A)
- e) One (1) DC Voltmeter (0-30V)
- f) One (1) Voltmeter Selector switch
- g) One (1) AC Ammeter
- h) One (1) AC Voltmeter
- i) Three (3) Timers (24V/12 V DC)
- j) Two (2) Auto/Manual Selector Switch
- k) Two (2) Auto/test/Manual Selector Switch
- l) Eleven (11) Aux. Contactors suitable for 24V/12V DC
- m) One (1) Motorized potentiometer for voltage adjustment
- n) Two (2) Set Battery charger as specified in Technical Specification
- o) One (1) Set Phase & Neutral bus bar.
- p) MCCB.
- q) Under voltage relay for mains.
- r) Two contractors of suitable ratings (one for GEN set & one for AC Mains) with over load relay.
- s) Any other item required for completion of Control scheme shall be deemed to be included.

5.0 Gen. SET Enclosure

5.1. General requirements

5.1.1. Engine, alternator, automatic failure (AMF) panel, Batteries and Chargers shall be installed in GEN set room, nearer to control room or as per site requirement. Further, acoustic enclosures shall also be provided such that the noise level of acoustic enclosure / GEN set shall meet the requirement of Ministry of environment & Forest (MOEF). The generator sets should also conform to Environment (Protection) Rules, 1986 as amended.

An exhaust fan with louvers shall be installed in the enclosure for temperature control inside the enclosure. The enclosure shall allow sufficient ventilation to the enclosed Set so that the body temperature is limit to 50°C. The air flow of the exhaust fan shall be from inside to the outside the shelter. The exhaust fan shall be powered from the GEN set supply output so that it starts with the starting of the GEN set and stops with the stopping of the GEN set. The enclosure shall have suitable viewing glass to view the local parameters on the engine.

- 5.1.2. Fresh air intake for the Engine shall be available abundantly; without making the Engine to gasp for air intake. A chicken mess shall be provided for air - inlet at suitable location in enclosure, which shall be finalized during detailed engineering.
- 5.1.3. The Enclosure shall be designed and the layout of the equipment inside it shall be such that there is easy access to all the serviceable parts.
- 5.1.4. Engine and Alternator used inside the Enclosure shall carry their manufacturer's Warranty for their respective Models and this shall not degrade their performance.
- 5.1.5. Exhaust from the Engine shall be let off through Silencer arrangement to keep the noise level within desired limits. Interconnection between silencer and engine should be through stainless steel flexible hose/ pipe.
- 5.1.6. All the Controls for Operation of the Set shall be easily assessable. There should be provision for emergency shutdown from outside the enclosure.
- 5.1.7 Arrangement shall be made for housing the Battery set in a tray inside the Enclosure.
- 5.1.8 Noise level: As per relevant guidelines. The bidder shall submit documentary evidence in support of the appropriate noise level limit.

5.2 Construction Features:

- 5.2.1. The enclosure shall be fabricated from at least 1.6 mm CRCA sheet steel and of Modular construction for easy assembling and dismantling. The sheet metal components shall be pre-treated by Seven Tank Process and Powder coated (PURO Polyester based) both-in side and outside – for long life. The hard-ware and accessories shall be high tensile grade. Enclosure shall be given a lasting anti-rust treatment and finished with pleasant environment friendly paint. All the hardware and fixtures shall be rust proof and able to withstand the weather conditions.
- 5.2.2. Doors shall be large sized for easy access and provided with long lasting gasket to make the enclosure sound proof. All the door handles shall be lockable type.
- 5.2.3. The Enclosure shall be provided with anti-vibration pads (suitable for the loads and vibration they are required to carry) with minimum vibration transmitted to the surface the set is resting on.

5.2.4. High quality rock wool of required density and thickness shall be used with fire retardant thermo – setting resin to make the Enclosure sound proof.

5.2.5. Provision for Neutral/Body Earthing

5.2.6. Points shall be available at two side of the enclosure with the help of flexible copper wires from alternator neutral, and electrical panel body respectively. The Earthing point shall be isolated through insulator mounted on enclosure.

6.0 ENVIRONMENTAL CONDITIONS

6.1 GEN sets shall meet the requirement of guidelines from MoEFCC and CPCB, Environmental (Protection) Rules 1986 as laid down by Min. of Environment & Forests read with GSR 371 (E) dated 17.5.2002 and its latest amendments in respect of noise and emission norms.

6.2 Site Conditions:

6.2.1 Ambient Temperature: The ambient temperature may vary from zero (0) degree Celsius in winters to Fifty (50) degree Celsius during peak summer season.

6.2.2 Altitude: Altitude above sea level will vary from 200m to 300m.

6.2.3 Humidity: The relative humidity may go up to 100%.

6.2.4 Air quality: Heavily Polluted. The air quality index of NCT of Delhi is to be taken in line with official records of CPCB, Ministry of Environment Forests and climate change

7.0 TESTS

7.1. The generator sets shall be tested for routine and acceptance tests as per the latest edition of relevant standards.

7.2. Type Tests: The bidder shall submit all the applicable type test reports of the equipment in line with latest edition of IS/IEC and validity of the type test reports shall be as per latest CEA guidelines, as applicable. The type test reports shall be submitted along with the bid. If any applicable type test has not been conducted by the bidder, then the same shall be conducted by the bidder free of cost and without affecting the completion period of the project/tender.

7.3. Supplier shall furnish copy of Type approval certificate from an Authorized agency for emission norms for each model of engine and noise level norms for each model of GEN Set with tender as well pre-dispatch inspection.

8.0 Diesel Generator set of stationary type having a net nominal electrical output of 250/125 kVA capacity at specified site conditions as per clause 06 of the specifications FOR site basis. De-rating shall be allowed as per relevant IS/ISO/IEC. GEN set shall be equipped with:

- (i) Engine complete with all accessories.
- (ii) An alternator directly coupled to the engine through coupling, complete with all accessories.
- (iii) Automatic voltage regulator.
- (iv) Complete starting arrangement, including two nos. batteries & chargers.
- (v) Base frame, foundation bolts etc.
- (vi) Fuel tank with capacity for 12 hours continuous running at full load.
- (vii) Oil pump for transferring to Day Tank.
- (viii) Engine Cooling and lubrication system.
- (ix) Engine air filtering system.
- (x) Exhaust silencer package.
- (xi) Set of GI pipes, valves, strainers, unloading hose pipes as required.
- (xii) All lubricants, consumable, touch up paints etc. for first filing, testing & commissioning at site.
- (xiii) The fuel oil for first commissioning will also be provided by the contractor.
- (xiii) AMF panel for control, metering and alarm.
- (xiv) Acoustic enclosure

GURANTEED TECHNICAL PARTICULARS FOR GEN SET

1.0 General

- 1.1 Contract's Name & Address
- 1.2 Manufacturer's, type and address

- a. Engine.
- b. Alternator
- c. Exciter
- d. Battery

2.0 Engine

- 2.1 Rating
- 2.2 Revolutions per min.
- 2.3 Number and arrangement of cylinder.
- 2.4 No. of strokes.
- 2.5 Method of starting.
- 2.6 Time required for starting
- 2.7 Auxiliary Power consumption
- 2.8 Type of Governor
- 2.9 Sensitivity of Governor
- 2.10 Guaranteed limits of Governing
 - a. Permanent variation
 - b. Full Load thrown off
 - c. Full load put on.
- 2.11 Total speed variation
- 2.12 Specification of fuel oil.
- 2.13 Specification of Lube oil
- 2.14 Guaranteed fuel consumption
 - a) At full load

- b) At 3/4 load
 - c) At 1/2 load
 - d) At 1/4 load
- 2.15 Lub.oil consumption
- 2.16 Mechanical efficiency
- 2.17 Thermal efficiency
- 2.18 Method of aspiration
- 2.19 Method of cooling of engine and lub. oil.
- 2.20 Amount of water required for cooling system.
- 2.21 Total weight.
- 2.22 Space requirement including clearances
- 2.23 Maker's name, type and technical literature for the following:
- a. Air filter & silencer.
 - b. Thermometer.
 - c. Pressure Gauges.
 - d. Level indicator
 - e. Tachometer.
 - f. Fuel oil pump
- 2.24 Mechanical auxiliaries loads connected on Radiator fans Main shaft with wiring.
- 2.25 Rated engine power and the ambient conditions at which rated power is defined.
- 2.26 Direction of rotation.
- 3.0 Storage Tank. (Outside)**
- a. Type and shade.
 - b. Capacity
 - c. Number Specifies.
 - d. Material of construction
 - e. Overall dimensions
 - f. Plate thickness
 - g. Installation paint.

4.0 Alternator

- 4.1 Rated K.W capacity.
- 4.2 Rated KVA capacity.
- 4.3 Rated Terminal Voltage.
- 4.4 Rated Power Factor
- 4.5 Rated Stator Current
- 4.6 Rated Speed.
- 4.7 Rated Frequency
- 4.8 No. of phases/ Terminals brought outside
- 4.9 Excitation current and voltage at rated 3 Amp DC power output and power factor
- 4.10 Efficiencies at 0.8 power factor at
 - a. 100% load.
 - b. 75% load.
 - c. 50% load.
 - d. 25% load.
- 4.11 Inherent regulation (%)
- 4.12 Impedance
 - a) X_a dir axis synchronous
 - b) $X'd$ dir axis transient
 - c) X^n dir axis sub transient
 - d) X_q quad axis reactance
 - e) X_q^n quad axis sub transient
- 4.13 Type of exciter used; capacity & rating of exciter
- 4.14 Class of Insulation.
- 4.15 Permissible Temp. Rise of.
 - a. Armature winding.
 - b. Field winding.
 - c. Bearing
- 4.16 Short circuit ratio
- 4.17 Rotor air gap
- 4.18 Overload capacity
- 4.19 Insulation level test voltage
- 4.20 Total weight & dimensions.

- 4.21 Applicable standard.
- 4.22 Automotive voltage regulator type, technical specifications and characteristics curves.
- 4.23 Electrical auxiliaries load connected to generator terminals with rating.

5.0 Engine Alternator Set

- 5.1 Starting time.
- 5.2 Interval between starting impulse
- 5.3 No. of starting impulse.
- 5.4 Time for picking up the load.
- 5.5 Voltage variation
- 5.6 Frequency variation
- 5.7 Duration of continuous full load operation.
- 5.8 Noise level.

6.0 Battery.

- 6.1 Type
- 6.2 Name of manufacturer and address
- 6.3 No. of Cells
- 6.4 Capacity in AH
- 6.5 Capacity current of
 - a) Full charged battery.
 - b) Fully discharged battery.
- 6.6 Average life in years.
- 6.7 Applicable standard.
- 6.8 Weight of the battery.

SECTION-XI

SWITCHYARD

SECTION: XI

SWITCHYARD ERECTION

1.0. GENERAL

The detailed scope of work includes design, engineering, manufacture, testing at works, supply on FOR destination site basis, insurance, handling, storage, erection testing and commissioning of various items and works as detailed herein.

This section covers the description of the following item

A. Supply of

- String insulators and hardware
- ACSR conductor
- Galvanized Steel Earth wire
- Aluminum Tubular Bus Bars
- Spacers
- Bus post insulators
- Earthing & Earthing materials
- Lightning protection materials
- Cabling material
- Other items

B. Erection of all items

1.1. String Insulator & hardware

The insulators for suspension and tension string shall conform to IEC60383 and long rod insulators shall conform to IEC 60433. Insulator hardware shall conform to IS: 2486.

1.1.1. Construction Features

- 1.1.1.1 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 markings on porcelain printed and applied before firing.
- 1.1.1.2 Porcelain used in insulator manufacture 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
- 1.1.1.3. Glazing of the porcelain shall be uniform brown colour, free from blisters, burrs and other similar defects
- 1.1.1.4. When operating at normal rated voltage there shall be no electric discharge between conductor and insulator which would cause corrosion or injury to conductors or insulators by the formation of substances due to chemical action. No radio interference shall be caused when operating at normal rated voltage.
- 1.1.1.5. 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 part 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.

- 1.1.1.6. Bidder 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 insulators, 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.
- 1.1.1.7. Clamps for insulator strings and Corona Control rings shall be of aluminum alloy as stipulated for clamps and connectors
- 1.1.1.8. 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
- 1.1.1.9. The tension Insulator hardware assembly shall be designed for 11500 kg tensile load. Earth wire tension clamp shall be designed for 1000 kg tensile load with a factor of safety of two (2).
- 1.1.1.10 The tension string assemblies shall be supplied along with suitable turn Buckle. Sag compensation springs if required may also be provided.
- 1.1.1.11 All hardware shall be bolted type.

1.2. Long Rod Insulators

- 1.2.1 As an alternative to disc insulator, Bidder can offer long rod insulators strings, with suitable hardware. The combination should be suitable for application specified and should offer the identical / equivalent parameters as would be available from insulator string comprising disc insulators and hardware combination.
- 1.2.2. All constructional features specified at Clause 1.1.1 of this Section shall also apply to the long rod insulator string.

1.3. Tests

In accordance with the stipulations of the specification, the suspension and tension strings, insulator and hardware shall be subjected to the type tests, acceptance tests and routine tests as per relevant standards.

1.4. Parameters

- 1.4.1. Disc Insulators 220KV
 - a) Type of Insulators Anti Fog type
 - b) Size of insulator units (mm) 255x145
 - c) Electro mechanical strength 120 KN
 - d) Creepage distance of individual insulator 430 mm
units (min. and as
required to meet total
Creepage distance)
 - e) Markings Marking on porcelain shall be printed and applied before firing
1.3 times the actual wet flashover voltage.
- * Long rod insulators may be used in place of disc insulators subject to
confirmation to equivalent electrical and mechanical parameter.

1.4.2

INSULATOR STRING

S.No.	Description	220 kV
A	Power frequency withstand voltage of the complete string with corona control ring (wet)	460
B	Lightning impulse withstand voltage of string with corona control ring (dry) – kVp	1050
C	Switching surge withstand voltage of string with corona control rings (wet)kVp.	NA
D	Min. corona extinction voltage level of string with corona control rings (dry)- kV rms.	156
E	RIV level in micro volts of string with corona control rings at 156 KV (rms) for 220 KV string across 300 Oh resistor at 1 MHz	1000 (Max.)
F	Total creepage distance of the insulator string (mm)	6125
G	Total no. discs per strings	15

For tension application, double insulator strings and for suspension purpose single suspension insulator string shall be used for 220 KV system.

2.0 ACSR ZEBRA CONDUCTOR

2.1 Details of conductor

2.1.1 The Conductor shall confirm to IS 398: 1982 except where otherwise specified herein.

2.1.2 The details of the conductor are tabulated below:

a) Stranding and wire diameter	54/3.18 mm Al +7/3.18 mm steel
b) No. of strands	
Steel	7
Aluminium Layer	54
c) Sectional area of Al.	418.6 mm ²
d) Total sectional area	483.1 mm ²
e) Overall diameter	28.62mm
f) Approx. wt.	1621kg/km.
g) Calculated d.c. resistance at 20 C	0.0680 Oh/km
h) Approximate calculated breaking load	13316 Kg.

Workmanship

2.2.1 The finished conductor shall be smooth, compact, uniform and free from all imperfections including spills and splits, die marks, scratches, abrasions, scuff marks, kinks (protrusion of wires), dents, press marks, cut marks, wire cross 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 spots (on account of reaction with trapped rain water etc.) dirt, grit etc.

2.2.2 All the Al. and steel strands shall be smooth, uniform and free, from all imperfections, such as spills and splits, die marks, scratches, abrasion and kinks after drawing and also after stranding.

2.2.3 The steel strands shall be hot dip galvanized and shall have a minimum zinc coating of 230 gm/sq.m. of the uncoated wire surface. The zinc coating shall be smooth, continuous and of uniform thickness, free from imperfections and shall withstand minimum three dips after stranding Preece tests. The finished strands and the individual wires

shall be of uniform quality and have the same properties and characteristics as prescribed in ASTM designation B 498-74.

- 2.2.4 The steel strands shall be performed and postformed in order to prevent spreading of strands in the event of cutting composite core wire. Care shall be taken to avoid damage to galvanization during performing and post forming operation.

2.3 Joints in Wires

2.3.1 Aluminium Wires

No joints shall be permitted in the individual wires in the outermost layer of the finished conductor. However, joints in the inner layers of the conductor shall be allowed but these joints shall be made by cold pressure butt welding.

There shall be no joint of any kind in the finished wire entering into the manufacture of the strand. There shall also be no strand splices in any length of the completed steel core of the conductor.

2.4 Tolerances

The manufacturing tolerance to the extent of the following limits only shall be permitted in the diameter of individual Al. and steel strands and lay ratio of the conductor.

2.5 Materials

2.5.1 Aluminium

The Al. strands shall be drawn from electrolytic aluminium rods having purity not less than 99.5% and a copper content not exceeding 0.04%.

2.5.2 Steel

The steel wire strands shall be drawn high carbon steel wire rods and shall conform to the following chemical composition.

Element	Composition
Carbon	0.50 to 0.85
Manganese	0.50 to 1.10
Phosphorous	Not more than 0.035
Sulphur	Not more than 0.045
Silicon	0.10 to 0.35

2.5.3 Zinc

The zinc used for galvanizing shall be electrolytic High Grade Zinc of 99.95% purity. It shall conform to and satisfy all the requirements of IS 209-1979.

2.6 Standard Length

- 2.6.1 The conductor shall be supplied in standard length of 2150 meters. Bidder shall indicate the standard length of the conductor to be offered by them. A tolerance of 10 m on the standard length offered by the Bidder shall be permitted. All lengths outside this limit of tolerance shall be treated as random lengths. No joint shall be allowed within a single span of stringing.

- 2.6.2 Random lengths will be accepted provided no length is less than 70% of the standard length and the total quantity of random shall be more than 5% of the total quantity. In addition, for every bobbin of random length, three (3) others shall be fabricated with a tolerance 10 m and all the above four drums shall be clearly identified and shipped together to the same site so that they can be installed in the same / trench.

- 2.7 **Tests**
- 2.7.1 The following type, acceptance and routine tests and tests during manufacturing shall be carried out on the conductor.
- 2.7.2 **Type Test**
In accordance with the stipulation of specification, the following type test reports of the conductor shall be submitted for approval as per clause 9.2 of section GTR.
- UTS test on stranded conductor
 - Corona extinction Voltage Test (dry & Wet)
 - Radio Interference voltage test (dry & wet)
 - DC resistance test pm stranded conductor
 - Stress strain test
- 2.7.3 **Acceptance Tests**
- Visual check for joints scratches etc. and lengths of conductor
 - Dimensional check on steel and Al. strands.
 - Check for lay ratios of various layers
 - Galvanising test on steel strands
 - Torsion and Elongation test on steel strands
 - Breaking load test on steel and Al. strands
 - Wrap test on steel and Al. strands
 - DC resistance test on Al. strands
 - Visual and dimensional check on drum
- Note:** All the above tests except test mentioned at (a) shall be carried out on aluminium and steel strands after stranding only.
- 2.7.4 **ROUTINE TEST**
- Check to ensure that the joints are as per specification
 - Check that there are no cuts, fins etc. on the strands
 - Check that drums are as per specification
 - All acceptance test as mentioned in Clause 2.7.3 above to be carried out on each coil.
- 2.7.5 **TEST DURING MANUFACTURE**
- Chemical analysis of Zinc used for Galvanizing
 - Chemical analysis of Al. used for making Al. strands
 - Chemical analysis of steel used for making steel strands
- 2.7.6 **Sample Batch for type Testing**
The contractor shall offer material for selection of samples for type testing only after getting quality assurance plans approved from owner's Quality Assurance Deptt. The sample shall be manufactured strictly in accordance with the Quality Assurance Plan approved by Owner.

2.4 GALVANISED STEEL EARTHWIRE

3.1. Details of Earth wire

- 3.1.1 The galvanised steel earth wire shall generally conform to the specification of ACSR core wire as mentioned in IS: 398 (Part-II)-1976 except where otherwise specified herein.
- 3.1.2 The details of the earth wire are tabulated below
- | | | | |
|----|-----------------------------|---|-----------------|
| a) | Stranding and wire diameter | : | 7/3.66 mm steel |
| b) | Number of strands | : | 1 |

	Steel core		
	Outer Steel Layer	:	6
c)	Total sectional area	:	73.65 mm ²
d)	Overall diameter	:	10.98 mm
e)	Approximate weight	:	583 kg/km
f)	Calculated d.c. resistance- tance at 20 ⁰ C	:	2.5 ohms/km
g)	Minimum ultimate tensile strength	:	68.4 kN
h)	Direction of lay of outer layer	:	Right hand

3.2. TESTS

3.2.1 The following type, routine & acceptance tests and tests during manufacturing shall be carried out on the earth wire.

4.0 TUBULAR BUS CONDUCTORS

4.1 General

Aluminium used shall be grade 63401 WP (range 2) conforming to IS: 5082.

4.2 Constructional Features

4.2.1 For out side diameter (OD) & thickness of the tube there shall be no minus tolerance, other requirements being as per IS: 2678 and IS: 2673

4.2.2 The aluminum tube shall be supplied in suitable cut length to minimize wastage.

4.2.3 The welding of aluminum tube shall be done by the qualified welders duly approved by the owner.

4.3 Tests

In accordance with standards 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 by the ultrasonic method. In addition to the above tests, 0.2% proof tests on both parent metal and Aluminium tube after welding shall be conducted.

4.4 Parameters

a)	Size	4"IPS (EH Type)
b)	Outer diameter (mm)	114.2
c)	Thickness (mm)	8.51
d)	Cross-sectional area (sq.mm)	2825.61
e)	Weight (kg/m)	7.7

5.0 BUS POST INSULATORS

The post insulators shall conform in general to latest IS : 2544, IEC-168 and IEC-815.

5.1 Tests

In accordance with the stipulations of the specification, the post insulators shall be subject to type, acceptance, sample and routine tests as per IS : 2544 and IEC-168.

5.2. Technical Parameters of Bus Post Insulators.

a)	Type	Solid Core
b)	Voltage class (kV)	245
c)	Dry and wet one minute power frequency withstand voltage(kV rms)	460
d)	Dry lightning impulse Withstand Voltage (kVp)	±1050
e)	Max. radio interference voltage (in micro volts) at voltage of 156kV (rms) for 220 kV between phase to ground	500
f)	Corona extinction voltage (kV rms)	156 (Min.)
g)	Total minimum cantilever Strength (Kg)	800
h)	Minimum torsional moment	----- As per IEC-273-----
i)	Total height of insulator (mm)	2300
(Minimum) Necessary sub-Structure/stool required to match bus height using standard structure shall be provided by the Contractor.		
j)	P.C.D	
	Top (mm)	127
	Bottom (mm)	254
k)	No. of bolts	
	Top	4
	Bottom	8
l)	Diameter of bolt/holes(mm)	
	Top	M16
	Bottom	18
m)	Pollution level as per IEC-815	Heavy(III)
n)	Minimum total creepage	6125

5.2.1. 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.

6.0 EARTHING

- 6.1 The earthing shall be done in accordance with requirements given hereunder and drawing titled 'Earthing Details' enclosed with the specification. The earthmat design shall be done by the Contractor as per IEEE-80. The soil resistivity measurement shall also be done by the Contractor. The resistivity measurement of stone (to be used for stone spreading) shall also be done by the Contractor to confirm the 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 design requirements.
- 6.2 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.

- 6.3 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) Indian Electricity Rules 1956 with latest amendments.
- d) National Electricity Safety code IEEE-80.

6.4 Details of Earthing System

	Item	Size	Material
a)	Main Earthing Conductor to be buried in ground	40mm dia	Mild Steel rod
b)	Conductor above ground & earthing leads (equipment)	75x12mm flat	G.S. Galvanised Steel
c)	Conductor above ground & earthing leads (for columns & aux. structures)	75x12mm flat	G.S. Galvanised Steel
d)	Earthing of indoor LT panels, Control panels and out door marshalling boxes, MOM boxes, Junction boxes& Lighting Panels etc	50x6 mm flat	G.S. Galvanised Steel
e)	Rod Earth Electrode	40mm dia, 3000mm long	Mild Steel
f)	Pipe Earth Electrode (in treated earth pit) as per IS.	40mm dia, 3000mm long	Galvanised Steel
g)	Earthing for motors	25X3 mm GS flat	Mild steel
h)	Earthing conductor along outdoor cable trenches	50x6mm MS flat	Mild steel
i)	Earthing of Lighting Poles	20 mm dia 3000 mm long	mild steel rod

The sizes of the earthing conductor indicated above are the minimum sizes.

6.5 Earthing Conductor Layout

- 6.5.1. Earthing conductors in outdoor areas shall be buried at least 600 mm below finished ground level unless stated otherwise.
- 6.5.2. 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.
- 6.5.3 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 “Earthing Details”. (Drawing enclosed).
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., galvanised iron 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.

- 6.5.4. Earthing conductor around the building shall be buried in earth at a minimum distance of 1500 mm from the outer boundary of the building. In case high temperature is encountered at some location, the earthing conductor shall be laid minimum 1500 mm away from such location.
- 6.5.5. Earthing conductors crossing the road shall be laid 300 mm below road or at greater depth to suit the site conditions.
- 6.5.6. Earthing conductor's embedded in the concrete shall have approximately 50 mm concrete cover.

6.6. 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.

6.7. Specific Requirement for Earthing Systems

- 6.7.1 Each earthing lead from the neutral of the power transformer shall be directly connected to two pipe electrodes in treated earth pit (as per IS) which in turn, shall be buried in Cement Concrete pit with a cast iron cover hinged to a cast iron frame to have an access to the joints. All accessories associated with transformer like cooling banks, radiators etc. shall be connected to the earthing grid at minimum two points.
- 6.7.2. 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.
- 6.7.3 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.

7.0 Main 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 drgs enclosed with the bid documents.

- 7.1. The Contractor shall furnish supporting calculations for the bus bars/conductors to show adequacy of design parameters for:
 - a) Fibre-stress
 - b) Cantilever strength of post insulators
 - c) Aeolian vibrations)
 - d) Short circuit forces in bundle conductor and spacer location for each span of ACSR conductor stringing as per layout drawings.
 - e) Vertical deflection of bus bars
- 7.1.1. 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 Owner's approval. Material for welding sleeve shall be same as that of Aluminium tube. Welding sleeve shall be of 600mm length

- 7.1.2. 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.
- 7.1.3. 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.
- 7.1.4. 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 along with the bid. Welding at site shall be done by adopting a qualified procedure and employing qualified welders as per ASME-Section IX

8.0 CABLING MATERIAL

8.1. CABLE TAGS AND MARKERS

- 8.1.1. Each cable and conduit run shall be tagged with numbers that appear in the cable and conduit schedule
- 8.1.2. 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.
- 8.1.3. Location of cables laid directly underground shall be clearly indicated with cable marker made of galvanised iron plate.
- 8.1.4. Location of underground cable joints shall be indicated with cable marker with an additional inscription "Cable joints".
- 8.1.5. The 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.
- 8.1.6. 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.

8.2 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 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 frames. 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.

SECTION-XII

CIVIL WORKS

SECTION: XII

CIVIL WORKS

MODEL TECHNICAL SPECIFICATION FOR CIVIL WORKS OF SUB-STATIONS

1.0 GENERAL TECHNICAL REQUIREMENTS

1.1 SCOPE OF WORK

- 1.1.1 The scope is to cover design, preparation of general arrangement drawings and working drawings, supply of materials and construction of all civil, structural and architectural works.
- 1.1.2 Description of the various sections of work under this specification and detailed scope are given herein after. The whole work under this scope is referred to as civil works.
- 1.1.3 The work to be performed under this specification consists of providing all labour, materials, plants, equipment, temporary works, constructional plant, fuel supplies, transportation and all incidental items not shown or specified but reasonably implied, or necessary for the proper completion of the work, all in strict accordance with the specifications and including revisions and amendments there to as may be required during the execution of the work.
- 1.1.4 The work under this specification shall consist of but not be limited to items mentioned below: -
- (1) GIS room cum Control Room Building, including internal electrification based on the drawings approved by the owner. The building shall be suitable for taking load of additional floor to be constructed in future.
 - (2) Outdoor DG Set based on the drawings approved by the owner.
 - (3) Pump House for pumping out the storm water of the yard and water from oil pit of transformers including supplying & installations of pumps/motors of 4.0 KW capacity & electrical fittings of ISI mark or as approved by engineer in charge for operation of the pump house.
 - (4) Switchyard fencing in accordance with the approved drawing by the owner.
 - (5) The civil works shall include civil foundations including pile foundations, if required, for transformer, towers, lighting cum lightning mast, equipment support structures, road cum rail arrangement including jack pad etc. as per the requirement for establishment of the sub-station.
 - (6) Supply and erection of gantry structures, lighting cum, lightning masts and supporting structure for all the equipments as per material and drawings approved by owner.
 - (7) Construction of cable trenches including removable precast RCC covers with lifting arrangement, cable trench road crossings, necessary sumps, cable trays and proper earthing as per approved drawings/specifications shall be inclusive in the scope of work. 220KV & 66kV outgoing feeders from GIS building up to the boundary wall of the substation, shall be in buried cable trench. Further details shall be finalized during detailed engineering..
 - (8) Soil sterilization and Development of yard
 - (9) Cement concrete roads and culverts within sub station boundary wall.
 - (10) Laying of sewers, storm water drains, water supply lines etc. including making connection with the municipal services after obtaining approval from Municipal Authorities by the contractor.
 - (11) Any other work required for functional requirement of establishment of the sub-station.

- (12) Soil investigation.
 - (13) Making arrangement for construction water, drinking water and toilet facilities with the establishment of site office.
 - (14) Construction of septic tank & soak-pit etc. if municipal sewer line does not exist.
 - (15) Construction of soak pit with sump pit within soak pit and sump well along with pipe drain for collecting oil/ rain water from soak pits of transformers.
 - (16) Fire protection wall between transformers if required in accordance with Tariff advisory committee (TAC) recommendations.
 - (17) All buildings shall be built as Green Building in line with green building concept of Energy Conservation cell.
 - (18) Site surfacing (Gravelling) and anti weed treatment.
 - (19) Storm water drainage and rain water harvesting.
- 1.1.5 The scope shall also include carrying out all relevant tests required for the civil works for the project.
- 1.1.6 The works shall be carried out-according to the design, Structural & Architectural drawings to be developed by the Contractor and approved by the owner. For all building, structures, foundations etc. necessary layout and details are to be developed by the Contractor keeping in view the functional requirement parameters/drawing. Certain minimum requirements are indicated in this specification for guidance and the bid shall cover complete requirement.
- 1.1.7 Fairly leveled land shall be handed over to the Contractor by the owner. Finished ground level shall be the finished formation level furnished by the owner. The layout and levels of all structures etc. shall be made by the contractor at his own cost from the general grid of the plot and bench marks given by the owner. The contractor shall give all help including instruments, materials and personnel to the owner for checking the detailed layout and correctness of the layout and levels. All the quality standards, fabrication and erection check lists, welding standards and other technical requirements shall be strictly adhered to by the Contractor.
- 1.1.8 The work in general, shall be executed as per detailed specifications for the civil works. However, in case specifications for a particular item are not specified, the same shall be governed as per the latest Indian Standard specifications/CPWD specifications as per directions of the owner, whose decision shall be final and binding.
- 1.1.9 220/66/33 KV GIS cum CONTROL ROOM BUILDING
- a) The buildings shall house 220kV, 66kV and 33kV Gas Insulated Switchgear (GIS) separately and other associated equipments inside in the GIS building.
 - b) The bidder shall submit the design & construction proposal of the building along with necessary information, data and drawings in the techno- commercial bid according to the complete requirements.
 - c) Tentative dimensions of GIS cum CONTROL ROOM building is 60mX15m for 220kV and tentative dimensions of GIS hall are 20mX10m for 66 kV & 33kV. However, the bidder shall finalize the dimensions for 220kV, 66 kV and 33kV GIS building according to the equipment offered by them providing enough space & access for erection & maintenance.

2.0 GEOTECHNICAL INVESTIGATION

2.1 GENERAL

The Contractor shall perform a detailed soil investigation to arrive at sufficiently accurate, general as well as specific information about the soil profile and the necessary soil parameters of the Site in order that the foundation of the various structures can be designed and constructed safely and rationally.

A report to the effect will be submitted by the Contractor for Purchaser's specific approval giving details regarding data proposed to be utilized for civil structures design.

The Contractor may visit the site to ascertain the soil parameters. Any variation in soil data shall not constitute a valid reason for any additional cost & shall not affect the terms & conditions of the contract. The test must be conducted under all the critical locations i.e. Control Room Building, Lighting cum lightening mast, Tower locations, Transformers etc.

2.2 SCOPE OF WORK

This specification covers all the work required for detailed soil investigation and preparation of a detailed report. The work shall include mobilization of necessary equipment, providing necessary engineering supervision and technical personnel, skilled and unskilled labour etc. as required to carry out field investigation as well as, laboratory investigation, analysis and interpretation of data and results, preparation of detailed Geo-technical report including specific recommendations for the type of foundations and the allowable safe bearing capacity for different sizes of foundations at different founding strata for the various structures of the substation. The Contractor shall make his own arrangement for locating the co-ordinates and various test positions in field as per the information supplied to him and also for determining the reduced level of these locations with respect to the benchmark indicated by the Purchaser.

All the work shall be carried out as per latest edition of the corresponding Indian Standard Codes.

2.2.1 Bore Holes

Bore holes of 150 mm diameter in accordance with the provisions of IS: 1892 at the rate of minimum one number bore hole per hectare up to 10meter depth or to refusal which ever occur earlier shall be drilled. In any case number of boreholes shall not be less than five. Tests shall be carried out in area wherever switchyard, building, road and other allied work has to be executed. By refusal it shall mean that a standard penetration blow count (N) of 100 is recorded for 30 cm penetration. Number of boreholes may be increased in case soil strata is varying from borehole to borehole in order to have fair idea of soil profile. In case of deep pile foundations soil investigation is to be carried out up to 25 m depth from ground level or refusal whichever is earlier. In case rock is encountered, coring in all the boreholes shall be carried out up to 3 meter in rock.

Performing Standard Penetration Tests at approximately 1.5 m interval in the borehole starting from 1.5 m below ground level onwards and at every change of stratum. The disturbed samples from the standard penetrometer shall also be collected for necessary tests.

Collecting undisturbed samples of 100/75 mm diameter 450 mm long from the bore holes at intervals of 2.5 m and every change of stratum starting from 1.0 m below ground level onwards in clayey strata.

The depth of Water Table, if encountered, shall be recorded in each borehole. In case the soil investigation is carried out in winter/summer, the water table for rainy season shall be collected from reliable sources and recorded in the report.

All samples, both disturbed and undisturbed, shall be identified properly with the borehole number and depth from which they have been taken.

The sample shall be sealed at both ends of the sampling tubes with wax immediately after the sampling and shall be packed properly and transported to the Contractor's laboratory without any damage or loss.

The logging of the boreholes shall be compiled immediately after the boring is completed and a copy of the bore log shall be handed over to the Engineer-in-charge.

2.2.1.1 Dynamic core penetration test

Dynamic core penetration test of two number shall be carried out with the circulation of betnonite slurry at specified locations and continuous record of penetration resistance (NG) upto 15m from natural ground level or the refusal shall be maintained by the contractor. IS: 4968(Part-2) shall be followed for carrying out the test and reporting results.

The location of test shall be approved by the Engineer-in-charge. On completion of the test, the results shall be presented as a continuous record as the number of blows required for every 300mm penetration of the cone into the soil.

2.2.2 Trial Pits

Trial pits shall be carried at specified one location per Hectare as directed by the Purchaser. The trial pits shall be 2 m x 2 m in size extending to 4 m depths, or as specified by the Owner. Undisturbed samples shall be taken from the trial pits as per the direction of the Purchaser.

2.2.3 Electrical Resistivity Test

This test shall be conducted to determine the Electrical resistivity of soil required for designing safety-grounding system for the entire station area. The specifications for the equipments and other accessories required for performing electrical resistivity test, the test procedure, and reporting of field observations shall confirm to IS: 3043. The test shall be conducted using Wagner's four electrode method as specified in IS: 1892, Appendix-B2. Unless otherwise specified at each test location, the test shall be conducted along two perpendicular lines parallel to the coordinate axis. On each line a minimum of 8 to 10 readings shall be taken by changing the spacing of the electrodes from an initial small value of 0.2 m up to a distance of 50.0 m.

2.2.4 Plate load test

Plate load test shall be conducted to determine the bearing capacity, modulus of sub grade reaction and load/settlement characteristics of soil at shallow depths by loading a plane and level steel plate kept at the desired depth and measuring the settlement under different loads, until a desired settlement takes place or failure occurs. The specification for the equipment and accessories required for conducting the test, the test procedure, field observations and reporting of results shall conform to IS: 1888. Modulus of sub grade reaction shall be conducted as per IS: 9214. The location and depth of the test shall be as given below:

- (a) One at Control Room Building location at the proposed foundation depth below finished ground level for bearing capacity.

Undisturbed tube samples shall be collected at 1.0 m and 2.5m depths from natural ground level for carrying out laboratory tests.

The size of the pit in plate load test shall not be less than five times the plate size and shall be taken up to the specified depth. All provisions regarding excavation and visual examination of pit shall apply here.

Unless otherwise specified the reaction method of loading shall be adopted. Settlement shall be recorded from dial gauges placed at four diametrically opposite ends of the test plate.

The load shall be increased in stages. Under each loading stage, record of Time vs Settlement shall be kept as specified in IS: 1888.

Backfilling of the pit shall be carried out as per the directions of the Owner. Unless otherwise specified the excavated soil shall be used for this purpose. In cases of gravel-boulder or rocky strata, respective relevant codes shall be followed for tests.

2.2.5 Water Sample

Representative samples of ground water shall be taken when ground water is first encountered before the addition of water to aid drilling of boreholes. The samples shall be of sufficient quantity for chemical analysis to be carried out and shall be stored in air-tight containers.

2.2.6 Back Filling of Bore Holes

On completion of each hole, the Contractor shall backfill all bore holes as directed by the Owner. The backfill material can be the excavated material.

2.2.7 Laboratory Test

1. The laboratory tests shall be carried out progressively during the field work after sufficient numbers of samples have reached the laboratory in order that the test results of the initial bore holes can be made use of in planning the later stages of the field investigation and quantum of laboratory tests.
2. All samples brought from field, whether disturbed or undisturbed shall be extracted/ prepared and examined by competent technical personnel, and the test shall be carried out as per the procedures laid out in the relevant I.S. Codes.

The following laboratory tests shall be carried out

- (a) Visual and Engineering Classification.
- (b) Liquid limit, plastic limit and shrinkage limit for C-Ø soils.
- (c) Natural moisture content, bulk density and specific gravity.
- (d) Grain size distribution.
- (e) Swell pressure and free swell index determination.
- (f) California bearing ratio.
- (g) Consolidated drained test with pore pressure measurement.
- (h) Chemical tests on soil and water to determine the carbonates, sulphates, nitrates, chlorides, Ph value, and organic matter and any other chemical harmful to the concrete foundation.
- (i) In case of rock samples following tests shall also be conducted:
 - i. Rock quality designation (RQD), RMR.
 - ii. UCC test.
 - iii. Point load index test.

2.2.8 Test Results and Reports

2.2.8.1 The Contractor shall submit the detailed report in two (2) copies wherein information regarding the geological detail of the site, summarised observations and test data, bore logs, and conclusions and recommendations on the type of foundations with supporting calculations for the recommendations. Initially the contractor shall submit draft report and after the draft report is approved, the final report in four (4) copies shall be submitted. The test data shall bear the signatures of the Investigation Agency, Vendor and also site representative of DTL.

2.2.8.2 The report shall include, but not limited to the following :-

- (a) A plan showing the locations of the exploration work i.e. bore holes, dynamic cone penetration tests, trial pits. Plate load test etc.

- (b) Bore Logs: Bore logs of each bore holes clearly identifying the stratification and the type of soil stratum with depth. The values of Standard Penetration Test (SPT) at the depths where the tests were conducted on the samples collected at various depths shall be clearly shown against that particular stratum.

Test results of field and laboratory tests shall be summarized strata wise as well in combined tabular form. All relevant graphs, charts tables, diagrams and photographs, if any, shall be submitted along with report. Sample illustrative reference calculations for settlement, bearing capacity, pile capacity shall be enclosed.

2.2.8.3 Recommendations :

The report should contain specific recommendations for the type of foundation for the various structures envisaged at site. The Contractor shall acquaint himself about the type of structures and their functions from the Owner. The observations and recommendations shall include but not limited to the following:

- (a) Geological formation of the area, past observations or historical data, if available, for the area and for the structures in the nearby area, fluctuations of water table etc.
- (b) Recommended type of foundations for various structures. If piles are recommended the type, size and capacity of pile and groups of piles shall be given after comparing different types and sizes of piles and pile groups.
- (c) Allowable bearing pressure on the soil at various depths for different sizes of the foundations based on shear strength and settlement characteristics of soil with supporting calculations. Minimum factor of safety for calculating net safe bearing capacity shall be taken as 3.0 (three). Recommendation of liquefaction characteristics of soil shall be provided.
- (d) Recommendations regarding slope of excavations and dewatering schemes.
- (e) Comments on the Chemical nature of soil and ground water with due regard to deleterious effects of the same on concrete and steel and recommendations for protective measures.
- (f) If expansive soil is met with, recommendations on removal or retainment of the same under the structure, road, drains, etc. shall be given. In the latter case detailed specification of any special treatment required including specification of materials to be used, construction method, equipments to be deployed etc. shall be furnished. Illustrative diagram of a symbolic foundation showing details shall be furnished.
- (g) Recommendations for additional investigations beyond the scope of the present work, if considered such investigation as necessary.
- (h) In case of foundation in rocky strata, type of foundation and recommendation regarding rock anchoring etc. should also be given.

3 SITE PREPARATION

The owner shall make fairly leveled land available to the contractor. The contractor at his own cost shall make the layout and levels of all structures etc. from the general grid of the plot and bench set by the contractor and approved by the owner. The Contractor shall give all help including instruments, materials and personnel to the Purchaser for checking the detailed layout and shall be solely responsible for the correctness of the layout and levels.

3.1 SCOPE

This clause covers the design and execution of the work for site preparation, such as, clearing of site, excavation and compaction of backfill for foundation, road construction, drainage, trenches and final topping by stone (broken hard stone).

3.2 GENERAL

- 1) The Contractor shall develop the site area to meet the requirement of the intended purpose.
- 2) If fill material is required, the fill material shall be suitable for the above requirement. The fill shall be such a material and the site so designed as to prevent the erosion by wind and water of material from its final compacted position or the in-situ position of undisturbed soil.
- 3) Material unsuitable for founding of foundations shall be removed and replaced by suitable fill material and to be approved by the owner.
- 4) Backfill material around foundations or other works shall be suitable for the purpose for which it is used and compacted to the density described under Compaction. Excavated material not suitable or not required for backfill shall be disposed off in areas as directed by engineer in charge upto authorized MCD dumping yard.

3.3 EXCAVATION AND BACKFILL

1. Excavation and backfill for foundations shall be in accordance with the relevant code.
2. Whenever water table is met during the excavation, it shall be dewatered and water table shall be maintained below the bottom of the excavation level during excavation, concreting and backfilling.
3. When embankments are to be constructed on slopes of 15% or greater, benches or steps with horizontal and vertical faces shall be cut in the original slope prior to placement of embankment material. Vertical faces shall measure not more than 1 m in height.
4. Embankments adjacent to abutments, culverts, retaining walls and similar structures shall be constructed by compacting the material in successive uniform horizontal layers not exceeding 15 cm in thickness. (Of loose material before compaction). Each layer shall be compacted as required by means of mechanical tampers approved by the Engineer in charge. Rocks larger than 10 cm in any direction shall not be placed in embankment adjacent to structures.
5. Earth embankments of roadways and site areas adjacent to buildings shall be placed in successive uniform horizontal layers not exceeding 20 cm in thickness in loose stage measurement and compacted to the full width specified. The upper surface of the embankment shall be shaped so as to provide complete drainage of surface water at all times.

3.4 COMPACTION

1. The density to which fill materials shall be compacted shall be as per relevant IS and as per direction of engineer in charge. All compacted sand filling shall be confined as far as practicable. Backfilled earth shall be compacted to minimum 95% of the Standard Proctor's density at OMC. The sub grade for the roads and embankment filling shall be compacted to minimum 95% of the Standard Proctor's density at OMC. Cohesion less material sub grade shall be compacted to 70% relative density (minimum).
2. At all times, unfinished construction shall have adequate drainage. Upon completion of the road's surface course, adjacent shoulders shall be given a final shaping, true alignment and grade.
3. Each layer of earth embankment when compacted shall be as close to optimum moisture content as practicable. Embankment material, which does not contain sufficient moisture to obtain proper compaction, shall be wetted. If the material contains any excess moisture, then it shall be allowed to dry before rolling. The rolling shall begin at the edges overlapping half the width of the roller each time and progress to the center of the road or towards the building as applicable. Rolling will also be required on rock fills. No compaction shall be carried out in rainy weather.

3.5 REQUIREMENT FOR FILL MATERIAL UNDER FOUNDATION

The thickness of fill material under the foundations shall be such that the maximum pressure from the footing, transferred through the fill material and distributed onto the original undisturbed soil will not exceed the allowable soil bearing pressure of the original undisturbed soil. For expansive soils the fill materials and other protections etc. to be used under the foundation is to be got approved by the owner.

4.0 ANTIWEED TREATMENT & STONE SPREADING

4.1 SCOPE OF WORK

The Contractor shall furnish all labour, equipment and materials required for complete performance of the work in accordance with the drawings, specification and direction of the owner.

Stone spreading along with cement concrete layer shall be done in the areas of the switchyard under present scope of work within fenced area including spare base within fenced area.

4.2 GENERAL REQUIREMENT

The material required for site surfacing/stone filling shall be free from all types of organic materials and shall be of standard quality, and as approved by the owner.

- 4.2.1 The material to be used for stone filling/site surfacing shall be uncrushed/crushed/broken stone of 20 mm nominal size (ungraded single size) conforming to Table of IS:383 –1970. Hardness, flakiness shall be as required for wearing courses are given below:

(a) Sieve Analysis limits (Gradation)
(IS: 383)

(b) Hardness

Abrasion value (IS: 2386 Part-IV) – not more than 40%

Impact value (IS: 2366 Part-IV) – not more than 30% and frequency shall be one test per 500 cu.m. with a minimum of one test per source.

(c) Flakiness Index

One test shall be conducted per 500 cu.m. of aggregate as per IS:2386 Part-I and maximum value is 25%.

- 4.2.2 After all the structures/equipments are erected, antiweed treatment shall be applied in the switchyard where ever stone spreading along with cement concrete is to be done and the area shall be thoroughly de-weeded including removal of roots. The recommendation of local agriculture or horticulture department may be sought where ever feasible while choosing the type chemical to be used. The antiweed chemical shall be procured from reputed manufacturers. The doses and application of chemical shall be strictly done as per manufacturer's recommendation. Nevertheless the effectiveness of the chemical shall be demonstrated by the contractor in a test area of 10MX10M (appx) and shall be sprinkled with water at least once in the afternoon everyday after forty eight hours of application of chemical. The treated area shall be monitored over a period of two to three weeks for any growth of weeds by the Engineer-in-charge. The final approval shall be given by Engineer-in-charge based on the results.

- 4.2.3 Engineer-in-charge shall decide final formation level so as to ensure that the site appears uniform devoid of undulations. The final formation level shall however be very close to the formation level indicated in the approved drawing.

- 4.2.4 After antiweed treatment is complete, the surface of the switchyard area shall be maintained, rolled/compacted to the lines and grades as decided by Engineer-in-charge. The sub grade shall be consolidated by using half ton roller with suitable water sprinkling arrangement to form a smooth and

compact surface. The roller shall run over the sub grade till the soil is evenly and densely consolidated and behaves as an elastic mass.

- 4.2.5 In areas that are considered by the Engineer-in-Charge to be too congested with foundations and structures for proper rolling of the site surfacing material by normal rolling equipments, the material shall be compacted by hand, if necessary. Due care shall be exercised so as not to damage any foundation structures or equipment during rolling compaction.
- 4.2.6 The sub grade shall be in moist condition at the time the cement concrete is placed. If necessary, it should be saturated with water for not less than 6 hours but not exceeding 20 hours before placing of cement concrete. If it becomes dry prior to the actual placing of cement concrete, it shall be sprinkled with water and it shall be ensured that no pools of water or soft patches are formed on the surface.
- 4.2.7 Over the prepared sub grade, 75mm thick base layer of cement concrete in 1:4:8 (1 cement: 4 coarse sand : 8 stone aggregate 20/40mm nominal size) shall be provided in the area excluding roads, drains, cable trenches as per detailed engineering drawing. For easy drainage of water, the slope of 1:1000 is to be provided from the ridge to the nearest drain. The ridge shall be suitably located at the center of the area between the nearest drains.
- 4.2.8 The scope of work for yard development is inclusive of removal of all vegetation growth i.e. grass, shrubs, cleaning and uprooting anti –weed treatment, compaction, grading to required slope and final 3 layer of yard treatment as follows :
- (i) 75mm thick base layer of cement concrete 1:4:8 (1 cement: 4 coarse sand : 8 stone aggregate 20/40mm nominal size)
 - (ii) 100mm thick layer of cement concrete 1:3:6 (1 cement: 3 coarse sand : 6 stone aggregate 20mm nominal size) with 6mm thick asbestos sheet upto full depth for contraction joints. Spacing of joints shall be approved by the Engineer-in-charge.
 - (iii) 100mm thick final layer of 20mm stone aggregate nominal size (ungraded single size)

5.0 SITE DRAINAGE

Providing rain water drainage system within the sub –station boundary under the present scope including connection at one or more points to the outfall point located outside the substation boundary wall is in the scope of contractor. Invert level of drainage system at outfall point shall be decided in such a way that the water can easily be discharged outside the substation boundary wall. In case outfall point is more than 50M away from boundary wall, only 50 meter drain outside the boundary wall is in the scope of contractor. Outfall point shall be got approved from Engineer- in- charge before commencement of construction. While designing the drainage system following points shall taken care of:

- (a) The surface of the switchyard shall be sloped to prevent accumulation of water.
- (b) Drain shall be constructed on both sides of roads. In the switchyard maximum spacing between two drains shall not be more than 100 meters. It will be ensured that no area is left undrained.
- (c) Open surface trapezoidal drains having 300mm bottom width and sides having slope of 1horizontal: 1.5 vertical with 300mm depth at starting point of drain shall be provided.
- (d) Longitudinal slope shall not be less than 1 in 1000.
- (e) Open surface drains shall be constructed with minimum 100mm thick plain cement concrete 1:2:4 (1 cement : 2 coarse sand: 4 stone aggregate 20mm nominal size). PCC 1:2:4 shall be laid over 75mm thick layer of PCC 1:4:8 (1cement: 4coarse sand: 8 stone aggregate 20mm nominal size.) Internal faces of drain are to be smooth and well finished with neat cement punning as final course.
- (f) The side wall of the drains shall be 25 mm above the stone level to prevent falling of stone into drain. Groove of 150 mm width shall be provided at 1500 mm spacing with suitable mild steel grating.
- (g) The maximum velocity for pipe drains and open drains shall be limited to 2.4m/sec and 1.8m/sec

respectively. However, minimum non-silting velocity of 0.6m/sec shall be ensured.

- (h) Pipe drains shall be provided in areas of switchyard where movement of crane will be necessary in operating phase of the substation.
- (i) For pipe drains, concrete pipe of class NP2 shall be used. However, for road crossings etc. higher strength pipe of class NP3 shall be provided. For rail crossings, RCC pipes of class NP4 shall be provided. For design of RCC pipes for drains and culverts, IS:456 and IS:783 shall be followed.
- (j) Two Nos. of portable pumps of 5 hp capacity for drainage of water shall be provided by the Contractor.
- (k) Pipe drains shall be connected through manholes at an interval of maximum 30m.
- (l) If the invert level of outfall point is above the last drain point in the substation boundary, sump of suitable size has to be constructed within the substation boundary.
- (m) The drainage scheme and associated drawings shall be got approved from the engineer in charge before commencement of construction.

6.0 RAINWATER HARVESTING

- (a) In addition to drainage of rainwater in accordance with clause 5.0 above the contractor shall make arrangement for rainwater harvesting also. Rainwater harvesting shall not be done if the depth of water table is within 8.0m from finished ground level.
- (b) Providing one number recharge structure with bore wells shall do Rainwater harvesting. The recharge structure shall be suitably located within the sub-station. Branch drains from the main drain carrying rainwater from entire switchyard, constructed in accordance with clause 5.0, shall be connected to the recharge structure.
- (c) The internal diameter of recharge shafts shall be 4.5 meter with 230mm thick lining of brick work upto a depth of 2.0 meter from ground level and 345mm thick brickwork below 2.0 meter depth. The brickwork shall be constructed with cement mortar 1:6 (1cement: 6 coarse sand). The overall depth of shaft shall be 5.0 meter below invert level of drain. The shaft shall be covered with RCC slab for a live load of 300 kg. per sqm. Two openings of size 0.7 x 0.7 meter shall be provided in the RCC cover slab. An iron cover made of 5mm thick chequered plate with hinges shall be provided on the openings. Galvanized M.S. rungs of 20mm diameter at spacing of 300 mm shall be provided in the wall of shaft below the opening in the RCC slab to facilitate cleaning of shaft.
- (d) A 300 mm diameter bore well shall be drilled in the centre of the shaft. The depth of bore well shall be 5.0 meter more than the depth of sub soil water.
- (e) A 100 mm dia medium duty MS pipe conforming to IS:1161 shall be lowered in the bore well keeping bail plug towards bottom of bore well. The pipe shall have 1.58mm holes for 4.0 meter length starting from 1.0 meter from bottom of bore well. Holes of 3.0mm diameter shall be provided for a length of 2.0 meter starting from the bottom level of coarse sand and down wards. The overall length of pipe shall be equal to total depth of bore well plus depth of shaft.
- (f) Gravel of size 3mm to 6mm shall be filled around 100 diameter MS pipe in the bore well. The shaft shall be filled with 500 mm thick layers each from the bottom of shaft with boulders of size 50mm to 150mm, gravel of size 5mm to 10mm, coarse sand having particle size 1.5mm to 2.0mm and boulders of size not less than 200mm respectively.

Drawing based on above details of recharge structure for rainwater harvesting has to be prepared by contractor and to be approved from engineer in charge.

7.0 ROADS AND CULVERTS

- (a) All the roads within the substation under the present scope is in the scope of contract. Layout of the roads, General detail & Arrangement drawing for the substation to be prepared by contractor and got

approved from engineer in charge. Adequate turning space for vehicles shall be provided and bend radii shall be set accordingly. Road to the transformer shall be as short and straight as possible. The top level of roads shall be 300mm above finished formation level of switchyard.

- (b) The double lane cement concrete road with minimum reinforcement shall have 7.0m width , 1.6 m wide 100 mm thick PCC(1:2:4) and earthen shoulder on either side of the road. Other roads shall be with 3.75 m cement concrete and 1.3 m wide 100 mm thick PCC(1:2:4) and earthen shoulder on either side of the road. All design and drawings of road shall be got approved from engineer in charge. The road from main gate upto control room building shall be double lane road and other roads in and around the substation shall be single lane road.
- (c) All roads shall be designed for class "C" traffic as per relevant IRC.
- (d) CPWD specification shall be followed for construction of Roads.
- (e) All the culverts and allied structures (required for road/rail, drain, trench crossings etc.) shall be designed for class AA loading as per IRC standard / IS code and should be checked for transformer loading.

8.0 TRANSFORMER FOUNDATIONS, RAIL TRACK/ ROAD CUM RAIL TRACK

The Contractor shall provide a RCC Rail cum road system integrated with the transformer foundation to enable installation and the replacement of any failed unit. The transfer track system shall be suitable to permit the movement of any failed unit fully assembled (including OLTC, bushings) with oil. This system shall enable the removal of any failed unit from its foundation to the Main road. If trench/drain crossings are required then suitable R.C.C. culverts shall be provided in accordance with I.R.C. standard / relevant IS.

The Contractor shall provide a pylon support system for supporting the fire fighting system if provided.

Each transformer including oil conservator tank and cooler banks etc. shall be placed in a self-sufficient pit surrounded by retaining walls (Pit walls). The clear distance of the retaining wall of the pit from the transformer shall be 20% of the transformer height or 0.8m whichever is more. The oil collection pit thus formed shall have a void volume equal to 100% volume of total oil in the transformer. The minimum height of the retaining walls shall be 20 cm above the finished level of the ground to avoid outside water pouring inside the pit. The bottom of the pit shall have a uniform slope towards the sump pit. While designing the oil collection pit, the movement of the transformer must be taken into account. The soak pits of all transformers shall be connected to a common sump well through a piping system. The capacity of sump well shall be designed with the consideration of volume of transformer and rainwater.

The grating shall be made of MS flat of size 50mmx 5mm placed at 30mm center to center and 25mmx5mm MS flat at a spacing of 150mm at right angle to each other. Maximum length of grating shall be 1500mm and width shall not be more than 500mm. The gratings, supported on ISMB 150mm, shall be placed at the formation level and will be covered with 100mm thick layer of broken/crushed/non-crushed stone having size 40mm to 60mm which acts as an extinguisher for flaming oil.

Each oil collection pit shall be drained towards a sump pit whose role is to drain water and oil due to leakage within the collection pit so that collection pit remains dry.

8.1 MATERIAL

Complete foundation shall be made of reinforced cement concrete M25 grade and shall be designed as per guidelines for design of foundations given in relevant clauses in IS codes.

8.2 DRAINAGE

One 5.0 H.P pump of approved make for sump well shall be supplied and installed by the Contractor to evacuate the fire fighting & rain water from the sump well in to the nearest drain. Pump house with one door & window to accommodate pump should be constructed.

9.0 FIRE PROTECTION WALLS

9.1 GENERAL

Fire protection walls shall be provided, if required, in accordance with Tariff Advisory Committee (TAC) recommendations.

9.2 MATERIAL

The firewall may be made of reinforced cement concrete (M-25 grade) as per the system requirement. Materials used must conform to the standards of the national Fire Prevention Association & TAC Norms.

9.3 FIRE RESISTANCE

The firewall shall have a minimum fire resistance of 4 hours. The partitions, which are made to reduce the noise level, shall have the same fire resistance. The walls of the building, which are used as firewalls, shall also have a minimum fire resistance of 4 hours.

The firewall shall be designed to protect against the effect of radiant heat and flying debris from an adjacent fire.

9.4 DIMENSIONS

The barrier shall extend at least 300 mm above the transformer bushing and pressure relief vent and length wise 600 mm beyond the transformer including any radiators and tap changer enclosure.

These dimensions might be reduced in special cases, as per the approval of owner where there is lack of space. A minimum of 2.0 meter clearance shall be provided between the equipments e.g. Autotransformer and firewalls.

The building walls, which act as firewalls, shall extend at least 1 m above the roof in order to protect it.

The firewall shall be made of reinforced cement concrete (M-25 grade), as per the system requirements.

9.5 MECHANICAL RESISTANCE

The fire wall shall have the mechanical resistance to withstand local atmosphere conditions. If this wall shall serve as a support for equipment such as insulators etc, its mechanical rigidity must be increased.

10.0 CABLE & PIPE TRENCHES

- (a) The cable trenches and pre-cast removable RCC covers with angle/channel nosing all around (with lifting arrangement) shall be constructed using RCC of M25 grade.
- (b) The cable trench walls shall be designed for the following loads.
 - (i) Dead load of 155 kg/m length of cable support + 75 Kg on one tier at the outer edge of tier.
 - (ii) Earth pressure + uniform surcharge pressure of $2T/m^2$.
- (c) Cable trench covers shall be designed for self-weight of top slab + concentrated load of 150 kg at center of span on each panel.
- (d) Necessary sumps shall be provided and each sump shall be provided with pump of 5 HP capacity. Cable trenches shall not be used as storm water drains.

- (e) The top of trenches shall be kept at least 100 mm above the final level of stone layer of yard development. The top of cable trench shall be such that the surface rainwater does not enter the trench.
- (f) All metal parts inside the trench shall be connected to the earthing system.
- (g) Trench wall shall not foul with the foundation. Suitable clear gap shall be provided.
- (h) The trench bed shall have a slope of 1/500 along the run & 1/250 perpendicular to the run.
- (i) Cable trenches shall be blocked at the ends if required with brick masonry in cement sand mortar 1:6 (1cement:6 fine sand) and plaster with 12mm thick 1:6(1cement:6 fine sand) cement sand mortar.
- (j) Cable trench crossing the roads/rails shall be designed for class AA loading of IRC and should be checked for transformer loading also.
- (k) All the construction joints of cable trenches i.e. between base slab to the base slab and the junction of vertical wall to the base slab as well as from vertical wall to wall and all the expansion joints shall be provided with approved quality PVC water stops and approximately 230x5mm size for those sections where the ground water tube is expected to rise above the junction of base slab and vertical wall of cable trenches.

11.0 FOUNDATION /RCC CONSTRUCTION

11.1 GENERAL

- (a) Work covered under this Clause of the Specification comprises the design and construction of foundations and other RCC constructions for switchyard structures, equipment supports, trenches, drains, jacking pad, pulling block, control cubicles, bus supports, transformer, marshalling kiosks, auxiliary equipments, buildings, tanks or for any other equipment or service and any other foundation required to complete the work. This clause is as well applicable to the other RCC constructions.
- (b) Concrete shall conform to the requirements mentioned in IS:456 (latest) and all the tests shall be conducted as per relevant Indian Standard Codes as mentioned in Standard field quality plan appended with the specification.

A minimum grade of M25 concrete shall be used for all structural/load bearing members as per latest IS 456 (latest).

- (c) If the site is sloppy, the foundation height will be adjusted to maintain the exact level of the top of structures to compensate such slopes.
- (d) The switchyard foundation's plinths and building plinths shall be minimum 300mm and 500 mm above finished ground level respectively.
- (e) Minimum 75mm thick lean concrete (1:4:8) shall be provided below all underground structures, foundations, trenches etc. to provide a base for construction.
- (f) Concrete made with Portland slag cement shall be carefully cured and special importance shall be given during the placing of concrete and removal of shuttering.
- (g) The design and detailing of foundations shall be done based on the approved soil data and sub-soil conditions as well as for all possible critical loads and the combinations thereof. The Spread footings foundation or pile foundation as may be required based on soil/sub-soil conditions and superimposed loads shall be provided.
- (h) If pile foundations are adopted, the same shall be cast-in-situ driven/bored or pre-cast or under reamed type as per relevant parts of IS Code 2911. Only RCC piles shall be provided. Suitability of the adopted pile foundations shall be justified by way of full design calculations. The bidder showing complete details of piles/pile groups, proposed to be used, shall submit detailed design calculations.

The bidder at their cost to establish the piles design capacity shall also carry out necessary initial load test. Only after the design capacity of piles has been established, the Contractor shall take up the job of piling. Routine tests for the piles shall also be conducted. All the work (design & testing) shall be planned in such a way that these shall not cause any delay in project completion.

11.2 DESIGN

(a) All foundation shall be of reinforced cement concrete. The design and construction of RCC structures shall be carried out as per IS:456 and minimum grade of concrete shall be M-25. Higher grade of concrete than specified above may be used at the discretion of Contractor without any additional financial implication to the DTL.

(b) Limit state method of design shall be adopted unless specified otherwise in the specification.

(c) For detailing of reinforcement IS:2502 and SP:34 shall be followed. Cold twisted deformed bars ($F_y=415 \text{ N/mm}^2$) conforming to IS:1786 or TMT bars as per CPWD specifications shall be used as reinforcement. However, in specific areas, mild steel (Grade I) conforming to IS:432 can also be used. Two layers of reinforcement (on inner and outer face) shall be provided for wall & slab sections having thickness of 150 mm and above. Clear cover to reinforcement shall be as per IS:456 (latest).

(d) RCC water retaining structures like storage tanks, etc. shall be designed as un cracked section in accordance with IS:3370 (Part I to IV) by working stress method. However, water channels shall be designed as cracked section with limited steel stresses as per IS:3370 (Part I to IV) by working stress method.

(e) The procedure used for the design of the foundations shall be the most critical loading combination of the steel structure and or equipment and/or superstructure and other conditions which produces the maximum stresses in the foundation or the foundation component and as per the relevant IS Codes of foundation design. Detailed design calculations shall be submitted by the bidder showing complete details of piles/pile groups proposed to be used.

(f) Design shall consider any sub-soil water pressure that may be encountered following relevant standard strictly.

(g) Necessary protection to the foundation work, if required shall be provided to take care of any special requirements for aggressive alkaline soil, black cotton soil or any other type of soil which is detrimental/harmful to the concrete foundations.

(h) RCC columns shall be provided with rigid connection at the base.

(i) All sub-structures shall be checked for sliding and overturning stability during both construction and operating conditions for various combinations of loads. Factors of safety for these cases shall be taken as mentioned in relevant IS Codes or as stipulated elsewhere in the Specifications. For checking against overturning, weight of soil vertically above footing shall be taken and inverted frustum of pyramid of earth on the foundation should not be considered.

(j) Earth pressure for all underground structures shall be calculated using co-efficient of earth pressure at rest, co-efficient of active or passive earth pressure (whichever is applicable). However, for the design of substructures of any underground enclosures, earth pressure at rest shall be considered.

(k) In addition to earth pressure and ground water pressure etc., a surcharge load of $2T/\text{Sq.m}$ shall also be considered for the design of all underground structures including channels, sumps, tanks, trenches, substructure of any underground hollow enclosure etc., for the vehicular traffic in the vicinity of the structure.

(l) Following conditions shall be considered for the design of water tank in pumps house, channels, sumps, trenches and other underground structures:

- (1) Full water pressure from inside and no earth pressure & ground water pressure & surcharge pressure from outside (application only to structures which are liable to be filled up with water or any other liquid).
 - (2) Full earth pressure, surcharge pressure and ground water pressure from outside and no water pressure from inside.
 - (3) Design shall also be checked against buoyancy due to the ground water during construction and maintenance stages. Minimum factor of safety of 1.5 against buoyancy shall be ensured ignoring the superimposed loadings.
- (m) Base slab of any underground enclosure shall also be designed for empty condition during construction and maintenance stages with maximum ground water table (GWT). Minimum factor of safety of 1.5 against buoyancy shall be ensured ignoring the super-imposed loadings.
- (n) Base slab of any underground enclosure like water storage tank shall also be designed for the condition of different combination of pump sumps being empty during maintenance stages with maximum GWT. Intermediate dividing piers of such enclosures shall be designed considering water in one pump sump only and the other pumps sump being empty for maintenance.
- (o) The foundations shall be proportioned so that the estimated total and differential movements of the foundations are not greater than the movements that the structure or equipment is designed to accommodate.
- (p) The foundations of transformer and circuit breaker shall be of block type foundation. Minimum reinforcement shall be governed by IS: 2974 and IS: 456.
- (q) The tower and equipment foundations shall be checked for a factor of safety of 2.2 for normal condition and 1.65 for short circuit condition against sliding, overturning and pullout. The same factors shall be used as partial safety factor over loads in limit state design also.

12.0 ADMIXTURES & ADDITIVES

- (a) Only approved admixtures shall be used in the concrete for the Works. When more than one admixture is to be used, each admixture shall be batched in its own batch and added to the mixing water separately before discharging into the mixer. Admixtures shall be delivered in suitably labeled containers to enable identification.
- (b) Admixtures in concrete shall conform to IS:9103. The water proofing cement additives shall conform to IS:2645. Concrete Admixtures/ Additives shall be approved by engineer in charge.
- (c) The Contractor may propose and the engineer in charge may approve the use of a water-reducing set-retarding admixture in some of the concrete. The use of such an admixture will not be approved to overcome problems associated with inadequate concrete plant capacity or improperly planned placing operations and shall only be approved as an aid to overcoming unusual circumstances and placing conditions.
- (d) The water-reducing set-retarding admixture shall be an approved brand of Ligno-sulphonate type admixture.
- (e) The water proofing cement additives shall be used as required/advised by the engineer in charge.

13.0 STRUCTURES

13.1 GENERAL

The scope of specification covers design, fabrication, proto-assembly, supply and erection of galvanized steel structures for towers, girders, lightning masts and equipment support structures. All galvanized steel structure shall be of lattice structure fabricated from structural steel conforming to IS 2062 (latest).

It is the intent of the owner to provide structures, which allow interchangeability of equipments at a later stage. Accordingly equipment support structure shall be provided with the provision of stool. Stools shall be provided 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 support structure.

The scope shall include supply and erection of all types of structures including bolts, nuts, washers, hangers, shackles, clamps anti climbing devices, bird guards, step bolts, inserts in concrete, gusset plates, equipment mounting bolts, structure earthing bolts, foundation bolts, spring washers, fixing plates, ground mounted marshalling boxes (AC/DC Marshalling box & equipment control cabinets), structure mounted marshalling boxes and any other items as required to complete the job.

The connection of all structures to their foundations shall be by base plates and embedded anchor/foundation bolts. All steel structures and anchor/foundation bolts shall be fully galvanized. The weight of the zinc coating shall be at least 0.610 kg/m² for anchor bolts / foundation bolts and for structural members. One additional nut shall be provided below the base plate which may be used for the purpose of leveling.

13.2 DESIGN REQUIREMENTS FOR STRUCTURES

- (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) For materials and permissible stresses IS:802, Part-I, Section-2 shall be followed in general. However, additional requirements given in following paragraphs shall be also considered.
- (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	5
Redundant members	5

- (4) Maximum slenderness ratios for leg members, other stressed members and redundant members for compression force shall be as per IS-802.
- (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.
- (6) The minimum bolt diameter shall be 16 mm.

13.3 STEP BOLTS

In order to facilitate inspection and maintenance, the structures shall be provided with climbing devices. Each tower shall be provided with step bolts not less than 16mm diameter & 175mm long spaced not more than 450mm apart, staggered on faces on one leg extending from about 1.0 meters above ground level to the top of the tower. The step bolt shall conform to IS: 10238. Ladders on towers with lighting appliances shall be provided with safety guards.

13.4 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 (latest), Importance factor of 1.5, 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 40.0 kA. IEC-865 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 on all external loads for the design of switchyard structures which are of lattice type.

- 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 and other gantries shall be designed for a minimum conductor tension of 2 metric tonnes per phase for 220/66kV or as per requirements whichever is higher. The distance between terminal gantry and dead end tower shall be taken as 100 metres. The design of these terminal gantries shall also be checked considering +/- 30 deg deviation of conductor in horizontal planes and plus 30 degree in vertical plane. For other gantries the structural layout requirements shall be adopted in design.
- e) The girders shall be connected with lattice columns by bolted joints.
- f) All Pipe support structures if 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/towers, 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) Lighting-cum-lightning Mast shall be 35m in height (32.5m lattice structure plus 2.5m pipe) and designed for diagonal wind condition. Lightning masts shall be provided with a structural steel ladder within its base up to a height of 25 meter. The ladder shall be provided with protection rings. One platform shall be provided at 25.0m height for mounting of lighting fixture. The platform shall also have protection railing. The details of lighting fixtures would be as per the approved drawings. High mast with integral motor technology which shall bring down the Light fixture for ease of maintenance is also acceptable to avoid separate platform at 25.0m height. The bidder shall maintain the lux level as per NIT and provision of lightning protection of switchyard.

13.5 DESIGN DRAWINGS, BILL OF MATERIALS AND DOCUMENTS

- (1) The Contractor shall furnish design, drawing detail BOMs on basis of BOM as enclosed including shop manufacturing drawings for every member to the Purchaser after award of the Contract. However, Contractor shall have to prepare and submit any other drawings, bill of materials (BOM) additionally required during design and construction stage which the Purchaser feels necessary. In case Purchaser feels that any design drawing, BOM are to be modified even after its approval, Contractor shall modify the designs & drawings and resubmit the design drawing, BOM as required in the specification.
- (2) The fabrication drawings to be prepared and furnished by the Contractor shall be based on the design approved by the Purchaser. 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 owner. The fabrication drawings shall be submitted to the owner. Proto shall be made only after approval of fabrication drawings.

- (3) The fabrication work shall start only after the final approval to the Fabrication drawing is accorded by the owner. The design drawing should indicate not only profile, but section, numbers and sizes of bolts and details of typical joints.
- (4) Such approval shall, however, not relieve the Contractor of his responsibility for the safety 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.

13.6 FABRICATION OF STEEL MEMBERS

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 provision 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.

13.7 PROTO-ASSEMBLY

- (1) 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.
- (2) Sample towers, beams and lighting-cum-lightening masts and equipment support structures shall be trial assembled in the fabrication shop and shall be inspected and cleared by Contractor based on the approved fabrication drawing before mass fabrication.

Pursuant to above the B.O.Ms along with proto-corrected fabrication drawings and shop manufacturing drawings for every member shall be prepared and submitted by the main vendor to owner as document for information. Such BOM, which shall be duly certified by the main vendor for its conformity to the approved design, shall be the basis for owner to carry out inspection.

13.8 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) All steel items, bolts, nuts and washers shall be hot dip galvanized.
- iii) 2.0% extra nuts and bolts shall be supplied for erection.

13.9 WELDING

The work shall be done as per approved fabrication drawings which clearly indicate various details of joints to be welded, type of weld, length and size of weld, whether shop or site weld etc. Symbols for welding on erection and shop drawings shall be according to IS: 813. Efforts shall be made to reduce site welding so as to avoid improper joints due to constructional difficulties.

13.10 FOUNDATION BOLTS

- (1) Foundation bolts for the towers and equipment supporting structures and elsewhere 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.
- (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.
- (3) All foundation bolts for lattice structure, pipe structure are to be supplied by the Contractor.

- (4) All foundation bolts shall be fully galvanized so as to achieve 0.61 kg. per Sq.m. of Zinc Coating as per specifications.
- (5) All foundation bolts shall conform to IS 5624 but the material, however shall be MS conforming to IS: 2062.

13.11 STABILITY OF STRUCTURE

The Supplier 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.

13.12 GROUTING

The method of grouting the column bases shall be subject to approval of Purchaser and shall be such as to ensure a complete uniformity of contact over the whole area of the steel base. The Contractor will be fully responsible for the grouting operations.

13.13 GALVANISING

- (1) All structural steel works and pipe supports shall be galvanized after fabrication.
- (2) Zinc required for galvanizing shall have to be arranged by the manufacturer. Purity of zinc to be used shall be 99.95% as per IS:209.
- (3) The Contractor shall be required to make arrangement for frequent inspection by the owner as well as continuous inspection by a resident representative of the owner, if so desired for fabrication work.

13.14 TOUCH-UP PAINTING

The touch up primers and paints shall consist of Red Oxide / Zinc chromate conforming to the requirements of IS: 2074 with a pigment to be specified by the owner.

13.15 INSPECTION BEFORE DISPATCH

Each part of the fabricated steel work shall be inspected as per approved quality plans and certified by the owner 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.

13.16 TEST CERTIFICATE

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

13.17 ERECTION

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.

13.18 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.

All tests mentioned in standard field quality plans have to be carried out and conformity of materials

and workmanship shall be ascertained.

14.0 CHAINLINK FENCING AND GATE

14.1 Fencing and gate shall be provided as per details given below:

1. Fencing shall be provided for complete switchyard as per drawing approved by engineer in charge. Separate gate shall be provided for men and equipment.
2. Internal fence surrounding the various equipments (if) mounted on ground or a height lower than 2.5m. Necessary gates shall be provided for each area so surrounded.
3. Drawing of fencing covering following specifications shall be prepared by contractor and shall got approved from engineer in charge.

14.2 PRODUCT MATERIALS

The minimum requirements are as follows:

Chain link fence fabric (without galvanization) in accordance to IS: 2721.

- | | | | |
|----|---------------------|---|--|
| 1. | Size of mesh | : | 75mm |
| 2. | Nominal wire size | : | 3.15mm diameter |
| 3. | Width of chain link | : | 1500mm |
| 4. | Painting | : | Two or more coats of approved standard
make synthetic enamel paint over a
coat of standard steel primer. |

Posts

The posts shall be of medium M.S. tubes of 50mm diameter conforming to grade Yst-22 (Kg/mm²). The tubes shall also conform to IS : 1161/IS 806. The length of tubular post shall be 2600 mm.

An M.S. base plate of size 160 X 160 X 6mm thick shall be welded with the tubular post. The post shall be provided on the top with M S plate.

The tubular post shall be welded with 8 number of M S flat of size 50 x 6mm – 75mm long. Two number of 13.5 mm diameter holes on each cleats shall be provided to bolt the fence fabric panel. The cleats shall be welded at equal spacing in such a way that 4 numbers of cleats are on one side and remaining 4 cleats are on the opposite side of the post. The cleats on the corner posts shall be welded in such a way that it suits the site requirement.

The whole assembly of tubular post shall be hot dip galvanized. The zinc coating shall be minimum 610 gram per sq. meter. The purity of zinc shall be 99.95% as per IS: 209.

Fence Fabric Panel

Chain link fencing shall be fabricated in the form of panel 1300 X 2928 mm. An M.S. flat of at least 50x6 mm size shall be welded all-round fence fabric to form a panel. Four pairs of 13.5mm diameter holes on the vertical M S flat matching the spacing of holes in cleats fixed with pipe shall be provided to fix the fence panel with the tubular posts. A washer shall also be provided below each nut. The contractor, for fixing the panels, shall supply the 12mm diameter bolts including nuts and washers. All nuts, bolts and washers shall be hot dip galvanized.

The fence panel shall be provided with two or more coats of approved standard synthetic enamel paint over approved standard steel primer.

Installation

1. Fence shall be installed along the switchyard line.
2. Post holes shall be excavated by approved method.
3. All posts shall be 3.0m apart measured parallel to ground surface.
4. Posts shall be set in 1:1.5:3 Plain Cement Concrete block of minimum 0.60x0.60x1.2m depth. 100mm thick plain cement concrete 1:4:8 shall be provided below concrete blocks. Posts

shall be braced and held in plumb position and true alignment and elevation until concrete has set.

5. Fence fabric shall not be installed until concrete has cured a minimum of 7 days.
6. Fence fabric panel shall be fixed to the post at 4 nos. MS flat each of 50x6, 75 long through 2 nos. of bolts (12 diameter) on each flat.
7. Tow wall of one brick thick over 75mm thick PCC (1:4:8) shall be provided below all fencing and between fence posts. Tow wall shall be minimum 200mm above and 500mm below finished ground level. All exposed surface of brick tow wall shall be provided with 1:6 cement sand plaster (15mm thick) and coated with two coats of cement paint over a coat of cement primer.

The painting pattern of fence panels shall be decided by Engineer-in-charge. It shall be preferable to paint the panel in different colour pattern such that it gives better aesthetic look.

Gate

1. The gate shall be made of medium duty M.S. pipe conforming to relevant I.S. with welded joints. The main frame (outer frame) of the gate shall be made of 65mm dia pipe and vertical pipes of 40mm dia shall be welded with the main frame. Other details shall be as per approved drawing.
2. The gates shall be fabricated with welded joints to achieve rigid connections. The gate frames shall be painted with one coat of approved steel primer and two coats of synthetic enamel paint.
3. The gates shall be provided with suitable locking arrangement.
4. The main gate shall be 6.0m wide and shall be of double leaf type. Next to the main gate, a men gate (1.25m wide single leaf) shall also be provided.
5. Two steel rollers in each leaf with rolling MS flat on road shall be provided with the gate.
6. Gate shall be installed in location as per approved drawing.

15.0 BUILDINGS - GENERAL REQUIREMENTS

15.1 GENERAL

The scope includes design, engineering and construction including anti-termite treatment, plinth protection DPC of Building including sanitary, water supply, electrification etc. of control room building, GIS Building etc. The buildings shall be of RCC framed structure of concrete of M25 grade (Min.).

The Contractor shall appoint a reputed architect (to be approved by DTL) for design of architecturally pleasing building.

15.2 AREA REQUIREMENT :-

(A) CONTROL ROOM BUILDING

The position of different floors of rooms are given below:

- | | |
|---------------------------|----|
| • Control room | FF |
| • ACDB room | GF |
| • DCDB-cum-battery room | GF |
| • Testing Lab | FF |
| • Conference room | FF |
| • S/Stn. Incharge office | FF |
| Plus attached Toilet | |
| Plus PS room | |
| • Room for engineers | FF |
| • Room for non-executives | FF |

- Lobby FF
- Corridor FF
- Portico GF
- Common toilet FF
(ladies & gents both separate)
- Changing room FF
- Toilet attached to FF
Conference room
- Janitor room FF
- Pantry FF
- Store GF
- GIS room GF
- Relay & Protection panels room GF
(Adjacent to GIS room)

Any future possibility of annexes building shall be taken care of while finalizing the layout of the control room building.

(B) GIS BUILDING :-

Dimensions of the building shall be decided by the bidder depending upon requirement. Provision for extension of the building in future shall be made. A corridor having width of 1500 mm shall be provided all around GIS to facilitate maintenance of equipments. Provision for service bay shall also be made. Panels shall be kept in an air-conditioned enclosure. This enclosure shall be separated from main GIS hall by providing glazed partition made of aluminium frame and 5.5 mm thick glass. Cable cellar room in GIS building shall be provided.

15.2.1 DESIGN

a) The buildings shall be designed :

1. to the requirements of the National Building Code of India, and the standards quoted therein.
2. for the specified climatic & loading conditions.
3. to adequately suit the requirements of the equipment and apparatus contained in the buildings and in all respects to be compatible with the intended use and occupancy.
4. with a functional and economical space arrangement.
5. for a life expectancy of structure, systems and components not less than that of the equipment which is contained in the building, provided regular maintenance is carried out.
6. to be aesthetically pleasing. Different buildings shall show a uniformity and consistency in architectural design.

7. to allow for easy access to equipment and maintenance of the equipment.
 8. with, wherever required, fire retarding materials for walls, ceilings and doors, which would prevent supporting or spreading of fire.
 9. with materials preventing dust accumulation.
- b) Suitable expansion joints shall be provided in the longitudinal direction wherever necessary with provision of twin columns.
 - c) Individual members of the buildings frame shall be designed for the worst combination of forces such as bending moment, axial force, shear force, torsion etc.
 - d) Permissible stresses for different load combinations shall be taken as per relevant IS Codes.
 - e) The building lighting shall be designed in accordance with the requirements of relevant section.
 - f) The building auxiliary services like air conditioning and ventilation systems, fire protection and detection systems and all other miscellaneous services shall be designed in accordance with the requirements specified in relevant section or elsewhere in this Specification.

15.2.2 DESIGN LOADS

Building structures shall be designed for the most critical combinations of dead loads, super-imposed loads, equipment loads, crane load (if any), wind loads and seismic loads.

Dead loads shall include the weight of structures complete with finishes, fixtures and partitions and should be taken as per IS: 1911.

Super-imposed loads in different areas shall include live loads, minor equipment loads, cable trays, small pipe racks/hangers and erection, operation and maintenance loads. Equipment loads shall constitute, if applicable, all load of equipments to be supported on the building frame.

For crane loads an impact factor of 30% and lateral crane surge of 10% (lifted weight + trolley) shall be considered in the analysis of frame according to provisions of IS: 875. The horizontal surge shall be 5% of the static wheel load.

The wind loads shall be computed as per IS 875 - 1987, Seismic Coefficient method/Response Spectrum method shall be used for the seismic analysis as per IS 1893 with importance factor 1.5.

Wind and Seismic forces shall not be considered to act simultaneously.

Floors/slabs shall be designed to carry loads imposed by equipment, cables and other loads associated with building. Floors shall be designed for live loads as per relevant IS. Cable load shall also be considered additionally for floors where these loads are expected.

In addition, beams shall be designed for any incidental point loads to be applied at any point along the beams. The floor loads shall be subject to Purchaser's approval.

For consideration of loads on structures, IS: 875 -1987, the following minimum superimposed live loads shall, however, be considered for the design.

a	Roof	1.5 KN/M2 0.75 KN/M2	for accessible roofs for in-accessible roofs
b	RCC-Floor	5 KN/M2 10 KN/M2(min.)	for offices for equipment floors or actual requirement, if higher than 10 kN/sqm based on equipment component weight and layout plans.
c	Stairs & balconies	5 KN/M2	
d	Toilet Rooms	2 KN/M2	
e	Chequered plate floor	4 KN/M2	
f	Walkways	3 KN/M2	

Any additional load coming in the structure shall be calculated as per IS: 875 -1987.

15.2.3 SUBMISSION

The following information shall be submitted for review and approval to the Purchaser:

1. Structural design calculations and drawing (including construction/ fabrication) for all reinforced concrete and structural steel structures.
2. Fully, dimensioned concept plan including floor plans, cross sections, longitudinal sections, elevations and perspective view of each building. These drawings shall be drawn at a scale not smaller than 1:50 and shall identify the major building components.
3. Fully dimensioned drawings showing details and sections drawn to scales of sufficient size to clearly show sizes and configuration of the building components and the relationship between them.
4. Product information of building components and materials, including walls partitions flooring ceiling, roofing, door and windows and building finishes.
5. A detailed schedule of building finishes including colour schemes.
6. A door & window schedule showing door types and locations, door lock sets and latch sets and other door hardware.

Approval of the above information shall be obtained before ordering materials or starting fabrication or construction as applicable.

15.2.4 FINISH SCHEDULE

The finishing schedule is given in subsequent clauses. Internal walls of GIS hall shall be painted with two or more coats of plastic emulsion paint (DSR item code 13.92.1). Paints used in the work shall be of best quality specified in CPWD specification.

15.2.5 FLOORING

Flooring in various rooms of control room building shall be as per detailed schedules given in Table -1. 52mm thick ironite flooring (DSR item code 11.8) shall be provided in GIS hall.

15.2.6 Walls

All the buildings shall be of framed superstructure. All walls shall be non-load bearing walls. Min. thickness of walls shall be 230 mm (one brick) with 1:6 cement sand mortar.

15.2.7 Plastering

All internal walls shall have minimum 15mm thick 1:6 cement sand plaster. The ceiling shall have 6mm thick 1:3 cement sand plaster.

15.2.8 External Finishing

External plaster 12mm thick shall be of 1:6 cement sand plaster. External surface of the control room and GIS building shall be painted with NOVALUX exterior paint as per manufacturer's specification. Minimum 20% area in elevation of control room building and GIS building shall be covered with 6mm thick coloured curtain glazing with powder coated aluminium frame for better aesthetic look in elevation.

Internal finish Schedule for control room building is given in Table -1 below:

INTERNAL FINISHING SCHEDULE TABLE

Sl. No.	Location	Flooring & skirting 150mm high	Wall internal	Ceiling	Doors, Windows ventilators
1.	Control Room, SCADA / communication & computer rooms	Vitrified tiles of approved shade & colour over CC flooring as specified. False ceiling	Surface of internal walls shall be prepared with POP putty to maintain smooth surface and line & levels. The prepared surface shall be finished with plastic emulsion paint/texture paint or any other high quality paint of approved colour and shade.	same as for internal walls	Powder coated Aluminium Indal or equivalent extruded sections as per IS 733 & 1285 Glazing Float glass (Min 5.5mm thick) double glazing with 12mm gap hermetically sealed.
2	Sub-Station in charge, officers, conference library/record, corridor, staff, protection room	Vitrified tiles of approved shade & colour over CC flooring as specified. False ceiling	Surface of internal walls shall be prepared with POP putty to maintain smooth surface and line & levels. The prepared surface shall be finished with plastic emulsion paint/texture paint or any other high quality paint of approved colour and shade.	same as for internal walls	Powder coated Aluminium extruded sections as at 1 door shutter Windows, Ventilators Aluminium as at 1.
3	Reception/lobby corridor	Granite stone as per approved pattern.	Surface of internal walls shall be prepared with POP putty to maintain	same as for internal	Powder coated Alum. Extruded Sections frame as

			smooth surface and line & levels. The prepared surface shall be finished with plastic emulsion paint/texture paint or any other high quality paint of approved colour and shade.	walls	at for S.No. 1 i.e. for entrance with glazing
4	Battery Room	Acid Resistant Tiles 25mm thick	DADO acid resistant tile 2.1M high Acid resistant paint above 2.1 M upto ceiling	Acid resistant paint	Steel door 45mm thick double sheet 18G steel suitably reinforced and filled with mineral wool. Hotrolled steel framed glazed window and ventilators
5	Electrical Room, DG Bldg. , platform	Ironite flooring	POP with emulsion paint or oil bound/ acrylic distemper	POP with emulsion paint or oil bound/ acrylic distemper	Steel door double sheet as above. Hot rolled steel framed glazed window and ventilators.
6	Toilet, pantry	Vitrified tiles of approved shade & colour over CC flooring as specified.	DADO vitrified tiles upto ceiling height for toilet and for pantry above working platform upto 750mm.	POP with emulsion paint or oil bound/ acrylic distemper	Provision of water less urinal in toilet. Powder coated Alum. Frame for pantry doors and teak wood frame with flush doors for toilets.
7	Stair	Granite stone with hand railing of stainless steel or decorative finish as per approval.	--	Waist slab bottom face white wash inside	Teak wood frame flush door shutter with Anodized Aluminium fixtures best quality Windows, ventilators aluminium as at 1.

Internal finishing of testing lab and changing room shall be as per internal finish schedule table serial no. 5 and 6 respectively.

15.2.9 ROOF

- Roof of the Buildings shall consist of Cast-in-situ RCC slab treated with a water proofing system which shall be an integral cement based treatment conforming to CPWD specification (item no. 25.8 of DSR 2002). The water proofing treatment shall be of following operations:
- Applying and grouting a slurry coat of neat cement using 2.75 kg/m² of cement admixed with proprietary water proofing compounds conforming to IS: 2645 over the RCC slab including cleaning the surface before treatment.
- Laying cement concrete using broken bricks/brick bats 25mm to 100mm size with 50% of cement mortar 1:5 (1 cement : 5 coarse sand) admixed with proprietary water proofing compound conforming to IS: 2645 over 20mm thick layer of cement mortar of min 1:5 (Cement : 5 coarse sand) admixed with proprietary water proofing compound conforming to IS: 2645 to required slope and treating similarly the adjoining walls up to 300mm height including rounding of junctions of walls and slabs.

- (d) After two days of proper curing applying a second coat of cement slurry admixed with proprietary water proofing compound conforming to IS: 2645.
- (e) Finishing the surface with 20mm thick joint less cement mortar of mix 1:4 (1 cement : 4 coarse sand) admixed with proprietary water proofing compound conforming to IS: 2645 and finally finishing the surface with trowel with neat cement slurry and making of 300 x 300 mm square.
- (f) The whole terrace so finished shall be flooded with water for a minimum period of two weeks for curing and for final test. All above operations to be done in order and as directed and specified by the Engineer-in-charge.

With average thickness of 120 mm and minimum thickness at khurra at 65 mm.

15.2.10 CABLE TRENCH IN GIS HALL

All cable trenches in GIS hall shall be covered with minimum 6mm thick MS chequered plate with suitable stiffeners and aluminium painting.

15.2.11 DOORS AND WINDOWS

The details of doors and windows of the control room building shall be as per finish schedule Table-1 conforming to relevant IS code. Rolling steel shutters and rolling steel grills shall be provided as per layout and requirement of buildings. Frameless glass (12mm thick) door with glass handle and locking arrangement shall be provided at the main entrance of control room building and entrance door of control room. Main entrance door of the control room building shall be double leaf sliding type. Etching pattern on glass of door shall be got approved.

The main control room door and GIS building entrance door shall be provided with access control system and entry shall be restricted through access cards.

15.2.12 PARTITION

Partitions, if required, shall be made of anodised aluminum frame provided with 5.5 mm thick etched glass (as per approved pattern) up to the roof and pre-laminated board up to 600mm above floor.

15.2.13 STAIRCASE

Granite (18mm thick) shall be provided in risers as well as treads. Railing shall be 50mm dia, 14 gauge of stainless steel pipe with stainless steel balusters and 12mm thick toughened glass 600mm high with etching on both sides of staircase between balusters.

15.2.14 PLUMBING & SANITATION

- i. All plumbing and sanitation shall be executed to comply with the requirements of the appropriate bye-laws, rules and regulations of the Local Authority having jurisdiction over such matters. The Contractor shall arrange for all necessary formalities to be met in regard to inspection, testing, obtaining approval and giving notices etc.
- ii. PVC "SYNTEX" or equivalent make Roof water tank of adequate capacity depending on the number of users for 24 hours storage shall be provided. Minimum 2 Nos 1500 litres capacity shall be provided.
- iii. Galvanised MS pipe of medium class conforming to IS: 1239 shall be used for internal & external piping work for potable water supply.
- iv. Sand CI pipes with lead joints conforming to IS: 1729 shall be used for sanitary works above ground level.

- v. Each toilet shall have the following minimum fittings.
- WC (Western type) 390 mm high with toilet paper roll holder and all fittings in toilets attached to conference and sub-station in charge office and WC (Indian Type) Orissa Pattern (580 x 440 mm) with all fittings shall be provided in common toilets.
 - Urinal (430 x 260 x 350 mm size) with all fittings.
 - Wash basin (550 x 400 mm) with all fittings.
 - Bathroom mirror (600 x 450 x 6 mm thick) hard board backing.
 - CP brass towel rail (600 x 20 mm) with C.P. brass brackets
 - Soap holder and liquid soap dispenser.
 - All urinals and washbasins shall be provided with built in sensors to regulate the flow of water.
- vi. Water cooler for drinking water with adequate water storage facility shall be provided and located near control room and not near toilet block.
- vii. 1 no. stainless steel kitchen sink with Drain board (510 x 1040 x 178 mm bowl depth) for pantry shall be provided.
- viii. All fittings, fastener, grating shall be chromium plated.
- ix. All sanitary fixtures and fittings shall be of approved quality and type manufactured by well known manufacturers. All items brought to site must bear identification marks of the type of the Manufacturer.
- x. Soil, waste and drain pipes, for underground works shall be stone ware for areas not subject to traffic load. Heavy duty cast iron pipes shall be used otherwise.
- 15.2.15 The Furniture of Godrej/ Rittal/ Pyrotech should be supplied by the contractor for control room and other rooms for executives & non-executives. The make, size & other details should be decided during detail engineering.

For 220 kV Substations

Control room table	1 no.
Tables for executives	2 nos.
Tables for non-executives	3 nos.
Chairs	19 nos.
Lockers	16 nos.
Almirah	3 nos.
Conference room equipped with projector & screen of latest configuration along with conference table with chairs for 10 persons	1 set

- 15.2.16 a) Control room table: Control room table shall be free standing table top type. The table top of the control room table shall be arc shaped for mounting monitors, keyboards and printers. It shall have concealed cable & wire way management system. The top surface of control room table shall be 30 mm thick with the top 12 mm of acrylic solid surface and the remaining 18 mm of laminated medium density fibre board. It shall consists of vertical, horizontal and base supports with their coverings for work surface, keyboard trays, mouse pads, monitors and concealed cable & wire way management, perforated trays with covers in both horizontal and vertical directions. Sliding keyboard trays shall be provided on the control room table. The CPU's shall be located separately on PC racks. The table shall be arranged in continuous arc shape. The exact profile of the control room table, dimensions, material, construction details etc. shall be as per the actual requirement and shall be finalized during detailed engineering.
- b) Chairs: Industry standard revolving chairs with wheels and with provision for adjustment of height (hydraulically/ gas lift) shall be provided for the operators, sub station in-charge and other personal in control room building. These shall be designed for sitting for long duration such that these are plate covered with poly-propylene cladding. Arm-rests in one piece shall be of poly-urethane and twin wheel castor of glass filled nylon. The exact details shall be finished & approved by Employer during detailed engineering.
- c) Tables:
- (i) Industry standard Executive & non Executive tables shall be provided & shall be as approved by Employer during detailed engineering.
 - (ii) Conference room standard tables shall be provided with acrylic coat for good finish. Details shall be finalized & approved by Employer during detailed engineering.
- d) Lockers: Suitable lockers shall be provided in the control room building for storing of personal articles of sub station personal. Details shall be finalized and approved by employer during detailed engineering.
- e) Almira: Steel Almirahs shall be provided for keeping documents in the control room building. The exact details and location shall be finalized and approved by employer during detailed engineering.

15.3 INTERNAL ELECTRIFICATION

Electrical wiring shall be through heavy duty concealed conduits. All fixtures and wiring shall be of best quality and ISI marked. (Fixtures shall be provided as per provision of energy conservation act), CFL Type.

- 15.4 All rooms like office, Conference/Library, Control Room, SCADA Room & Reception Lobby of Control Room Building shall be provided with provisions compatible with telephone, computer etc. as per approved layout plan during detailed engineering stage.
- 15.5 Car/scooter shed as per drawing/design as submitted by contractor of size 10X3.5M approx. and approved by engineer-in-charge with frame of steel pipes etc. and with polycarbonate sheet proofing is to be provided near control room as per concept layout plan prepared by contractor and approved by DTL.

16.0 BUILDING STORM WATER DRAINAGE FOR ALL BUILDINGS

The building drain shall be provided for the collection of storm water from the roofs. This water shall be collected in junction boxes and these boxes shall drain to the main drainage system of the station.

PVC with 10kg/cm² pressure rain water down comers with water tight joints shall be provided to drain off the rain water from the roof. These shall be suitably concealed with masonry work of cement

concrete or cladding material. The number and size of down comers shall be governed by IS:1742 and IS:2527.

All drains inside the buildings shall have minimum 40 mm thick grating covers and in areas where heavy equipment loads would be coming, precast RCC covers shall be provided in place of steel grating.

For all buildings, suitable arrangement for draining out water collected from equipment blow down, leakages, floor washings fire fighting etc. shall be provided for each floor.

17.0 SWITCHYARD CIVIL WORKS

17.1 SCOPE

The scope under this item covers all structural and civil works associated with successful erection and commissioning of station switchyard. The details of scope are as follows. This is only guideline and shall not be taken as exhaustive.

- (1) Design, engineering, fabrication, proto-assembly, supply and erection of galvanized steel structures for lighting-cum-lightening mast, towers, beams/girders and equipment support structures, Towers, girders, lighting/lightening mast and equipment support structures shall be lattice type structure fabricated from structural steel conforming to IS 2062 (latest). All galvanized lattice structures shall be inclusive of all fixtures such as nuts, bolts, hangers, shackles, clamps, ant l-climbing device, danger and phase plates, inserts in concrete, foundation bolts, base plates, cap plates, stiffeners, dampers fixtures, for supporting of operating mechanism boxes, control cabinet and any other item to complete the job.
- (2) Design engineering, fabrication, supply, erection and painting of supports, embedment in cable trenches, bolts and nuts and any other accessories required to complete the job.
- (3) Excavation, dewatering, carriage of excavated earth materials, PCC mud mat piling, casting of concrete foundations pile caps, backfilling etc.
- (4) Design, Engineering, excavation, dewatering, carriage of excavated earth, P.C.C. mudmat, construction of R.C.C. cable trench and pipe trenches with necessary precast R.C.C. covers with lifting facilities, sump pit, etc. wherever trenches cross road or rail track the sections below such crossings shall be designed as per Indian Road Congress or Indian Railway Specification. Drainage of the trenches shall be suitably designed.
- (5) Drainage of the area is also in Bidder's scope. It may be noted that the cable trench should not be used for drainage purpose.
- (6) Drainage of the area in the switchyard is in bidder scope. The drainage water should be collected in suitable sump and arrangements for pumping out water including the provision of pump and pump house is in the bidder scope.
- (7) Cable trenches / drains should be provided with RCC trench covers with angle iron nosing all round. Thickness of the trench covers should not be less than 50mm. All trench covers should be provided with suitable arrangement for lifting.
- (8) The cable trenches shall be provided with suitable hangers and cable tray with proper earthing to support the cables.
- (9) All foundations for the switchyard structures shall be designed as per relevant IS:4091 "Code of practice for design and construction of foundations for transmission line towers and poles" and 13:456 (latest) "Code of practice for plain and reinforced concrete".
- (10) The finished level of the Civil Works in the grid sub-station should be fixed in relation to the outside road(Municipal Road) as under:

i) Outside road (Municipal Road) Final finished level after metalling	100.00M (Reference Point)
ii) Formation level	100.20M
iii) Yard level	100.35M
iv) Inside roads and top of trenches in yard	100.45M
v) Equipment foundations	100.50M
vi) plinth level of the control room building	101.20M

18.0 SUBSTATION BOUNDARY WALL:

1. The scope is to cover design, preparation of drawings for boundary wall, MS gate along with concertina coil on boundary wall and security room at entrance gate.
2. The height of boundary wall shall be 2.7M from FGL and 610mm dia concertina coil over boundary wall fixed with arrangement of Y shape angle grouted on RCC columns.
3. The boundary wall structure shall be RCC (M-25 grade) frame with 23cm brick filling in panels in cement mortar 1:4 (1 cement: 4 coarse sand).
4. For design of boundary wall, security room relevant IS code shall be followed.
5. The foundation of boundary wall and security room shall be designed as per site requirement.
6. The boundary wall and security room shall be finished with 12mm/15mm cement plaster mix 1:4 and acrylic smooth exterior paint on base of white cement base putty minimum thickness 1mm. Painting with synthetic enamel paint on steel work.

19.0 MISCELLANEOUS GENERAL REQUIREMENTS

- (1) Dense concrete with controlled water cement ratio as per IS-code shall be used for all underground concrete structures such as pump-house, tanks, water retaining structures, cable and pipe trenches etc. for achieving water-tightness.
- (2) All joints including and expansion joints for the water retaining structures shall be made water tight by using PVC ribbed water stops with central bulb. However, kicker type (externally placed) PVC water stops shall be used for the base slab and in other areas where it is required to facilitate concreting. The minimum thickness of PVC water stops shall be 5 mm and minimum width shall be 230mm.
- (3) All underground water retaining concrete structures shall have water proofing cement additive conforming to IS:2645 water proofing for walls and base slab of all underground concrete structures like basements pump houses etc. shall be by "Injection Method".
- (4) Bricks having minimum 75 kg/cm² compressive strength can only be used for masonry work. Contractor shall ascertain himself at site regarding the availability of bricks of minimum 75kg/cm² compressive strength before submitting his offer. All brick work shall be designed as per latest Indian standards and shall be plastered on both faces. All brick walls shall be minimum 230mm thick (excluding plaster). All RCC ceiling shall be plastered with 6 mm thick plaster.
- (5) All roofs shall have heavy duty water proofing with roof insulation and grading under bed which shall be provided to give an ultimate run off gradient of not less than 1:100 to effectively dispose off the rain water. The minimum height of RCC parapets on roof shall be 900mm and the thickness shall be 100mm (exclusive of plaster) and plaster shall be provided on both faces.
- (6) Rain water down comers shall be concealed either in brick work by encasing in cement concrete or by any other suitable arrangement with approval of Engineer-in-Charge.
- (7) All roofs shall be provided with access through staircase.

- (8) All buildings shall have 750mm wide plinth protection all round.
- (9) Monorails, Monorail girders and fixtures shall be provided by the Bidder wherever required.
- (10) The scope of drainage of surface/storm water drainage shall include layout and construction of drains, including culverts and connection of drains to the trunk drains including making good the connections of these plant drains with trunk drains.
- (11) The scope of disposal of foul water from toilets shall include layout and laying of all sewers for sewerage system including all fittings and fixtures ancillary works such as connections manholes inspection chambers, etc. and disposal thereof to the nearest existing Municipal drain provision of Septic tank and Soak pit. Manholes shall be provided by the Bidder at all the junctions of sewer lines with trunk sewerage line.
- i. All the trenches inside the control room building will be covered with 6mm thick M.S. Chequered plates of suitable sizes. The walls of the trenches will be provided with suitable angle iron nosing for placement of the chequered plates. Suitable M.S. iron hangers will be provided in the trenches.
 - ii. All foundations embedment, inserts, blockouts required for equipments shall be provided by bidder.
 - iii. 50mm thick DPC shall be provided before laying of masonry.
 - iv. All steel section and fabricated structures which are required to be transported by sea shall be provided with anti corrosive paint to take care of sea worthiness.
 - v. All mild steel parts used in the water retaining structures shall be hot-double dip galvanized. The minimum coating of the zinc shall be 750 gm/sq. m. for galvanized structures and shall comply with IS:2629 and IS:2633. Galvanizing shall be checked and tested in accordance with IS:2633. The galvanizing shall be followed by the application of an etching primer and dipping in black bitumen in accordance with BS:3416.
 - vi. A screed concrete layer not less than 100 mm thick and of grade not weaker than M10 conforming to IS:456-2000 shall be provided below all water retaining structures. A sliding layer of bitumen paper or craft paper shall be provided over the screed layer to destroy the bond between the screed and the base slab concrete of the water retaining structures.
 - vii. Doors and windows on external walls of the buildings (other than areas provided, with insulated metal claddings) shall be provided with RCC sunshade over the openings with 300 mm projection on either side of the openings. Projection of sunshade from the wall shall be minimum 450 mm over window openings and 750 mm over door openings.
 - viii. All stairs shall have maximum riser height of 150 mm and a minimum tread width of 300 mm. Minimum width of stairs shall be 1500 mm.
 - ix. Angles 50x50x6 mm (minimum) with lugs shall be provided for edge protection all round cut outs/openings in floor slab, edges of drains supporting grating covers, edges of RCC cable/pipe trenches supporting covers, edges of manholes supporting covers, supporting edges of manhole precast cover and any other place where breakage of corners of concrete is expected.
 - x. Anti termite chemical treatment shall be given to column pits, wall trenches, foundations of buildings, filling below the floors etc. as per IS:6313 and other relevant Indian Standards.
 - xi. Hand-railing minimum 900mm high shall be provided around all floor/roof openings, projections/ balconies, walk ways, platforms, steel stairs etc. All handrails and ladder pipes shall be 32 mm nominal bore MS pipes (medium class) and shall be galvanized (medium-class as per IS:277). All rungs for ladder shall also be galvanized as per IS:277 medium class. For RCC stairs, hand railing with 20 mm square MS bars, balustrades with suitable MS flats & aluminium handrails shall be provided.
 - xii. Items/components of buildings not explicitly covered in the specification but required for completion of the project shall be deemed to be included in the scope.

- xiii. Bidders shall submit following documents for the proposed buildings along with the offer:
- Architectural floor plans, elevations, cross-sections and perspective view in colour of all buildings. (Bidder shall submit three different schemes).
 - Blow-up sketch of any typical detail.
 - Finishing schedules of both material and colour for both internal and external areas.

(12) As per the directions of Govt. of NCT of Delhi, it has been made mandatory to use following recycled Construction & Demolition waste products as a first choice in all the construction/civil works in the city of Delhi by Private and Govt. agencies:

List of Recycled C&D Products

- Kerb Stone (side of roads)
- Paving blocks, interlocking tiles and drain covers (pedestrian areas and gardens).
- Cold molded bricks (for non load bearing structures such as wall between RCC columns, small to medium height fencing walls, partition walls without additional load, etc.).
- Manufactured sand (4.75 mm to 75 u size) - for non structural purposes.
- GSB (Granular Sub Base) and BSB (Brick Sub Base) up to 65mm size for road work especially for urban roads. For rural roads up to 30% can be from recycled GSB.
- Recycled concrete aggregate can be used in all grades of plain Cement Concrete (PCC) for non structural use.
- Recycled aggregates (coarse as well as fine) can be used 100% for lean concrete (less than M15 grade).
- Use of soil recovered from mixed C&D for filling purpose (road and embankment making).

Accordingly, it is mandatory to use a minimum of 2% processed/recycled products from C&D waste for building works and 10% processed/recycled products from C&D waste for road works. Such processed/recycled C&D waste shall be procured only from the manufacturers who have been authorized for the purpose either by the Delhi Pollution Control Committee or Urban Local Bodies or other Delhi govt. agencies.

20.0 INTERFACING

The proper coordination & execution of all interfacing civil works activities like fixing of conduits in roofs/walls/floors, fixing of foundation bolts, fixing of lighting fixtures, fixing of supports/ embedment, provision of cut outs etc. shall be the sole responsibility of the Contractor. He shall plan all such activities in advance and execute in such a manner that interfacing activities do not become bottlenecks and dismantling, breakage etc. is reduced to minimum.

21.0 WATER SUPPLY

- Water and electricity shall be arranged by the contractor at his own cost.
- The contractor shall carry out all the plumbing/erection works required for supply of water in control room building.
- The contractor shall carry out all the plumbing/erection works required for supply of water to all switch yard buildings.
- The details of tanks, pipes, fittings, fixtures etc for water supply shall be approved by engineer in charge.
- A scheme shall be prepared by the contractor indicating the layout and details of water supply which shall be got approved by the Purchaser before actual start of work including all other incidental items not shown or specified but as may be required for complete performance of the works.
- Bore wells and pumps for water supply are in the scope of contractor.

22.0 SEWERAGE SYSTEM

- Sewerage system shall be provided for control room building cum administrative building.
- The Contractor shall construct septic tank and soak pit suitable for 50 users for sub station if the municipal sewer in the vicinity does not exists. In case municipal sewer line is available in the area, the connection of sewerage system of switch yard building with municipal sewer shall be in the scope of bidder.
- The system shall be designed as per relevant IS Codes.

23.0 STATUTORY RULES

- (1) Contractor shall comply with all the applicable statutory rules pertaining to factories act (as applicable for the State). Fire Safety Rules of Tariff Advisory Committee. Water Act for pollution control etc.
- (2) Provisions for fire proof doors, number of staircases, fire separation wall, plastering on structural members (in fire prone areas) etc. shall be made according to the recommendations of Tariff Advisory Committee.
- (3) Statutory clearance and norms of State Pollution Control Board shall be followed as per Water Act for effluent quality from plant.
- (4) Requirement of sulphate resistant cement (SRC) for sub structural works shall be decided in accordance with the Indian Standards based on the findings of the detailed soil investigation to be carried out by the Bidder.
- (5) Foundation system adopted by Bidder shall ensure that relative settlement and other criteria shall be as per provision in IS:1904 and other Indian Standards.
- (6) All water retaining structures designed as uncracked section shall also be tested for water tightness at full water level in accordance with clause no. 10 of IS:3370 (Part-I).
- (7) Construction joints shall be as per IS: 456-2000.
- (8) All underground concrete structures like basements, pumps houses, water retaining structures etc. shall have plasticizer cum water proofing cement additive conforming to IS:9103. In addition, limit on permeability as given in IS:2645 shall also be met with. The concrete surface of these structures in contact with earth shall also be provided with two coat of bituminous painting for water/damp proofing. In case of water leakage in the above structures, Injection Method shall be applied for repairing the leakage.
- (9) All building/construction materials shall conform to the best quality specified in CPWD specifications if not otherwise mentioned in this specification.
- (10) All tests as required in the standard field quality plans have to be carried out.
- (11) The type and treatment of all foundation shall be as per recommendation of geo-technical investigation reports.

24.0 FIELD QUALITY PLAN FOR CIVIL WORKS

The field quality plan for all civil works shall be in accordance with CPWD specification and other relevant Indian Standard Codes. All quality checks and procedures shall be followed as per relevant CPWD norms.

SECTION-XIII

SUBSTATION AUTOMATION

TECHNICAL SPECIFICATIONS OF SUBSTATION AUTOMATION SYSTEM (SAS)

1.0 SCOPE

1.1. The Substation Automation System (SAS) shall be installed to control and monitor all the sub-station equipment from Centralised Control Centre (CCC) & State Load Dispatch Centre (SLDC) as well as from local control centre.

1.2. The SAS shall contain the following main functional parts:

- a) Bay Control Unit (BCU), Intelligence Electronic Devices (IEDs), RTUs, Phasor measurement units (PMUs) for control, interlocking, measurement and monitoring.
- b) Redundant Station Human Machine Interface (HMI) with industrial grade servers
- c) Redundant managed switched Ethernet Local Area Network communication infrastructure with hot standby.
- d) Redundant Gateway for remote monitoring and control via industrial grade hardware (to CCC) through Secure IEC 60870-5-104 protocol. Number of Ports shall be as per requirement of CCC.
- e) Redundant Gateway for remote monitoring and control via industrial grade hardware (to SLDC), the gateway should be able to communicate with SLDC on IEC 60870-5-104 protocol. It shall be the bidder's responsibility to integrate his offered system with existing SLDC system for exchange of desired data.
- f) DR / Engineering PCs, as specified.
- g) Remote HMI and work station along with necessary printers, only if specified as requirement by the owner.
- h) Peripheral equipment like printers, display units, key boards, Mouse etc.

1.3. It shall enable local station control via a PC by means of human machine interface (HMI) and control software package, which shall contain an extensive range of supervisory control and data acquisition (SCADA) functions.

- 1.4. It shall include communication gateway, intelligent electronic devices (IED) for bay control, protection and monitoring and inter IED communication infrastructure. An architecture drawing for SAS is enclosed.
- 1.5. The communication gateway shall facilitate the information flow with remote control centres. The bay level intelligent electronic devices (IED) for protection and control shall provide the direct connection to the switchgear without the need of interposing components and perform control, protection, and monitoring functions.
- 1.6. The Sub-station Automation system being offered shall generally confirm to provision of IEC 62351, IEEE1686 and NERC CIP (applicable part such as CIP 003, CIP-005, and CIP-007) for cyber security.
- 1.7. Portability & Interoperability: The system shall be designed for hardware independence and operation in a network environment that facilitates interoperability and integration of third-party applications of different versions.

2. REFERENCES

The standards given below contain provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of these standards.

IS/IEC No.	Title
IS/IEC 61850	Communication networks and systems for power utility automation - ALL PARTS
IS/IEC 61850-3: 2013	Communication Networks and Systems for Power Utility Automation Part 3 General Requirements
<u>IS/IEC/TS 62351 (all parts)</u>	Power Systems Management and Associated Information Exchange - Data and Communications Security (all parts)

IEC 60870-5-101	Tele control equipment and systems - Part 5-101: Transmission protocols - Companion standard for basic tele control tasks
IEC 60870-5-104	Tele control equipment and systems - Part 5-104: Transmission protocols - Network access for IEC 60870-5-101 using standard transport profiles
IEC 62351	Power systems management and associated information exchange - Data and communications security
IEC 62443	Industrial communication networks - Network and system security

The design, material, testing and commissioning of substation automation system shall comply with all latest & currently applicable statutes, regulations and safety codes in India. The material shall also conform to the latest applicable codes & standards.

Except as noted, all the equipment and accessories shall be designed, manufactured tested and offered conforming the requirements of the latest editions of relevant codes & standards.

National standards will be acceptable only if they are established to be equivalent or superior to referred standards. In all such cases, copies of English translation of all such standards shall be enclosed with the bid.

In the event of any conflict between the codes and standards referred to in this specification and the requirement of this specification, the latest revision of standard shall prevail.

3. SYSTEM DESIGN

3.1 General System Design

The Substation Automation System (SAS) shall be suitable for operation and monitoring of the complete substation including future extensions as specified by the owner.

The systems shall be of the state-of-the art suitable for operation under electrical environment present in Extra high voltage substations, follow the latest engineering practice, ensure long-term compatibility requirements and continuity of equipment supply and the safety of the operating staff.

The offered SAS shall support remote control and monitoring from Remote Control centres via gateways.

The system shall be designed such that personnel without any background knowledge in Microprocessor-based technology are able to operate the system. The operator interface shall be intuitive such that operating personnel shall be able to operate the system easily after having received some basic training.

The system shall incorporate the control, interlocking, measurement, monitoring and protection functions specified, self-monitoring, signalling and testing facilities, measuring as well as memory functions, event recording and evaluation of disturbance records. It shall also have provisions for inhibiting control on any or all devices for purpose of maintenance. The devices under maintenance shall be provided with tags which shall include provision for entering text (256 characters).

Maintenance, modification or extension of components may not cause a shutdown of the whole substation automation system. Self-monitoring of components, modules and communication shall be incorporated to increase the availability and the reliability of the equipment and minimize maintenance.

IP addressing of the system shall be as per the IP plan provided by the owner.

The system shall be remotely accessed for control, monitoring, operation and collection of disturbance records and hence shall be provided with a firewall/router/ layer-3

switches (Preferred) to comply at least with the requirements of CIP-005, CIP-007 (Critical infrastructure protection) standard as per NERC (North American Electric Reliability Council) and Cyber Security based on IEC62351, IEC62443-3-3, and NERC-CIP. Vendors shall be certified at least for bronze level practice certification -IEC62443-2-4.

Bay level unit (a bay comprises of one circuit breaker and associated disconnectors, earth switches and instrument transformer), bay mimic along with relay and protection panels and DPC panels (to be described in other sections of technical specifications by the owner) in air-conditioned Switchyard Panel Room suitably located in switchyard (GIS hall relay room in case of GIS s/s) and Station HMI in Control Room building for overall optimisation in respect of cabling and control room building.

3.2 System Architecture

The SAS shall be based on a decentralized architecture and on a concept of bay-oriented, distributed intelligence.

Functions shall be decentralized, object-oriented and located as close as possible to the process.

The main process information of the station shall be stored in distributed databases. The typical SAS architecture shall be structured in two levels, i.e. bay level and station level.

At **Bay Level**, the IEDs shall provide all bay level functions regarding control, monitoring and protection, inputs for status indication and outputs for commands. The bay level intelligent electronic devices (IED) for protection and control shall provide the direct connection to the switchgear without the need of interposing components and perform control, protection, and monitoring functions.

Each bay control IED shall be independent from each other and its functioning shall not be affected by any fault occurring in any of the other bay control units of the station.

The data exchange between the electronic devices on bay and station level shall take place via the communication infrastructure. This shall be realized using fibre-optic cables, thereby guaranteeing disturbance free communication. The fibre optic cables shall be run in G. I. conduit pipes / HDPE pipes. Data exchange is to be realised using the

protocols defined and standardized in the latest edition of IEC 61850 with a redundant managed switched Ethernet communication infrastructure. The modelling of various aspects of Substation Automation System, like, Data Objects, Data Attributes, Logical Nodes, etc. shall be according to the latest edition of IEC 61850.

The communication shall be made in fault tolerant ring, excluding the links between individual bay IEDs to switch wherein the redundant connections are not envisaged, such that failure of one set of fibre shall not affect the normal operation of the SAS. However failure of fibre shall be alarmed in SAS. Each fibre optic cable shall have four (4) spare fibres.

The typical architecture for SAS is enclosed as Annexure 4.

At Station Level, the entire station shall be controlled and supervised from the station HMI. It shall also be possible to control and monitor the bay from the bay level equipment at all times.

Clear control priorities shall prevent operation of a single switch at the same time from more than one of the various control levels, i.e. CCC, station HMI, bay level or apparatus level. The priority shall always be on the lowest enabled control level.

The station level contains the station-oriented functions, which cannot be realised at bay level, e.g. alarm list or event list related to the entire substation, gateway for the communication with remote control centres.

The GPS time synchronising signal (as specified by the owner) for the synchronization of the entire system shall be provided and shall be capable for IEC 61850 Ed.2.0 IEDs.

Energy meters with Mod-bus /Open DLMS (Device Language Message Specification) protocol shall be connected to SCADA F.O. network through appropriate converter to have metering data to dedicated computer in control room.

The SAS shall contain the functional parts as described in **1.2** above.

3.3 FUNCTIONAL REQUIREMENTS

The high-voltage apparatus within the station shall be operated from different places:

- Remote control centres
- Station HMI.
- Local Bay controller IED (in the bays)

Operation shall be possible by only one operator at a time with the priority to the lowest enabled control level.

The operation shall depend on the conditions of other functions, such as interlocking, synchro-check, control-inhibit tags etc. (see description in ``Bay level control function’’).

3.3.1 Select-Before-Execute

For security reasons the command is always to be given in two stages: selection of the object and command for operation under all mode of operation except emergency operation. Final execution shall take place only when selection and command are actuated.

3.3.2 Command Supervision

Bay/station interlocking and blocking

Software Interlocking is to be provided to ensure that inadvertent incorrect operation of switchgear causing damage and accidents in case of false operation does not take place.

In addition to software interlocking hardwired interlocking are to be provided for:

- (a) Bus Earth switch Interlocking
- (b) Transfer Bus interlocking (if applicable)

It shall be a simple layout, easy to test and simple to handle when upgrading the station with future bays. For software interlocking the bidder shall describe the scenario while an IED of another bay is switched off or fails.

A software interlock override function shall be provided which can be enabled to bypass the interlocking function.

3.3.3 Run Time Command Cancellation

Command execution timer (configurable) must be available for each control level connection. If the control action is not completed within a specified time, the command should get cancelled and an alarm shall be generated to indicate the failure of command.

3.3.4 Self-Supervision

Continuous self-supervision function with self-diagnostic feature shall be included. The redundant components such as servers, gateway shall monitor each other for availability and the active device shall takeover all the functions of the failed device. This failover shall happen within 30 seconds. The events occurring when a server is in failed state shall be synchronised from the active server.

4 SUBSTATION AUTOMATION SYSTEM (SAS) FUNCTIONS, FEATURES & USER CONFIGURATION

The monitoring, controlling and configuration of all input and output logical signals and binary inputs and relay outputs for all built-in functions and signals shall be possible both locally and remotely.

It shall also be possible to interconnect and derive input and output signals, logic functions, using built-In functions, complex voltage and currents, additional logics (AND-gates, OR gates and timers). (Multi-activation of these additional functions should be possible).

4.1. Bay Level Functions

In a decentralized architecture the functionality shall be as close to the process as possible. In this respect, the following functions can be allocated at bay level:

- a) Bay control functions including data collection functionality in bay control/protection unit.
- b) Bay protection functions

Separate IEDs shall be provided for bay control function and bay protection function.

4.1.1. Bay Control Functions

4.1.1.1. Overview of functions

- a) Control mode selection
- b) Select-before-execute principle
- c) Command supervision:
 - i) Interlocking and blocking
 - ii) Double command
- d) Synchro check, voltage selection
- e) Run Time Command cancellation
- f) Transformer tap changer control (Raise and lower of tap) (for power transformer bays)
- g) Transformer Master/follower selection
- h) Operation counters for circuit breakers and pumps
- i) Hydraulic pump/ Air compressor runtime supervision
- j) Operating pressure supervision through digital contacts only
- k) Breaker position indication per phase
- l) Alarm annunciation
- m) Measurement display
- n) Local HMI (local guided, emergency mode)

- o) Interface to the station HMI.
- p) Data storage for at least 200 events
- q) Auto-reclose mode selection (Non-Auto/1-phase etc.)
- r) Protection transfer switch control (for Transfer Bus scheme arrangement)
- s) Monitoring of Gas Tight Chambers in GIS
- t) Monitoring of temperature of Transformer and Reactor
- u) Monitoring of Multi gas output of Transformer and Reactor gas analyser
- v) Any other requirement specified elsewhere in the specification.
- w) Switchgear position

4.1.1.2. Control mode selection

Bay level Operation:

As soon as the operator receives the operation access at bay level the operation is normally performed via bay control IED. During normal operation bay control unit allows the safe operation of all switching devices via the bay control IED.

EMERGENCY Operation

It shall be possible to close or open the selected Circuit Breaker with ON or OFF push buttons even during the outage of bay IED. All the interlocks shall be get bypassed under such circumstances.

REMOTE mode

Control authority in this mode is given to a higher level (Remote Control Centre/Station HMI) and the installation can be controlled only remotely. Control operation from lower levels shall not be possible in this operating mode.

4.1.1.3. Synchronism and energizing check

The synchronism and energizing check functions shall be bay-oriented and distributed to the bay control and/or protection devices. These features are:

- Settable voltage, phase angle, and frequency difference.
- Energizing for dead line - live bus, live line - dead bus or dead line – dead bus with no synchro-check function.
- Synchronising between live line and live bus with synchro-check function

4.1.1.4. Voltage selection

The voltages relevant for the Synchro check functions are dependent on the station topology, i.e. on the positions of the circuit breakers and/or the isolators. The correct voltage for synchronizing and energizing is derived from the auxiliary switches of the circuit breakers, the isolator, and shall be selected automatically by the bay control and protection IEDs.

4.1.1.5. Transformer tap changer control

Digital RTCCs shall be integrated with the SAS to provide Tap Changer Control functions.

4.1.1.6. Auto-reclose mode selection

Auto –reclose mode selection for each of the Circuit breaker shall be facilitated through bay controller IED.

4.1.1.7. Protection transfer switch control (As applicable)

Based on selection of isolator for double main with transfer switching scheme or single main with transfer switching scheme for the switchyard, the protection shall be transferred automatically with an alarm indication that protection is successfully transferred.

4.1.1.8. Monitoring of Gas Chambers in GIS Sub-stations

In case of a GIS sub-stations, all the gas tight chambers are required to be monitored individually phase wise for their SF6 gas density status by the bay

control unit in a bay. Sufficient numbers of inputs are required to be provided in the BCU. In case there is any limitation of number of inputs in the BCU, additional BCU are required to be provided without any cost implication to OWNER. These inputs shall be used for necessary monitoring, control and protection purpose.

4.1.2. Bay Protection Functions

4.1.2.1. General

The protection functions are independent of bay control function. The protection shall be provided by separate protection IEDs (numerical relays) and other protection devices as per specification of Protection system (to be specified separately by the Owner).

IEDs, shall be connected to the communication infrastructure for data sharing and meet the real-time communication requirements for automatic functions. The data presentation and the configuration of the various IEDs shall be compatible with the overall system communication and data exchange requirements.

Event and disturbance recording function

Each IED should contain an event recorder capable of storing at least 200 time-tagged events. Protection IED shall have built-in disturbance recorder function. Disturbance recorder as a standalone unit can also be specified by the Owner, if required. Disturbance recorder shall be used to record the graphic form of instantaneous values of voltage and current in all three phases, open delta voltage & neutral current, open or closed position of relay contacts, circuit breakers including relay internal digital signals during the system disturbances or trip event. Detailed specification of Disturbance recorder shall be separately specified by the owner. one set of evaluation software shall be supplied and loaded in DR/engineering work-station (evaluation unit) and Automatic downloading of disturbance files from IEDs to evaluation unit shall be done through station bus conforming to IEC 61850.

4.1.2.2. Bay monitoring function

Analogue inputs for voltage and current measurements shall be connected directly to the voltage transformers (VT) and the current transformers (CT) without intermediate transducers or through merging units. The values of active power (W), reactive power (VAR), frequency (Hz), and the rms values for voltage (U) and current (I) shall be calculated in the Bay control/protection unit.

4.2. Station Level Functions

4.2.1. Status Supervision

The position of each switchgear, e.g. circuit breaker, isolator, earthing switch, transformer tap changer, Transformer/Reactor Temperature, Transformer/Reactor Multi gas conditions, Temperature of Switchyard Panel Room, Ambient Temperature etc., shall be supervised continuously. Every detected change of position shall be immediately displayed in the single-line diagram on the station HMI screen, recorded in the event list, and a hard copy printout shall be produced. Alarms shall be initiated in the case of spontaneous position changes.

The switchgear positions shall be indicated by two auxiliary switches, normally closed (NC) and normally open (NO), which shall give ambivalent signals. An alarm shall be initiated if these position indications are inconsistent or if the time required for operating mechanism to change position exceeds a predefined limit.

The SAS shall also monitor the status of sub-station auxiliaries. The status and control of auxiliaries shall be done through separate one or more IED and all alarm and analogue values shall be monitored and recoded through this IED.

4.2.2. Measurements

The analogue values acquired/calculated in bay control/protection unit shall be displayed locally on the station HMI and in the remote control centre. The abnormal values must be discarded. The analogue values shall be updated based on the dead band settings and the same shall be demonstrated during FAT of the system.

Threshold limit values shall be selectable for alarm indications.

4.2.3. Event and Alarm Handling

Events and alarms are generated either by the switchgear, by the control IEDs, or by the station level unit. They shall be recorded in an event list in the station HMI. Alarms shall be recorded in a separate alarm list and appear on the screen. All, or a freely selectable group of events and alarms shall also be printed out on an event printer. The alarms and events shall be time-tagged with a time resolution of 1 ms. The tentative list for various feeders and systems are enclosed as Annexure-I.

4.2.4. Station HMI

4.2.4.1. Substation HMI operation

On the HMI the object has to be selected first. In case of a blocking or interlocking conditions are not met, the selection shall not be possible and an appropriate alarm/annunciation/notification shall occur. If a selection is valid the position indication will show the possible direction, and the appropriate control execution button shall be pressed in order to close or open the corresponding object.

Control operation from other places (e.g. CCCs) shall not be possible in this operating mode.

4.2.4.2. Presentation and dialogues

The operator station HMI shall be a redundant with hot standby and shall provide basic functions for supervision and control of the substation. The operator shall give commands to the switchgear on the screen via mouse clicks.

The HMI shall give the operator access to alarms and events displayed on the screen. Aside from these lists on the screen, there shall be a printout of alarms or events in an event log.

An acoustic alarm shall indicate abnormalities, and all unacknowledged alarms shall be accessible from the screen selected by the operator.

The following standard views shall be available from the HMI:

- a) Dynamic Single-line diagram (Overall as well as Voltage class wise) showing the switchgear status and measured values
- b) Voltage class wise detailed Gas SLD showing Gas tight compartments for GIS Substation
- c) Control dialogues with interlocking or blocking information details. This control dialogue shall tell the operator whether the device operation is permitted or blocked and also show the Interlocking logic with status.
- d) Dynamic Substation system architecture
- e) Measurement dialogues substation/ bay -oriented
- f) Alarm list, station / bay-oriented
- g) Event list, station / bay-oriented
- h) Bay wise detailed view for each bay comprising following
 - ✓ CB monitoring
 - ✓ Trip relay status & control
 - ✓ Synchronization status & control
 - ✓ Trip transfer switch status / control
 - ✓ A/R In-Out Status
 - ✓ Carrier In-Out status
 - ✓ PT selection status
 - ✓ Bus bar zone switching status
 - ✓ All protection function alarm
- i) Bus bar protection alarm
- j) Transformer / Reactor monitoring for DGA, FOTS, RTCC, Moisture drying etc.
- k) Substation AC-DC Auxiliary monitoring

- ✓ LT AC system
- ✓ DC system

l) Transformer/Reactor fire protection system

4.2.4.3. HMI design principles

Consistent design principles shall be adopted with the HMI concerning labels, colours, dialogues and fonts. Non-valid selections shall be dimmed out.

The object status shall be indicated using different status colours for:

- a) Selected object under command
- b) Selected on the screen
- c) Not updated, obsolete values, not in use or not sampled
- d) Alarm or faulty state
- e) Warning or blocked
- f) Update blocked or manually updated
- g) Control blocked
- h) Normal state
- i) Energised or de-energised state (based on substation topology)

4.2.4.4. Process status displays and command procedures

The process status of the substation in terms of actual values of currents, voltages, frequency, active and reactive powers as well as the positions of circuit breakers, isolators and transformer tap-changers shall be displayed in the station single-line diagram.

In order to ensure a high degree of security against undesired operation, a "select-before-execute" command procedure shall be provided. After the "selection" of a switch, the operator shall be able to recognize the selected device

on the screen, and all other switchgear shall be blocked. As communication between control centre and device to be controlled is established, the operator shall be prompted to confirm the control action and only then final execute command shall be accepted. After the “execution” of the command the operated switching symbol shall flash until the switch has reached its new position.

The operator shall be in a position to execute a command only, if the switch is not blocked and if no interlocking condition is going to be violated. The interlocking statements shall be checked by the interlocking scheme implemented at bay and station level.

After command execution the operator shall receive a confirmation that the new switching position has been reached or an indication that the switching procedure was unsuccessful with the indication of the reason for non-functioning.

4.2.4.5. System supervision & display

The SAS system shall be comprehensively self-monitored such that faults are immediately indicated to the operator, possibly before they develop into serious situations. Such faults are recorded as a faulty status in a system supervision display. This display shall cover the status of the entire substation including all switchgear, IEDs, communication infrastructure and remote communication links, and printers at the station level, etc. Interlocking status of switchgear shall be available for monitoring.

4.2.4.6. Event list

The event list shall contain events that are important for the control and monitoring of the substation.

The event and associated time (with 1ms resolution) of its occurrence has to be displayed for each event.

The operator shall be able to call up the chronological event list on the monitor at any time for the whole substation or sections of it.

A printout of each display shall be possible on the hard copy printer.

The events shall be registered in a chronological event list in which the type of event and its time of occurrence are specified. It shall be possible to store all events in the computer for at least one month. The information shall be obtainable also from a printed event log.

The chronological event list shall contain:

- a) Position changes of circuit breakers, isolators and earthing devices
- b) Indication of protective relay operations
- c) Fault signals from the switchgear
- d) Switchgear local / remote status (as applicable)
- e) Switchgear bypass position switch status (if applicable)
- f) Indication when analogue measured values exceed upper and lower limits. Suitable provision shall be made in the system to define two level of alarm on either side of the value or which shall be user defined for each measurement.
- g) Loss of communication.
- h) User actions (control/Tag placement/manual update) with USER identity
- i) System messages (Operator logging info, System supervision and device monitoring, failure of supervisory control etc.)

Filters for selection of a certain type or group of events shall be available. The filters shall be designed to enable viewing of events grouped per:

- a) Date and time
- b) Bay
- c) Device

- d) Function e.g. trips, protection operations etc.
- e) Alarm class

4.2.4.7. Alarm list

Faults and errors occurring in the substation shall be listed in an alarm list and must be displayed in a flashing state along with an audible alarm. After acknowledgement of the alarm, it should appear in a steady (i.e. not flashing) state and the audible alarm shall stop. The alarm should disappear only if the alarm condition has physically cleared and the operator has reset the alarm with a reset command. The state of the alarms shall be shown in the alarm list (Unacknowledged and persistent, Unacknowledged and cleared, Acknowledged and persistent).

Filters for selection of a certain type or group of alarms shall be available as for events.

In addition to the regular alarms, following alarms shall also be displayed and logged:

- a) Alarms shall be displayed on the HMI, for each device of SAS when they lose time synchronization.
- b) 'GOOSE Fail Alarm' shall be configured which shall be generated when any of the subscriber IEDs fails to receive any of the GOOSE messages. These alarms shall be mapped IED-wise in the station HMI.

4.2.4.8. Object picture

When selecting an object such as a circuit breaker or isolator in the single-line diagram, the associated bay picture shall be presented first. In the selected object picture, all attributes like

- a) Type of blocking/Control inhibit Tag
- b) Authority

- c) Local / remote control mode
- d) CCC / SAS control
- e) Errors, etc. shall be displayed.

4.2.4.9. Control dialogues

The operator shall give commands to the system by means of mouse click located on the single-line diagram. Data entry is performed with the keyboard. Dedicated control dialogues for controlling at least the following devices shall be available:

- a) Breaker and disconnector
- b) Transformer tap-changer
- c) Mode selection (L/R, Non-Auto/1-ph, Auto/Manual etc.)

4.2.5. User-authority levels

It shall be possible to restrict activation of the process pictures of each object (bays, apparatus...) within a certain user authorisation group. Each user shall then be given access rights to each group of objects, e.g.:

- a) Display only
- b) Normal operation (e.g. open/close of switchgear)
- c) Restricted operation (e.g. by-passed interlocking)
- d) System administrator

For maintenance and engineering purposes of the station HMI, the following authorisation levels shall be available:

- a) No engineering allowed
- b) Engineering/configuration allowed
- c) Entire system management allowed

The access rights shall be defined by passwords assigned during the log-in procedure. Only the system administrator shall be able to add/remove users and change access rights.

In case of non-activity for a pre-determined period (say 30 minutes), the system will automatically logged out the user and user has to log in again for doing any operation. Further each operation must be logged in in the event/alarm list along with the user name.

4.2.6. Reports

The reports shall provide time-related follow-ups of measured and calculated values. The data displayed shall comprise:

- a) Trend reports:
 - i) Day (mean, peak)
 - ii) Month (mean, peak)
 - iii) Semi-annual (mean, peak)
 - iv) Year (mean, peak)
- b) Historical reports of selected analogue Values:
 - i) Day (at 15 minutes interval)
 - ii) Week
 - iii) Month
 - iv) Year

It shall be possible to select stored values from the database in the process display on-line. Scrolling between e.g. days shall be possible. Unsure values shall be indicated. It shall be possible to select the time period for which the specific data are stored in the memory.

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

- a) Daily voltage and frequency curves depicting time on X-axis and the appropriate parameters on the Y-axis. The time duration of the curve is 24 hours.
- b) Weekly trend curves for real and derived analogue values.
- c) Printouts of the maximum and minimum values and frequency of occurrence and duration of maximum and minimum values for each analogue parameter for each circuit in 24 hr period.
- d) Provision shall be made for logging information about breaker status like number of operation with date and time indications along with the current value it interrupts (in both condition i.e. manual opening and fault tripping)
- e) Equipment operation details shift wise and during 24 hours.
- f) Printout on adjustable time period as well as on demand for MW, MVAR, Current, Voltage on each feeder and transformer as well as Tap Positions, temperature and status of pumps and fans for transformers.
- g) Printout on adjustable time period as well as on demand system frequency and average frequency.
- h) Reports in specified formats which shall be handed over to successful bidder. The bidder has to develop these reports. The reports are limited to the formats for which data is available in the SAS database.
- i) It shall be possible to generate user made reports based on measured/recorded values of various combination of parameters particularly for transformer and reactors for healthiness of equipment depending upon defined criterion. This generation of reports must be

user friendly and shall be easy to define.

All the utilities/tools used for building a report shall be provided with the system so that the owner is able to build new reports. The tools shall be user friendly with 'drag & drop' or 'menu based selection' features and shall not require any knowledge of programming.

The reports utility shall be configured such that reports requiring long duration data (yearly) shall not take more than 2 minutes and does not impact the other applications running in the system.

4.2.7. Trend Display (historical data)

It shall be possible to illustrate all types of process data as trends - input and output data, binary and analogue data. The trends shall be displayed in graphical form as column or curve diagrams with a maximum of 10 trends per screen. Adjustable time span and scaling ranges must be provided.

It shall be possible to change the type of value logging (direct, mean, sum, or difference) on-line in the window. It shall also be possible to change the update intervals on-line in the picture as well as the selection of threshold values for alarming purposes.

4.2.8. Automatic Disturbance File Transfer

All recorded data from the IEDs with integrated disturbance recorder as well as dedicated disturbance recording systems shall be automatically uploaded (event triggered and once per day in case no event during the day) to a dedicated computer and be stored on the hard disc in specified folders. Disturbance reports shall be accessible to Remote Control Centre also

4.2.9. Disturbance Analysis

The PC-based work station shall have necessary software to evaluate all the required information for proper fault analysis.

4.2.10. IED Parameter Setting

It shall be possible to access all protection and control IEDs for reading the parameters (settings) from the station HMI or from a dedicated monitoring computer. The setting of parameters or the activation of parameter sets shall only be allowed after entering a password.

4.2.11. Automatic Sequences

The available automatic sequences in the system should be listed and described, (e.g. sequences related to the bus transfer in a GIS). It must be possible to initiate pre-defined automatic sequences by the operator and also define new automatic sequences. The automatic sequencing is required to be developed at SCADA level.

4.3. GATEWAY

4.3.1 Communication Interface

The Substation Automation System shall have the capability to support simultaneous communications with multiple independent remote master stations. The gateways shall be compatible to the BCUs/IEDs supporting interoperability as per relevant IECs.

The Substation Automation System shall have communication ports on each gateway (two gateways per station) as follows:

- (a) Four ports for Remote Control Centres on Secure IEC 60870-5-104 protocol.
- (b) One port for IEC 60870-5-104 for Regional System Coordination Centre (SLDC)

(No. of ports shall be user specific)

The communication interface to the SAS shall allow scanning and control of defined points within the substation automation system independently for each

control centre. The substation automation system shall simultaneously respond to independent scans and commands from owner's control centres (CCCs & SLDC). The substation automation system shall support the use of a different communication data exchange rate (bits per second), scanning cycle, and/or communication protocol to each remote control centre. Also, each control centre's data scan and control commands may be different for different data points within the substation automation system's database.

The Gateway shall collect the IEC 61850 data directly from the IEDs through Ethernet switches, without using any other intermediate interface or network device, and should be implemented in a separate hardware, so that the failure of the local SCADA Server would not impact the remote communication through the Gateway.

The Gateway shall identify the actions performed by the each of the remote masters individually and log it in its database. The logs for last 30 days shall be stored and accessible at the Station HMI.

4.3.2. Remote Control Centre Communication Interface

Owner will supply communication channels between the Substation Automation System and the remote control centre. The communication channels provided by Owner will consist either of power line carrier, optical fibre, or leased line, the details of which shall be provided during detailed Engineering.

4.3.3. Interface Equipment

The Vendor shall provide interface equipment for communicating between Substation Automation system and Remote control centres and between Substation Automation system and Regional System Coordination Centre (SLDC). However, the communication channels available for this purpose shall be separately specified by the owner.

The communication interface with the CCCs is an Ethernet interface. In case of

PLCC communication any modem supplied shall not require manual equalization and shall include self-test features such as manual mark/space keying, analogue loop-back, and digital loop-back. The modems shall provide for convenient adjustment of output level and receive sensitivity. The modem should be stand-alone complete in all respects including power supply to interface the SAS with communication channel. The configuration of tones and speed shall be programmable and maintained in non-volatile memory in the modem. All necessary hardware and software shall also be in the scope of bidder except the communication link along with communication equipment between substation control room and Remote Control Centre.

4.3.4. Communication Protocol

The communication protocol for gateway to control centre must be open protocol and shall support IEC 60870-5-104 and IEC 61850 for all levels of communication for sub-station automation such as Bay to station HMI, bay to bay etc. based on requirement specified. The protocol shall support the features such as Report by exception; Periodic reporting so that the data update times at the CCC/SLDC can be optimised.

5.0 SYSTEM HARDWARE

5.1 Redundant Station HMI, Remote HMI (Remote HMI only if mentioned in by the owner as a requirement) and Disturbance Recorder Work station:

The vendor shall provide redundant station HMI in hot standby mode. The servers used in these work stations shall be of industrial grade.

It shall be capable to perform all functions for entire substation including future requirements as indicated in the SLD. It shall use industrial grade components. Processor and RAM shall be selected in such a manner that during normal operation not more than 30% capacity of processing and memory are used.

Supplier shall demonstrate these features.

The capacity of hard disk shall be selected such that the following requirement should occupy less than 50% of disk space:

- a) Storage of all analogue data (at 15 Minutes interval) and digital data including alarm, event for two years and trend data for thirty(30) days,
- b) Storage of all necessary software,
- c) 500GB space for OWNER'S use.

Supplier shall demonstrate that the capacity of hard disk is sufficient to meet the above requirement.

5.1.1 HMI (Human Machine Interface)

The VDU shall show overview diagrams (Single Line Diagrams) and complete details of the switchgear with a colour display. All event and alarm annunciation shall be selectable in the form of lists. Operation shall be by a user friendly function keyboard and a cursor positioning device. The user interface shall be based on WINDOWS concepts with graphics & facility for panning, scrolling, zooming, de cluttering etc.

5.1.2 Visual Display Units/TFT's (Thin Film Technology)

The display units shall have high resolution and reflection protected picture screen. High stability of the picture geometry shall be ensured. The screen shall be at least 32" diagonally in size and capable of colour graphic displays.

The display shall accommodate resolution of 1920 X 1080 pixels or better.

5.1.3 Printer

It shall be robust & suitable for operation with a minimum of 132 characters per line. The printing operation shall be quiet with a noise level of less than 45 dB suitable for location in the control room. Printer shall accept and print all ASCII characters via master control computer unit interface.

The printer shall have in built testing facility. Failure of the printer shall be indicated in the Station HMI. The printer shall have an off line mode selector switch to enable safe maintenance. The maintenance should be simple with provisions for ease of change of print head, ribbon changing, paper insertion etc.

All reports and graphics prints shall be printed on laser printer. One dot matrix printer shall be exclusively used for hourly log printing.

All printers shall be continuously online.

5.1.4 Mass Storage Unit

The mass storage unit shall be built-in to the Station HMI. All operational measured values, and indications shall be stored in a mass-storage unit in form of DVD RW. The unit should support at least Read (48X), Write (24X), and Re-Write (10X) operations, with Multi-Session capability. It should support ISO9660, Rock ridge and Joliet File systems. It should support formatting and use under the operating system provided for Station HMI. The monthly back up of data shall be taken on disc. The facility of back up of data shall be inherent in the software.

5.1.5 Switched Ethernet Communication Infrastructure

The bidder shall provide the redundant switched optical Ethernet communication infrastructure for SAS. One switch shall be provided to connect all IEDs in one diameter of 400kV yard and for two bays of 220kV or below yard to communication infrastructure. Each switch shall have at least two spare ports for connecting bay level IEDs and one spare port for connecting station bus. Bidder shall keep provision of 100% spare capacity for DTL USE

The Ethernet Fast Switches shall be compliant to IEC 61850. These Switches shall be suitable for the substation environment and shall conform to type tests as per IEC 61850-3.

Apart from IEC 61850-3, communication and networking protocol requirement should be included as under:

Standards: IEEE802.3, 802.3u, 802.3x, 802.1D, 802.1W, 802.1Q, 802.1p, 802.1X, 802.3ad

Protocols: IGMP V1/V2/V3 device, GMRP, GVRP, SNMP V1/V2c/V3, DHCP Server/Client, DHCP Option 82, BootP, STNP, SMTP, RARP, RMON

- Designed for Industrial Networking Capability:
- Turbo Ring (Recovery time < 20 ms) RSTP/STP (IEEE802.1 W/D) for Ethernet redundancy.
- IGMP Snooping and GMRP for filtering multicast traffic from industrial Ethernet Protocols.
- Port based IEEE802.1Q VLAN and GVRP protocol to ease Network Planning.

- QoS-IEEE802.1p/1Q and TOS/Diff Serv to increase determinism 802.3ad, LACP for optimum bandwidth utilization.
- IEEE802.1X and https/SSL to enhance network security.
- SNMP V1/V2c/V3 for different levels of network management.
- RMON for efficient network monitoring and proactive capability.
- Bandwidth management to prevent unpredictable network status.
- ABC-01 (Automatic Backup Configurator) for system configuration backup
- Port Lock for access from unauthorized MAC address.
- Port mirroring for online debugging.
- Automatic recovery of connected device's IP addresses.

5.1.6 Firewall and Router

There shall be two sets of Firewall and Layer-3 switches (preferred)/ Routers (As required) which shall be connected to a LAN. This LAN shall be different than the IEC 61850 LAN. The substation firewall and Layer-3 switches (Preferred) / Routers (As required) shall be suitable for the substation environment and shall comply with the requirements for IEC 61850-3.

The substation firewall shall have the following features:

- a) IP firewall features such as Address/port inspection and filtering
- b) Shall be state ful firewall
- c) Shall support up to 4 Ethernet switches 10/100 Mbps
- d) Shall support IPv4 and IPv6
- e) Shall have IP sec/VPN with 3DES/AES encryption
- f) Shall have NAT
- g) Shall have syslog capability
- h) Shall be NERC compliant

- i) Shall have hot- standby operation with similar layer-3 switch /router

The substation layer-3 switches / routers shall have the following features:

- a) Routing protocols such as OSPF and support for IPv4 and IPv6
- b) 4 Ethernet interfaces of 10/100 Mbps
- c) 2 E1 interfaces
- d) Hot standby operation with a similar router
- e) Support IEEE 802.3u, 802.1p, 802.1Q, 802.1d, 802.1w,
- f) Traffic prioritization for routed IP flows/ports

The substation firewall, layer-3 switches and/or router can be a single device.

5.2 Bay Level Unit or Bay Control Unit (BCU)

5.2.1 General

- a) Bay Control Unit (BCU) shall be provided for each Bays (a bay comprises of one circuit breaker and associated disconnector, earth switches and instrument transformer, Number of bays shall be as specified by the owner) for control and monitoring of the bay equipment. Separate BCU (as per specification) shall be provided for the monitoring of substation auxiliaries.
- b) The BCUs shall have adequate capacity for the estimated hardwired Inputs & Outputs plus a minimum of two Inputs and a minimum of two outputs as spare capacity per BCU. Requirement for external IO modules shall be avoided as far as possible.
- c) BCUs shall have redundant DC Power Supply or with automatic changeover scheme, to be fed from the two station DC power supplies. Each power supply shall be supervised separately and alarmed.
- d) 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/ on-line configuration displays etc.

- e) In the event of switchgear apparatus controls, the software-interlocking scheme should be applied based on hardwired analog/digital inputs or Process Bus signals. In the event of closing control for circuit breakers requiring checking of synchronization conditions, software synchro-check scheme should be applied as well. Auto-reclose functions mentioned elsewhere in the specification, if required, can also be applied.

5.2.2 Design

- a) The bay unit shall use industrial grade components. The bay level unit, based on microprocessor technology, shall use numerical techniques for the calculation and evaluation of externally input analogue signals. They shall incorporate select-before-operate control principles as safety measures for operation via the HMI. Following power interruption and/or communications failure, the BCU shall be capable to restart automatically. Time synchronisation of BCUs with UTC time shall be done over the IEC61850 field LAN for Substation with SAS. For conventional substation, Time synchronisation of BCU shall be done by other suitable Time synch input like IRIG-B, RS232 etc.
- b) They shall perform all bay related functions, such as control commands, bay interlocking, data acquisition, data storage, event recording and shall provide inputs for status indication and outputs for commands. They shall be directly connected to the switchgear. The bay unit shall acquire and process all data for the bay (Equipment status, fault indications, measured values, alarms etc.) and transmit these to the other devices in sub-station

automation system. In addition, this shall receive the operation commands from station HMI and control centre.

- c) One no. Bay Control unit shall be provided for supervision and control of each 400, 220, 66 & 33 kV bay (a bay comprises of one circuit breaker and associated disconnector, earth switches and instrument transformer). The Bay level unit shall be equipped with analogue and binary inputs/outputs for handling the control, status monitoring and analogue measurement functions. All bay level interlocks are to be incorporated in the Bay level unit so as to permit control from the Bay level unit/ local bay mimic panel, with all bay interlocks in place, during maintenance and commissioning or in case of contingencies when the Station HMI is out of service. Bay Control Unit can also include supervision and control of more than one no of bays if specifies by the owner (for medium voltage level only).
- d) The bay control unit to be provided for the bays shall be preferably installed in the CB relay panel/feeder protection panel for respective bay. Further in case of one and half breaker schemes, the BCU for Tie CB shall be provided in Tie CB relay panel. The tie CB relay panel shall also house the Ethernet switch (es) to be provided for the diameter. The bay control unit for future bay (if required by the owner) shall be installed in a separate panel.
- e) The Bay level unit shall meet the requirements for withstanding electromagnetic interference according to relevant parts of IEC 61850. Failure of any single component within the equipment shall neither cause unwanted operation nor lead to a complete system breakdown.

5.2.3 Input/ Output (I/O) Modules (applicable for non-Process Bus SAS)

- a) The I/O modules shall form a part of the bay level unit / Bay control unit and shall provide coupling to the substation equipment. The I/O modules shall acquire all switchgear information (i.e. data coming directly from the switchgear or from switchgear interlocking devices) and transmit commands for operation of the switchgear.
- b) It shall be suitable for analog inputs from secondary of instrument transformers.
- c) The BCU/IED shall be able to integrate at least 10 analog input channels as a minimum and digital input / output channel to meet the control & monitoring scheme requirement.
- d) Plant alarms and indications will be derived as digital input. Plant contacts shall change state to register the specified status change or alarm, and each input shall be configurable to register a positive input from either a closed or open contact, i.e. input signals may be either a normally open or a normally closed contact. Alarm contacts may be either fleeting or sustained inputs. Digital filtering to suppress plant contact bounce shall be provided for each input. Time tagging to a resolution of 1 ms shall be provided.
- e) The pulse counting inputs shall be provided as per scheme requirement. These inputs shall acquire and count impulses produced by potential free contacts, which can be either, normally open or normally closed. Pulse counting inputs shall be provided as either a separate input module or using digital inputs. These inputs shall meet the same requirements specified for digital inputs; additionally they shall be able to cater for pulse rates up to 10 per second.
- f) Where DC analogue measurement inputs are provided as per the scheme requirement, they shall be capable of accepting unipolar and bipolar current of range 0-10/4-20mA and -10 to +10 mA (range as applicable for the project), with over/under range detection.
- g) The command outputs shall be designed to provide select and execute outputs. The period of the command pulse shall be configurable between 0.1 second and 15 seconds on point basis. The command pulses shall reset immediately

after the command is executed. Controls transmitted between the operator workstation of SAS / SCADA and the BCU shall comprise a select, check back & execute sequence (or other means of providing high message security).

- h) The I/O modules shall acquire all switchgear/bay information (i.e. data coming directly from the switchgear or from switchgear interlocking devices) and transmit commands for operation of the switchgear/bay operational devices

5.2.4 The BCU supplied for substation automation system shall further meet the requirements mentioned elsewhere in the specification.

5.3 Extendibility in Future

Offered substation automation system shall be suitable for extension in future for additional bays. During such requirement, all the drawings and configurations, alarm/event list etc. displayed shall be designed in such a manner that its extension shall be easily performed by the owner. During such event, normal operation of the existing substation shall be unaffected and system shall not require a complete shutdown. The vendor shall provide all necessary software tools along with details to perform addition of bays in future and complete integration with SAS by the user. These software tools shall be able to configure IED, add additional analogue variable, alarm list, event list, modify interlocking logics etc. for additional bays/equipment which shall be added in future.

Following is to be ensured during initial supply of system:

- a) All the licenses for various components such as SCADA, servers, configuration tools for various IEDs, Gateways etc. shall be for complete system i.e. system as per single line diagram including both present and future scope. The vendor shall submit the list of equipment and Inputs/Outputs covered under the licences provided.
- b) All the servers shall be capable of handling total system (present and future).

In case of extension packages, the interoperability between devices compliant to IEC 61850 Edition 2 (or latest) and existing devices compliant to IEC 61850 Edition 1 should be ensured.

6.0 SOFTWARE STRUCTURE

The software package shall be structured according to the SAS architecture and strictly divided in various levels. Necessary firewall shall be provided at suitable points in software to protect the system. An extension of the station shall be possible with lowest possible efforts. Maintenance, modification or an extension of components of any feeder may not force a shut-down of the parts of the system which are not affected by the system adaptation. The software package shall not affect the interoperability between various devices as per relevant standards.

6.1 Station Level Software

6.1.1 Human-Machine Interface (HMI)

The base HMI software package for the operator station shall include the main SAS functions and it shall be independent of project specific hardware version and operating system. It shall further include tools for picture editing, engineering and system configuration. The system shall be easy to use, to maintain, and to adapt according to specific user requirements. Systems shall contain a library with standard functions and applications.

6.2 Bay Level Software

6.2.1 System Software

The system software shall be structured in various levels. This software shall be placed in a non-volatile memory. The lowest level shall assure system performance and contain basic functions, which shall not be accessible by the application and maintenance engineer for modifications. The system shall support the generation of typical control macros and a process database for user specific data storage. In case of restoration of links after failure, the software along with

hardware shall be capable of automatically synchronising with the remaining system without any manual interface. This shall be demonstrated by vendor during integrated system test.

6.2.2 Application Software

In order to ensure robust quality and reliable software functions, the main part of the application software shall consist of standard software modules built as functional block elements. The functional blocks shall be documented and thoroughly tested. They form part of a library.

The application software within the control/protection devices shall be programmed in a functional block language.

6.3 Network Management System (NMS)

The vendor shall provide network management system software for following management functions:

- a) Configuration Management
- b) Fault Management
- c) Performance Monitoring

This system shall be used for management of communication devices and other IEDs in the system. This NMS can be loaded in DR work-station and shall be easy to use, user friendly and menu based. The NMS shall monitor all the devices in the SAS and report if there is any communication fault/problem in the monitored devices. The NMS shall

- a) Maintain performance, resource usage, and error statistics for all managed links and devices and present this information via displays, periodic reports and on demand reports.
- b) Maintain a graphical display of SAS connectivity and device status.
- c) Issue alarms when error conditions occurs
- d) Provide facility to add and delete addresses and links

- e) The NMS shall monitor all the devices (including all communication ports & links) in the SAS and report if there is any communication fault/problem in the monitored devices

6.4 Operating System

The Operating system of the Servers, HMIs and Gateways shall be hardened in line with the following suggested guidelines to reduce its vulnerability to cyber-attacks.

6.4.1 Secure Build Strategy

Packages unnecessary for system operation are not to be installed during the initial build of the servers and workstations, reducing the amount of post-build hardening required. Any packages that must be installed but is not required to be actively running have to be disabled.

The software to be removed and/or disabled includes, but is not limited to:

- a) Games
- b) Messaging services
- c) Servers or clients for unused Internet services
- d) Software compilers (except where required, i.e. development platform)
- e) Unused networking and communication protocols
- f) Unused operating system features
- g) free utilities delivered with OS

6.4.2 Generic and Default Accounts

Disable or remove all unnecessary generic and default user accounts from the operating system and third party applications. Application accounts (such as daemon) that exist strictly for identification and ownership are disabled from all interactive, network, or other access to prevent unauthorized access. Required accounts and their functions have to be documented.

6.4.3 Insecure Protocol

Insecure protocols such as telnet, FTP, RSH, and RCP have to be disabled from operation.

6.4.4 Malicious Software Prevention

Implementation of anti-virus and other malicious software prevention tools to detect, prevent, deter, and mitigate the introduction, exposure, and propagation of malware. Supplier shall verify that commercially available anti-malware products do not cause harm to the product.

Provide procedures on how to update the signature database of the anti-malware software, if provided.

6.4.5 System Whitelisting

System whitelisting is to be done i.e. the software takes an inventory of the host in a known good state, and any applications not present at that time (such as viruses, malware, games, portable applications, etc.) are prevented from executing.

6.4.6 Ports and Services

The system shall be configured by the supplier to only use those ports and services required for normal and emergency operations. The ports and services required for operation are documented and supplied to the customer as part of the deliverable system documentation.

6.4.7 Host-Based Firewalls

The host-based firewalls shall be configured with a standardized set of rules as an additional layer of security if the network firewalls fail. The host-based firewalls are configured with a default deny rule that logs any traffic not explicitly allowed.

In the case where a service cannot be disabled but does not require communication with hosts external to itself, this host-based firewall also serves to prevent any communication to the port(s) used by that service.

6.4.8 Removable Media

Removable media (CD and DVD, USB Drives, etc.) is not required for the operation of the SAS and may be inhibited from operation exception case of data back up on CD/DVD as per specification.

- 6.5** The vendor shall provide each software in two copies in CD to load into the system in case of any problem related with Hardware/Communication etc.

7.0 GENERAL GUIDELINES FOR IEC 61850 SAS ENGINEERING

- a) Data exchange is to be realised using the protocols defined and standardized in the latest edition of IEC 61850 with a redundant managed switched Ethernet communication infrastructure. The modelling of various aspects of Substation Automation System, like, Data Objects, Data Attributes, Logical Nodes, etc. shall be according to the latest edition of IEC 61850.
- b) During the GOOSE communication engineering, it shall be ensured that the publishing IEDs shall have the quality attribute included invariably for each GOOSE message in the GOOSE dataset. Further, the subscriber IEDs shall not use any GOOSE message which it receives without the quality attribute.
- c) The GOOSE subscribing IEDs shall have the feature of detecting duplicate GOOSE message and intrusion using State Number (StNum), Sequence Number (SqNum) fields of a GOOSE message. Once duplicate GOOSE messages or intrusion is detected, the subscribing device shall discard the GOOSE messages from that particular publishing device and shall generate an alarm.

The GOOSE subscribing IEDs shall have the feature of detecting duplicate GOOSE message and intrusion. Once duplicate GOOSE messages or intrusion is detected, the subscribing device shall discard the GOOSE messages from that particular publishing device and shall generate an alarm.

- d) If the association between the publisher and subscriber is lost (please refer Sec. 6.2 of IEC 61850 part 7-3), the ‘validity’ field of the quality will be set to questionable, and the detailQual ‘oldData’ will be set. The rest of quality fields will not be changed.
- e) Separate VLANs shall be created for multicast communication between IEDs belonging to different voltage levels. Also, a ‘Cross-VLAN’ shall be created which will include the IEDs of different voltage levels together as per the requirement of the cross communication for control/protection schemes.
- f) A guideline over usage of logical nodes for Report Control/ GOOSE control engineering shall be issued during the detailed engineering.
- g) In the control and protection schemes, wherever GOOSE messages are used, the schematic documents submitted by the vendor should indicate the communication between LNs used in the indicating the source and destination LNs.
- h) For GOOSE publish, “Native” logical nodes should be utilized as far as possible and use of generic logical node GGIO should be avoided as far as possible.
- i) Separate data sets should be utilized for GOOSE and MMS messages.
- j) Selection of GOOSE data sets shall be though “Quality” and “General” data attributes i.e. without time tag as being L2 protocol
- k) GOOSE performance class should be as per IEC 61850 latest editions as tabulated hereunder.
- l) For GOOSE based functions, event timings should be measured for critical schemes with multiple simulations during FAT & SAT to ensure required network performance

8.0 TESTS

The substation automation system offered by the bidder shall be subjected to following tests to establish compliance with IEC 61850 for EHV sub-station equipment installed in sheltered area in the outdoor switchyard and specified ambient conditions:

8.1 Type Tests

8.1.1 Control IEDs /BCU and Communication Equipment

The above equipment shall confirm to following type tests as per IEC 61850-3:

a. Power Input:

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

b. Accuracy Tests:

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

c. Insulation Tests:

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

d. Influencing Quantities

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

e. Electromagnetic Compatibility Test:

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

f. Function Tests:

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

g. Environmental tests:

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

8.1.2 All the IEDs, other communication equipment including Ethernet switches and SCADA/SAS software shall be compliant with the latest edition of IEC 61850 and should conform to conformance tests as per IEC 61850-10.

8.2 Factory Acceptance Tests

The supplier shall submit a test specification for factory acceptance test (FAT) and commissioning tests of the station automation system for approval based on the standard SAS FAT procedure of OWNER. Standard SAS FAT procedure shall be provided by OWNER during detail engineering for reference. For the individual bay level IED's applicable type test certificates shall be submitted.

The manufacturing and configuration phase of the SAS shall be concluded by the factory acceptance test (FAT). The purpose is to ensure that the Vendor has interpreted the specified requirements correctly and that the FAT includes checking to the degree required by the user. The general philosophy shall be to deliver a system to site only after it has been thoroughly tested and its specified

performance has been verified, as far as site conditions can be simulated in a test lab. During FAT the entire Sub-station Automation System including complete control and protection system to be supplied under present scope shall be tested for complete functionality and configuration in factory itself. The extensive testing shall be carried out during FAT. The purpose of Factory Acceptance Testing is to ensure trouble free installation at site. No major configuration setting of system is envisaged at site.

The bidder shall provide the SCD file after FAT to site so that any intermittent issues with FAT configuration and changed site configuration (if any) can be analysed.

If the complete system consists of parts from various suppliers or some parts are already installed on site, the FAT shall be limited to sub-system tests. In such a case, the complete system test shall be performed on site together with the site acceptance test (SAT).

In case of extension of sub-station, Factory Acceptance Test shall be carried out with the help of a demo system owned by supplier. However, the complete system is to be tested along with SCADA at site by the supplier after complete integration of the system.

8.2.1 Hardware Integration Tests

The hardware integration test shall be performed on the specified systems to be used for Factory tests when the hardware has been installed in the factory. The operation of each item shall be verified as an integral part of system. Applicable hardware diagnostics shall be used to verify that each hardware component is completely operational and assembled into a configuration capable of supporting software integration and factory testing of the system. The equipment expansion capability shall also be verified during the hardware integration tests. The vendor specifically demonstrates how to add a device in future in SAS during FAT. The

device shall be from a different manufacturer than the SAS supplier.

8.2.2 Integrated System Tests

Integrated system tests shall verify the stability of the hardware and the software. During the tests all functions shall run concurrently and all equipment shall operate a continuous 100 Hours period. The integrated system test shall ensure the SAS is free of improper interactions between software and hardware while the system is operating as a whole.

8.3 Site Acceptance Tests

The site acceptance tests (SAT) shall completely verify all the features of SAS hardware and software. The vendor shall submit the detailed SAT procedure and SAT procedure shall be read in conjunction with the specification.

9.0 SYSTEM OPERATION

9.1 Substation Operation

9.1.1 Normal Operation

Operation of the system by the operator from the remote CCC or at the substation shall take place via industry standard HMI (Human Machine interface) subsystem consisting of graphic colour VDU, a standard keyboard and a cursor positioning device (mouse).

The coloured screen shall be divided into 3 fields:

- i) Message field with display of present time and date
- ii) Display field for single line diagrams
- iii) Navigation bar with alarm/condition indication

For display of alarm annunciation, lists of events etc a separate HMI View node shall be provided.

All operations shall be performed with mouse and/or a minimum number of function keys and cursor keys. The function keys shall have different meanings depending on the operation. The operator shall see the relevant meanings as function tests displayed in the command field (i.e. operator prompting). For control actions, the switchgear (i.e. circuit breaker etc.) requested shall be selectable on the display by means of the cursor keys. The switching element selected shall then appear on the background that shall be flashing in a different colour. The operator prompting shall distinguish between:-

- a.Prompting of indications e.g. fault indications in the switchgear, and
- b.prompting of operational sequences e.g. execution of switching operations

The summary information displayed in the message field shall give a rapid display of alarm/message of the system in which a fault has occurred and alarm annunciation lists in which the fault is described more fully.

Each operational sequence shall be divided into single operation steps which are initiated by means of the function keys/WINDOW command by mouse. Operator prompting shall be designed in such a manner that only the permissible keys are available in the command field related to the specific operation step. Only those switching elements shall be accessed for which control actions are possible. If the operation step is rejected by the system, the operator prompting shall be supported by additional comments in the message field. The operation status shall be reset to the corresponding preceding step in the operation sequence by pressing one of the function keys. All operations shall be verified. Incorrect operations shall be indicated by comments in the message field and must not be executed.

The offer shall include a comprehensive description of the system. The above operation shall also be possible via WINDOWS based system by mouse.

10.0 POWER SUPPLY

Power for the substation automation system shall be derived from station DC power supplies.

Inverter of suitable capacity shall be provided for station HMI disturbance recorder evaluation unit and its peripheral devices e.g. printer etc. In the event of Power failure, necessary safeguard software shall be built for proper shutdown. Separate Inverters powered from separate station DC supplies shall be provided for Main & hot standby SAS system. Separate Inverter shall also be supplied for Remote HMI & Workstation only if applicable.

11.0 DOCUMENTATION

The following documents shall be submitted for owner's approval during detailed engineering:

- (a) System Architecture Drawing
- (b) Hardware Specification
- (c) Functional Design Document
- (d) Clear procedure describing how to add an IED/bay/diameter in future covering all major supplier
- (e) VLAN architecture drawing

The following documentation to be provided for the system in the course of the project shall be consistent, CAD supported, and of similar look/feel. All CAD drawings to be provide in “dxf” format.

- a) List of Drawings
- b) Substation automation system architecture
- c) Block Diagram

- d) Guaranteed technical parameters, Functional Design Specification and Guaranteed availability and reliability
- e) Calculation for power supply dimensioning
- f) I/O Signal lists
- g) Schematic diagrams
- h) List of Apparatus
- i) List of Labels
- j) Logic Diagram (hardware & software)
- k) Switchyard Panel Room layout drawing
- l) Control Room Lay-out
- m) Test Specification for Factory Acceptance Test (FAT)
- n) Test Specification for Site Acceptance Test (SAT)
- o) The SCD files of the station's project shall be submitted by the vendor during the FAT and after successful commissioning of SAS.
- p) A GOOSE matrix sheet with publisher and subscriber IEDs.
- q) Product Manuals (Installation, Configuration, maintenance, Troubleshooting, detailed diagnostics etc.)
- r) Assembly Drawing
- s) Operator's Manual
- t) Complete documentation of implemented protocols between various elements
- u) Listing of software and loadable in CD ROM
- v) Other documents as may be required during detailed engineering

Two sets of hard copy and four sets of CD ROM/USB drive containing all the as built documents/drawings shall be provided.

12.0 TRAINING, SUPPORT SERVICES, MAINTENANCE AND SPARES

12.1 Training

Vendor personnel who are experienced instructors and who speak understandable

English shall conduct training. The vendor shall arrange on its own cost all hardware training platform required for successful training and understanding in India. The Vendor shall provide all necessary training material. Each trainee shall receive individual copies of all technical manuals and all other documents used for training. These materials shall be sent to Owner at least two months before the scheduled commencement of the particular training course. Class materials, including the documents sent before the training courses as well as class handouts, shall become the property of Owner. Owner reserves the right to copy such materials, but for in-house training and use only. Hands-on training shall utilize equipment identical to that being supplied to Owner. The man-days shall be 150.

The schedule, location, and detailed contents of each course will be finalized during Owner and Vendor discussions.

12.2 Computer System Hardware Course

A computer system hardware course shall be offered, but at the system level only. The training course shall be designed to give Owner hardware personnel sufficient knowledge of the overall design and operation of the system so that they can correct obvious problems, configure the hardware, perform preventive maintenance, run diagnostic programs, and communicate with contract maintenance personnel. The following subjects shall be covered:

- (a) System Hardware Overview: Configuration of the system hardware.
- (b) Equipment Maintenance: Basic theory of operation, maintenance techniques and diagnostic procedures for each element of the computer system, e.g., processors, auxiliary memories, LANs, routers and printers. Configuration of all the hardware equipment.
- (c) System Expansion: Techniques and procedures to expand and add equipment such as loggers, monitors, and communication channels.
- (d) System Maintenance: Theory of operation and maintenance of the redundant hardware configuration, failover hardware, configuration control

panels, and failover switches. Maintenance of protective devices and power supplies.

- (e) Subsystem Maintenance: Theory of design and operation, maintenance techniques and practices, diagnostic procedures, and (where applicable) expansion techniques and procedures. Classes shall include hands-on training for the specific subsystems that are part of Owner's equipment or part of similarly designed and configured subsystems. All interfaces to the computing equipment shall be taught in detail.
- (f) Operational Training: Practical training on preventive and corrective maintenance of all equipment, including use of special tools and instruments. This training shall be provided on Owner equipment, or on similarly configured systems.

12.3 Computer System Software Course

The Vendor shall provide a computer system software course that covers the following subjects:

- (a) System Programming: Including all applicable programming languages and all stand-alone service and utility packages provided with the system. An introduction to software architecture, Effect of tuning parameters (OS software, Network software, database software etc.) on the performance of the system.
- (b) Operating System: Including the user aspects of the operating system, such as program loading and integrating procedures; scheduling, management, service, and utility functions; and system expansion techniques and procedures
- (c) System Initialization and Failover: Including design, theory of operation, and practice
- (d) Diagnostics: Including the execution of diagnostic procedures and the interpretation of diagnostic outputs,

- (e) Software Documentation: Orientation in the organization and use of system software documentation.
- (f) Hands-on Training: One week, with allocated computer time for trainee performance of unstructured exercises and with the course instructor available for assistance as necessary.

12.4 **Application Software Course**

The Vendor shall provide a comprehensive application software courses covering all applications including the database and display building course. The training shall include:

- a) Overview: Block diagrams of the application software and data flows. Programming standards and program interface conventions.
- b) Application Functions: Functional capabilities, design, and major algorithms. Associated maintenance and expansion techniques.
- c) Software Development: Techniques and conventions to be used for the preparation and integration of new software functions.
- d) Software Documentation: Orientation in the organization and use of functional and detailed design documentation and of programmer and user manuals.
- e) Hands-on Training: One week, with allocated computer time for trainee performance of unstructured exercises and with the course instructor available for assistance as necessary.

12.5 **Requirement of training:**

The vendor shall provide training for OWNER personnel comprehensively covering following courses.

S. No.	Name of Course
1	Computer System Hardware

- 2 Computer System Software
- 3 Application Software

13.0 Maintenance

13.1 Maintenance Responsibility during and after the Guaranteed Availability Period

During Guaranteed Availability Period, the Vendor shall take continual actions to ensure the guaranteed availability and shall make available all the necessary resources such as specialist personnel, spare parts, tools, test devices etc. for replacement or repair of all defective parts and shall have prime responsibility for keeping the system operational. During guarantee period as specified in tender document, vendor shall arrange visit of SAS manufacturer's representative to site as per requirement to review the performance of system and in case any defect/shortcoming etc. is observed during the period, the same shall be set right by the vendor within 15 days. After the expiry of the Guarantee Period, a Comprehensive Annual Maintenance Contract (AMC) with a validity of five (05) years shall be provided from the date of end of the guarantee period.

14.0 SPARES

14.1 Consumables

All consumables such as paper, cartridges shall be supplied by the vendor till the SAS is taken over by the owner.

14.2 Availability Spares

In addition to mandatory spares as listed in BOQ for SAS, the bidder is required to list the spares, which may be required for ensuring the guaranteed availability during the guaranteed availability period. (For a minimum tenure of five years and a maximum of ten years).

During the guaranteed availability period, the spare parts supplied by the Vendor shall be made available to the Vendor for usage subject to replenishment at the earliest. Thus, at the end of availability period the inventory of mandatory spares

with the Owner shall be fully replenished by the Vendor. However, any additional spares required to meet the availability of the system (which are not a part of the above spares supplied by the Vendor) would have to be supplied immediately by the Vendor free of cost to the Owner.

The price of above availability spare, as assessed by the SAS vendor, shall be deemed to be included in the complete SAS price.

The bidders must ensure the availability and supply of four (4) set of special tools and tackles. The availability of spares shall be ensured by the bidder for at least 10 years from the date of commissioning and handing over of the SAS to DTL.

14.3 Special Tools for IEC 61850 based SAS

The vendor shall supply a GOOSE Inspection and Simulation Tool. The tool(s) shall have the capability to sniff and inspect the GOOSE in the data network. The tool(s) shall also have the capability to extract the GOOSE information from .icd/.scd file(s) and simulate them.

The price of above shall be deemed to be included in the complete SAS.

15.0 LIST OF EQUIPMENTS

Quantity of following equipment shall be decided by bidder in order to achieve guaranteed reliability and availability as declared by bidder.

- a) Station HMI workstation
- b) Redundant Station HMI (in Hot-standby mode) workstation
- c) Bay level units along with bay mimic for number of bays as detailed by the owner separately.
- d) Bay Level Unit for Auxiliary system (as per requirement)

- e) Disturbance Recorder Work Station(Maintenance HMI)
- f) Colour Laser Printer – 1 No. (For Reports & Disturbance records)
- g) Dot matrix printers - (one each for Alarms and log sheets)
- h) All interface equipment for gateway to CCC and SLDC
- i) Communication infrastructure between Bay level units, Station HMI, Printers, gateways, redundant LAN etc. as required
- j) Remote disturbance recorder workstation and remote HMI and along with one colour laser A4 printer (Remote HMI, only if specified as requirement by the owner).
- k) Modems as per requirement.
- l) Routers/ layer-3 switches – 2 Nos.
- m) Apart from above, two nos. Of engineering laptops installed with complete set of all the licensed software used in the SAS shall mandatorily be supplied by the bidder.
- n) Any other equipment as necessary.

16.0 RELIABILITY AND AVAILABILITY

The SAS shall be designed so that the failure of any single component, processor, or device shall not render the system unavailable. The SAS shall be designed to satisfy the very high demands for reliability and availability concerning:

- a) Mechanical and electrical design
- b) Security against electrical interference (EMI)
- c) High quality components and boards
- d) Modular, well-tested hardware
- e) Thoroughly developed and tested modular software
- f) Easy-to-understand programming language for application programming
- g) Detailed graphical documentation and application software
- h) Built-in supervision and diagnostic functions

- i) Security
 - i) Experience of security requirements
 - ii) Process know-how
 - iii) Select before execute at operation
 - iv) Process status representation as double indications
- j) Distributed solution
- k) Independent units connected to the local area network
- l) Back-up functions
- m) Panel design appropriate to the harsh electrical environment and ambient conditions
- n) Panel grounding immune against transient ground potential rise
- o) Auxiliary power fluctuations

Outage terms

1) Outage

The state in which substation automation system or a unit of SAS is unavailable for Normal Operation due to an event directly related to the SAS or unit of SAS. In the event, the owner has taken any equipment/system other than Sub-station Automation System for schedule/forced maintenance, the consequent outage to SAS shall not be considered as outage for the purpose of availability.

2) Actual outage duration (AOD)

The time elapsed in hours between the start and the end of an outage. The time shall be counted to the nearest 1/4th of an hour. Time less than 1/4th of an hour shall be counted as having duration of 1/4th of an hour.

3) Period Hours (PH)

The number of hours in the reporting period. In a full year the period hour are 8760h (8784h for a leap year).

4) Actual Outage hours (AOH)

The sum of actual outage duration within the reporting period

$$AOH = \sum AOD$$

5) Availability:

Each SAS shall have a total availability of 99.98 % i.e. the ratio of total time duration minus the actual outage duration to total time duration.

16.1 Guarantees Required

The availability for the complete SAS shall be guaranteed by the Vendor. The vendor shall demonstrate their availability guaranteed by conducting the availability test on the total sub-station automation system as a whole after commissioning of total Sub-station Automation system. The test shall verify the reliability and integrity of all sub-systems. Under these conditions the test shall establish an overall availability of 99.98%. After the lapse of 1000 Hours of cumulative test time, test records shall be examined to determine the conformance with availability criterion. In case of any outage during the availability test, the vendor shall rectify the problem and after rectification, the 1000 Hours period start after such rectification. If test object has not been met the test shall continue until the specified availability is achieved.

The vendor has to establish the availability in a maximum period of three months from the date of commencement of the availability test.

After the satisfactory conclusion of test both vendor and owner shall mutually agree to the test results and if these results satisfy the availability criterion, the test is considered to be completed successfully. After that the system shall be taken over by the owner and then the guarantee period shall start

17) Specifications for HMI/Engineering PC/Gateways/SDC specifications as below:

S. No.	Parameter	Requirement
1	Mounting	19" Rack mountable 4U height

2	Power Supply	230V AC, 400W (max)
3	Processor	Intel Core i7 or equivalent or an improved version or higher
4	RAM	12GB Expandable up to 32GB
5	HDD	1 Terabyte HDD (min)/ SSD
6	CD Drive	DVD RW
7	I/O	6 USB Ports 1 Serial RS232 Port 1 Parallel Port 1 VGA 1 Audio (MIC-In, Line-Out)
8	Temperature	Operating Temperature: 0 to 40°C Storage Temperature: -5 to 60°C
9	Relative Humidity	10 to 90% non condensing
10	Ethernet Port	2x10/100/1000 Ethernet Ports Connector RJ45x2
11	Operating System	Windows 10 or higher version preloaded with recovery CD and must be compatible with the SAS software to be installed.

- 18)** Sub Station Data Concentrator (SDC) hardware with same specifications of Industrial server for communication with Remote Access System (RAS) server at Centralised Control Centre. RAS Client software shall be installed in SDC for remote assess of various IEDs installed in the substation from Centralised Control Centre for Automatic Fault Analysis system and relay configuration from Centralised Control Centre and should also be incorporated in the architecture drawing.

Historian server with same specifications of Industrial server shall also be used for memory back up and should also be incorporated in the architecture drawing.

- 19) The supplier shall ensure that the supplied equipments should be fully compatible for interfacing with the existing SCADA system.

Annexure-01 -05 enclosed with TS

ANNEX 1

List of Analogue and Digital Inputs

Basic Monitoring requirements are:

- a) Switchgear status indication
- b) Measurements (U, I, P, Q, f)
- c) Event
- d) Alarm
- e) Oil & Winding temperature of transformer & reactor individual units
- f) ambient temperature
- g) Status and display of 415V LT system, 220V & 48V DC system
- h) Status of display of Fire protection system and Air conditioning system.
- i) Acquisition of all counters in Digital Protection Coupler (DPC)panels through potential free contacts from DPC or independently by counting the receive/send commands.
- j) Acquisition of alarm and fault record from protection relays
- k) Disturbance records
- l) Monitoring the state of batteries by displaying DC voltage, charging current and load current etc.
- m) Tap-position of Power Transformer
- n) Temperature measured with Optical Temperature sensor (being provided by Transformer/Reactor manufacturer)
- o) Dissolved Hydrogen / multi gas & Moisture Content monitor of Transformer
- p) Status and display of LT transformer & its associated switchgear for station auxiliary supply

List of Inputs

The list of input for typical bays is as below:

Analogue inputs

- i) For Each line
 - Current
 - R phase
 - Y phase
 - B phase
 - Voltage
 - R-Y phase
 - Y-B phase
 - B-R phase
- ii) For each transformer/reactor
 - Current
 - R phase
 - Y phase
 - B phase
 - WTI (Winding Wise)
 - OTI
 - Multigas DGA parameters
 - Tap position (for transformer only)
- iii) For TBC and bus coupler
 - Current
 - R phase
 - Y phase
 - B phase
- iv) Common
 - a) Voltage for Bus-I, Bus-II and Transfer bus wherever applicable

Voltage	R-Y phase
	Y-B phase
	B-R phase

- b) Frequency for Bus-I and Bus-II
- c) Ambient temperature (switchyard)
- d) Switchyard Panel Room Temperature.
- e) LT system
 - i) Voltage R-Y, Y-B, B-R of Main Switch Board section-I
 - ii) Voltage R-Y, Y-B, B-R of Main Switch Board section-II
 - iii) Voltage R-Y, Y-B, B-R of Diesel Generator
 - iv) Current from LT transformer-I
 - v) Current from LT transformer-II
 - vi) Current from Diesel Generator
 - vii) Voltage of 220V DCDB-I
 - viii) Voltage of 220V DCDB-II
 - ix) Current from 220V Battery set-I
 - x) Current from 220V Battery set-II
 - xi) Current from 220V Battery charger-I
 - xii) Current from 220V Battery charger-II
 - xiii) Voltage of 48V DCDB-I
 - xiv) Voltage of 48V DCDB-II
 - xv) Current from 48V Battery set-I
 - xvi) Current from 48V Battery set-II
 - xvii) Current from 48V Battery charger-I
 - xviii) Current from 48V Battery charger-II

Digital Inputs:

The list of input for various bays/SYSTEM is as follows:

1. Line bays

- i) Status of each pole of CB.
- ii) Status of Isolator, Earth switch
- iii) CB trouble
- iv) CB operation/closing lockout
- v) Pole discrepancy optd
- vi) Trip coil faulty
- vii) LBB operated
- viii) Bus bar protection trip relay operated
- ix) Main breaker auto recloser operated
- x) Tie/transfer auto recloser operated
- xi) A/R lockout
- xii) Tie/transfer breaker Autoreclose lockout
- xiii) Direct trip-I/II sent
- xiv) Direct trip-I/II received
- xv) Main I/II-Inter trip send
- xvi) Main I/II-Inter trip received
- xvii) O/V STAGE – I operated
- xviii) O/V STAGE – II operated
- xix) MAIN-I/II CVT FUSE FAIL
- xx) MAIN-I PROTN TRIP
- xxi) MAIN-II PROTN TRIP
- xxii) MAIN-I PSB ALARM
- xxiii) MAIN-I SOTF TRIP
- xxiv) MAIN-I R-PH TRIP
- xxv) MAIN-I Y-PH TRIP

- xxvi) MAIN-I B-PH TRIP
- xxvii) MAIN-I START
- xxviii) MAIN-I/II Carrier aided trip
- xxix) MAIN-I/II fault in reverse direction
- xxx) MAIN-I/II ZONE-2 TRIP
- xxxi) MAIN-I/II ZONE-3 TRIP
- xxxii) MAIN-I/II weak end infeedoperated
- xxxiii) MAIN-II PSB alarm
- xxxiv) MAIN-II SOTF TRIP
- xxxv) MAIN-II R-PH TRIP
- xxxvi) MAIN-II Y-PH TRIP
- xxxvii) MAIN-II B-PH TRIP
- xxxviii) MAIN-II start
- xxxix) MAIN-II aided trip
- xl) MAIN-I/II fault in reverse direction
- xli) Back-up o/c optd
- xlii) Back-up e/f optd
- xliii) 220V DC-I/II source fail
- xliv) DPC Protection Channel-I FAIL
- xlv) DPC Protection Channel-II FAIL
- xlvi) Main II (Line Current Differential With Inbuilt Distance Protection)

2. **Transformer bays (HV Side)**

- i) Status of each pole of CB,
- ii) Status of Isolator, Earth switch
- iii) CB trouble
- iv) CB operation/closing lockout
- v) Pole discrepancy optd
- vi) Trip coil faulty

- vii) LBB optd
- viii) Bus bar protn trip relay optd
- ix) REF OPTD
- x) DIF OPTD (Phase Wise)
- xi) OVERFLUX ALARM (MV)
- xii) OVERFLUX TRIP (MV)
- xiii) OVERFLUX ALARM (HV)
- xiv) OVERFLUX TRIP (HV)
- xv) HV BUS CVT ½ FUSE FAIL
- xvi) MV BUS CVT ½ FUSE FAIL
- xvii) OTI ALARM/TRIP
- xviii) PRD OPTD (each PRD)
- xix) OVERLOAD ALARM
- xx) BUCHOLZ TRIP
- xxi) BUCHOLZ ALARM
- xxii) OLTC BUCHOLZ ALARM
- xxiii) OLTC BUCHOLZ TRIP
- xxiv) OIL LOW ALARM
- xxv) back-up O/C (HV) optd
- xxvi) back-up E/F (HV) optd
- xxvii) 220V DC-I/II source fail
- xxviii) TAP MISMATCH
- xxix) GR-A PROTN OPTD
- xxx) GR-B PROTN OPTD
- xxxi) back-up O/C (MV) optd
- xxxii) back-up E/F (MV)optd
- xxxiii) Healthiness of each Protection Relay through watchdog contact.

3. **Transformer bays (MV Side)**

- i) Status of each pole of CB, Isolator, Earth switch
- ii) CB trouble
- iii) CB operation/closing lockout
- iv) Pole discrepancy optd
- v) Trip coil faulty
- vi) LBB optd
- vii) Bus bar protn trip relay optd
- viii) Back-up impedance relay (If applicable)
- ix) 220V DC-I/II source fail
- x) GR-A PROTN OPTD
- xi) GR-B PROTN OPTD

4. **Line/Bus Reactor bays (as applicable):**

- i) Status of each pole of CB, Isolator, Earth switch
- ii) CB trouble
- iii) CB operation/closing lockout
- iv) Pole discrepancy optd
- v) Trip coil faulty
- vi) LBB optd
- vii) Bus bar protn trip relay optd
- viii) REF OPTD
- ix) DIF OPTD (Phase wise)
- x) Line/ BUS CVT ½ FUSE FAIL
- xi) OTI ALARM/TRIP
- xii) PRD OPTD
- xiii) BUCHOLZ TRIP
- xiv) BUCHOLZ ALARM
- xv) OIL LOW ALARM

- xvi) Back-up impedance relay
- xvii) 220V DC-I/II source fail
- xviii) GR-A PROTN OPTD
- xix) GR-B PROTN OPTD

5 **Bus bar Protection**

- i) Bus bar main-I trip
- ii) Bus bar main-II trip
- iii) Bus bar zone-I CT open
- iv) Bus bar zone-II CT open
- v) Bus transfer CT sup. Optd
- vi) Bus transfer bus bar protnoptd
- vii) Bus protection relay fail

6. **Auxiliary system**

- i) Incomer-I On/Off
- ii) Incomer-II On/Off
- iii) 415V Bus-I/II U/V
- iv) 415v bus coupler breaker on/off
- v) DG set bkr on/off
- vi) Alarm/trip signals for DG set
- vii) LT transformer-I Bunchholz Alarm & trip
- viii) LT transformer-II Buchloz Alarm & trip
- ix) LT transformer-I WTI Alarm & trip
- x) LT transformer-II WTI Alarm & trip
- xi) LT transformer-I OTI Alarm & trip
- xii) LT transformer-II OTI Alarm & trip
- xiii) Exchange fail
- xiv) Time sync. Signal absent
- xv) Alarm/trip signals for Battery and Battery charger

- xvi) 220v DC-I earth fault
- xvii) 220v DC-II earth fault
- xviii) Alarm/trip signals for Fire protection system

7. Switchyard Panel Room:

- i) AC Compressor 1 ON/OFF
- ii) AC Compressor 2 ON/OFF
- iii) Fire Detection 1 ON/OFF
- iv) Fire Detection 2 On/OFF
- v) Switchyard Panel Room Temperature High Alarm

The exact number and description of digital inputs shall be as per detailed engineering requirement. Apart from the above mentioned digital inputs, minimum of 200 inputs shall be kept for employer's/owner's use in future for new substations. For extension substations, minimum 04 nos. digital inputs per bay shall be kept for future use.

8) Performance requirement may also be included.

Message types:

Each message type has for each application (performance class) a defined maximum value.

The following message types are defined for an SA system:

- Type 1 – Fast message (e.g. GOOSE)
- Type 1A – Trip (e.g. GOOSE)
- Type 1B – Others (e.g. GOOSE)
- Type 2 – Medium speed messages
- Type 3 – Low speed messages (e.g. Reports)
- Type 4 – Raw data messages

- Type 5 – File transfer functions
- Type 7 – Command message with access control

ANNEX 2

List of IO Points to be transmitted to SLDC

- a) MW and MVAR for all lines , transformers ,reactors and Capacitors
- b) Voltage of all buses
- c) Frequency of all 400Kv and 765kV Buses
- d) Frequency of one 220Kv Bus
- e) All Breakers
- f) All isolators
- g) Tap Position for all transformers
- h) Master protection signal for all feeders, transformers Units and Bus Bar
- i) Loss of Voltage signal for Bus bar
- j) All the points identified in point (e),(h) and (i) above as GPS Time stamped.
- k) Temperature value per substation.
- l) Any other point decided during detailed engineering

ANNEXURE- 3

ABBREVIATIONS

AES: Advanced Encryption Standard

AOD: Actual Outage Duration

AOH: Actual Outage Hours

BCU: Bay Control Unit

CB: Circuit Breaker

CIP: Critical infrastructure protection

CSD: Controlled Switching Device

CT: current transformer

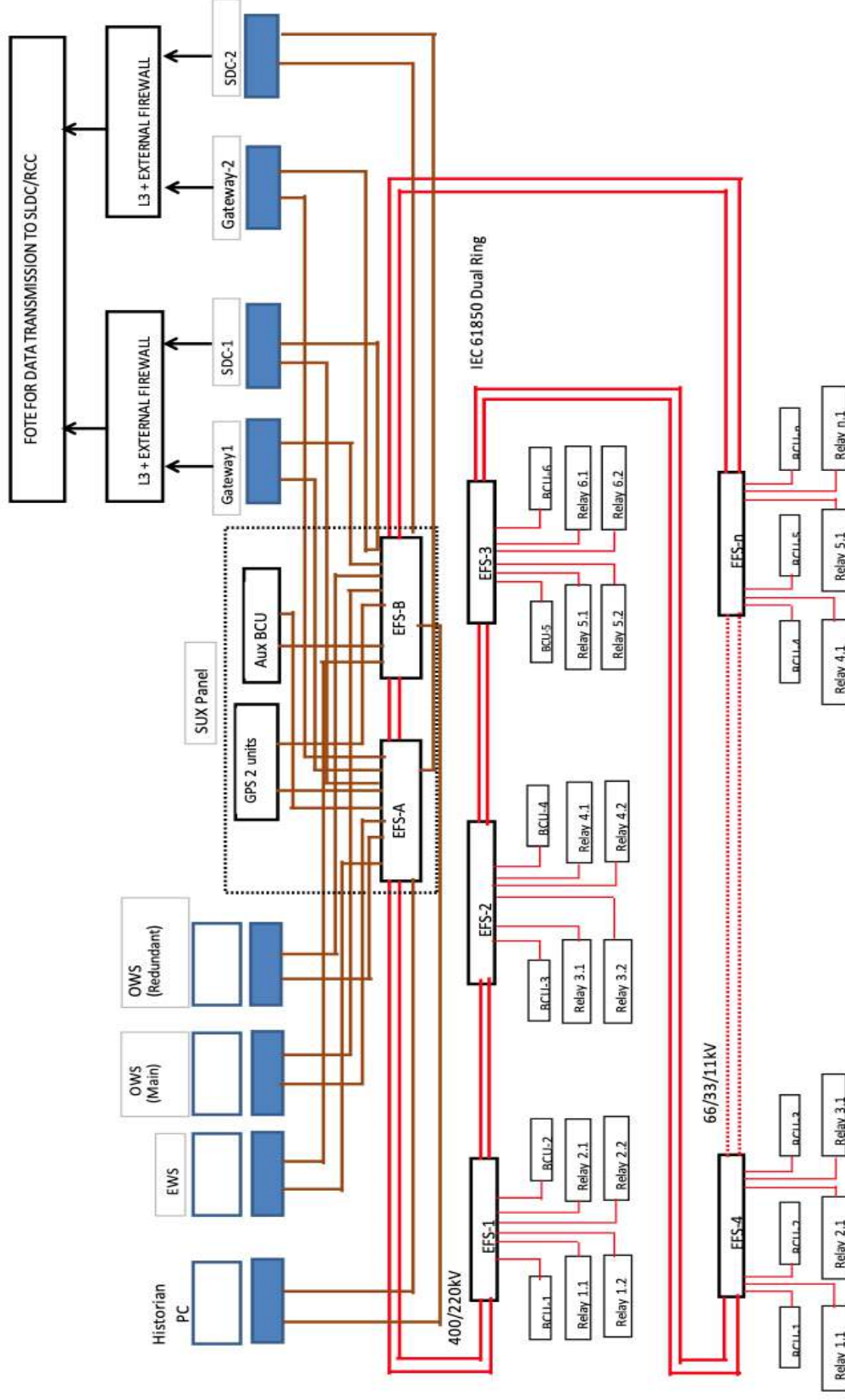
DES: Data Encryption Standard

DPC: Digital Protection Coupler
DR: Disturbance Recorder
EHV: Extra High Voltage
EMC: electromagnetic Compatibility
EMI: electromagnetic interference
FAT: Factory Acceptance Test
FOTS: Fibre Optic Temperature sensors
GIS: Gas Insulated Substation
GOOSE: Generic Object Oriented Substation Event
GPS: Global Positioning System
HDPE: High-density polyethylene
HMI: Human Machine Interface
HSR: High-availability Seamless Redundancy
I/O: Input/output
ICD: IED Configuration Description
IEC: International Electro-technical Commission
IED: Intelligence Electronic Device
IEEE: Institute of Electrical and Electronics Engineers
IP: Internet Protocol
LAN: Local Area Network
LN: Logical Node
MB: Marshaling Box
MU: Merging Unit
NAT: Network address translation
NC: normally closed
NERC: North American Electric Reliability Council
NMS: Network Management System
NO: normally open
OSPF: Open Shortest Path First
PC: Personal Computer
PH: Period Hours

PRP: Parallel Redundancy Protocol
PTP: Precision Time Protocol
RAM: Random access Memory
CCC: Remote Control Centre
SLDC: Remote Control and Supervision Centre
RTCC: Remote Tap Changer Control
SAS: Substation Automation System
SAT: Site Acceptance Test
SCADA: supervisory control and data acquisition
SCD: Substation Configuration Description
SF6: Sulfur hexafluoride
SGC: Switchgear Controller
SGC: Switchgear Controllers
SLD: Single Line Diagram
SMV: Sampled Measured Value
SNTP: Simple Network Time Protocol
TFT: Thin Film technology
VDU: Visual Display Unit
VLAN: Virtual LAN
VPN: virtual private network
VT: voltage transformer

SYSTEM ARCHITECTURE FOR SUBSTATION AUTOMATION

ANNEXURE-4



TERMS AND DEFINITION

- 1.1 **Attribute:** Named element of data and of a specific type. [IEC 61850-8-1].
- 1.2 **Back-up Protection:** Protection which is intended to operate when a system fault is not cleared, or an abnormal condition is not detected within the required time either because of failure or inability of other protection to operate or failure of the appropriate circuit breaker(s) to trip.
- 1.3 **Bay:** A bay comprises of one circuit breaker and associated disconnectors, earth switches and instrument transformers.
- 1.4 **Bay Control Unit:** It is the numerical device utilized as an interfacing device between the primary system process comprising the main CTs, Disconnectors and circuit-breaker and performs the associated data acquisition, pre-processing and control as well as supervisory functions.
- 1.5 **Breaker Control Device (or Controller):** Control device for HV circuit breaker.
- 1.6 **Busbars:** In a substation, the busbar assembly is necessary to make a common connection for several circuits.
- 1.7 **CIM:** In electric power transmission and distribution, the Common Information Model (CIM), a standard developed by the electric power industry that has been officially adopted by the International Electro-technical Commission (IEC), aims to allow application software to exchange information about the configuration and status of an electrical network.

- 1.8 Circuit Breaker:** A mechanical switching device, capable of making, carrying and breaking currents under normal circuit conditions and also making, carrying for a specified time and breaking currents under abnormal circuit conditions such as those of short circuit.
- 1.9 Client:** entity that requests a service from a server, or which receives unsolicited data from a server. [IEC 61850-7-1].
- 1.10 Critical Assets:** Facilities, systems and equipment which, if destroyed, degraded, or otherwise rendered unavailable, would affect the reliability or operability of the Bulk Electric System.
- 1.11 Cyber Assets:** In a substation, they are the programmable electronic devices and communication networks including hardware, software, and data.
- 1.12 Critical Cyber Assets:** Cyber Assets which are essential to the reliable operation of Critical Assets.
- 1.13 Dataset:** permits the grouping of data and data attributes. Used for direct access and for reporting and logging. The attribute Dataset shall identify a DATA-SET that is contained in the LOGICAL-NODE.
- 1.14 Disconnecter:** A mechanical switching device which provides, in the open position, an isolating distance in accordance with specified requirements.
- 1.15 Ethernet:** is a family of computer networking technologies for local area networks (LANs) commercially introduced in 1980. Systems communicating over Ethernet divide a stream of data into individual packets called frames. Each frame contains source and destination addresses and error-checking data so that damaged data can be detected and retransmitted. The standards define several wiring and signalling variants. The original 10BASE5 Ethernet used coaxial cable as a shared medium. Later the coaxial cables were

replaced by twisted pair and fiber optic links in conjunction with hubs or switches. Data rates were periodically increased from the original 10 megabits per second, to 100 gigabits per second. Since its commercial release, Ethernet has retained a good degree of compatibility. Features such as the 48-bit MAC address and Ethernet frame format have influenced other networking protocols.

1.16 EMI: Electromagnetic Interference.

1.17 Fault Clearance: The power system must be designed and operated to avoid instability, loss of synchronism, voltage collapse, undesired load shedding and unacceptable frequency and voltage. Good protection practices help meet these objectives by detecting and clearing faults rapidly. Rapid fault clearance helps: prevent severe power swings or system instability, minimize disruption of system, power transfer capability, prevent unreliable services, limit or prevent damage to equipment.

1.18 Fault Clearance Time: The time interval between the fault inception and the fault clearance.

1.19 Feeder Bay: In a substation, the bay relating to a feeder or a link to a transformer, a generator or another substation.

1.20 GOOSE: Generic Object Oriented Substation Event (IEC GOOSE) supports the exchange of a wide range of possible common data (digital and analogue) organized by a DATA-SET.

1.21 IED: Intelligent Electronic Device.

1.22 LAN: Local Area Network.

1.23 Logical Node: smallest part of a function that exchanges data. A logical node is an object defined by its data and methods.

- 1.24 Merging Unit (wherever required) :** Interface unit that accepts multiple analogue CT/VT and publishing time synchronized data streams of multicast unidirectional messages via the logical interfaces 4 and 5 over process bus LAN. [IEC 61850-9-2 LE]
- 1.25 Multicast:** Uni-directional, connectionless communication between a server and a selected set of clients. [IEC 61850-6].
- 1.26 Numeric Protection:** A numeric protection performs analogue to digital conversion on samples of the secondary voltage and/or current signals and uses numerical methods to determine relay operation.
- 1.27 Peer-to-Peer:** is a communications model in which each party has the same capabilities and either party can initiate a communication session. Other models with which it might be contrasted include the client/server model and the master/slave model. In some cases, peer- to- peer communications is implemented by giving each communication node both server and client capabilities.
- 1.28 Process Bus:** is the communication bus between the primary equipment installed in the yard and the IEDs installed in the control room. The Process layer of the substation is related to gathering information such as Voltage, Current and status information from the transformers and transducers connected to the primary power system process – the transmission of electricity. IEC 61850 Part 9.2 which defines a “configurable” dataset that can be transmitted on a multi-cast basis from one publisher to multiple subscribers.
- 1.29 Protected Zone:** The portion of a power system protected by a given protection system or a part of that protection system. The boundary of the protected zone is defined by the position of the current transformers in order to identify the location of the fault. The position of the circuit breakers is chosen in order to facilitate the isolation of the fault.
- 1.30 Protection Equipment:** Equipment incorporating one or more protection relays and, if necessary, logic elements intended to perform one or more specified protection functions.
Note: protection equipment is part of a protection system

- 1.31 Protection Relay:** A measuring relay which, either solely or in a combination with other relays, is a constituent of protection equipment.
- 1.32 Redundancy:** In an item is the existence of more than one means for performing a required function.
- 1.33 Substation Automation System:** provides automation within a substation and includes the IEDs and communication network infrastructure. [IEC 61850-1].
- 1.34 Sampled Analogue Value:** IEC 61850-9-2 is used to transmit the signals (voltage, current as well as status information) from Non-Conventional or Conventional Instrument Transformers to IEDs such as Protective Relays using a Merging Unit. The digitally formatted and time stamped multicast Sampled Analogue Values are transmitted via Fiber Optic to IEDs.
- 1.35 SCL:** Substation Configuration Language.
- 1.36 Server:** on a communication network, a functional node that provides data to, or that allows access to its resources by, other functional nodes. A server may also be a logical subdivision, which has independent control of its operation, within the software algorithm (and/or possibly hardware) structure. [IEC 61850-6]
- 1.37 SIPS:** System Integrity Protection Schemes.
- 1.38 Sampled Measured Value:** See sampled analogue value.
- 1.39 Station Bus:** The station bus provides primary communications between the various Logical Nodes, which provide the various station protection, control, monitoring, and logging functions.

SECTION-XIV

CONTROL & RELAY PANELS

SECTION: XIV

RELAY AND PROTECTION PANELS

(Applicable for Sub-station with Automation System)

1.0 GENERAL

- 1.1 This specification covers the design, engineering, manufacture, assembly, testing, supply and delivery of relay and protection panels complete with wiring, meters, relays, control switches and other miscellaneous equipments specified herein after in this specifications for 400 kV, 220 kV, 66 kV and 33 kV voltage levels in DTL system.
- 1.2 The relay and protection panels shall be complete with all components and accessories which are necessary or usual for their efficient performance and satisfactory maintenance under the various operating and atmospheric conditions. Such parts shall be deemed to be within the scope of supply, whether specifically included or not in the specifications. The successful bidder shall not be eligible for any extra charges for such accessories etc.

1.3 CLIMATIC CONDITIONS

The climatic conditions prevailing at site are as follows:

1	Maximum ambient air temperature as per IS: 9676	45°C
2	Standard ambient air temperature as per IS: 9676	40°C
3	Maximum Relative Humidity	100%
4	Minimum Relative Humidity	10%
5	Average annual rainfall	750 mm
6	Average no. of rainy day	50
7	Average no. of thunderstorm days per annum	40
8	Altitude	Not exceeding 300 meters
9	Rain months	June to Oct.
10	Wind pressure as per IS 875	195 Kg/Sq. meters up to 30 meters

The atmosphere is generally laden with mild acid and dust in suspension during the dry months and is subject to fog in cold months. The variation between daily minimum and maximum temperature could be to the extent of 15/20 deg. C. Heavy lightening is in the area during the rainy months. All the equipments shall be designed to withstand seismic forces corresponding to seismic zone – IV.

1.4 STANDARDS

- 1.4.1 The design, manufacture, testing and performance of the equipment provided under this specification shall comply with the standards and rules given in this specification.

- 1.4.2 Unless otherwise specified the equipment shall conform to the latest applicable Indian Standards. The equipment complying with any other authorized standards such as British, USA, etc. will also be considered if it ensures performance equivalent or superior to Indian Standards specified below. In the event of supply of equipment conforming to any internationally recognized standards other than the Indian Standards, the salient features of comparison shall be brought out in the tender. The copies of such standard in English language or their English translation shall be attached with the offer.
- 1.4.3 The bidder shall note that standards mentioned in the specification are not mutually exclusive or complete in themselves, but intended to compliment each other.
- 1.4.4 The bidder shall also note that list of standards presented in this specification may not be complete and exhaustive. Whenever necessary the list of standards shall be considered in conjunction with specific IS/IEC.

LIST OF STANDARDS

IS-3231	Electrical relays for power system protection.
IS-3842 Part-I to VII	Application guide for electrical relays
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
IEC-60051 : (P1 to P9)	Recommendations for Direct Acting indicating analogue electrical measuring instruments and their accessories.
IEC-60255 (Part 1 to part 23)	Electrical relays.
IEC-60297 (P1 to P4)	Dimensions of mechanical structures of the 482.6mm (19 inches) 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 meters
IEC-60547	Modular plug-in Unit and standard 19-inch rack mounting unit based on NIM Standard (for electronic nuclear instruments)
BS-142	Electrical protective relays
IS-722	Energy meters
IS-13010	Watt hour meter
IS-1248	Electrical indicating instrument
IS-6875	Control switches
IEC-337 and 3371	Control switches LV switching device for control and auxiliary circuits
IS-2605	Auxiliary current transformers
IS-3165	Auxiliary potential transformers
IS-1554 part-I	PVC insulated cables up to & including 1100V.
IS-2208	HRC cartridge fuses links up to 650V.
IS-8828	MCB's
IS-2516	Circuit breaker

2. CONSTRUCTIONAL FEATURES

- 2.1 Simplex panel shall consist of a vertical front panel with equipment mounted thereon and having wiring access from front for control & relay panels. In case of panel having width more than 800mm, double leaf-doors shall be provided. Doors shall have handles with either built-in locking facility or will be provided with pad-lock.
- 2.2 Relay panels shall be of simplex type design as indicated. It is the responsibility of the Contractor to ensure that the equipment specified and such unspecified complementary equipment required for completeness of the protective/control schemes is properly accommodated in the panels without congestion and if necessary, provide panels with larger dimensions. No price increase at a later date on this account shall be allowed. However, the width of panels that are being offered to be placed in control rooms, should be in conformity with the space availability in the control room.
- 2.3 Panels shall be completely metal enclosed and shall be dust, moisture and vermin proof. The enclosure shall provide a degree of protection not less than IP-42.

- 2.4 Panels shall be free standing, floor mounting type and shall comprise structural frames completely enclosed with specially selected smooth finished, cold rolled sheet steel of thickness not less than 3 mm for weight bearing members of the panels such as base frame, front sheet and door frames, and 2.0 mm for sides, door, top and bottom portions. There shall be sufficient reinforcement to provide level transportation and installation.
- 2.5 All doors, removable covers and panels shall be gasketed all around with synthetic rubber gaskets Neoprene/EPDM generally conforming with provision of IS 11149. However, XLPE gaskets can also be used for fixing protective glass doors. Ventilating louvers, if provided shall have screens and filters. The screens shall be made of either brass or GI wire mesh.
- 2.6 Design, materials selection and workmanship shall be such as to result in neat appearance, inside and outside with no welds, rivets or bolt head apparent from outside, with all exterior surfaces true and smooth.
- 2.7 Panels shall have base frame with smooth bearing surface, which shall be fixed on the embedded foundation channels/insert plates. Anti vibration strips made of shock absorbing materials which shall be supplied by the contractor, shall be placed between panel & base frame.
- 2.8 Cable entries to the panel shall be from the bottom. The bottom plate of the panels shall be fitted with removable gland plates of adequate size for fixing the cable gland. Necessary number of cable glands made of brass (electroplated) of size to suit purchaser's external cables to the panels shall be supplied. Cable glands shall be screw type and made of brass and shall be suitable for PVC armoured cable. Cable gland plate fitted on the bottom of the panel shall be connected to earthing of the panel/station through a flexible braided copper conductor rigidly.
- 2.9 Relay panels of modern modular construction would also be acceptable.
- 2.10 Synchronising sockets shall be provided on panel wherever applicable.

3.0 MOUNTING

- 3.1 All equipment on and in panels shall be mounted and completely wired to the terminal blocks ready for external connections. The equipment on front of panel shall be mounted flush. No equipment shall be mounted on the doors.
- 3.2 Equipment shall be mounted such that removal and replacement can be accomplished individually without interruption of service to adjacent devices and are readily accessible without use of special tools. Terminal marking on the equipment shall be clearly visible.
- 3.3 The Contractor shall carry out cut out, mounting and wiring of the free issue items supplied by others which are to be mounted in his panel in accordance with the corresponding equipment manufacturer's drawings. Cut outs if any, provided for future mounting of equipment shall be properly blanked off with blanking plate.

- 3.4 The centre lines of switches, push buttons and indicating lamps shall be not less than 750mm from the bottom of the panel. The centre lines of relays, meters and recorders shall be not less than 450mm from the bottom of the panel.
- 3.5 The centre lines of switches, push buttons and indicating lamps shall be matched to give a neat and uniform appearance. Like wise the top lines of all meters, relays and recorders etc. shall be matched.
- 3.6 No equipment shall be mounted on the doors.
- 3.7 All equipment connections and cabling shall be designed and arranged to minimize the risk of fire and damage which may be caused by fire.
- 3.8 Provision shall be made in the panel for earthing the panels and mountings.

4.0 **PANEL INTERNAL WIRING**

- 4.1 Panels shall be supplied complete with interconnecting wiring provided between all electrical devices mounted and wired in the panels and between the devices and terminal blocks for the devices to be connected to equipment outside the panels. When panels are arranged to be located adjacent to each other all inter panel wiring and connections between the panels shall be furnished and the wiring shall be carried out internally.
- 4.2 All wiring shall be carried out with 1100V grade, single core, stranded copper conductor wires with PVC insulation and shall be FRLS type. The minimum size of the multi-stranded copper conductor used for internal wiring shall be as follows:
- All circuits except current transformer circuits and voltage transformer circuits – one 1.5mm sq. per lead.
 - All current transformer circuits one 2.5 sq.mm lead.
 - Voltage transformer circuit (for energy meters): Two 2.5 mm sq. per lead.
- 4.3 All internal wiring shall be securely supported, neatly arranged, readily accessible and connected to equipment terminals and terminal blocks. Wiring gutters & troughs shall be used for this purpose where necessary, while terminating wiring at equipment/terminal blocks the wiring shall be securely bunched so that the position of each individual connection wire does not get disturbed when disconnected from equipment terminals.
- 4.4 Auxiliary bus wiring for AC and DC supplies, voltage transformer circuits, annunciation circuits and other common services shall be provided near the top of the panels running throughout the entire length of the panels.
- 4.5 Wire termination shall be made with solder less crimping type and tinned copper lugs, which firmly grip the conductor. Insulated sleeves shall be provided at all the wire terminations. Engraved core identification plastic ferrules marked to correspond with panel wiring diagram shall be fitted at both ends of each wire.

Ferrules shall fit tightly on the wire and shall not fall off when the wire is disconnected from terminal blocks. All wires directly connected to trip circuit breaker or device shall be distinguished by the addition of red coloured unlettered ferrule.

- 4.6 Longitudinal troughs extending throughout the full length of the panel shall be preferred for inter panel wiring. Inter-connections to adjacent panel shall be brought out to a separate set of terminal blocks located near the slots of holes meant for taking the inter-connecting wires.
- 4.7 Contractor shall be solely responsible for the completeness and correctness of the internal wiring and for the proper functioning of the connected equipments.
- 4.8 The control scheme shall incorporate necessary isolating device for easy testing and isolation of faults in the control and signaling circuits.
- 4.9 The colour coding for wiring inside the panel shall be as follows:
 - a) Earth: Green
 - b) Neutral: Black
 - c) Phases: Red, Yellow, Blue

5.0 TERMINAL BLOCKS

- 5.1 All internal wiring to be connected to external equipment shall terminate on terminal blocks. Terminal blocks shall be 1100 V grade and have 10 Amps. Continuous rating, moulded piece, complete with insulated barriers, stud type terminals, washers, nuts and lock nuts. Markings on the terminal blocks shall correspond to wire number and terminal numbers on the wiring diagrams. All terminal blocks shall have shrouding with transparent unbreakable material.
- 5.2 Disconnecting type terminal blocks for current transformer and voltage transformer secondary leads shall be provided. Also current transformer secondary leads shall be provided with short circuiting and earthing facilities.
- 5.3 Terminal blocks shall be fully enclosed with easily removable covers and made of moulded non-inflammable plastic material. The terminal block shall have marking strips and all terminals shall be clearly marked with identification number or letters to facilitate connection to the external wiring.
- 5.4 At least 20% spare terminals shall be provided on each panel and these spare terminals shall be uniformly distributed on all terminal blocks.
- 5.5 Unless otherwise specified, terminal blocks shall be suitable for connecting the following conductors of external cable on each side.
 - All CT & PT circuits: minimum of two of 2.5mm Sq. copper.
 - All other circuits: minimum of one of 2.5mm Sq. Copper.
- 5.6 There shall be a minimum clearance of 250mm between the first row of terminal blocks and the associated cable gland plate or panel side wall. Also the clearance between two rows of terminal blocks edges shall be minimum of 150mm.

- 5.7 Arrangement of the terminal block assemblies and the wiring channel within the enclosure shall be such that a row of terminal blocks is run in parallel and close proximity along each side of the wiring-duct to provide for convenient attachment of internal panel wiring. The side of the terminal block opposite the wiring duct shall be reserved for the Owner's external cable connections. All adjacent terminal blocks shall also share this field wiring corridor. All wiring shall be provided with adequate support inside the panels to hold them firmly and to enable free and flexible termination without causing strain on terminals.
- 5.8 The number and sizes of the Owner's multi core incoming external cables will be furnished to the Contractor after placement of the order. All necessary cable terminating accessories such as gland plates, supporting clamps & brackets, wiring troughs and gutters etc. (except glands & lugs) for external cables shall be included the scope of supply.

6.0 PAINTING

- 6.1 All sheet steel work shall be phosphated in accordance with the IS: 6005 "Code of practice for phosphating iron and steel".
- 6.2 Oil, grease, dirt and swarf shall be thoroughly removed by emulsion cleaning.
- 6.3 Rust and scale shall be removed by pickling with dilute acid followed by washing with running water rinsing with a slightly alkaline hot water and drying.
- 6.4 After phosphating, thorough rinsing shall be carried out with clean water followed by final rinsing with dilute dichromate solution and oven drying.
- 6.5 The phosphate coating shall be sealed with application of two coats of ready mixed, stoved type zinc chromate primer. The first coat may be "flash dried" while the second coat shall be stoved.
- 6.6 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. The exterior colour of paint shall be of a slightly different shade to enable inspection of the painting.
- 6.7 A small quantity of finished paint shall be supplied for minor touching up required at site after installation of the panels.
- 6.8 The finished painted surface of panels shall present aesthetically pleasing appearance free from dents and even surface.
- 6.9 In case the bidder proposes to follow any other established painting procedure like electrostatic painting, the procedure shall be submitted for DTL's review and approval.

7.0 NAME PLATES AND MARKINGS

- 7.1 All equipment mounted on front and rear side as well as equipment mounted inside the panels shall be provided with individual name plates with equipment designation engraved. Also on the top of each panel on front as well as rear side, large and bold nameplates shall be provided for circuit/feeder designation.
- 7.2 All front mounted equipment shall also be provided at the rear with individual name plates engraved with tag numbers corresponding to the one shown in the panel internal wiring to facilitate easy tracing of the wiring.
- 7.3 All relays and other devices shall be clearly marked with manufacturer's name, manufacturer's type, serial number and electrical rating data.
- 7.4 Name Plates shall be made of non-rusting metal or 3 ply lamicoid. Name plates shall have white engraving letters on black or dark blue background. The labels designation and the size of the lettering the labels shall be subject to approval of the purchaser.
- 7.5 Each switch shall bear clear inscription identifying its function e.g. 'BREAKER' '52A', "SYNCHRONISING" etc. Similar inscription shall also be provided on each device whose function is not other-wise identified. If any switch device does not bear this inscription separate name plate giving its function shall be provided for it. Switch shall also have clear inscription for each position indication e.g. "Trip-Neutral-Close", "ON-OFF", "R-Y-B-OFF" etc.
- 7.6 All the panels shall be provided with name plate mounted inside the panel bearing LOA No & Date, Name of the Substation & feeder and reference drawing number.

8.0 MISCELLANEOUS ACCESSORIES

- 8.1 **Plug Point:** 240V, Single phase 50Hz, AC socket with switch suitable to accept 5 Amps and 15 Amps pin round standard Indian plug, shall be provided in the interior of each cubicle with ON-OFF switch.
- 8.2 **Interior Lighting:** Each panel shall be provided with a fluorescent lighting fixture rated for 240 Volts, single phase, 50 Hz supply for the interior illumination of the panel controlled by the respective panel door switch.
- 8.3 **Switches and Fuses:** Each panel shall be provided with necessary arrangements for receiving, distributing and isolating 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 breakers (MCB). Selection of the main and sub-circuit MCB rating shall be such as to ensure selective clearance of sub-circuit faults. MCBs shall conform to IS: 13947. Each MCB shall be provided with one potential free contact and the same shall be wired for annunciation purpose. MCBs shall have imprints of the 'rating' and 'voltage'.
- 8.4 **Space Heater:** Each panel shall be provided with a space heater rated for 240V,

single phase, 50 Hz AC supply for the internal heating of the panel to prevent condensation of moisture. The fittings shall be complete with switch unit.

- 8.5 **ENERGY METERS:** - ABT meters (Microprocessor-based 3 Phase, 4 wire bi directional TriVector meter) of 0.2 accuracy class with open communication protocol (DLMS) of reputed make shall be supplied for each line protection panel and transformer panel for metering purpose. They shall be type tested as per IS / IEC. Details of the same shall be submitted to the Employer.

9.0 EARTHING

- 9.1 All panels shall be equipped with an earth bus securely fixed. Location of earth bus shall ensure no radiation interference for earth systems under various switching conditions of isolators and breakers. The material and the sizes of the bus bar shall be at least 25 X 6 sq. mm perforated copper with threaded holes at a gap of 50mm with a provision of bolts and nuts for connection with cable armours and mounted equipment etc for effective earthing. When several panels are mounted adjoining each other, the earth bus shall be made continuous and necessary connectors and clamps for this purpose shall be included in the scope of supply of Contractor. Provision shall be made for extending the earth bus bars to future adjoining panels on either side.
- 9.2 Provision shall be made on each bus bar of the end panels for connecting Substation earthing grid. Necessary terminal clamps and connectors for this purpose shall be included in the scope of supply of Contractor.
- 9.3 All metallic cases of relays, instruments and other panel mounted equipment including gland plate, shall be connected to the earth bus by copper wires of size not less than 2.5 sq. mm. The colour code of earthing wires shall be green. Earthing wire shall be connected on terminals with suitable clamp connectors and soldering shall not be permitted.
- 9.4 Looping of earth connections which would result in loss of earth connection to other devices when the loop is broken, shall not be permitted. Earthing may be done in such a manner that no circulating current shall flow in the panel.
- 9.5 VT and CT secondary neutral or common lead shall be earthed at one place only at the terminal blocks where they enter the panel. Such earthing shall be made through links so that earthing may be removed from one group without disturbing continuity of earthing system for other groups.
- 9.6 An electrostatic discharge point shall be provided in each panel connected to earth bus via 1 Mega Ohm resistor.

10.0 RELAYS

- 10.1 All relays shall conform to the requirements of IS:3231/IEC-60255/IEC 61000 or other applicable standards. Relays shall be suitable for flush or semi-flush mounting on the front with connections from the rear.

- 10.2 All main protective relays shall be of numerical type and communication protocol shall be as per IEC 61850. Further, the test levels of EMI as indicated in IEC 61850 shall be applicable to these. All the relays shall be directly connected to the inter bay bus using fiber optic cables and shall support peer to peer communication. The relay shall generate GOOSE message as per IEC 61850 standards for interlocking and shall also ensure interoperability with 3rd Party relays. Each relay shall also generate an ICD file in XML format for engineering / integration to a vendor independent SCADA System. The relays should have a port for local communication for relay settings, modifications etc.
- 10.3 All the relays should have time synchronization facility and shall be connected with existing time synchronizing equipment available with DTL, with the available signals like PPS, PPM, IRIG-B, potential free contact etc.
- 10.4 All protective relays shall be in draw out or plug-in type/modular cases with proper testing facilities. Necessary test plugs/test handles shall be supplied loose and shall be included in contractor's scope of supply.
- 10.5 All AC operated relays shall be suitable for operation at 50 Hz. AC Voltage operated relays shall be suitable for 110 Volts VT secondary and current operated relays for 1 amp CT secondary. All DC operated relays and timers shall be designed for the DC voltage specified, and shall operate satisfactorily between 80% and 110% of rated voltage. Voltage operated relays shall have adequate thermal capacity for continuous operation.
- 10.6 The protective relays shall be suitable for efficient and reliable operation of the protection scheme described in the specification. Necessary auxiliary relays and timers required for interlocking schemes for multiplying of contacts suiting contact duties of protective relays and monitoring of control supplies and circuits, lockout relay monitoring circuits etc. also required for the complete protection schemes described in the specification shall be provided. All protective relays shall be provided with at least two pairs of potential free isolated output contacts. Auxiliary relays and timers shall have pairs of contacts as required to complete the scheme; contacts shall be silver faced with spring action. Relay case shall have adequate number of terminals for making potential free external connections to the relay coils and contacts, including spare contacts. Relay case size shall be chosen so as not to introduce any limitation on the use of available contacts of the relay.
- 10.7 All protective relays, auxiliary relays and timers except the lock out relays, master relay and interlocking relays specified shall be provided with self-reset type contacts. All protective relays and timers shall be provided with externally hand reset positive action operation indicators with inscription. All protective relays which do not have built-in hand-reset operation indicators shall have additional auxiliary relays with operating indicators (Flag relays) for this purpose. Similarly, separate operating indicator (auxiliary relays) shall also be provided in the trip circuits of protections located outside the board such as Buchholz relays, oil and winding temperature protection, sudden pressure devices, fire protection etc.
- 10.8 Timers shall be electronic/digital or software base timer. Time delay in terms of milliseconds obtained by the external capacitor resistor combination is not preferred and shall be avoided .

- 10.9 No control relay which shall trip the power circuit breaker when the relay is de-energised shall be employed in the circuits.
- 10.10 Provision shall be made for easy isolation of trip circuits of each relay for the purpose of testing and maintenance.
- 10.11 Auxiliary seal-in-units provided on the protective relays shall preferably be of shunt reinforcement type. If series relays are used the following shall be strictly ensured
- (a) The operating time of the series seal-in-unit shall be sufficiently shorter than that of the trip coil or trip relay in series with which it operates to ensure definite operation of the flag indicator of the relay.
 - (b) Seal-in-unit shall obtain adequate current for operation when one or more relays operate simultaneously.
 - (c) Impedance of the seal-in-unit shall be small enough to permit satisfactory operation of the trip coil on trip relays when the D.C. Supply Voltage is minimum.
 - (d) Trip-circuit seal-in is required for all trip outputs, irrespective of the magnitude of the interrupted current. The trip-circuit seal-in logic shall not only seal-in the trip output(s), but also the relevant initiation signals to other scheme functions, (e.g. initiate signals to the circuit-breaker failure function, reclosing function etc.), and the alarm output signals.
 - (e) Two methods of seal-in are required, one based on the measurement of AC current, catering for those circumstances for which the interrupted current is above a set threshold, and one based on a fixed time duration, catering for those circumstances for which the interrupted current is small (below the set threshold).
 - (f) For the current seal-in method, the seal-in shall be maintained until the circuit-breaker opens, at which time the seal-in shall reset and the seal-in method shall not now revert to the fixed time duration method. For this seal-in method, the seal-in shall be maintained for the set time duration. For the line protection schemes, this time duration shall be independently settable for single- and three-pole tripping.
 - (g) Seal-in by way of current or by way of the fixed duration timer shall occur irrespective of whether the trip command originates from within the main protection device itself (from any of the internal protection functions), or from an external device with its trip output routed through the main protection device for tripping. Trip-circuit seal-in shall not take place under sub-harmonic conditions (e.g. reactor ring down).
- 10.12 All protective relays and alarm relays shall be provided with one extra isolated pair of contacts wired to terminals exclusively for future use.
- 10.13 Any alternative/additional protections or relays considered necessary for providing

- complete effective and reliable protection shall also be offered separately. The acceptance of this alternative/ additional equipment shall lie with the DTL.
- 10.14 The bidder shall include in his bid a list of installations where the relays quoted have been in satisfactory operation.
- 10.15 All devices required for correct operation of each relay shall be provided. The supplier shall ensure that all terminals and the contacts of the relays are readily brought out for connections as required in the final approval scheme. The type of the relay case size offered shall not create any restriction on the availability of contact terminals for wiring connections.
- 10.16 All relays and their drawings shall have phase indications as R-Red, Y-Yellow, B-blue.
- 10.17 For numerical relays, the scope shall include the following:
- a) Necessary software and hardware to up/down load the data to/from the relay from/to the personal computer installed in the substation. However, the supply of PC is not covered under this clause. The copy of software (2 Nos.) is to be supplied to protection department & substation under execution.
 - b) The relay shall have suitable communication facility for future connectivity to SCADA. The relay shall be capable of supporting IEC 870-5-103 and IEC 61850 protocol.
 - c) Manuals for all relays (both Soft & Hard copy) and Computer manuals are to be supplied at every sub-station and 4 copies in Protection department and one copy each in Planning department and C&MM department. 2 nos. copies of complete system files after testing & commissioning is to be supplied to protection department & substation under execution.

11.0 TRANSMISSION LINE PROTECTION

- 11.1 The line protection relays are required to protect the line and clear the faults on line within shortest possible time with reliability, selectivity and full sensitivity to all type of faults on lines. The general concept is to have two fast operating distance protection scheme preferably with two different make for 400 kV system. In case of 220 kV system one fast operating distance & one fast operating current differential protection scheme be adopted. The Main-I and Main-II will generally be operated from signal from different cores of line VT. In case line VT is out due to any reason manual selection for Bus VT will be made. The Main-I and Main-II protections having equal performance requirement specially in respect of time as called for Main-I and Main-II for 400 & 220KV transmission lines. In case of 220KV O/H lines and XLPE cables Distance protection will be used as Main-I whereas the current differential protection will be used as Main-II protection. For 220 kV XLPE cable auto reclosing feature is not required whereas for 220 kV O/H lines auto reclosing feature is required. The general concept is to have Main (distance protection) and back up protection for 66 kV & 33 kV line feeders.

- 11.2 The Transmission system for which the line protection equipment are required is shown in the reference drawing/document(s). The length of lines and the line parameters (Electrical Constants) shall be provided during detailed engineering.
- 11.3 The maximum fault current could be as high as 40 kA for 400 kV and 220 kV system and 31.5 KV for 66 KV and 33 kV, but the minimum fault current could be as low as 20% of rated current of CT secondary. The starting & measuring relays characteristics should be satisfactory under these extremely varying conditions.
- 11.4 The protective relays shall be suitable for use with capacitor voltage transformers having non-electronic damping and transient response as per IEC.
- 11.5 Disturbance Recorder, Distance to fault Locator and Over voltage relay (stage -1) functions if offered as an integral part of line protection relay, shall be acceptable provided these meet the technical requirements as specified in the respective clauses.
- 11.6 Auto reclose relay function if offered as an integral part of line distance protection relay, shall be acceptable provided the auto reclose relay feature meets the technical requirements as specified in the respective clause.
- 11.7 The following protections shall be provided for each of the Transmission lines:

For 400 KV

Main-I: Numerical distance protection scheme (with back up IDMT earth fault protection)

Main-II: Numerical distance protection scheme (with back up IDMT earth fault protection) of a different make from that of Main-I

For 220KV

Main-I: Numerical distance protection scheme (with back up IDMT earth fault protection)

Main-II: Line current differential protection scheme

For 66KV & 33 KV

Main: Numerical distance protection scheme

Back up: Directional over current and Earth fault Protection

- 11.8 The detailed description of the above line protections is given here under:

11.8.1 Numerical Distance Protection scheme:

- (a) Shall be numerical type and shall have continuous self monitoring and diagnostic feature.
- (b) Shall be non-switched type with separate measurements for all phase to phase and phase to ground faults.
- (c) Shall have stepped time-distance characteristics five independent zones.
- (d) Shall have quadrilateral or Polygonal shaped characteristics.
- (e) Shall have following maximum operating time (including trip relay time , if any) under given set of conditions and with CVT being used on line (with all filters included).

i) for 400 KV & 220 KV lines:

Descriptions	For 400kV & 220 kV
Source to Impedance ratio	4
Relay setting (Ohms)	10 or 20
Fault Locations (as % of relay setting)	50
Fault resistance (Ohms)	0
Maximum operating time (Milliseconds)	40 for all faults

ii) for 66 kV & 33 kV lines:

For 66 kV & 33 kV lines maximum operating time is 45 ms for 3 ph. Faults & 60 ms for all other faults

- (f) The relay shall have an adjustable characteristics angle setting range of 30 - 85 degree or shall have independent resistance (R) and reactance (X) setting.
- (g) Shall have independent time setting range of 0-5 sec for all five zones.
- (h) Shall have resetting time of less than 55 milli-seconds (including the resetting time of trip relays).
- (i) Shall have variable residual compensation.
- (j) Shall have memory circuits with defined characteristics in all three phases to ensure correct operation during close-up 3-phase faults and other adverse conditions and shall operate instantaneously when circuit breaker is closed to zero-volt 3 phase fault.
- (k) Shall have weak end in-feed feature.

- (l) Shall be suitable for single and three phase tripping.
- (m) Shall have a continuous current rating of two times of rated current. The voltage circuit shall be capable of operation at 1.2 times rated voltage. The relay shall also be capable of carrying a high short time current of 70 times rated current without damage for a period of 1 sec.
- (n) Shall be provided with necessary self reset type trip duty contacts for completion of the scheme (Minimum number of these trip duty contacts shall be four per phase) through built in high speed trip relays. Making capacity of these trip contacts shall be 30 Amp for 0.2 seconds with an inductive load of $L/R > 10$ mill seconds.
- (o) Shall be suitable for use in permissive under reach / over reach /blocking communication mode.
- (p) Shall have suitable number of potential free contacts for Inter Tripping, Auto reclosing, CB failure, Event Logger, Disturbance recorder & Data acquisition system.
- (q) Include power swing blocking protection which shall
 - Have suitable setting range to encircle the distance protection described above.
 - Block tripping during power swing conditions.
 - Release blocking in the event of actual fault
- (r) Include fuse failure protection which shall
 - Monitor all the three fuses of V.T. and associated cable against open circuit.
 - Inhibit trip circuits on operation and initiate annunciation.
 - Have an operating time less than 7 milliseconds
 - Remain inoperative for system earth faults
- (s) Include a directional back up Inverse Definite Minimum Time (IDMT) earth fault relay with normal inverse characteristics as per IEC 60255-3 as a built in feature
- (t) Must have a current reversal guard feature. Must also have module for Tx and Rx for interconnection with other end relay through fibre optic cable. Relay must be able to send and receive three independent codes.
- (u) Must have SOTF (Switch on to Fault) feature

11.8.2 Numerical Line Current Differential Scheme:

- (a) Shall be phase segregated current line differential protection scheme.
- (b) For overhead lines and cables for short length for primary ckt.

- (c) Shall have high sensitivity for differential current below the minimum line loading of 20%.
- (d) Suitable for single and three phase tripping.
- (e) Shall be suitable for different CT ratio of the CTs provided at the terminals of the line.
- (f) Shall be non-operative for transient cable/line charging current without affecting the sensitivity of the relay.
- (g) Shall have high stability for high through fault currents.
- (h) Shall have measurement of delay time to remote line terminals for dynamic compensation of delay in differential measurement.
- (i) Shall have CT Secondary current supervision.
- (j) Shall have Continuous self monitoring and diagnostic feature.
- (k) Potential free binary contacts shall be wired as per requirement for Inter Tripping, Auto reclosing, direct trip, CB failure, Disturbance recorder & Data acquisition system (These contacts are included in the total no of contacts).
- (l) Shall have facility for selecting synchronizing or dead line charging features.
- (m) Shall be based on IEC 61850 and should be communicable through direct fiber optic as well as through multiplexers.
- (n) Shall be suitable for Direct inter tripping.
- (o) Measurement:

The relay shall have the following measurements:

Local and remote phase current
 Local neutral current
 Phase bias and differential currents.
 Sequence currents.
 Thermal state.

The relay shall provide protection signaling supervision indicating the following parameters:

Channel propagation delay.
 Channel status.
 Number of valid and error messages.

- (p) In Case of communication failure, relay shall work as Numerical Distance Protection scheme with all features mentioned in Distance relay specifications.

11.8.3 Numerical Back-up directional Over Current and Earth fault protection scheme with high set feature

- (a) Shall have three over current and one earth fault element(s) which shall be either independent or composite unit(s).
- (b) The scheme shall include necessary VT fuse failure relays for alarm purposes
- (c) Over current relay shall
 - Have directional IDMT characteristic with a definite minimum time of 3.0 seconds at 10 times setting and have a variable setting range of 50-200% of rated current.
 - have low transient, over reach high set instantaneous unit of continuously variable setting range 100-2000 % of rated current.
 - Have a characteristic angle of 30/45 degree .
 - Include self / electrical reset flag indicators or LEDs.
- (d) Earth fault relay shall
 - Have directional IDMT characteristic with a definite minimum time of 3.0 seconds at 10 times setting and have a variable setting range of 20-80% of rated current
 - Have low transient, over reach high set instantaneous unit of continuously variable setting range 10-1000 % of rated current.
 - Have a characteristic angle of 45/60 degree lag.
 - Include self/ electrical reset flag indicators or LEDs.
 - Have internal feature in the relay for open delta voltage to the relay.

11.8.4 All trip relays used in transmission line protection scheme shall be of self/electrical reset type depending on application requirement.

12.0 Circuit Breaker Protection

This shall include following function:

12.1 **AUTO RECLOSING RELAY** shall be separate from Main-I and Main-II protection. However, auto reclose as inbuilt function of bay controller unit (BCU) provided for substation automation is acceptable. The auto reclose shall

- (a) Have single phase or/and three phase reclosing facilities.
- (b) Have a continuously variable single phase dead time range of 0.1-2 seconds.
- (c) Have a continuously variable three phase dead time range of 0.1-2 seconds.
- (d) Have a continuously variable reclaim time range of 5-25 seconds.
- (e) Have facilities for selecting check synchronizing or dead line charging

features. It shall be possible at any time to change the required feature by reconnection of links.

- (f) Have priority circuit to closing of both circuit breakers in case one and half/double breaker arrangements for 400 kV to allow sequential closing of breakers
- (g) Include check synchronizing relay which shall
 - Have a time setting continuously variable between 0.5-5 seconds with a facility of additional 10 seconds.
 - Have a response time within 200 milli seconds with the timer disconnected.
 - Have a phase angle setting not exceeding 35 degree
 - Have a voltage difference setting not exceeding 10%
- (h) Include dead line charging relay which shall
 - Have two sets of relays and each set shall be able to monitor the three phase voltage where one set shall be connected to the line CVTs with a fixed setting of 20% of rated voltage and the other set shall be connected to the bus CVTs with a fixed setting of 80% of rated voltage.
 - Incorporate necessary auxiliary relays and timers to give comprehensive scheme.

12.2 LOCAL BREAKER BACK-UP PROTECTION SCHEME shall

- (a) Be triple pole type
- (b) Have an operating time of less than 15 milli seconds
- (c) Have a resetting time of less than 15 milli seconds
- (d) Have three over current elements
- (e) be arranged to get individual initiation from the corresponding phase of main protections of line for each over current element. However, common three phase initiation is acceptable for other protections and transformer /reactor equipment protections.
- (f) Have a setting range of 20-80% of rated current
- (g) have a continuous thermal withstand two times rated current irrespective of the setting
- (h) Have a timer with continuously adjustable setting range of 0.1-1 seconds.

- (i) Have necessary auxiliary relays to make a comprehensive scheme.
- (j) Be suitable for 220 V DC supply.

12.3 TRIP CIRCUIT SUPERVISION RELAY

- (a) The relay shall be capable of monitoring the healthiness of each 'phase' trip-coil and associated circuit of circuit breaker during 'ON' and 'OFF' conditions.
- (b) The relay shall have adequate contacts for providing connection to alarm and event logger.
- (c) The relay shall have time delay on drop-off of not less than 200 milli seconds and be provided with operation indications for each phase.

13.0 LINE OVER VOLTAGE PROTECTION RELAY shall

- (a) monitor all three phases
- (b) have two independent stages and stage- 1 & II relay are acceptable as built in with line distance relays Main I & II respectively .
- (c) have an adjustable setting range of 100-170% of rated voltage with an adjustable time delay range of 1 to 60 seconds for the first stage.
- (d) Have an adjustable setting range of 100-170% of rated voltage with a time delay of 100-200 milliseconds for the second stage.
- (e) be tuned to power frequency
- (f) Provided with separate operation indicators (flag target) for each stage relays.
- (g) Have a drop-off to pick-up ratio greater than 95%.
- (h) provide separate output contacts for each 'Phase' and stage for breaker trip relays, event logger and other scheme requirements.

14.0 TRANSFORMER PROTECTION

14.1 Transformer differential protection scheme shall

- (a) Be triple pole type, with faulty phase identification/ indication
- (b) have an operating time not greater than 30 milli seconds at 5 times the rated current .
- (c) Have three instantaneous high set over-current units.

- (d) Have an adjustable bias setting range of 20-50%
- (e) Be suitable for rated current of 1 Amp.
- (f) have second harmonic or other inrush proof features and also should be stable under normal over fluxing conditions. Magnetising inrush proof feature shall not be achieved through any intentional time delay e.g. use of timers to block relay operation or using disc operated relays
- (g) Have an operating current setting of 15% or less
- (h) include necessary separate interposing current transformers for angle and ratio correction or have internal feature in the relay to take care of the angle & ratio correction
- (i) shall be numerical type and shall have continuous self monitoring and diagnostic feature.
- (j) have a disturbance recording feature to record graphic form of instantaneous values of current in all three windings in nine analogue channels in case of 400kv class and above transformers and 6 analogue channels for lower voltage transformers, during faults and disturbances for the pre fault and post fault period. The disturbance recorder shall have the facility to record the following external digital channel signals apart from the digital signals pertaining to differential relay.
 - i. REF protection operated
 - ii. HV breaker status
 - iii. LV breaker status
 - iv. Buchholz /OLTC Buchholz alarm / trip
 - v. WTI/OTI/PRD alarm/trip of transformer

Necessary hardware and software for down loading the data captured by disturbance recorder to the personal computer or work station available in the substation shall be included in the scope.

14.2 Over fluxing protection Relays shall

- (a) Operate on the principle of Voltage to frequency ratio and shall be phase to phase connected
- (b) Have inverse time characteristics, matching with transformer over fluxing withstand capability curve.
- (c) Provide an independent 'alarm' with the time delay continuously adjustable between 0.1 to 6.0 seconds at values of V/f between 100% to 130% of rated values.

- (d) Tripping time shall be governed by 'v/f' Vs. time characteristics of the relay
- (e) have a set of characteristics for Various time multiplier settings. The maximum operating time of the relay shall not exceed 3 seconds and 1.5 seconds at 'v/f' values of 1.4 and 1.5 times, the rated values, respectively.
- (f) Have an accuracy of operating time, better than $\pm 10\%$.
- (g) Have a resetting ratio of 95 % or better.
- (h) Be acceptable as a built in feature of numerical transformer differential relay

14.3 Numerical Restricted Earth Fault Protection shall

- (a) Be single pole type
- (b) Be of current/voltage operated high impedance type
- (c) Have a current setting range of 10-40% of 1 Amp./ have a suitable voltage setting range.
- (d) Be tuned to the system frequency
- (e) have suitable non-linear resistor to limit the peak voltage to 1000 Volts.

14.4 Numerical Back-up Over Current and Earth fault protection scheme with high set feature

- (e) Shall have three over current and one earth fault element(s) which shall be either independent or composite unit(s).
- (f) The scheme shall include necessary VT fuse failure relays for alarm purposes
- (g) Over current relay shall
 - have directional IDMT characteristic with a definite minimum time of 3.0 seconds at 10 times setting and have a variable setting range of 50-200% of rated current
 - have low transient, over reach high set instantaneous unit of continuously variable setting range 500-2000 % of rated current
 - have a characteristic angle of 30/45 degree lead
 - include self/ electrical reset flag indicators or LEDs.
- (h) Earth fault relay shall
 - have directional IDMT characteristic with a definite minimum time of 3.0 seconds at 10 times setting and have a variable setting range of 20-80% of rated current

- have low transient, over reach high set instantaneous unit of continuously variable setting range 200-800 % of rated current
- have a characteristic angle of 45/60 degree lag
- include self/ electrical reset flag indicators or LEDs
- include necessary separate interposing voltage transformers or have internal feature in the relay for open delta voltage to the relay.

14.5 Transformer Overload Protection Relay shall

- (a) be of single pole type
- (b) be of definite time over-current type
- (c) have one set of over-current relay element, with continuously adjustable setting range of 50%-200% of rated current
- (d) Have one adjustable time delay relay for alarm having setting range of 1 to 10.0 seconds, continuously.
- (e) Have a drop-off/pick-up ratio greater than 95%.
- (f) be acceptable as built in feature of numerical transformer differential relay

15.0 TRIPPING RELAY

High Speed Tripping Relay shall

- (a) Be instantaneous (operating time not to exceed 10 milliseconds).
- (b) Reset within 20 milliseconds
- (c) Be D.C. operated
- (d) have adequate contacts to meet the requirement of scheme, other functions like auto-reclose relay, LBB relay as well as cater to associated equipment like event logger, Disturbance recorder, fault Locator, etc.
- (e) Be provided with operation indicators for each element/coil.

16.0 FLAG RELAYS

These shall have

- (a) self/ electrical reset flag indication

- (b) have minimum 4NO and 1 NC or combination as required for each relay.

17.0 DC SUPPLY SUPERVISION RELAY

- (a) The relay shall be capable of monitoring the failure of D.C. supply to which, it is connected.
- (b) It shall have adequate potential free contacts to meet the scheme requirement.
- (c) The relay shall have a 'time delay on drop-off' of not less than 100 milliseconds and be provided with operation indicator/flag.

18.0 BUS BAR PROTECTION (For New & Replacement of Whole Scheme)

- 18.1 Redundant (1+1) numerical Bus Bar protection scheme for each bus system (Bus1 +Bus2) for 400kV shall be provided. The scheme shall be engineered so as to ensure that operation of any one out of two schemes connected to main faulty bus shall result in tripping of the same.
- 18.2 Single bus bar protection scheme shall be provided for each bus for 220KV voltage level.
- 18.3 Each Bus Bar protection scheme shall
 - (a) Have maximum operating time up to trip impulse to trip relay for all types of faults of 25 milliseconds at 5 times setting value.
 - (b) Operate selectively for each bus bar
 - (c) Give hundred percent securities up to 40 KA fault level for 400KV and 220KV
 - (d) Incorporate continuous supervision for CT secondary against any possible open circuit and if it occurs, shall render the relevant zone of protection inoperative and initiate an alarm
 - (e) Not give false operation during normal load flow in bus bars.
 - (f) Incorporate clear zone indication.
 - (g) Be of phase segregated and triple pole type
 - (h) Provide independent zones of protection (including transfer bus if any). If the bus section is provided then each side of bus section shall have separate set of bus bar protection schemes.
 - (i) include individual high speed electrically reset tripping relays for each feeder.
 - (j) Be transient free in operation

- (k) include continuous D.C. supplies supervision.
 - (l) not cause tripping for the differential current below the load current of heaviest loaded feeder. Bidder shall submit application check for the same.
 - (m) Shall include necessary C.T. Switching relays wherever C.T. switching is involved and have 'CT' selection incomplete alarm
 - (n) Include protection 'IN/OUT' switch for each zone.
 - (o) shall include trip relays, CT switching relays(if applicable) , auxiliary CTs (if applicable) as well as additional power supply modules, input modules etc. as may required to provide a Bus-bar protection scheme for the complete bus arrangement i.e. for all the bay or breakers under this specification as well as for the future bays as per the Single line diagram for new substations. However for extension of bus bar protection scheme (if specified) in existing substations, scope shall be limited to the bay or breakers covered under this specification. Suitable panels to mount these are also included in the scope of the work.
 - (p) Shall have disturbance recorder.
- 18.4 Built-in Local Breaker Backup protection feature as a part of bus bar protection scheme shall also be acceptable.
- 18.5 At existing substations, Bus-bar protection scheme with independent zones for each bus will be available. All necessary co-ordination for 'AC' and 'DC' interconnections between existing schemes (Panels) and the bays proposed under the scope of this contract shall be fully covered by the bidder. Any auxiliary relay, trip relay, flag relay and multi tap auxiliary CTs (in case of biased differential protection) required to facilitate the operation of the bays covered under this contract shall be fully covered in the scope of the bidder.
- (a) The test terminal blocks (TTB) to be provided shall be fully enclosed with removable covers and made of moulded, non-inflammable plastic material with boxes and barriers moulded integrally. All terminals shall be clearly marked with identification numbers or letters to facilitate connection to external wiring. Terminal block shall have shorting, disconnecting and testing facilities for CT circuits.

19.0 DISTURBANCE RECORDER

- 19.1 Disturbance recorder shall be microprocessor based and shall be used to record the graphic form of instantaneous values of voltage and current in all three phases, open delta voltage & neutral current, open or closed position of relay contacts and breakers during the system disturbances and built in feature of line distance/ line current differential/ transformer current differential / Bus bar protection relay is acceptable provided the requirements of following clauses are met.

- 19.2 The disturbance recorder shall consist of individual acquisition units, one for each feeder and an Evaluation unit which is common for the entire Substation. Whenever, more than one acquisition units are connected to an Evaluation unit, necessary hardware and software shall also be supplied for on line transfer of data from all acquisition units to Evaluation unit. If there are any constraints for one Evaluation unit to accept the data from number of acquisition units under the present scope, adequate number of Evaluation units shall be supplied. In case of extension of existing substation(s), one set of Evaluation unit shall be supplied for each substation where ever disturbance recorders are specified.
- 19.3 Disturbance recorder shall have 8 analog and 16 digital channels for each feeder.
- 19.4 Acquisition units shall acquire the fault data for the pre fault and post fault period and transfer them to Evaluation unit automatically to store in the hard disk. The acquisition units shall be located in the protection panels of the respective feeders.
- 19.5 The acquisition unit shall be suitable for inputs from current transformers with 1A rated secondary and capacitive voltage transformers with 63.5V (phase to neutral voltage) rated secondary. Any device required for processing of input signals in order to make the signals compatible to the Disturbance recorder equipment shall form an integral part of it. However, such processing of input signals shall in no way distort its waveform.
- 19.6 The equipment shall be carefully screened, shielded, earthed and protected as may be required for its safe functioning. Also, the disturbance recorder shall have stable software, reliable hardware, simplicity of maintenance and immunity from the effects of the hostile environment of EHV switchyard which are prone to various interference signals typically from large switching transients.
- 19.7 The Evaluation unit shall consist of a desktop personal computer (including TFT colour monitor, mouse and keyboard) and printer. The desktop PC shall be of latest configuration.
- 19.8 Necessary software for transferring the data automatically from local evaluation unit to a remote station and receiving the same at the remote station through owner's PLCC/VSAT/LEASED LINE shall be provided.
- 19.9 Evaluation software shall be provided for the analysis and evaluation of the recorded data made available in the PC under DOS/WINDOWS environment. The Software features shall include repositioning of analog and digital signals, selection and amplification of time and amplitude scales of each analog and digital channel, calculation of MAX/MIN frequency, phase difference values, recording of MAX/MIN values etc. of analog channel, group of signal to be drawn on the same axis etc, listing and numbering of all analog and digital channels and current, voltage, frequency and phase difference values at the time of fault/tripping. Also, the software should be capable of carrying out Fourier /Harmonic analysis of the current and voltage wave forms. The disturbance records shall also be available in COMTRADE format (IEEE standard-Common Format for Transient data Exchange for Power System)
- 19.10 The Evaluation unit shall be connected to the printer to obtain the graphic

form of disturbances whenever desired by the operator.

19.11 Disturbance recorder acquisition units shall be suitable to operate from 220V DC as available at sub-station. Evaluation unit along with the printer shall normally be connected to 240V, single phase AC supply. In case of failure of AC supply, Evaluation unit and printer shall be switched automatically to the station DC through Inverter of adequate capacity which shall form a part of Fault recorder system.

19.12 The acquisition unit shall have the following features

- (a) Facility shall exist to alarm operator in case of any internal faults in the acquisition units such as power supply fail, processor / memory fail etc and same shall be wired to annunciation system.
- (b) The frequency response shall be 5 Hz on lower side and 250 Hz or better on upper side.
- (c) Scan rate shall be 1000 Hz/channel or better.
- (d) Pre-fault time shall not be less than 100 milliseconds and the post fault time shall not be less than 2 seconds (adjustable). If another system disturbance occurs during one post-fault run time, the recorder shall also be able to record the same. However, the total memory of acquisition unit shall not be less than 5.0 seconds.
- (e) The open delta voltage and neutral current shall be derived either through software or externally by providing necessary auxiliary transformers.
- (f) The acquisition unit shall be typically used to record the following digital channels:
 - 1. Main CB R phase open
 - 2. Main CB Y phase open
 - 3. Main CB B phase open
 - 4. Main-1 carrier received
 - 5. Main-1 protection operated
 - 6. Main Auto reclosed operated
 - 7. Over Voltage -Stage-1 /2 operated
 - 8. Stub/ UF protection operated
 - 9. Direct Trip received
 - 10. Main-2 carrier received
 - 11. Main- 2/ Back Up protection operated
 - 12. Bus bar protection operated
 - 13. LBB operated of main circuit breaker

(g) In case the disturbance recorder is in-built part of line distance/ line

current differential/ transformer current differential / Bus bar protection, above digital channels may be interfaced either externally or internally.

- (h) Any digital signal can be programmed to act as trigger for the acquisition unit. Analog channels should have programmable threshold levels for triggers and selection for over or under levels should be possible.
- 19.13 The printer shall be compatible with the desktop PC and shall use Plain paper. The print out shall contain the Feeder identity, Date and time (in hour, minute and second up to 100th of a second), identity of trigger source and Graphic form of analogue and digital signals of all the channels. Two packets of paper (500 sheets in each packet) suitable for printer shall be supplied.
- 19.14 Each Disturbance recorder shall have its own time generator and the clock of the time generator shall be such that the drift is limited to ± 0.5 seconds/day, if allowed to run without synchronization. Further, Disturbance recorder shall have facility to synchronise its time generator from Time Synchronisation Equipment having output generator from Time Synchronization Equipment/ GPS having output of following types.
- Voltage signal : (0-5V continuously settable, with 50m Sec. minimum pulse duration)
 - Potential free contact (Minimum pulse duration of 50 m Sec.).
 - IRIG-B
 - RS232C
 - RJ-45/Ethernet

20.0 DISTANCE TO FAULT LOCATOR

- (a) Be electronic or microprocessor based type.
- (b) Be 'On-line' type
- (c) Be suitable for breaker operating time of 2 cycles
- (d) Have built-in display unit
- (e) The display shall be directly in percent of line length or kilometers without requiring any further calculations
- (f) have an accuracy of 3% or better for the typical conditions defined for operating timings measurement of distance relays.
- (g) The above accuracy should not be impaired under the following conditions:
- presence of remote end infeed
 - predominant D.C. component in fault current
 - high fault arc resistance

- severe CVT transients
- (h) Shall have mutual zero sequence compensation unit if fault locator is to be used on double circuit transmission line.
- (i) built in feature of line distance relay is acceptable provided the requirements of above clauses are met.

21.0 TIME SYNCHRONISATION EQUIPMENT (if applicable)

- 21.1 The Time synchronisation equipment shall receive the coordinated Universal Time (UTC) transmitted through Geo Positioning Satellite System (GPS) and synchronise equipments to the Indian Standard Time in a substation.
- 21.2 Time synchronisation equipment shall include antenna, all special cables and processing equipment etc.
- 21.3 It shall be compatible for synchronisation of Event Loggers, Disturbance recorders and SCADA at a substation through individual port or through Ethernet realised through optic fibre bus.
- 21.4 Equipment shall operate up to the ambient temperature of 50 degree centigrade and 100% humidity.
- 21.5 The synchronisation equipment shall have 2 micro second accuracy. Equipment shall give real time corresponding to IST (taking into consideration all factors like voltage, & temperature variations, propagation & processing delays etc).
- 21.6 Equipment shall meet the requirement of IEC 60255 for storage & operation.
- 21.7 The system shall be able to track the satellites to ensure no interruption of synchronisation signal.
- 21.8 The output signal from each port shall be programmable at site for either one hour, half hour, minute or second pulse, as per requirement.
- 21.9 The equipment offered shall have six (6) output ports. Various combinations of output ports shall be selected by the customer, during detailed engineering, from the following:
- Voltage signal : Normally 0-5V with 50 milliseconds minimum pulse duration. In case any other voltage signal required, it shall be decided during detailed engineering.
 - Potential free contact (Minimum pulse duration of 50 milli Seconds.)
 - IRIG-B
 - RS232C
- 21.10 The equipment shall have a periodic time correction facility of one second periodicity.

- 21.11 Time synchronization equipment shall be suitable to operate from 220V DC as available at Substation.
- 21.12 Equipment shall have real time digital display in hour, minute, second (24 hour mode) & have a separate time display unit to be mounted on the top of control panels having display size of approx. 100 mm height.

22.0 RELAY TEST KIT (If specified in BOQ)

One automatic relay test kit suitable for both steady state and dynamic testing of all types of relay (voltage, current, frequency, distance and differential) electromechanical/static/numerical/along with inbuilt HMI/ separate laptop all accessories, test leads, carrying case etc. shall be supplied by bidder. The make of the test set shall be approved by DTL before placement of order. It should be suitable for testing of relay supplied.

23.0 TYPE TESTS

- 23.1 All equipment and components shall be subjected to routine tests and type tests according to relevant standards and such other tests as may be required to ensure that all equipment and component are satisfactory and in accordance with the specification. Any modification required in the testing procedure shall be made as directed by the purchaser at no additional cost to the purchaser. No equipment shall be dispatched from the manufacture works before the relevant tests reports have been approved by the purchaser.
- 23.2 The reports for following type tests shall be submitted by the bidder for the Protective relays, Fault locator, Disturbance recorder and Event Logger.
- (a) Insulation tests as per IEC 60255-5
 - (b) High frequency disturbance test as per IEC 60255-4 (Appendix -E) Class III (not applicable for electromechanical relays)
 - (c) Fast transient test as per IEC 1000-4, Level III (not applicable for electromechanical relays)
 - (d) Relay characteristics, performance and accuracy test as per IEC 60255
 - Steady state Characteristics and operating time
 - Dynamic Characteristics and operating time for distance protection relays and current differential protection relays
 - For Disturbance recorder and Event logger only performance tests are intended under this item.
 - (e) Tests for thermal and mechanical requirements as per IEC 60255-6
 - (f) Tests for rated burden as per IEC 60255-6
 - (g) Contact performance test as per IEC 60255-0-20 (not applicable for Event

logger, Distance to fault locator and Disturbance recorder).

- 23.3 Steady state & Dynamic characteristics test reports on the distance protection relays, as type test, shall be based on test programme specified in Appendix A on simulator/network analyzer/PTL. Alternatively, the files generated using Electromagnetic transient Programme (EMTP) can also be used for carrying out the above tests. Single source dynamic tests on transformer differential relay shall be/ should have been conducted based on general guidelines specified in CIGRE committee 34 report on Evaluation of characteristics and performance of Power system protection relays and protective systems.

24.0 CONFIGURATION OF RELAY & PROTECTION PANELS

The following is the general criteria for the selection of the equipments to be provided in each type of panel.

LINE PROTECTION PANEL

The Line Protection panel for transmission lines shall consist of following relays and protection schemes.

Sl. S.No.	Description	400 kV	220kV	66 kV	33 kV
1	Main-1 Numerical Distance protection scheme	1 No.	1 No.	1 No.	1 No.
2	Main-2 Numerical Distance protection scheme	1 No.	NIL	NIL	NIL
3	Main-2 Numerical Current Differential protection scheme	NIL	2 Nos.*	NIL	NIL
4	Over Voltage Protection Scheme	1 No.	1 No.	NIL	NIL
5	Disturbance Recorder	1 No.	1 No.	1 No.	1 No.
6	Distance to fault Locator	1 No.	1 No.	1 No.	1 No.
7	3 phase Trip Relays	2 Nos	2 Nos	2 Nos	2 Nos
8	Flag relays , carrier receive relays, aux. Relays timers etc as per scheme Requirements	Lot	Lot	Lot	Lot
9	Under Voltage relay for isolator/earth switch	2 Nos	2 Nos	2 Nos	2 Nos
10	ABT meters (Microprocessor-based 3 Phase, 4 wire bi directional TriVector meter) of 0.2 accuracy class with open communication protocol (DLMS) - 02 nos. (one main & one check meter) along with TTB	1 No.	1 No.	1 No.	1 No.
11	Teed protection for 5 CT scheme in one & half breaker schemes	2 Nos	NIL	NIL	NIL
12	Directional back up Over current and E/F protection scheme	1 No.	NIL	1 No.	1 No.

In a substation where 400kV and 220 KV lines are under the scope of the

contract, bidder is required to give identical Main 1 and main 2 distance/current differential protection scheme for both voltage levels.

NOTE: The configuration of control and relay panel may be reviewed by the bidder considering requirements of the different clauses of the NIT document.

* 02 Nos. current differential relays of same make & type, one for local & other for remote end.

TRANSFORMER PROTECTION PANEL

The protection panel for Auto transformer/Transformer shall consists of the following equipments:

S. No.	Description	HV side	MV/LV side
1	Transformer Differential Protection scheme	1 Nos.	Nil
2	Restricted Earth fault protection scheme @ Not applicable for autotransformer	1 Nos.	1 no@
3	Directional back up O/C and E/F relay with non directional high set feature	1 No.	1 No.
4	Over Fluxing Protection scheme \$ applicable only for 400/220kV Transformer	1 Nos.	1 no.\$
5	Overload protection scheme	1 Nos.	Nil
6	Three phase trip relays	2 nos.	2 nos.
7	CVT selection relays as per scheme requirement	Lot	Lot
8	Flag relays, aux relays, timers etc as per scheme requirement including transformer alarms and trip functions	Lot	Lot
9	ABT meters (Microprocessor-based 3 Phase, 4 wire bi directional TriVector meter) of 0.2 accuracy class with open communication protocol (DLMS) along with TTB	1 No.	2 Nos.

Bus Coupler Protection Panel

A Protection Panel for Bus Coupler shall consist of following equipments:

S. No.	Description	400 KV	220 KV	66 KV	33 KV
1	IDMT over current & earth fault relays	1 set	1 set	1 set	1 set
2	DC Supply Supervision Relays	2 Nos.	2 Nos.	2 Nos.	2 Nos.
3	CT Switching Relays (if applicable)	1 set	1 set	1 set	1 set
4	Trip Circuit Supervision Relay	6 nos.	6 nos.	3 nos.	3 nos.
5	Flag Relays, Auxiliary Relays, Timers, Trip Relays etc. as per scheme requirement	Lot	Lot	Lot	Lot
6	PT Fuse Failure Relays	1 set	1 set	1 set	1 set

BREAKER RELAY PANEL

For 66 & 33 kV system, separate breaker relay panel is not required. However, relay from

serial no. 2 to 5 should be installed on main protection panel (Line/ Transformer). The breaker relay panel for 400 & 220 kV shall comprise of the following:

Sl. No.	Description	With A/R	Without A/R
1	Breaker failure Protection Scheme	1 No.	1 No.
2	DC supply Supervision relay	2 Nos.	2 Nos.
3	Trip Circuit supervision relays	6 Nos.#	6 Nos.#
4	Auto reclose scheme with check synchronizing and dead line charging relay	1 Nos.	NIL
5	Flag relays, aux relays, timers, trip relays as per scheme requirements.	Lot	Lot

Trip supervision relays shall be 2 numbers for each 66 KV & 33 KV Circuit Breaker

25.0 ERECTION AND MAINTENANCE TOOL EQUIPMENTS

All special testing equipment/ tools required for the installation and maintenance of the apparatus, instruments devices shall be furnished in relevant schedule.

26.0 TROPICALISATION

Control room will be normally air-cooled/air- conditioned. All equipments shall however be suitable for installation in a tropical monsoon area having hot, humid climate and dry and dusty seasons with ambient conditions specified in the specification. All control wiring, equipment and accessories shall be protected against fungus growth, condensation, vermin and other harmful effects due to tropical environment.

27. REACTOR PROTECTION

27.1 Differential Protection Relay shall

- Numerical (IEC 61850 compliant) type
- be triple pole type
- have operation time less than 25 milli-seconds at 5 times setting
- be tuned to system frequency
- have current setting range of 10 to 40% of 1 Amp. **or** a suitable voltage setting range
- be high or low impedance / biased differential type
- be stable for all external faults, CT saturation.

27.2 Restricted Earth Fault Protection Relay shall

- be Numerical (IEC 61850 compliant) type

- b) be single pole type
- c) be of current/voltage operated high impedance type
- d) have a current setting of 05-40% of 1 Amp./have a suitable voltage setting range
- e) be tuned to system frequency
- f) have a suitable non-linear resistor to limit the peak voltage to 1000 Volts

27.3 Back up impedance protection Relay shall

- a) be Numerical (IEC 61850 compliant) type
- b) be triple pole type, with faulty phase identification/ indication
- c) be single step polarised 'mho' distance/ impedance relay suitable for measuring phase to ground and phase to phase faults
- d) have adequate ohmic setting range to cover at least 60% of the impedance of the reactor and shall be continuously variable
- e) have an adjustable characteristic angle of 30-80 degree
- f) have a definite time delay relay with a continuously adjustable setting range of 0.2-2.0 seconds.
- g) include VT failure feature which shall block the tripping during VT fuse failure condition
- h) have Back-up over current and earth fault protection as built in function

27.4 Further, Reactor auxiliary protections contacts (Buchholz, PRD, Oil Temperature, Winding Temperature ,oil level ,fire protection etc.) can be wired suitably in above protections or provide separate Flag relays/Auxiliary relays as per scheme requirements. Further reactor protections shall be grouped such that Differential protection, Buchholz-I trip and Winding temperature trip are on DC-1 while REF protection, Back-up Impedance protection, PRD-I and Oil temperature trip are on DC-2. In case multiple trip contacts for Buchholz relay / PRD relays are available, then their contacts shall be wired to both Group of Protection.

28) REACTOR PROTECTION PANEL:

The protection panel for Reactor shall consist of the following protection schemes and relays:

Sl.No.	Description	Qty
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1.	Reactor Differential Protection scheme(IEC 61850 compliant)	1 no.
2.	Restricted Earth fault protection scheme(IEC 61850 compliant)	1 no.
3.	Reactor back up impedance protection scheme(IEC 61850 compliant)	1 No.
4.	Three phase trip relays	2 nos.
5.	CVT selection relay as per scheme requirement	Lot
6.	Flag Relays/ Aux. Relays for wiring Reactor auxiliary protection contacts such as Buchholz, Oil Temperature, Winding Temperature, PRV SPR etc. as per scheme requirement	As required

29) Essential features of Numerical Reactor Differential and REF protection relays for 400kV and 220kV substations

S.No.	Parameter Description	
1	Auxiliary Voltage Rating:	220V DC \pm 10%
2	Analog Module:	3 set of three phase current input, two independent Neutral current input and one set of three phase voltage input
3	Vn Rating:	100-120V AC at 50Hz (Phase to phase)
4	In Rating:	1A/5A
5	Input/ Outputs:	Min of 16 BI+ 16 BO (including at least 6 nos fast output trip relays with high breaking capacity, minimum 15A) + 1no. (4-20mA) analog input module
6	Other Hardware Options:	Ethernet (100Mbit/s) + IRIG-B + FO port at the rear. RJ45 or RS 232 port in the front for local communication with the laptop.
7	Protocol Options:	IEC 61850-8-1 and Upgradable to Process bus

8	Software Version:	Latest version available
9.	Other features	<ol style="list-style-type: none"> 1. Disturbance recorder 2. Fault recorder 3. Breaker failure protection 4. Back up over current and earth fault protection 5. Event logger 6. Time synchronization with necessary port as per site requirement. 7. Over flux feature

TEST PROGRAMME FOR DISTANCE RELAYS

General Comments:

1. These test cases are evolved from the report of working group 04 of study committee 34 (Protection) on evaluation of characteristics and performance of power system protection relays and protective systems. For any further guidelines required for carrying out the tests, reference may be made to the above document.
2. The test shall be carried out using network configuration and system parameters as shown in the figure-1
3. All denotations regarding fault location, breakers etc are referred in figure –1
4. The fault inception angles are referred to R- N voltage for all types of faults
5. The fault inception angle is zero degree unless otherwise specified.
6. Where not stated specifically, the fault resistance (R_f) shall be zero or minimum as possible in simulator
7. Single pole circuit breakers are to be used
8. The power flow in double source test is 500 MW

System parameters

System voltage =400KV

CTR= 1000/1

PTR = 400000/110 (with CVT, the parameters of CVT model are shown in figure –2)

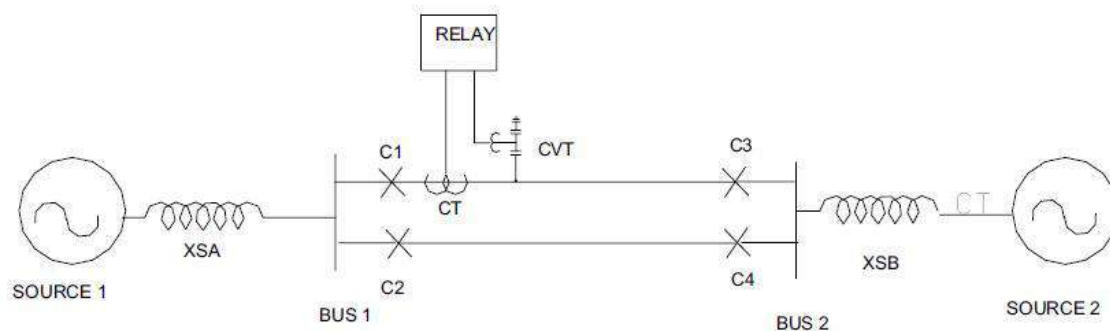


FIGURE 1

Positive Sequence Resistance, (r1)	0.02897 Ω		
Positive Sequence Reactance (x1)	0.3072 Ω		
Zero Sequence Resistance (r0)	0.2597 Ω		
Zero Sequence Reactance (x1)	1.0223 Ω		
Zero Sequence Mutual Resistance (rm)	0.2281 Ω		
Zero Sequence Mutual Reactance (xm)	0.6221 Ω		
Zero Sequence susceptance (bo)	2.347 μ mho		
Positive Sequence susceptance (b1)	3.630 μ mho		
Type of line	Short		Long
Secondary line impedance	2 Ω		20 Ω^*
Length of line in Kms	23.57		235.7
SIR	4	15	4
Source	29.09	109.09 Ω	290.9 Ω

impedance (pry) (at a Time constant of 50 ms)	Ω (5500 MVA)	(1467 MVA)	(550 MVA
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* Alternatively, the tests can be done with 10 Ω secondary impedance and source impedance may accordingly be modified.

CVT Model

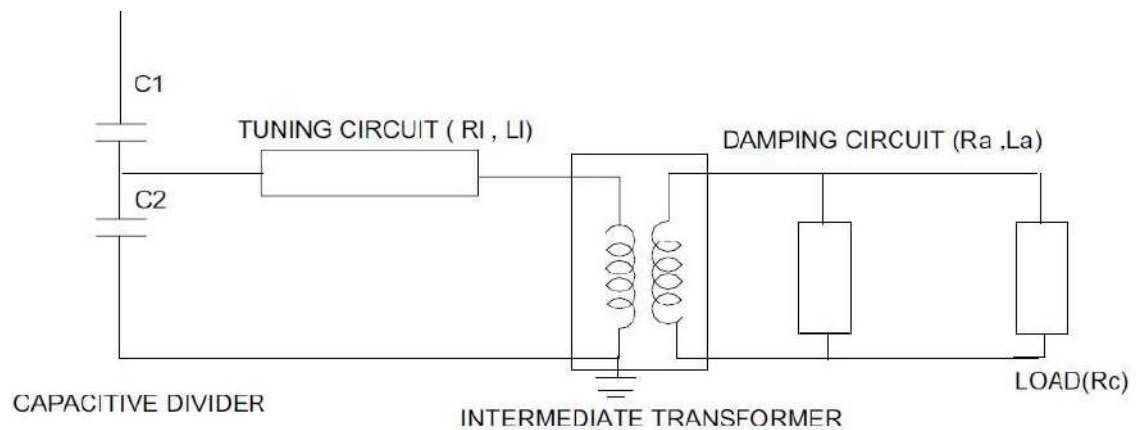


Figure-2

XC1	1.455 μ mho
XC2	27.646 μ mho
R _I	320 Ω
XL _I	34243 Ω
R _a	4.200 Ω
X _{la}	197.92 Ω
R _c	14.00 Ω
Transformation ratio of Intermediate transformer	181.8

DETAILS OF FAULT CASES TO BE DONE

Sl No	Description	Single source with short line(2 Ω)		Single source long	Double source with short double line (2 Ω)	Double source with long single line (20 Ω)
		CLOSE C1, OPEN C2,C3,C4		CLOSE C1, OPEN C2,C3,C4	CLOSE C1, C2,C3,C4	CLOSE C1,C3 OPEN C2,C4
		SIR=4	SIR=15	SIR =4	SIR = 4	SIR=4
1	Dynamic accuracy for zone 1	Tests to be done at 2 locations (84 % and 76 % of line length) X 4 faults (RN , YB, YBN,RYB) X 2 fault inception angle(0°, 90°)= 16 cases	Tests to be done at 2 locations (84 % and 76 % of line length)X 4 faults (RN, YB, YBN,RYB) X 2 fault inception angle(0°,90°)= 16 cases	Tests to be done at 2 locations (84 % and 76 % of line length) X 4 faults (RN , YB, YBN, RYB) X 2 Fault inception angle(0°,90°)= 16cases		Tests to be done at 2 locations (84%and 76% of line length) X4 faults (RN ,YB, YBN,RYB) X 2fault inception angle(0°, 90°)= 16 cases
2	Operating time for zone 1 at SIR =4	Tests to be done at 3 locations (0% , 40% and 64% of line length) X 4	Tests to be done at 3 locations (0 % , 40 % and 64 % of line length) X 4 faults (RN ,	Tests to be done at 3 locations (0 % , 40 % and 64 % of line length) X 4 faults	Tests to be done at 1 location (40 % of line length) X 4 faults	Tests to be done at 1 location (40 % of line length) X 4 faults

		4 faults (RN, YB, YBN, RYB) X 4 fault inception angle (0°, 30°, 60° and 90°) = 8	YB, YBN, RYB) X 4 fault inception angle (0°, 30°, 60° and 90°) = 48 cases	(RN, YB, YBN, RYB) X 4 fault inception angle (0°, 30°, 60° and 90°) = 48 cases	(RN, YB, YBN, RYB) X 4 fault inception angle (0°, 30°, 60° and 90°) = 16 cases	(RN, YB, YBN, RYB) X 4 fault inception angle (0°, 30°, 60° and 90°) = 16 cases
3	Operating time for zone II and Zone III	Tests to be done at 1 location (100 % of line length) X 1 faults (RN, YB, YBN, RYB) X 2 zones (II and III) = 2 cases	Tests to be done at 1 location (100 % of line length) X 1 faults (RN, YB, YBN, RYB) X 2 zones (II and III) = 2 cases	Tests to be done at 1 location (100 % of line length) X 1 faults (RN, YB, YBN, RYB) X 2 Zones (II and III) = 2 cases		
4	Switch on to fault feature			Tests to be done at 2 location (0 % and 32 %) X 1 faults (RYB) Any fault inception angle = 2 cases		
5	Operation during current reversal				Tests to be done at 2 location (0 % and 80 % of line length) X 1 faults (RN) X 1 fault inception angle (0 degrees) = 2 cases	
		CLOSE C1, C2, C3, C4	C1, OPEN	CLOSE C1, OPEN C2, C3, C4	CLOSE C1, C2, C3, C4	CLOSE C1, C3, OPEN C2, C4

		SIR=4	SIR=15	SIR =4	SIR = 4	SIR=4
6	Operation at simultaneous faults				Tests to be done at 2 location (8 % and 64 % of line length) X 2 faults (RN in circuit 1 to BN in circuit 2 and RN in circuit 1 to RYN in circuit 2 in 10 ms) X 1 fault inception angle (0 °) = 4 cases (*1)	
7	Directional sensitivity					Tests to be done at 1 location (0% reverse) X 6 faults (RN,YB, YBN , RYB,RN with Rf=13.75 ohm(sec) and RYN with Rf= 13.75 Ohm (sec) X 2 fault inception angle (0°,90°)= 12 cases
8	Limit for fault resistance					Tests to be done at 2 location (0% and 68 % of line length) X 1 fault (RN with Rf=13.75

						ohm(sec) X 2 fault inception angle (0°,90°)= 4 cases
9	Operation at evolving faults					Tests to be done at 2 location (32 % and 0% of line length) X 2 faults (RN to RYN) x in 2 timings (10 ms and 30 ms) X 2 load direction (from A to B and from B to A) =16 cases
10	Fault locator function, in case the same is offered as built in feature	Measure fault location for all cases under 1 and 2	Measure fault location for all cases under 1 and 2	Measure fault location for all cases under 1 and 2	Measure fault location for all cases under 2 and 6	Measure fault location for all cases under 2, 7 and 9

SCHEDULE OF GUARANTEED PARTICULARS

(RELAY & PROTECTION PANEL)

(With Automation)

I. RELAY & PROTECTION PANELS:

1. Name & Address of Manufacturer of panels

2. **Manufacturer's type and designation**
3. **Type of construction (simplex / duplex)**
4. **Dimensions of the panels.**
5. **Dimensions of supporting channel.**
6. **Thickness of the steel plates proposed for use on panels.**
 - (a) **Front**
 - (b) **Rear**
 - (c) **Sides, top and bottom**
7. **Degree of protection**
8. **Confirm whether offered manufacturer of relay & Protection panels and protective relays have tested commissioned and they are in successful operation for at least two years in respective voltage system.**

II. **SWITCH BOARD WIRING:**

1. **Insulation of wiring.**
2. **Size of wiring conductor of following :**
 - i) **P.T. Circuits**
 - ii) **C.T. Circuits.**
 - iii) **DC Supply circuits**

iv) Other circuits

- 3. Size of earthing bar of safety earthing.**
- 4. Type of terminals provided on wiring.**
- 5. Wiring conductor aluminium / copper.**

III. DIGITAL MULTI FUNCTION METER

- 1. Maker's Name and country.**
- 2. Type of Instrument**
- 3. Size**
- 4. Whether magnetically shielded or not**
- 5. Limits of error in the effective range.**

6. V.A. Burden (VA)

(i) Current coil (VA)

(ii) Potential coil (VA)

7. Power Consumption

i) Current coil (Watts)

ii) Potential coil (Watts)

8. Temperature at which the instruments are calibrated.

9. Description of leaflet reference Nos. submitted.

10. Range.

11. Ratings

- i) CT Secondary**
- ii) VT Secondary**
- iii) DC auxiliary**
- iv) Frequency range**
- v) Operating principal**
- vi) Thermal rating**

12. Accuracy class

13. Display of (YES / NO)

(a) Real time rms value of amp.

(b) Real time rms value of voltage

(c) Real time average pf

(d) Real time frequency

(e) Real time average power in MW, MVA_r (I_g),(I_d) and MVA

14. Type of connection

IV. ENERGY METER

1. Maker's Name and country.

2. Type of Instrument

3. Size

4. Whether magnetically shielded or not

5. Limits of error in the effective range.
6. V.A. Burden (VA)
 - i) Current coil (VA)
 - ii) Potential coil (VA)
7. Power Consumption
 - i) Current coil (Watts)
 - ii) Potential coil (Watts)
8. Temperature at which the instruments are calibrated.
9. Description of leaflet reference Nos. submitted.
10. Range
11. Ratings
 - i) CT Secondary
 - ii) VT Secondary
 - iii) Frequency range
 - iv) Thermal rating
12. Accuracy class
13. Display of (YES / NO)
 - (a) LCD test
 - (b) Real time with date
 - (c) Inst. Line current

- (d) Inst. phase voltage**
- (e) Inst. Average power factor**
- (f) maximum demand in MW/ MVA**
- (g) Cumulative energy parameters in different resistors for**
 - i) MWh**
 - ii) MVarh**
 - iii) MVarh(Id)**
 - iv) MVAh**

14. Type of connection

V TRANSMISSION LINE PROTECTION

V. (A) NUMERICAL DISTANCE PROTECTION RELAYS:

- 1. Name & Address of Manufacturer**
- 2. Manufacturer's type and designation**
- 3. Switched or non switched type (is it with separate measurements for single/ three phase faults)**
- 4. Setting range of offset feature**
- 5. Whether the relay is having self monitoring feature**
- 6. Whether relay is compatible for SCADA Equipments and can be used for Permissive Under reach/Over reach/Blocking scheme etc.**
- 7. Suitable for single and three phase trip**

8. **Type of shaped characteristic**
9. **IDMT earth fault relay meeting Normal Inverse Characteristic as per IEC 60253 is**
Being offered as built in feature for lines
10. **If No, Type of IDMT being offered.**
11. **Built in feature offered with the relay(Yes/No)**
 - i) **Disturbance Recorder**
 - ii) **Over-Voltage(One stage only)**
 - iii) **Auto reclose along with deadline charging and check synchronizing.**

V. (B) NUMERICAL CURRENT DIFFERENTIAL PROTECTION RELAYS:

1. **Name & Address of Manufacturer**
2. **Manufacturer's type and designation**
3. **Phase segregated current line differential Protection scheme.**
4. **Overhead lines and cables length for primary ckt**
5. **High sensitivity for differential current below the minimum line loading of 20%.**
6. **For single and three phase tripping.**
7. **Suitable for different CT ratio of the CTs provided at the terminals of the line.**
8. **Non-operative for transient cable/line charging current without affecting the**

sensitivity of the relay.

- 9. High stability for high through fault currents.**
- 10. Measurement of delay time to remote line terminals for dynamic compensation of delay in differential measurement.**
- 11. CT Secondary current supervision.**
- 12. Continuous self monitoring and diagnostic feature.**
- 13. Suitable no. of free contacts for Inter Tripping, Auto reclosing, direct trip, CB failure, Disturbance recorder & Data acquisition system.**
- 14. Facility for selecting synchronizing or dead line charging features. It shall be possible at any time to change the required feature by reconnection of Links.**
- 15. Based on IEC 61850 and communicable through direct fiber optic as well as through multiplexers.**
- 16. Suitable for Direct inter tripping.**
- 17. Ratings for Relays:**

Current Rating

Voltage Rating
Aux DC Voltage
Optical Isolated Binary Input
Binary Output

- 18. Power Swing Blocking**
- 19. Switch on-to-fault protection**
- 20. Fuse failure feature**
- 21. Fault Recorder**
- 22. Breaker failure protection**
- 23. Event logger**
- 24. Measurement:**

**Whether the relay having the following
Measurements?**

Local and remote phase current
Local neutral current
Phase bias and differential currents.
Sequence currents.
Thermal state.

**The relay provide protection signaling
supervision indicating the following parameters:**

Channel propagation delay.
Channel status.
Number of valid and error messages.

25. Whether in case of failure of communication, relays having features of Numerical Distance Protection Relays?

V.(C)	Backup Directional over current and earth fault relay :	Overcurrent relay	Earth Fault relay
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- 1. Name & Address of Manufacturer**
- 2. Manufacturer's type and designation**
- 3. Whether characteristic will confirm to IEC 255-3**
- 4. Two O/C and one E/F elements
Are whether independent or composite unit?**
- 5. Polarisation**
 - a. Current**
 - b. Potential**
- 6. Current coil rating**
- 7. Tap range**
- 8. Potential rating**
- 9. VA burden**
 - a. Current coil**
 - b. Highest tap**

- c. **Lowest tap.**
- 10. **Directional sensitivity**
- 11. **VT fuse failure relay/feature included
For alarm.**
- 12. **Unit setting range**
 - (i) **Inverse time**
 - (ii) **High set**
- 13. **Time of operation at maximum time dial wetting at :**
 - (i) **10 times tap setting.**
- 14. **Trip contact rating (Amps.)**
- 15. **Whether seal in contact provided or not**
- 16. **Descriptive leaflets ref.**

V(D) **DISTURBANCE RECORDER**

(a) Acquisition unit

- 1. **Name & Address of Manufacturer**
- 2. **Manufacturer's type and designation**
- 3. **Number of analogue channels**
- 4. **Number of digital recording channels**
- 5. **Built in feature of main-1 distance relay is offered**
- 6. **Pre-fault memory(msec.)**

7. **Post-fault memory(msec.)**
8. **Total storage memory in sec.**
9. **Sampling Frequency**
10. **resolution of the event channels(ms)**
11. **Time display present?**
12. **data output in COMTRADE is available**

(b) Evaluation unit

1. Name & Address of Manufacturer

2. Manufacturer's type and designation

**3. Number of acquisition unit that can be connected
to one evaluation unit**

4. Technical parameter of evaluation unit

- a. processor and speed**
- b. RAM and hard disk capacity**
- c. additional facility**
- d. details of printer**

**5. Details of power supply arrangement for acquisition
unit (including printer)**

V(E) **AUTO RECLOSE RELAY**

1. Name & Address of Manufacturer

2. Manufacturer's type and designation

3. Electromechanical/ststic/numerical

**4. Auto reclose relay alongwith deadline charging
and check synchronizing relay for line
offered as a part of distance relay**

5. Suitable for single and three phase?

6. Single phase dead time setting range

7. Three phase dead time setting range

8. Reclaim time setting range

VI. TRANSFORMER PROTECTION

VI(A) DIFFERENTIAL RELAYS:

1. Name & Address of Manufacturer

2. Manufacturer's type and designation

3. Current coil rating

4. Tap range (Bias setting range)

Coil 1

Coil 2

Coil 3

5. Maximum VA Burden

(i) Operating Coil

(ii) Restraining Coil

6. Power consumption

(i) Operating Coil

(ii) **Restraining Coil**

7.	Whether three instantaneous units provided?	Yes / No

8. Second Harmonic restraint provided or not.

9. Range of H.T.L.T. ratios over which the relay can be used.

10. Operating time.

11. Trip contact rating.

12. Whether seal in contacts provided or not.

13. How ratio/phase angle correction are being done (interposing transformer/internal feature in the relay)

14. Descriptive leaflet No.

VI(B)	Directional over current	Over current	Earth Fault
	and earth fault relay :	relay	relay

1. Name & Address of Manufacturer

2. **Manufacturer's type and designation**
3. **Whether the relay is having self monitoring feature**
4. **Directional sensitivity**
5. **Unit setting range**
 - a) **Inverse time**
 - b) **High set**

VII	BUS BAR PROTECTION RELAY	Phase fault	Earth Fault
		relay	relay
1.	Name and Address of Manufacturer		
2.	Manufacturer's type and designation		
3.	Type of relay		
4.	Principle of operation		
5.	Current coil rating		
6.	Max VA Burden		
7.	Setting Ranges <ol style="list-style-type: none"> i) Current ii) Time 		
8.	Power consumption		
9.	Operating time		
10.	Trip contact rating		
11.	Descriptive leaflet No.		

I) NUMERICAL DIFFERENTIAL RELAYS:

- 1. Name & Address of Manufacturer**
- 2. Manufacturer's type and designation**
- 3. Current coil rating**
- 4. Tap range (Bias setting range)**
 - Coil 1**
 - Coil 2**
 - Coil 3**
- 5. Maximum VA Burden**
 - (iii) Operating Coil**
 - (iv) Restraining Coil**
- 6. Power consumption**
 - (iii) Operating Coil**
 - (iv) Restraining Coil**
- 7. Whether three instantaneous units provided?**
- 8. Second Harmonic restraint provided or not.**
- 9. Range of H.T.L.T. ratios over which the relay can be used.**
- 10. Operating time.**
- 11. Trip contact rating.**
- 12. Whether seal in contacts provided or not.**
- 13. How ratio/phase angle correction are being done**
(Interposing transformer/internal feature in the relay)
- 14. Descriptive leaflet no.**
- 15. Reactor auxiliary protections contacts (Buchholz, PRV, Oil Temperature, Winding Temperature, fire protection etc.) can be wired suitably in above protections or provide separate Flag relays/Auxiliary relays as per scheme requirements.**

16. Offered Relay Complete Model No./Cortec No

II) NUMERICAL BACKUP IMPEDANCE RELAY

- 1. Make**
- 2. Type & complete model no**
- 3. Whether Numerical measurement.**
- 4. Auxiliary DC Voltage with permissible tolerance.**
- 5. CT input with Permissible over load.**
- 6. PT input with permissible over load.**
- 7. Type and no. of measuring elements.**
- 8. No. of zones.**
- 9. Type and no. of starting units.**
- 10. Relay characteristics**
- 11. Impedance setting range**
- 12. Timer range**
- 13. Relay characteristics angle range for**
Measuring units
Starting units
- 14. Max. VA burden per phase.**
Current circuit
Potential circuit
DC circuits
- 16. Whether continuous self monitoring and diagnostic feature is available.**
- 17. Have Back-up over current and earth fault protection as built in function**
- 18. Descriptive leaflet no**

III) NUMERICAL RESTRICTED EARTH FAULT RELAYS:

- 1. Make**
- 2. Type & Model no./**
- 3. Whether comply to Principle Technical Parameters**
- 4. Maximum VA burden**
- 5. Operating time**
 - i) Minimum**
 - ii) Maximum**
- 6. Description leaflet Ref. no.**
- 7. No. of contacts make and carry for 0.5 sec and break type.**

8. Whether contacts self reset or hand reset.
9. Contact ratings
10. Make and carry continuously
 - i) Make and carry for 0.5 sec.
 - ii) Break resistive load and inductive load with 40 m. sec. time current.
11. Setting range.

SECTION-XV

POWER & CONTROL CABLE

SECTION: XV

POWER & CONTROL CABLES

A. TS OF 1100V GRADE XLPE/PVC INSULATED POWER CABLES

1. TECHNICAL REQUIREMENTS

1.1. General

- 1.1.1. The cables shall be suitable for laying in racks, ducts, trenches, conduits and underground buried installation with uncontrolled back fill and chances of flooding by water.
- 1.1.2. They shall be designed to withstand all mechanical, electrical and thermal stresses under steady state and transient operating conditions. The XLPE /PVC insulated L.T. power cables of sizes 240 sq. mm. and above shall withstand without damage a 3 phase fault current of at least 45 kA for at least 0.12 second, with an initial peak of 105 kA in one of the phases. The armour for these power cables shall be capable of carrying 45 kA for at least 0.12 seconds without exceeding the maximum allowable temperature of PVC outer sheath.
- 1.1.3. The XLPE insulated cables shall be capable of withstanding a conductor temperature of 250°C during a short circuit without any damage. The PVC insulated cables shall be capable of withstanding a conductor temperature of 160°C during a short circuit.
- 1.1.4. The Aluminium/Copper wires used for manufacturing the cables shall be true circular in shape before stranding and shall be uniformly good quality, free from defects. All aluminium used in the cables shall be of H2 grade.
- 1.1.5. The fillers and inner sheath shall be of non-hygrosopic, fire retardant material, shall be softer than insulation and outer sheath shall be suitable for the operating temperature of the cable.
- 1.1.6. Progressive sequential marking of the length of cable in meters at every one meter shall be provided on the outer sheath of all cables.
- 1.1.7. Strip wire armouring method of IS:1554 (Part 1) – 1988 shall not be accepted for any of the cables.
- 1.1.8. The cables shall have outer sheath of a material with an oxygen index of not less than 29 and a temperature index of not less than 250°C.
- 1.1.9. The size of conductor in the cables shall be in line with relevant IS and as per requirement of scope of scheme/tender.
- 1.1.10. The normal current rating of all PVC insulated cables shall be as per IS:3961 and that of XLPE insulated cables shall be as per relevant IS/IEC.
- 1.1.11. Repaired cables shall not be accepted.
- 1.1.12. Allowable tolerance on the overall diameter of the cables shall be as per relevant IS/IEC.

1.2. Climatic Conditions

- 1.2.1. The cables covered under this specification are for laying in the climatic conditions that are prevailing at the sites of Delhi.

a)	Max Ambient temperature	50 ⁰ C
b)	Min Ambient temperature	0 ⁰ C
c)	Ref. Ambient temperature as per IS:9676	43.3 ⁰ C

d)	Relative humidity (% range)	10 – 100 %
e)	Average number of rainy days per annum	50
f)	Average rainfall	750 mm
g)	Altitude not exceeding	300 meters

1.2.2. The atmosphere is generally laden with mild acid and dust in suspension during the dry months and is subjected to fog in cold months. Heavy lightning occurs in the area during rainy months (June to October).

1.3. Standards

1.3.1. The cables as stipulated in this specification shall conform to the latest applicable provision of the following standards:-

1.	IS:1554(Part-I)	Specification for PVC insulated (Heavy Duty) electric cables for working voltage up to including 1100 V.
2.	IS: 3961	Recommended current rating for cable.
3.	IS:8130	Conductors for insulated electric cables and flexible cores.
4.	IS:5831	PVC Insulation and sheath of electric cables.
5.	IS:10810(58)	Oxygen index
6.	IS:10810(63)	Standard test method for density of smoke from burning/decomposition of plastics
7.	IS:10810(64)	Temp. Index.
8.	IS:3975	Low carbon galvanized steel wires, formed wires and tapes for armouring of cables - specifications
9.	IS:2982	Copper conductors insulated cables and cords.
10.	IS-10418	Specification for drums for electric cables.
11.	IS-10810(53)	Flammability Test.
12.	IS-10810(60)	Thermal stability of PVC Insulation and sheath.
13.	IS-10810(61)	Flame retardant test.
14.	IS-10810(62)	Fire resistance test for bunched cables.
15.	IS-694	PVC insulated cables for working voltages upto and including 1100 volts.
16.	IS-6380	Elastometric insulating and sheath of electric cables.
17.	IEC-60502-1	Power cables from 1kV to 3kV
18.	IS-7098-1	Power cables up to 1100V, XLPE insulated.

1.3.2. Unless otherwise specified, the equipment shall conform to the latest applicable standards mentioned above. The equipment complying with any other internationally

accepted standard will also be considered if it ensures performance equivalent to or superior to standards detailed above. In the event of supply requirement conforming to any internationally recognized standards other than the Indian Standards, the salient features of comparison shall be brought out in the tender. Photocopies of such standards in English Language or English Translation shall be attached with the offer. In case of any consistency provisions in ISS and IEC shall prevail.

1.4. Marking

- 1.4.1. The cable shall be marked DTL PROPERTY, year of manufacturing throughout the length in addition to marking as per IS/IEC. The progressive sequential marking on the length of the cable in meters at every one meter shall be provided on the outer sheath of the cable/ cable drum.

2. XLPE Power Cables

- 2.1. The XLPE insulated cables shall be of FR-LSH type, C2 category, suitable for normal working temperature of 90°C conforming to IS:7098(Part-I) / IS: 7098 (Part-II)/ IEC-60502-01 and its amendments read alongwith this specification. The conductor shall be stranded aluminium/copper circular/sector shaped and compacted. In multi core cables, the core shall be identified by red, yellow, blue and black colored strips or coloring of insulation. A distinct inner sheath shall be provided in all multi core cables. For XLPE cables, the inner sheath shall be of extruded PVC of type ST-2 of IS:5831. When armouring is specified for single core cables, the same shall consist of aluminium wires/strips. The outer sheath shall be extruded PVC to Type ST-2 of IS:5831 for all XLPE cables.

3. PVC Power Cables

- 3.1. The PVC insulated 1100V grade power cables shall be of FR-LSH 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 85°C. The conductor shall be stranded aluminium/copper. The Insulation shall be extruded PVC type-C of IS: 5831. A distinct inner sheath type ST-2 shall be provided in all multicore cables. For multicore armoured cables, the inner sheath shall be of extruded PVC. The outer sheath shall be extruded PVC of Type ST-2 of IS: 5831 for all cables.

4. CABLE DRUMS

- 4.1. Cables shall be supplied in non-returnable wooden or steel drums of heavy construction. Wooden drum shall be properly seasoned sound and free from defects. Wood preservative shall be applied to the entire drum.
- 4.2. Standard lengths for each size of power cables shall be 500/1000 meters. The cable length per drum shall be subject to a tolerance of plus or minus 5% of the standard drum length. The Purchaser shall have the option of rejecting cable drums with shorter lengths. However, the total quantity of cables after taking into consideration of all cable drums for each size shall be within the tolerance of $\pm 2\%$.
- 4.3. A layer of water proof paper shall be applied to the surface of the drums and over the outer most cable layer.
- 4.4. A clear space of at least 40 mm shall be left between the cables and the lagging.

- 4.5. Each drum shall carry the manufacturer's name, the Purchaser's name, address and contract number and type, size and length of the cable, net and gross weight stencilled on both sides of drum. A tag containing the same information shall be attached to the leading end of the cable. An arrow and suitable accompanying wording shall be marked on one end of the reel indicating the direction in which it should be rolled.
- 4.6. Packing shall be sturdy and adequate to protect the cables, from any injury due to mishandling or other conditions encountered during transportation, handling and storage. Both cable ends shall be sealed with PVC/Rubber caps so as to eliminate ingress of water during transportation and erection.

5. TESTS

- 5.1. **Type Tests:** The bidder shall submit all the applicable type test reports of the power cable in line with latest edition of IS/IEC, as applicable, and validity of the type test reports shall be as per CEA guidelines. The reports shall be submitted for review by DTL. If any type test has not been conducted by the bidder, than the same shall be conducted by the bidder free of cost and without affecting the completion period of the project/tender.
- 5.2. **Routine and Acceptance tests:** All the applicable routine and acceptance tests on the power cables shall be conducted by the bidder as per relevant IS/IEC during and after manufacture (As applicable).

GTP OF PVC INSULATED POWER CABLE

1. Name of Manufacturer and country:
2. Standard according to which cable is manufactured
3. Rated voltage
4. Continuous current rating in air at ambient temperature:
5. Short time current withstand (3 seconds):
6. Short time current withstand (1 seconds):
7. Short time current withstand (0.5 seconds)
8. Allowable conductor temperature for short circuit:
9. Conductor:
 - a. Material
 - b. cross-sectional area
 - c. Whether stranded
 - d. Number and diameter of wire (before stranding)
10. Insulation:
 - a. Material
 - b. Nominal Thickness
 - c. Core Identification
11. Inner Sheath
 - a. Material
 - b. Whether extruded or wrapped?
 - c. Thickness (Minimum)
 - d. Calculated diameter under sheath
 - e. Color of sheath
12. Outer Sheath
 - a. Material
 - b. Thickness (Minimum)
 - c. Extruded or wrapped?
 - d. Calculated diameter under sheath

- e. Color of sheath
- f. FR-LSH properties
- g. Oxygen Index
- h. Temperature Index:
- i. Smoke density rating
- j. Acid Gas Generation (HCL)
- k. Flammability Test
- 13. Size and material of armour
- 14. Whether round wire or tape
- 15. Details of screen , if any
- 16. Total overall diameter of cable:
- 17. Maximum DC resistance at 20 degree Celsius:
- 18. Inductance of cable per kM
- 19. One minute power frequency withstand voltage
- 20. Impulse withstand voltage
- 21. Water immersion test voltage
- 22. Safe pulling force when pulled by pulling eye
- 23. Minimum Bending radius
- 24. Insulation resistance constant at room temperature
- 25. Tensile strength of conductor
- 26. Max. Allowable continuous operating temperature
- 27. Volume Resistivity
- 28. Dielectric constant at 50Hz, 20degree Celsius
- 29. Tan Delta at 50Hz, 20degree Celsius
- 30. Continuous current rating when laid in air in ambient temperature of 50degree Celsius and for maximum conductor temperature 85 degree Celsius for PVC cable:
- 31. Filler
- 32. Sequential length marking
- 33. Type of cable end sealing
- 34. Embossing /printing
- 35. Cable drums
- 36. Dimension of drum
- 37. Shipping weight
- 38. Nominal length per drum

GTP OF XLPE INSULATED POWER CABLE

- 1. Name of Manufacturer and country:
- 2. Standard according to which cable is manufactured
- 3. Rated voltage
- 4. Type and category
- 5. Continuous current rating in air at ambient temperature:
- 6. Rating factors applicable to the current ratings for various conditions of installation:
- 7. Short circuit capacity:
 - a. Short circuit current for 01 second:
 - b. Conductor temperature allowed for short circuit duty
- 8. Conductor:
 - a. Material
 - b. Grade
 - c. Form of conductor
 - d. cross-sectional area

- e. Direction of lay of stranded layers
9. Conductor resistance (DC) at 20 degree celsius
10. Insulation:
 - a. Material
 - b. Nominal Thickness
 - c. Minimum Thickness
11. Inner Sheath
 - a. Material
 - b. Thickness (Minimum)
 - c. Calculated diameter under sheath
 - d. Color of sheath
12. Armour
 - a. Type and material of armour
 - b. Direction of armouring
 - c. Calculated diameter of cable over inner sheath (under armour)
 - d. Nominal diameter of wire
 - e. Number of armour wires (Approx.)
 - f. Short circuit capacity of armour and duration
 - g. DC resistance at 20 degree Celsius and resistivity of armour
13. Outer Sheath
 - a. Material
 - b. Thickness (Minimum)
 - c. Extruded or wrapped?
 - d. Calculated diameter under sheath
 - e. Color of sheath
 - f. FR-LSH properties
 - g. Oxygen Index
 - h. Temperature Index:
 - i. Smoke density rating
 - j. Acid Gas Generation (HCL)
 - k. Flammability Test
14. Details of screen , if any
15. Total overall diameter of cable:
16. Maximum DC resistance at 20 degree Celsius:
17. Whether cables offered are ISI marked
18. Short time current withstand (0.5,1,3 seconds)
19. Inductance of cable per kM
20. One minute power frequency withstand voltage
21. Impulse withstand voltage
22. High voltage test
23. Water immersion test voltage
24. Safe pulling force when pulled by pulling eye
25. Minimum Bending radius
26. Insulation resistance constant at room temperature
27. Tensile strength of conductor
28. Max. Allowable continuous operating temperature
29. Volume Resistivity
30. Dielectric constant at 50Hz, 20degree Celsius
31. Tan Delta at 50Hz, 20degree Celsius
32. Continuous current rating when laid in air in ambient temperature of 50degree Celsius and for maximum conductor temperature 90 degree Celsius for XLPE cable:
33. Filler
34. Sequential length marking
35. Type of cable end sealing

- 36. Embossing /printing
- 37. Cable drums
- 38. Dimension of drum
- 39. Shipping weight
- 40. Nominal length per drum

Note: Only applicable parameters as per IS/IEC to be filled

B. SPECIFICATION OF 1.1kV GRADE CONTROL CABLE

1.0 SCOPE

- 1.1 This specification covers the design, manufacturing, testing and supply of FR-LSH Control Cable of High conductivity, annealed copper, acid, alkali, weather, oil and moisture resistant armoured Multi-core laid up heavy duty PVC insulated and graded up to 1100 Volts sheathed cables for electric supply and control purposes.
- 1.2 The Control cables are required for power supply, control & connections of various equipments including protective devices etc.

2.0 GENERAL TECHNICAL REQUIREMENT

- 2.1 Cable under this specification shall be suitable for use on A.C. or D.C. System for rated voltages up to 1100 Volts to earth R.M.S.
- 2.2 All materials shall be free from flaws and defects and shall conform to the relevant Indian Standards and good engineering practice.
- 2.3 The cables shall be suitable for laying in racks, ducts, trenches, conduits and underground buried installation with uncontrolled back fill and chances of flooding by water.
- 2.4 These shall be designed to withstand all mechanical, electrical and thermal stresses under steady state and transient operating conditions.
- 2.5 The Copper wires used for manufacturing the cables shall be true circular in shape before stranding and shall be uniformly good quality, free from defects.
- 2.6 Cable shall have suitable fillers laid up with the conductors a substantially circular cross section before the sheath is applied, fillers shall be suitable for operating temp of the cable and compatible with the insulating material.
- 2.7 All materials shall be new, unused and of finest quality. Repaired cables shall not be accepted.
- 2.8 Workmanship shall be neat, clean and of highest grade.
- 2.9 Control cable shall be anti rodent type.

- 2.10 Unless brought out clearly the tenderer shall conform to the specifications scrupulously. Any deviation from the specification shall be brought out in the representative schedule of deviation forming part of the tender. Any deviation between the specifications and the descriptive catalogue of the equipment with the offer, not clearly brought out in the schedule of deviation shall not be considered as valid deviations and the equipment shall deem to be as per specifications. Reasons for any deviation shall be spelled out clearly in the schedule itself.

3.0 CLIMATIC CONDITIONS

The cables covered under this specification are for laying in the climatic conditions that are prevailing at the sites of Delhi.

a)	Max Ambient temperature	50 ⁰ C
b)	Min Ambient temperature	0 ⁰ C
c)	Ref. Ambient temperature as per IS:9676	43.3 ⁰ C
d)	Relative humidity (% range)	10 – 100 %
e)	Average number of rainy days per annum	50
f)	Average rainfall	750 mm
g)	Altitude not exceeding	300 meters

The atmosphere is generally laden with mild acid and dust in suspension during the dry months and is subjected to fog in cold months. Heavy lightning occurs in the area during rainy months (June to October).

4.0 STANDARDS

The cables as stipulated in this specification shall conform to the latest applicable provision of the following standards:-

1.	IS:1554(Part-I)	Specification for PVC insulated (Heavy Duty) electric cables for working voltage upto including 1100 V.
2.	IS: 3961	Recommended current rating for cable.
3.	IS:8130	Conductors for insulated electric cables and flexible cores.
4.	IS:5831	PVC Insulation and sheath of electric cables.
5.	IS:10810(58)	Oxygen index
6.	IS:10810(63)	Standard test method for density of smoke

		from burning/decomposition of plastics
7.	IS:10810(64)	Temp. Index.
8.	IS:3975	Low carbon galvanized steel wires, formed wires and tapes for armouring of cables - specifications
9.	IS:2982	Copper conductors insulated cables and cords.
10.	IS-10418	Specification for drums for electric cables.
11.	IS-10810(53)	Flammability Test.
12.	IS-10810(60)	Thermal stability of PVC Insulation and sheath.
13.	IS-10810(61)	Flame retardant test.
14.	IS-10810(62)	Fire resistance test for bunched cables.
15.	IS-694	PVC insulated cables for working voltages upto and including 1100 volts.
16.	IS-6380	Elastometric insulating and sheath of electric cables.

Unless otherwise specified, the equipment shall conform to the latest applicable standards mentioned above. The equipment complying with any other internationally accepted standard will also be considered if it ensures performance equivalent to or superior to standards detailed above. In the event of supply requirement conforming to any internationally recognized standards other than the Indian Standards, the salient features of comparison shall be brought out in the tender. Photocopies of such standards in English Language or English Translation shall be attached with the offer. In case of any consistency provisions in ISS and IEC shall prevail.

5.0 MARKING

- 5.1 The cable shall be marked DTL PROPERTY, year of manufacturing and ISI marked throughout the length in addition to marking as per IS 1554 (Part-I). The progressive sequential marking on the length of the cable in meters at every one meter shall be provided on the outer sheath of the cable/ cable drum.
- 5.2 Identification of cores shall be done by printing legible Hindu Arabic Numerals on all cores as per IS :1554 (Part-I)
- 5.3 Identification, Packing And Marking as per IS-1554(Part-1).

Constituent	Code Letter
PVC Insulation	Y
Steel Round Wire Armour	W

PVC Outer Sheath	Y
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6.0 CONSTRUCTIONAL FEATURES

The control cables are required for power supply, control & connections of various equipments including protective devices etc.

6.1 TYPE OF CABLES

The cable shall be multi core HR PVC insulated type C2 (FR-LSH) category conforming to IS-1554(Part-1) and/or relevant subsections/ clauses of this Technical Specification.

6.2 CONDUCTOR

The cable conductor shall be made from **stranded** copper to form compact conductor having a resistance within the limits specified in IS. **Size of conductor shall be as per relevant IS and in line with scope of scheme.** The normal current rating of all PVC insulated cables shall be as per IS: 3961.

6.3 INSULATION (PVC Type C Category)

The insulation of the cable shall be designed and manufactured for the specified system voltage. The manufacturing process shall ensure that insulation is free from voids. The insulation shall withstand mechanical and thermal stresses under steady stage and transient short circuit operating conditions. Test requirement for PVC insulation sheath shall be as per Table 2 of IS: 5831-1984.

6.4 INNER SHEATH (HR FRLS PVC)

The sheath shall be suitable to withstand the site conditions and desired temp. It shall be of adequate thickness and applied by a continuous process to produce a sheath of consistent quality, free from all defects. PVC, sheath shall be extruded and to HR FR-LSH type.

6.5 ARMOUR

6.5.1 Single galvanized steel wire armouring shall be used for multi core cables which shall comply with the reference of IS-3975-1979.

6.5.2 For control cables only galvanized round steel wire armouring shall be used.

6.6 OUTER SHEATH (HR FR-LSH PVC)

6.6.1 The outer sheath should be of flame retardant low smoke heat resistant PVC compound type ST2 conforming to requirements of IS:5831-1984.

6.6.2 The cables shall have outer sheath of a material with an oxygen index of not less than 29 and a temperature index of not less than 250°C at 21 percent of oxygen as per IS 1554 (part-I).

7.0 CABLE DRUMS

- 7.1 Cables shall be supplied in nonreturnable wooden drums of heavy construction as per IS 10418. Wooden drum shall be properly seasoned sound and free from defects. Wood preservative shall be applied to the entire drum.
- 7.2 Standard lengths for each size of control cables shall be 500/1000 meters. The cable length per drum shall be subject to a tolerance of plus or minus 5% of the standard drum length. However, tolerance of plus or minus 1% of total ordered cable length is permissible. The owner shall have the option of rejecting cable drums with shorter lengths. Maximum One (1) number non standard length of cable size(s) maybe supplied in drums for completion of order.
- 7.3 A layer of water proof paper shall be applied to the surface of the drums and over the outer most cable layer.
- 7.4 A clear space of at least 40 mm shall be left between the cables and the lagging.
- 7.5 Each drum shall carry the manufacturer's name, the purchaser's name, address and contract number and type, size and length of the cable, net and gross weight stenciled on both sides of drum. A tag containing the same information shall be attached to the leading end of the cable. An arrow and suitable accompanying wording shall be marked on one end of the reel indicating the direction in which it should be rolled.
- 7.6 Packing shall be sturdy and adequate to protect the cables, from any injury due to mishandling or other conditions encountered during transportation, handling and storage. Both cable ends shall be sealed with PVC/Rubber caps so as to eliminate ingress of water during transportation and erection.

8.0 TYPE, ROUTINE AND ACCEPTANCE TESTS

1. **Type Tests:** The bidder shall submit all the applicable type test reports of the cable system in line with latest edition of IS-1554 part-I and validity of the type test reports shall be as per CEA guidelines. The reports shall be submitted for review by DTL. If any type test has not been conducted by the bidder, than the same shall be conducted by the bidder free of cost and without affecting the completion period of the project/tender.
2. **Routine and Acceptance tests:** All the applicable routine and acceptance tests on the control cables shall be conducted by the bidder as per relevant IS during and after manufacture (As applicable).

SCHEDULE OF GUARANTEED TECHNICAL PARTICULARS TO BE FURNISHED BY THE TENDERERS.

S.No. DESCRIPTION

1. Name of the manufacturer / Address
2. Manufacturer's type & designation
3. Type of use (suitable to be laid in ground/duct/also to be laid exposed to atmosphere conditions).
4. Standard to which manufactured.

5. Rated Current.
6. Rated Voltage.
7. Rated Frequency
8. Suitable for earthed or unearthed system.
9. Continuous current rating when laid in air in an ambient temp. of 50°C and for max. conductor temp. of 85°C for PVC cable.
10. **Material of Insulation:**
 - a) Thickness (average) (in mm)
 - b) Material of insulation and composition.
 - c) Tensile strength.
 - d) Min % elongation at break without ageing.
 - e) Minimum thermal resistivity of dielectric in electrical measure (diff. In C between opposite face of 4 cm cubes of the di-electric to cause transference of Watt heat).
 - f) Insulation resistance in ohm/250m of finished cable at 20°C.
11. **Conductor:**
 - a) Materials (Cu)
 - b) Grade
 - c) Nominal cross-section area (sq.mm)
 - d) No. & dia of wire (No/mm)
 - e) Current density
 - f) Max. normal operation temp. of conductor in cable.
12. **Short Circuit Capacity:**
 - a) Short circuit current (KArms)
 - b) Duration of short circuit (sec)
 - c) Conductor temp. allowed for the short circuit duty (°C)
 - d) Formula relating short circuit current (in rms) and duration (in sec).
 - e) Short ckt. max. conductor temp.
13. **Outer sheath :**
 - a) Material
 - b) Calculated diameter under sheath.
 - c) Type of thickness.
 - d) Composition of PVC for outer sheath.
 - e) Operating temperature
 - f) Weather flexibility test arid or not.
 - g) Oxygen index at room temperature.
 - h) Temperature index at 21% of oxygen
 - i) HCL % by weight.
14. Overall diameter of cable
15. Length of cable in each drum.
16. Weight of the cable.
17. **Inner sheath:**
 - a) Material composition.
 - b) Thickness allowable (minimum in mm)

- c) Operating temperature
 - d) Method of application of inner sheath.
 - e) Calculated diameter over the Laid up cores (mm)
18. Short circuit capacity with conductor temperature of 90°C at commencement of short circuit possible max. temperature.
19. Resistance of cable at 20°C per KM.
20. Inductance of cable per KM.
21. **Armouring :**
- a) Type & Material of armour (wire/strip)
 - b) Calculated diameter under armour (mm)
 - c) Nominal diameter of round armour wire
 - d) Short circuit capacity armour alongwith formulae.
 - e) Single or double wire armouring.
 - f) Nominal size of wire/strip.
 - g) Area of wire/strip
 - h) Maximum D.C. Resistance at 20°C .
 - i) Joint in armour.
22. Die-electric constant 50 Hz at 20°C .
23. Tan- Delta at 50 Hz at 20°C .
24. Volume resistivity.
25. Max. allowable continuous operating temp.
26. Tensile strength.
27. Whether type test certificate enclosed or not.
28. The sequence in which the type tests have been performed.
29. Insulation resistance in ohm/250m of finished cable at 20°C .
30. **Test Voltage:**
- a) High voltage test voltage (KV)
 - b) Water immersion test voltage (KV)
31. Safe Pulling force when pulled by Pulling eye on the conductor (kg)
32. Minimum bending radius permissible
33. Are all the cables approved by ISI & marked as such (Y/N)
34. Whether the cables are type tested as per IS (Y/N)

C. TECHNICAL SPECIFICATIONS FOR UNARMORED U/G FIBER OPTIC CABLE

This section describes the functional requirements, major technical parameters, Type and Factory Acceptance Testing requirements for underground fiber optic cable. Marking, packaging and transportation requirements have also been described.

2.1 General

The underground fiber optic cable shall be unarmored and shall be suitable for underground installation in pipes. The cable should be of low weight, small volume and high flexibility. The mechanical design and construction of each unit shall be inherently robust and rigid under all condition of operation, adjustment, replacement, storage and transport.

2.2 Applicable Standards

The cable shall conform to the standards named below and the technical specifications described in the following sections.

ITU-T Recommendations G-652.

Electronic Industries Association, EIA/TIA 455-78A, 455-3A, 455-62A, 455-164A/167A/174. 455-168A/ 169A/ 175A, 455-176, 455-59, EIA/TIA 598, EIA 455-104.

International Electro technical Commission standards, IEC 60304, IEC 60794-1-2, IEC 60811-5-1.

Bell core GR-20.

2.3 Fiber Type(s) and Counts

The cable shall contain 12 Dual Window Single Mode (DWSM) fibers conforming to G.652 as per the bill of the Quantity and the Technical parameters stipulated in the following sections. The BOQ for each type of cable has been provided in the appendices.

2.4 Optical Characteristics

The attenuation coefficient for wavelength between 1525nm and 1575nm shall not exceed the attenuation coefficient at 1550nm by more than 0.05dB/km. The attenuation coefficient between 1285nm and 1330nm shall not exceed the attenuation coefficient at 1310nm by more than 0.05dB/km. The attenuation of the fibre shall be distributed uniformly throughout its length such that there are no point discontinuities in excess of 0.1dB. The fibre attenuation characteristics specified in table 2-1 shall be “guaranteed” fibre attenuation of any & every fibre reel. Further the average cabled fibre attenuation, averaged over 100kms of cabled fibre, (as measured during the factory acceptance testing) shall be as specified in 2-1.

DWSM fibres shall conform to the requirements specified in Table 2-1 below.

Table 2-1

DWSM Optical Fibre Characteristics

Fibre Description:	Dual Window Single-Mode
Mode Field Diameter:	8.6 to 9.5nm um(±10% of the nominal value)
Cladding Diameter:	125.0 um ± 2um

Mode field Concentricity Error:	$\leq 1.0 \mu\text{m}$
Cladding non-circularity	$\leq 2\%$
Cable Cut off Wavelength	$\leq 1260\text{nm}$
1550 loss performance	As per G.652
Proof Test Level	$\geq 0.35\text{Gpa}$
Attenuation coefficient	@ 310nm $\leq 0.35 \text{ dB/Km}$ @1550nm $\leq 0.23 \text{ dB/Km}$
Chromatic Dispersion : Maximum:	20 ps/(nm x km) 1550 nm 3.5 ps/ (nm x km) 1288-1339nm 5.3 ps/ (nm x km) 1271-1360nm
Zero Dispersion Wavelength:	1300 to 1324 nm
Zero Dispersion Slope:	-0.093 ps/(nm ² x km) maximum
Polarization mode dispersion coefficient	$\leq 0.5 \text{ ps/km}^{1/2}$
Temperature Dependence:	Induced attenuation $\leq 0.05 \text{ dB}$ (-60 °C + 85 °C)
Bend performance:	@1310nm(75 \pm 2nmdia Mandrel), 100 turns: Attenuation rise <0.05 dB/km @1550nm(75 \pm 2nmdia Mandrel), 100 turns: Attenuation rise <0.10 dB/km @1550nm(32 \pm 0.5 dia Mandrel), 1 turn: Attenuation rise <0.50 dB/km
End of Table	

2.5 General Construction

The optical cable shall consist of a central fibre optic unit protected by one or more layers of helically wound anti-hygroscopic tape or yarn. The central fibre optic unit shall be designed to house and protect the fibres from damage due to forces such as crushing, bending, twisting, tensile stress and moisture, wide temperature variations, hydrogen evolution etc. The fibre shall be of loose tube construction. The inner polyethylene jacket and outer sheath jackets shall be free from pinholes, joints, splits or any other defects,. All fibre optic cable shall have a minimum service life span of 25 years.

2.5.1 Colour Coding & Fibre Identification

Individual optical fibres within a fibre unit, and fibre units shall be identifiable in accordance with EIA/TIA598 or IEC 60304 or Bellcore GR-20 colour –coding scheme. The colour coding system shall be discernible throughout the design life of the cable. Colouring utilized for colour coding optical fibres shall be integrated into the fibre coating and shall be homogeneous. The colour shall not bleed from one fibre to another and shall not fade during fibre preparation for termination or splicing. Each cable shall have tracibility of each fibre back to the original fibre manufacturer's fibre number and parameters of the fibre. If more than the specified number of fibres included in any cable, the spare fibres shall be tested by the cable manufacturer and any defective fibre shall be suitably bundled, tagged and identified at the factory by the vendor.

2.5.2 Strength Members

The central fibre optic unit should include a central strength member of Fibre Reinforced Plastic (FRP) or other suitable material. Peripheral strength members and aramid yarns are also acceptable. The central FRP strength member may be of slotted type with SZ lay (reverse oscillation lay) of fibre units or it may be cylindrical type with helical lay of fibre units.

2.5.3 Filling Compound

The interstices of the central fibre optic unit and cable shall be filled with a suitable compound to prohibit any moisture ingress or any longitudinal water migration within fibre optic unit or along the fibre optic cable. The water tightness of the cable shall meet or exceed the test performance criteria as per IEC60794-1-2-F5. The filling compound used shall be a non-toxic homogeneous water proofing compound that is free of dirt and foreign matter, anti-hygroscopic, electrically nonconductive and non-nutritive to fungus. The compound shall also be fully compatible with all cable components it may come in contact with and shall inhibit the generation of hydrogen within the cable. The filling compound shall remain stable for ambient temperature up to +70 °C and shall not drip, flow or leak with age or at change of temperatures. Reference method to measure drip point shall be as per IEC60811-5-1 and drip point shall not be less than 70 °C.

2.5.4 The Sheath/Inner Jacket

The sheath shall be black, smooth, concentric, and shall be free from holes, splits, blisters and other surface flaws. The sheath shall be extruded directly over the central fibre optic unit and shall also be non-hygroscopic. The cable sheath design shall permit easy removal without damage to the optical fibres or fibre units. The sheath shall be made from good quality of weather resistant polyethylene compound (Black High Density Polyethylene-HDPE) and thickness shall be $\geq 1.8\text{mm}$.

2.5.5 The Outer Jacket/Termite protection

A circular jacket of not less than 0.65mm Polymide-12(Orange Nylone-12) material should be applied over the sheath as an outer jacket. The outer jacket shall have smooth finish and shall be termite resistant.

RIP Cord: Suitable rip cord(s) shall be provided to open the outer sheath of the cable. The rip cord(s) shall be properly waxed to prevent wicking action and shall not work as a water carrier.

2.6 Mechanical Parameters & Tests

- (A) **Tensile Strength:** The cable shall be of sufficient strength to withstand a load of value $T \text{ (N)} = 9.81 \times 2.5 \times W$ Newton or 2670 N whichever is higher (where W is the mass in Kg of 1 Km cable). The load shall be sustained for 10 minutes and the strain of the fiber monitored. The load shall not produce a strain exceeding 0.25% in the fiber and shall not cause any permanent damage to any constituent part of the cable. The change in optical attenuation during or after the application of the rated tensile load in accordance with IEC 60794-1-2-EI procedure shall not exceed 0.05dB/Km both for 1310 nm and 1550 nm wavelength. The attenuation shall be noted before strain, and after release of strain for all the fibers.

- (B) **Crush test** (Compressive Strength): The cable shall withstand a compressive force of at least 2000 N. applied for at least 60 seconds between two plates of 100mm x 100mm in accordance with IEC60 794-1-2-E3 procedure. This compressive load applied in accordance with IEC60794-1-2-E3 shall not cause any permanent damage to any constituent part of the cable. The change in optical attenuation during or after the application of the compressive load shall not exceed 0.05dB/Km both 1310nm and 1550nm wavelength. The attenuation shall be noted before and after the test for all the fibers.
- (C) **Bend Radius:** The cable bend radius under no load shall be less than or equal to 20 times the cable diameter. The test method shall be according to the IEC60794-1-2-E11 (procedure-I). The fibers and component parts of the cable shall not suffer permanent damage when the cable is repeatedly wrapped and unwrapped 4 complete turns of 10 complete cycles around a mandrel of 20 times to the cable diameter. The change in optical attenuation after the test shall not exceed 0.05dB/Km both for 1310nm and 1550nm wavelength. The attenuation shall be noted before and after the test for all the fibers. Outer Jacket shall not show any cracks visible to the naked eye when examined whilst still wrapped on the mandrel.
- (D) **Cable Bending test** (Repeated bending): The cable shall withstand repeated bending when tested in accordance with EIA-455-104 and shall not cause any permanent damage to any constituent part of the cable. The cable sample shall be at least 5 meters or more. The change in optical attenuation during or after the application of the repeated bending test shall not exceed 0.05dB/Km for all the fibers. The attenuation shall be noted before and after the test for all the fibres. The test requirement shall be as mentioned below:-
- | | |
|---|---------------------------|
| Weight | 5Kg |
| Minimum distance from pulley centre to holding device | 216 mm |
| Minimum distance from weight to pulley centre | 457mm |
| Pulley diameter | 20 times to the cable dia |
| Angle of turning | 90° |
| No. of cycles | 30 |
| Time required for 30 cycles | 2 min. |
- (E) **Impact Test:** The cable shall withstand at least 10 impacts of 50N load from a 0.5 meter height with impacting surface radius of 300mm. This impact load applied at the same place in accordance with IEC60794-1-2-E4 shall not cause any permanent damage to any constituent part of the cable. The change in optical attenuation during or after the application of the impact load shall not exceed 0.05dB/Km. The attenuation shall be noted before and after the test for all the fibres.
- (F) **Torsion test:** The cable shall withstand 10 cycles of $\pm 180^\circ$ torsion with 100N load applied on a 2m sample. This load cycle applied in accordance with IEC60794-1-2-E7 shall not cause any permanent damage to any constituent part of the cable. The change in optical attenuation during or after the application of the torsion load shall not exceed 0.05dB/km for all the fibres. The attenuation shall be noted before and after the test.
- (G) **Kink test** (Resistance): When a cable of sample length 10 times the minimum bend radius as defined above is subjected to kinking, it shall not result in any fibre breakage and the kink shall disappear after normalizing the cable. The change in optical attenuation after the application of the kink in accordance with IEC60794-1-2-E10 shall not exceed 0.05dB/km for all the fibres.

- (H) **Water penetration test**(Resistance to water ingress): The resistance to water ingress of the cable shall meet or exceed the test performance criteria as as per IEC60794-1-2-F5 method F5B. Before applying the water tight sleeve at one end the outer jacket shall be stripped. A water soluble fluorescent dye shall be used for testing.The duration of test shall be 7 days. In addition after the test the cable shall be ripped open and distance up to which water has seeped shall be noted.
- (I) **Drip Test**(Seepage of Filling Compound): For testing, a sample of 30cm length of the cable with one end sealed by the end cap will be taken and outer jacket, sheath, binder tapes shall be removed by 5cms from open end of the sample. The filling compound will be wiped thoroughly and the sample be kept vertically with open end down ward in the oven for 24 hours at 70 °C. temperature with a filter paper under the sample. The filter paper should not indicate any sign of drip or oily impression. The reference test specification shall be as per IEC60811-5-1 to measure drip point.
- (J) **Environmental Test:** Temperature cycling test shall be carried out on one drum length of the cable to ensure stability of attenuation parameter of the cable when subjected to temperature change which may occur during storage, transportation, and operation. The permissible temperature range for storage and operation will be from -20°C to +70°C. The rate of change of temperature during test shall be 1°C per minute. The cable shall be kept for 12 hours at each of the following temperature and should follow the specification IEC60794-1-2-F1. Two cycles shall be performed.

TA2	: -20°C
TA1	: -10-°C
TB1	: +60°C
TB2	: +70°C

The attenuation shall be measured at the end of each temperature range both at 1310nm & 1550nm. The change of attenuation of fibre used shall be ≤ 0.05 dB both for 1310 & 1550nm for entire range of temperature for all the fibres in each cycle.

- (K) **Termite Resistance Test:** The outer jacket shall be demonstrated to be termite resistant. The exact procedure for the test shall be mutually agreed between the Contractor and the Purchaser and shall generally be in line with test procedures followed by reputed test laboratories.
- (L) **Abrasion Test:** To be conducted as per IEC 60794-1-E2 or equivalent international test method.
- (M) **Flexure Rigidity Test:** To be conducted as per ASTM D-790. The test shall not cause any permanent damage to any constituent part of the cable. The change in optical attenuation after the test shall not exceed 0.05 dB/km. The attenuation shall be noted before and after the test for all the fibres.
- (N) **Figure of Eight Test:** 1000m of cable shall be uncoiled from the drum and arranged in figure of eight, each loop having a maximum, dimension of 2m. It shall be possible to arrange cable in figure of 8 with relative ease and the cable shall not show any visible damages.

- (O) **Cable Ageing Test:** After Environmental test the cable shall be subjected to a temperature of 85 ± 2 °C for 168 hours. Cable shall then be brought to ambient temperature and stabilized for 24hours. The change in optical attenuation after the test shall not exceed 0.05dB/km. For 1310 as well as 1550nm wavelengths. The attenuation shall be noted before and after the test for all the fibres.
- (P) **Embitterment Test of Loose tube:** The minimum length of the test sample depend on the outside diameter of the loose tube and should be 85mm for tubes upto 2.5mm outside dia. The length of the bigger tubes should be calculated by using the following equation:
- $$L_o > 100 \times ((D^2 + d^2) / 4)^{1/2}$$
- Where
- L_o = Length of tube under test
 D = Outside dia of loose tube
 d = inside dia of loose tube
- Both the ends of a buffer tube test sample may be mounted in a tool which is clamped in jaws of a tensile machine which exert a constant rate of movement. The movable jaw may move at a rate if 50mm per minute toward the fixed jaw. Under load the tube will bend, so that the tube is subjected to tensile and compressive stresses. The fixture for holding the tube should be designed in a manner that the tube might bend in all directions without further loading. The tube should not get embrittled. No ink should appear on the tube up to the safe bend dia of tube (20D) where D is the outside diameter of the loose tube. There should not be any physical damage or mark on the tube surface.
- (Q) **Kink Resistance test on the loose tube:** A longer length of The loose tube is taken(with fibre and gel), a loop is made and loop is reduced to the minimum bend radius of loose tube i.e. 20 D.(where D is the outside dia of the loose tube). This test is to be repeated 4 times on the same sample length of the loose tube. No damage or kink should appear on the surface of the tube.
- (R) **Drainage test for loose tube:** A tube length to 40cm shall Be cut and filled with filling gel ensuring there are no air bubbles and the tube is completely full. The filled tube is placed in a horizontal position on a clean worktop and cut 5cm from each end so that the finished length of the sample is 30cm. The filled tube shall be left in a horizontal position at an ambient temperature for 24 hrs. The sample tube is then suspended vertically in an environment heat oven over a weighed beaker. It is left in the oven at a temperature of 70 °C for a period of 24 hrs. At the end of the 24hrs. period the beaker is checked and weighed to see if there is any gel in beaker. There shall be no gel or oil in the beaker.
- (S) **Check of easy removal of sheath:** The sheath shall be Cut in circular way using a sheath removal tool and the about 300mm length of the sheath should be removed in one operation. It should be observed during sheath removal process that no undue extra force is applied and no component part of the cable is damaged. It shall be possible to remove the sheath easily. Easy removal of both the outer jacket and the inner sheath shall be checked separately.
- (T) **Effect of aggressive media on the cable surface(Acidic and alkaline behaviour) :** The test shall be conducted as per method no.ISO175. The two test samples of the finished cable each of 600mm in length are taken and the ends of the samples shall be sealed. These test samples are put in the PH4 and PH10 solutions separately. After 30days these samples are taken out from the solutions and examined for any corrosion etc. on the sheath and other markings of the cables. The sample should not show any effect of these solution on the sheath and other marking of the cable.

2.7 Optical fibre cable marking

A suitable marking shall be applied in order to identify this cable from the other cables. Marking on the cable shall be indelible, of durable quality, shall last long and shall be applied at regular interval of one-meter length. Marking shall be imprinted and must clearly contrast with the surface and colors used must withstand the environmental influences experienced in the field,

The accuracy of the sequential marking must be within $\pm 0.5\%$ of the actual measured length. The sequential length marking must not rub off during normal installation. In case laser printing is used the marking shall not exceed 0.15mm depth. The optical fibre cable shall have the following markings in every metre.

Type of Cable
Running metre length
No. of fibres
Type of fibre
Laser symbol & caution notice
Year of manufacture and batch no.
Manufacturer's name
D T L

2.8 Operating Instructions

Complete technical literature in English with detailed cable construction diagram of various sub-component with dimensions and test data of the cable shall be provided. All aspects of installation shall also be covered in the handbook.

2.9 TEST AND INSPECTION:

The general conditions for Type and Factory Acceptance Testing shall be as follows:-

2.9.1 TYPE TEST

Type testing shall be carried out as per IEC for fiber optic cable & the tests listed in table 2-2 shall be carried out as type tests for fibers.

Table 2-2

Type test for Fibres

S. No.	Test Name	Acceptance Criteria	Test procedure
1.	Attenuation	TS Table 2-1	EIA/TIA 455-78A
2.	Attenuation Variation with wavelength	TS Table 2-1	EIA/TIA 455-78A
3.	Attenuation at Water Peak	TS Table 2-1	EIA/TIA 455-78A
4.	Temp.Cycling (Temp. dependence of Attenuation)		EIA/TIA 455-3A, 2 cycles
5	Attenuation with Bending (Bend performance)		
6.	Mode Field dia.		EIA/TIA 455-164A/167A/174
7.	Chromatic Dispersion		EIA/TIA455-168A/

			169A/175A
8	Cladding Diameter		EIA/TIA 455-176
9	Point Discontinuities of attenuation		EIA/TIA 455-59
10	Core-Clad concentricity error		EIA/TIA 455-176
	-- End of Table---		

2.9.2 Factory Acceptance Testing

The tests listed in Table 2-3 shall be carried out as Factory Acceptance Test for Underground fibre optic cable.

Table 2-3

Factory Acceptance Tests on Underground Fibre Optic Cable

S.No.	Factory Acceptance Test
1.	Attenuation Co-efficient (1310,1550, and Water Peak)
2.	Point discontinuities of attenuation
3.	Chromatic Dispersion
4.	Visual Material verification and dimensional checks as per approved drawings
5.	Resistance to Water Ingress test
6.	Tensile strength test/Strain test
7.	Impact test
8.	Kink test

SECTION-III : QUALITY ASSURANCE PROGRAMME

To ensure that the equipment and services under the scope of contract, whether manufactured or performed within the contractors work or at his sub contractors premises or at the owners site or at the other place of the work are in accordance with the specifications, the contractors shall adopt suitable quality assurance programme to control such activities at all points, as necessary. Such programme shall be outlined by the contractor and finally accepted by the owner/authorize representative after discussion before the award of contract. The QA programme shall be in line with ISO 9001/IS-14001.

GENERAL REQUIREMENTS QUALITY ASSURANCE

All materials, components and equipment covered under this specification shall be procured, manufactured, erected, commissioned and tested at all stages, as per comprehensive quality assurance programme. An indicated programme of the inspection/tests to be carried out by the contractor for some of the major items is given in the respective technical specifications. This is however, not intended to form a comprehensive programme as it is the contractor responsibility to draw up and implement such programme duly approved by the owner. The detailed quality plans for manufacturing and field activities should be drawn by the bidder and will be submitted to owner for approval. Schedule of finalization of such quality plans will be finalized before award.

Manufacturing quality plan will detail out for all the components and equipments, various tests/inspection, to be carried out as per the requirement of this specification and standards mentioned therein and quality practices and procedure followed by contractors quality control organization, the relevant reference document and standards, acceptance norms,

inspection documents raised etc. during all stages of material procurement, manufacturer, assembly and final testing performance testing.

Field quality plans will detail out for all the equipment the quality practices and procedures etc. to be followed by the contractors site quality control organization, during various stages of site activities from receipt of materials/equipment at site.

The Contractor shall also furnish copies of the reference documents/plant standards/acceptance norms/tests and inspection procedure etc., as referred in quality plans alongwith quality plans. These quality plans and reference documents/standards etc. will be subject to Owner's approval without which manufacture shall not proceed. These approved documents shall form a part of the contract. In these approved quality plans Owner shall identify Customer Hold Points (CHP), i.e. test/checks which shall be carried out in presence of the Owner's engineer or his authorized representative and beyond which the work will not proceed without consent of Owner/authorized representative in writing. All deviations to this specification, approved quality plans and applicable standards must be documented and referred to Owner alongwith technical justification for approval and disposition.

No material shall be dispatched from the manufacture's work before the same is accepted subsequent to pre-dispatch final inspection including verification of records of all previous tests/inspection by Owner's engineer/authorized representative, and duly authorized for dispatch issuance of MDCC.

All material used for equipment manufacture including casting and forging etc. shall be of tested quality as per relevant codes/standards. Details of results of the tests conducted to determine the mechanical properties, chemical analysis and details of heat treatment procedure recommended and actually followed shall be recorded on certificates and time temperature chart. Tests shall be carried out as per applicable material standards and/or agreed details.

SECTION-XVI

Visual Monitoring

Section-XVI

Visual monitoring system for Remote monitoring of unmanned new S/stn equipment

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 lighting pump house, stores and main gate, shall be provided. The contractor shall design, supply, erect, test and commission the complete system including cameras, Network 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 outdoors 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: The operation of each and every isolator pole of the complete yard (including future scope).

1. All the Transformer and Reactors (including future scope).
2. All the Entrance doors of Control Room Building and Fire-fighting Pump House and Switchyard Panel Room.
3. All the gates of switchyard.
4. Main entrance Gate.
5. All other Major Equipments (such as CB, CT, CVT, LA etc. for present and future)

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.

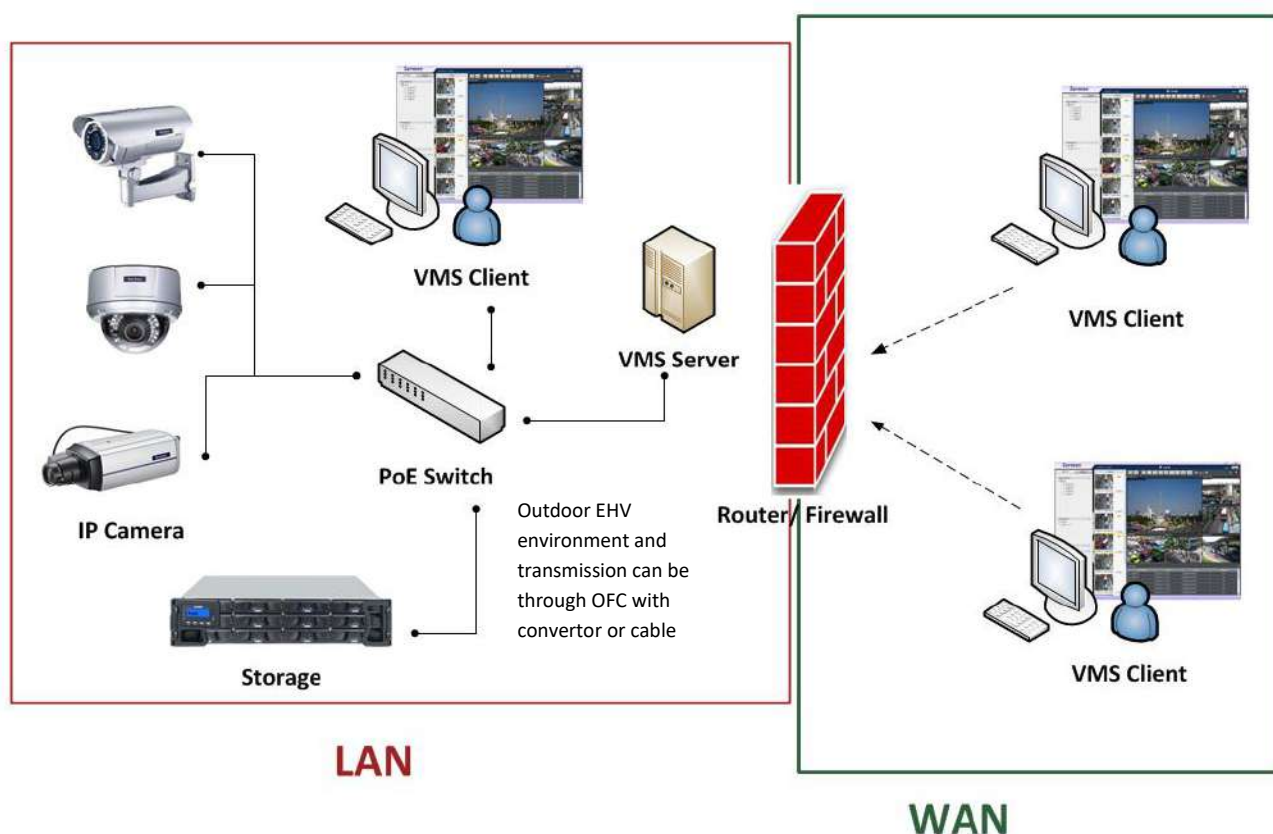
- 1.1.1 The Video Monitoring system shall be an integrated system with IP network centric functional and management architecture aimed at providing high-speed manual / automatic operation for best performance.
- 1.1.2 The system should facilitate viewing of live and recorded images and controlling of all cameras by the authorized users.
- 1.1.3 The system shall use video signals from various types of indoor/outdoor Charge Couple Device (CCD) color cameras installed at different locations, process them for viewing on workstations/monitors in the control Room and simultaneously record all the cameras after compression **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 cameras recordings for a period of 15 days or more @ 25 FPS (Frame Per Second), at 4 CIF (Common Intermediate Format) 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 240 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 Architecture

The conceptual system architecture of the visual monitoring system is described below:



1.3 System requirements:

- System must provide built-in facility of watermarking or Digital certificate to ensure tamperproof recording.
- All cameras may be connected through a suitable LAN which shall be able to perform in 400 / 220kV class sub-station environment without fail.
- 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.
- 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 original 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. The client can log into WAN and then monitor the live video / recorded video of the substation.
- k) The contractor shall provide the Software Development Kit (SDK) and Application Program Interface (API) for all the system software's including NVR / Cameras installed under the CCTV system.
The Software Development Kit (SDK) / Application programming interface (API) for the NVR and the cameras shall be supplied including for the future integration of the following functions with visual monitoring system
 - (i) Camera- Network device discovery, live video streaming, video capture configuration, video compression configuration, event and metadata configuration, storage recording.
 - (ii) NVR- Network device discovery, video capture configuration, video compression configuration, video recording control, video recording search, video replay control.
- l) The equipment should generally conform to Electro magnetic compatibility requirements for outdoor equipment in EHV switchyards. The major EC required for Cameras and other equipment shall be as under:

Technical Specification for Visual Monitoring System

- | | |
|---|-------------------------|
| 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 61000-4-12 |
| 3. AC Voltage Dips & Interruption/Variation (Level 4) | - As per IEC 61000-4-12 |
| 4. Electrostatic Discharge (Level4) | - As per IEC 61000-4-2 |
| 5. Power Frequency Magnetic Field (Level 4) | - As per IEC 61000-4-8 |
| 6. Ripple on DC Power Supply (Level 4) | - As per IEC 61000-4-17 |

Type test reports to establish compliance with the above requirement shall be submitted during detailed engineering.

1.3.1 Video Surveillance Application Software

- a) Digital video surveillance software 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 back up 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 window 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 disables or 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 a facility for scheduled recording. Different recordings 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 to 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, then the retrieval should be possible. The system should also allow for backup of specified data on any drive like DVD's or any other device in a format which can be replayed through 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.

1.3.2 Network video recorder

The Network 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/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.), 8MB cache, 4GB RAM with suitable NVIDIA graphics card, 3TB HDD, Raid 5.
2.	Recording and display Frame rate	Real time 25 frames per second per channel, manual select.
3.	Recording Resolution	PAL: 1280 X 720, 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 setting, 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 of 30mins.

1.3.3 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 DELHI TRANSCO 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) The cameras must be of Day and Night type. The cameras must be controllable for use in black & white mode when needed. The cameras shall have provision to operate with enhanced sensitivity in the darkest conditions.
- d) The cameras must be operative in automatic mode for switching from day mode to night mode depending on the ambient natural light intensity without having to manually operate. All cameras shall be operative in color in day and black & white mode in low illumination condition.

- e) It should have sufficient range for viewing all the poles of isolators and other equipments with high degree of clarity.
- f) The VMS cameras shall be suitable for wall mounting, ceiling mounting and switchyard structure mounting.
- g) Cameras shall be connected through cable and / or optical fiber cable to visual monitoring system. If OFC interface is not available in the camera suitable media converters placed in weather proof outdoor cubicle should be supplied. Camera should also have the provision for wireless connection.
- h) The camera shall meet the following requirement:
 - Build in surge and lighting protection
 - Communication: RS232, RS485, TCP/IP
 - UL certified.
- i) It shall be possible to define at 128 selectable preset locations so that the cameras get automatically focused on the selection of the location for viewing a predefined location.
- j) The camera should be able to detect motion in day & night environment having light intensity of color: 0.5 Lux; B&W: 0.05 Lux.
- k) 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. Weather resistant sunshields shall be provided in the camera housing for all cameras required to be installed outdoors. Enclosure shall have provision to avoid fogging during high humidity conditions. Housing shall be robust and not have effect of electromagnetic induction in 400 / 220 KV switchyard.
- l) All camera recording 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.
- m) 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	0.5 Lux (Color), 0.05 lux (Black)
3.	Camera enclosure	IP 66 Grade
4.	Iris/Focus	Auto/Manual
5.	Video Compression	Dual Stream H.264 and MPEG user selectable
6.	Support Dual-Stream	Primary/secondary stream, H.264 and MPEG 4 optional
7.	Video Definition	Primary stream 1600 X 1200, 1280 X 960, 1280 X 720, Secondary stream 800X 600, 400 X 288, 192 X 144
8.	Video Parameters	Brightness, Hue, Contrast, Saturation and image Quality
9.	Video Frame Rate	PAL:1-25 frames/sec

		NTSC: 1-30 frames/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	Min. 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.	PTZ Data Transfer Baud / Bit Rates Supported	Selectable 2400 bps / 4800 bps / 9600 bps
13.	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)
14.	Panning range	Complete 360 degrees (horizontal)
15.	Pan Speed	Adjustable, 0.1 degree / second ~ 250 degrees / second
16.	Tilting Range	Minimum 180° Tilt Rotation
17.	Tilt Speed	Adjustable, 0.1 degree / second ~ 150 degrees / second
18.	In Build Storage	Camera should have inbuilt storage TF or SD format for recording and storing pictures
19.	IP Class	IP 66 Standard
20.	Working Temperature	-0°C ~ +50°C
21.	Working Humidity	10 ~ 90 %

1.3.4 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.

2.0 Future Integration

In future the system should be able to integrate at central control location. Hence the system should be based on open platform. Otherwise the contractor must provide the Software Development Kit (SDK) and Application Program Interface (API) for all the system software 's including NVR / Cameras installed under the project. These solutions shall provide a unified device interface to devices, including different kinds of third party devices as follows defined by ONVIF standards. The contractor shall assist for future integration.

3.0 Cable and Other Accessories

Any optical fiber cable used in the project shall be suitable for transmitting the video signal from camera to media converter and further to server without any loss to signal. The copper cable being used shall be suitable for 1100 V rating and shall conform to respective IS standards. The media converters and switches should be suitable for continuous operation. The outdoor rack shall be suitable for all weather conditions with locking arrangement.

Location of cable laid directly under ground shall be indicated clearly by cable marker made of galvanized iron plate. These markers shall be spaced at an interval of 30 meters and at every change of direction in the cable laid area.

4.0 Training

The training for configuration of camera, software shall be offered at respective sites by contractor.

SECTION-XVII

FIBRE OPTIC TERMINAL **EQUIPMENT (FOTE)**

Section-XVII

Technical Specification of Fibre Optic Terminal Equipment (FOTE)

1.1. Introduction of Scope and General Requirement of FOTE

This document describes the technical specifications of FOTE equipment to be installed in Fiber Optic communication system for terminating optical cable.

The FOTE equipment shall be designed to operate in electrical high-voltage networks and shall be suitable for installations in substations with harsh environment and high electromagnetic interference conditions. It shall be highly reliable and provide secure communications for real time signals such as DATA, VOICE, IP/ETHERNET, SCADA, TELE-PROTECTION and Line Current Differential Relay Communication including status/control signals. The equipment offered shall already be working successfully in telecommunication networks operated by power utilities. It shall comply with the latest ITU-T recommendations and ETSI standards and be able to be interconnected with legacy multiplexers and other telecommunication equipment.

For each location, the supplier is required to assess the environmental conditions for the equipment to be installed under this specification. The supplier shall be responsible for all necessary enclosure, rack or equipment upgrades etc. to ensure the proper operation of the installed equipment.

The equipment shall be in line with current practice as followed by Department of Telecommunication (Govt. of India) or by internationally accepted practices for communication system.

The security related requirements of the equipment shall be as per DoT (Department of Telecommunication) guidelines and all similar security requirements as amended by DoT on time to time basis shall be followed/complied by the supplier.

Equipment supplied shall be supported for its maintenance and availability of spares by its OEM for minimum 7 years from the date of its supply.

Integration: bidder / supplier should be responsible to integrate the entire supplied equipment with the existing communication system (PLCC, OLTE, OFC, MUX, EPAX and RTU etc.). The supplier should supply any necessary hardware, cards, cables, connectors etc. Required in supplied & existing system for integration without any additional cost.

1.2. General Characteristics

1.2.1. Description - FOTE communication system

The proposed FOTE communication system shall be fiber optic based SDH Transmission equipment and PDH Terminal Equipment. SDH shall be used for transmission and PDH equipment for termination of voice, data and Tele -protection interfaces, Distance relays / Line current differential relay communication.

SDH equipment shall be a separate Terminal, which shall support to STM-4 capacity network interfaces with minimum 3 MSP (Multiplex Section Protection) directions which shall be field upgradeable by simply changing the required SFPs.

PDH Equipment shall support the Voice & Data communication requirements of RTUs, SCADA / EMS system, PABX and other Power system interfaces such as Distance Relays, Line Differential Current Relay communication, Tele-protection signalling.

The FOTE system, comprising of SDH and PDH equipment shall meet all the communications requirements of the substation and shall provide data & voice connectivity across the various locations or connectivity of RTUs with Control Centre.

The RTUs located at various locations will report to Control Centre using IEC 60870-5-101 or IEC 60870-5-104 / IEC-61850 Protocol. The proposed communication system shall provide connectivity of some RTUs over TCP/IP protocol using Ethernet interface and other RTUs over serial interface.

1.3. Functional Requirement

The primary function of the FOTE is to provide a highly reliable voice and data communication with support of the SCADA/EMS and tele-protection signalling.

A brief summary of the communication system requirements is as follows:

- (a) Ethernet over SDH
- (b) The connectivity envisaged between RTUs and Control Centre is Wide Area Network (WAN) on TCP-IP using IEC 60870-5-104
- (c) High speed E1 channel support
- (d) 64kbps & Nx64kbps data channel support
- (e) Low speed (300 -19200 bps) data channel support
- (f) Voice (2 wires / 4 wires) channel support.
- (g) C37.94 optical interface supports for Distance Relay Communication / Tele-protection signalling and Line Current Differential Protection Relay Communication.
- (h) Data transport supporting Network Management channels

1.3.1.General Systems Requirements

Required characteristics are defined and specified herein at the system level, subsystem level, and equipment level to provide 1:1 redundancy at all critical levels and to ensure maximum uptime and system availability.

1.3.2.System Upgradeability and Expandability

Equipment supplied shall be sized (though not necessarily equipped) to support system / subsystem expansion to full capacity as required for specified aggregate transmission rates. Equipment units provisioned for equipped subunits shall be terminated at appropriate patching facilities or termination blocks. Power supplies shall be appropriately sized for maximum equipped system capacity.

1.3.3.General Physical Characteristics

All supplied equipment shall be new and of the finest production quality. The Employer will not accept modules or printed-circuit boards that are modified by appending wires or components. Wired strapping options shall be incorporated in the board design to meet the above requirement.

1.3.4.Redundancy Requirements and Protection Schemes

Equipment redundancy and Automatic Protection Schemes (APS) are specified in the Table 1. The failure of one element shall not prevent the use of any other that has not failed.

Table 1

FOTE 1:1 Redundancy Requirements - SDH

Power Supply -----	1:1 APS or distributed power supply
Common control* cards-----	1:1 APS
<p>* = Common control card which must provide 1:1 Redundancy and are required for operation of the equipment and include:</p> <p>(a) Processor</p> <p>(b) Cross-Connect</p> <p>(c) Timing</p> <p>(d) SDH Network Interfaces</p>	

FOTE 1:1 Redundancy Requirements – PDH

Power Supply -----	1:1 APS or distributed power supply
Common control* cards-----	1:1 APS
<p>* = Common control card which must provide 1:1 Redundancy and are required for operation of the equipment and include:</p> <p>(e) Processor</p> <p>(f) Cross-Connect</p> <p>(g) Timing</p> <p>(h) E1 Network Interfaces</p>	

The offered equipment shall support automatic switchover function between the redundant modules and all required modules and hardware to support the automatic switch over shall be provided by the Supplier.

1.3.5. Lost Signal Recovery

At any digital signal level, reapplication of a lost signal shall result in automatic resynchronization and full restoration to normal operation without manual intervention. All alarms incident to the signal failure, shall be automatically cleared at the equipment, rack and monitoring levels and normal operation indications restored and reported if applicable.

1.4. Functional Description

1.4.1.FOTE Requirements

The Supplier shall be required to provide a FOTE package that shall include SDH and PDH (E1 Drop & Insert Multiplexer) FOTE Equipment in compliance with the electrical input-output characteristics provided in Table 2&3.

The SDH transmission network node should be equipped with minimum three ports of STM-1/4 for optical interface 16xE1 and 8xFastEthernet interface (L2). For clarity, the basic functions accomplished at the network nodal points, are described briefly as follows:

The E1 Primary Rate PDH multiplexer shall connect to the E1 interface provided by the SDH Transmission Equipment and used to accomplish Digital Access Cross-Connect (DACS) as well as subscriber connectivity to the Digital Communication Network. Subscriber Line Units shall provide analog to digital and direct digital conversion to 64Kbps digital channel in the Conference of European Postal and Telecommunications Administration (CEPT) standard hierarchy, thirty (30) such 64 Kbps digital channels shall be Time-Division Multiplexed (TDM) resulting in a single 2.048 Mbps (E1) digital bit stream totalling up to sixty (60) such 64 Kbps analog / digital channels to be accommodated in a single chassis.

Digital Drop-Insert and Branching Equipment shall be used to digitally interface a small number of channels at spur locations without requiring successive D/A and A/D conversions of the throughput channels.

The Digital Cross Connect Equipment (DACS) must be an intergraded part of the primary (E1) Multiplexer stream to support Digital Access Cross-Connect (DACS), Drop-Insert as well as PDH Primary Rate Terminal Equipment functions.

The equipment shall also have an interface for external 2048 kHz synchronization signal according to ITU-T Recommendation G.703.

1.4.2.Drop & Insert Multiplexing

Drop & Insert multiplexing in conformance with CEPT E1 characteristics shall be required at locations where the subscriber requirement is minimal. The drop and insertion of up to 60 x 64 Kbps channels supporting subscriber line units (SLU) shall be required at intermediate locations. The Drop & Insert Muxes supplied shall be performance and card compatible with

the Channel Bank Equipment provided so that all Subscriber Line Interface cards are interchangeable.

**SDH Transmission and Multiplexing Equipment
(Table-2)**

Network Interfaces: Field Upgradeable between STM-1, STM-4, by changing the SFP
Cross connect Capacity: 20G
Optical Wavelength NOTE (1) : 1310/1550nm
Optical Source NOTE (2) : Laser
Optical Source Life Span: Better than 5x10⁵hours
Optical Fibre Type: G.652 D
Optical Connectors: Type LC
Transmission Quality: Per ITU-T G.821, G.823, G.826
Source Primary Power -48 Vdc
Equipment Specifications: Per ITU-T G.783
Tributary, Electrical Interface: Per ITU-T G.703, 75 _
Ethernet Interface: 10/100 Mbps
SDH Bit Rates: Per ITU-T G.703
Optical Interfaces: Per ITU-T G.957, G.958
Frame and Multiplexing Structure for SDH: Per ITU-T G.707
Synchronization: Per ITU-T G.813
Management Functions: Per ITU-T G.774, G.784
Protection Architectures: Per ITU-T G.841
Built In Testing and Alarms: Per ITU-T G.774, G.783, G.784

NOTE (1) Optical wavelength shall be selected considering the characteristics of the optical fibre and the link budget.

NOTE (2) Eye Safety for Laser Equipment: To avoid eye damage, when a receiver detects a line interruption, it is required that the optical power of the laser shall be reduced to Safe limits on the transmitter in the opposite direction as per ITU-T G.958.

NOTE (3) In case other than FC-PC connector is provided in the equipment, suitable patch cord with matching connector are to be provided to connect with FODP

PDH, E1 Primary Rate Multiplexing Equipment (Table-3)

Applicable Standards:	PDH per CCITT Recommendation G.703, G.704, G.711 and G.712
Total Number of Tributaries:	Up to 60 X 64 Kbps
Alternative Sub-rate Tributaries:	n X 64 Kbps V.36 64Kb/s V.11/V.36
Output Aggregate Rate: Interface Code: Impedance: Peak Level @ 120 ohm: Peak Level @ 75 ohm: Maximum Insertion Loss:	2.048 Mb/s \pm 50 ppm HDB3 75 ohm unbalanced 3.0 volts \pm 10% 2.37 volts \pm 10% 6 dB
Signal Waveform: Frame Structure: Jitter Performance:	Per CCITT G.703 Per CCITT G.742 Per CCITT G.823
Primary Power Supply Voltage:	-48 Vdc

1.4.3. Mux and Drop / Insert Functions

The offered FOTE package must be capable of providing up to at least 60, 64 Kbps channels voice, data and C37.94 Optical Tele-protection coupler channels interfacing requirements which are defined at the subscriber line level. Primary multiplexing in conformance with CEPT E-1 characteristics shall be used to provide first order multiplexing of up to 60 Subscriber Line Units (SLUs).

1.4.4. Subscriber Line Units / Subscriber Line Interface Cards

The terms Subscriber Line Interface Cards and Subscriber Line Units (SLU) have been used interchangeably throughout the specification. Multiple configurations of SLUs shall be required to provide subscriber to primary multiplexer bank interfacing for a variety of voice and data communications. In case there are changes in number or type of cards because of changes in channel requirements, the contract price shall be adjusted accordingly.

The SLU interface requirements are discussed in the following subparagraphs:

(a) Voice Channels

The voice channel requirement is for (I) 4-Wire E&M trunking in support of PABX trunks & PLC VF and (II) 2-Wire telephonic interfaces. 2 wire SLUs shall be DTMF/TP optioned for 2-wire loop start or 2-wire GND start. The voice cards shall utilize ITU.T A - law commanded PCM G.711, 64 Kbits/s encoding.

(b) Sub-Channel Data Multiplexing

For this Project, the RTU data interface to the wideband telecommunications network node shall be defined at the DTE level at low-speed rates of 300, 600 and 1200 baud. The port shall be compatible with RS232C interface. The Supplier shall be required to furnish 64 Kbps SLU asynchronous dataplexing for at least 4 selectable low speeds DTE interfaces whenever multiple asynchronous data circuits are required.

(c) Synchronous Data

The Supplier shall provide a direct DTE interface for synchronous communications at speed of 64Kbps and compatible with CCITT G.703 Kbit/s, V.35 and X.21 interfaces. Data rate selection shall be switch selectable or programmable.

(d) Nx64 kbps Synchronous Data

There is also a requirement for N x 64 kbps V.35, X.21 interfaces. The tentative quantities have been identified in the appendices. However the final BoQ shall be worked out during detailed design.

C37.94 Optical Interfaces for connecting to Digital Protection Couplers to provide Distance Tele-protection

There is a requirement to connect to Digital Protection Couplers to provide Distance Relay / Line current differential relay communication& Tele-protection using C37.94 channels. Necessary interfaces required to in the FOTE need to be provided for successful transmission of data/commands of Current Differential relay/Tele-protection signalling equipment/ inbuilt Tele-protection of Distance relay.

1.4.5.Drop-Insert and Cross-Connect Functions and Capability

The FOTE shall be fully capable of implementing standard applications such as "Groom and Fill", Drop & Insert/Bypass, Broadcast Routing at 64Kps, Primary Rate Channel Level.

1.5. MDF, DDF and Cabling

For the purposes of the specification, the supplier shall provide cabling, wiring and MDFs interfacing to the wideband telecommunications system. Equipment and material components for MDF and cabling are also part of this procurement. It shall be the supplier's responsibility to provide all cable support required for full supplied equipment interconnection with the MDF and shall be in accordance with communications industry standard practices and the requirements mentioned in the technical specifications.

1.5.1. MDF Patching Facilities

The Supplier shall supply and install all cabling, wiring, connectors, cross connects, Main Distribution Frames (MDF) associated with the installation and interconnection of equipment procured under this package as follows:

- (a) Cabling (including connectors) for E1 level connections from SDHDDF to new PDH equipment. To the extent possible, existing cable at site shall be used.
- (b) MDF for termination of all the subscriber channels at new PDH node
- (c) Cabling and connectors required to enable subscriber-to-subscriber circuits over the telecom network. The Line side of the MDF shall be cabled to the Primary Multiplex and the equipment side shall be cabled to the MDF of the assigned subscriber (PLCC, PABX, Telephone at wideband locations etc.)
- (d) Any other cables, connections etc. required for a fully functional, integrated telecom system.

The connections amongst various equipment such as termination equipment and subscriber MDF set shall always be routed through DDF and MDF to provide maintenance access.

1.5.2.Main Distribution Frames

The Supplier shall make provision for cross connection of subscriber services to the subscribers utilizing Krone or equivalent and shall provide full connectivity up to and terminated on the equipment side of the appropriate DDFs and line side of MDFs. The Supplier shall terminate on the equipment side of patching facilities provided by other contracts and shall provide DSX type patching facilities supporting aggregate bit streams (i.e. dataplexers and E-1 Channel Banks). Separate patch panels or MDFs shall be provided for Data and Voice. All cross connects shall be accomplished utilizing one, two or three pair patch cords. Patch plugs are permissible for direct one-to-one circuit "cut-thru".

1.6. Craft Terminal

Each equipment (Drop/Insert Multiplexer and DACS etc.) on the fibre optic communication network shall include provision for connecting a portable personal computer (PC) to be known as craft terminal to support local commissioning and maintenance activities. Through the use of this PC and local displays/controls, the operator shall be able to:

- (a) Change the configuration of the station & the connected NEs.
- (b) Perform tests
- (c) Get detailed fault information

The craft terminal shall be connected to the interface available in the communication equipment. Portable (Laptop) computers (craft terminal) complete with necessary system and latest application software to support the functions listed above.

1.6.1. Hardware Requirements Craft Terminal configuration

The Craft Terminal shall be a Laptop PC having minimum configuration of Intel i5 Processor, 14-15" Display, 4GB RAM, DVD-RW Drive, 1TB Hard Disk Drive, WiFi, Keyboard with Touchpad, USB ports, latest MS Windows OS, 2.5-3 hours battery back-up capacity.

1.6.2 Patch Cables & accessories

All patch cords, screws and accessories etc for successful installation & commissioning

1.7. Minimum Base Configuration

This configuration may be increased appropriately during detailed engineering process to meet the communication requirement and for making the system fully operational. Following is the minimum base configuration for FOTE equipment to be supplied by the contractor.

S.No	Description	Qty	Remark
1	STM-4 SDH with 3MSP Protected Directions		
1.1	Base Equipment (with all common cards, cross-connect /control cards, optical base cards, power supply cards, power cabling, other necessary hardware accessories including sub-rack, patch cords etc.)	01 No	
1.2	Optical Interfaces / SFPs (SFPs as per optical link budget)	06 Nos.	
1.3	Tributary Cards		
1.3(a)	E1 Interfaces	16 E1	
1.3(b)	Ethernet Interface 10/100 Mbps with L2 Switching	08 Interfaces	
1.3(c)	Digital Distribution Frame	01 No	

2	PDH Terminal Equipment	
2.1	Base Equipment (Common cards, control cards, optical base cards, power supply cards, power cabling, other necessary hardware accessories including sub-rack)	
2.2	Subscriber Line Interface Cards	
2.2(a)	2 wire (sub/sub) voice channel card	8 voice channels
2.2(b)	4 wire (E&M) voice channel card	8 voice channels
2.2 (c)	Asynchronous sub channel data card (V.24/V.28)	4 data channels
2.3	Main Distribution Frame (MDF) for 100 pairs	1 No.
2.4	C37.94 Optical Couplers for Differential Relays & Tele-protection*	Qty as per requirement

*To be decided during detailed engineering in consultation with Protection Division

3	Equipment Cabinet	
3.1	For SDH and PDH equipment (Additional cabinet to be supplied, if more equipment space is required for supplied equipment.)	1 Nos.
4	Craft Terminal	
4.1	Laptop PC with latest MS Windows OS and application software for management of SDH & PDH	1 No.
5	Patch Cables & accessories (All patch cords, screws and accessories etc for successful installation & commissioning)	1 set

1.8. Tests

The tests shall conform to all Type, routine and acceptance tests as per applicable relevant standards like IS, IEC, ITU standards etc. issued from time to time.

1.9. GUARANTEE TECHNICAL PARTICULARS FOR FOTE

Name of Manufacturer:		(To be filled up by Order)
Model:		
Type:		
GENERAL:		
Type of multiplexer	SDH: ADM	
Complying to ITU-T	Yes/NO	
Transmission Capacity:		
STM-4:622Mbit/s	Yes/NO	
STM-1:155Mbit/s	Yes/NO	
Access capacity on 2Mbit/s	Min. channels Max. channels	
Access capacity on 64kbit/s	Min. channels Max. channels	
Redundant Central Processor Available	YES/NO	
Digital Cross Connect Function (Fully on- blocking)	YES/NO	
PDH cross connect capacity	Min. N x 2Mbit/s Max. N x 2Mbit/s	N=
SDH cross connect capacity, high order	Minimum x VC4	
Tele-protection interface:		
Integrated distance tele-protection interface	YES/NO	
Integrated optical tele-protection interface	YES/NO	
Addressing of protection commands	YES/NO	
Loop test for measuring delay time	YES/NO	
1+1 switch-over less than 10ms	YES/NO	
Time for switch-over		
USER interfaces		
Voice interfaces for trunk lines:		
Integrated tele-protection		
Interface for Commands:		
Number of independent commands		
Transmission time max.	6 ms	
Signal voltage	Max VDC	

1+ 1 com path protection	YES/NO	
Data: interfaces per module		
V.24/V.28(RS-232)	Number 'N'	N=
V.11/X.24(RS-432)	Number 'N'	N=
V.35	Number 'N'	N=
Integrated LAN port available on DATA Interface	YES/NO	
Software programmable board available	YES/NO	
Functions available for individual configuration: - 1+1 path protection - point-multipoint - performance monitoring - sub rate multiplexing available for all data interface	YES/NO YES/NO YES/NO YES/NO	
Ethernet interface		
Ethernet A & Ethernet B (Two Independent Ethernet path for Redundancy) 10/100BaseT ports 1000Base LX/ SX ports L2 switching function WAN capacity Mbit/s Logical WAN ports Routing Protocol	8 x RJ45 electrical 2 x optical YES/NO NXVC12 or NXVC3 Min N'=' IP Routing	N= N'='
Integrated Ethernet Hub 10/100BaseT ports	Min. 6x RJ45	
Integrated alarm gathering module:		
Number of external alarms per module	Min. 8 Nos.	
Auxiliary power supply for ext. contacts		
Ambient Conditions:		
Operating Temperature	°C	
Storage Temperature	°C	
Relative Humidity	% hum	
Power Supply		
Nominal Supply voltage	AC volts	
	DC volts	
Operation	DC (-48) volts	
Fully redundant power supply	YES/NO	
Dual power feeding	YES/NO	

List of Abbreviations

AAL	ATMAdaptationLayer	VCAT	Virtual Concatenation
ADM	Add-drop multiplexed	VF	VoiceFrequency
ATM	AsynchronousTransferMode		
ALS	AutomaticLaserShutdown		
BIP	Bitter leaved Parity		
CAS	Channel Associated Signalling		
CAP	Carrier-less Amplitude and Phase		
CRC	Cyclic Redundancy Check		
DACS	Digital Access Cross-Connect		
DCN	Data Communication Network		
DTMF	Dual Tone Multi-Frequency		
EN	European Norm		
EOW	Engineering Order Wire		
ETS	European Telecommunications Standards		
FOTE	Fiber Optic Terminal Equipment		
GPS	Global Positioning System		
GPF	General framing Procedure		
HDLC	High Level data Link Control		
HDSL	High Density Subscriber Line		
IEC	International Electrical Commission		
ITU	International Telecommunication Union		
IP	Internet Protocol		
ISDN	Integrated Services Digital Network		
MCMI	Multi Coded Mark Inversion		
MDF	Main Distribution Frames		
MS	Multiplex Section		
NE	Network Element		
NMS	Network Management System		
LAN	Local Area Network		
LCAS	Link capacity Adjustment Scheme		
OS	Optical Section		
OSI	Open System Interconnection		
OSPF	Open Shortest Path First		
PDH	Plesiochronous Digital Hierarchy		
PPP	Point-to-Point Protocol		
RS	Regenerator Section		
SDH	Synchronous Digital Hierarchy		
SNMP	Simple Network Management Protocol		
SOH	Section Overhead		
SSM	Synchronization Status Messaging		
STM	Synchronous Transport Module		
TCP	Transmission Control Protocol		
TDM	Time Division Multiplexed		
TMN	Telecommunications Management Network.		
TTI	Trail Trace Identifier		
VC	Virtual Container		
VCAT	Virtual Concatenation		
VF	Voice Frequency		

SECTION-XVIII

LIGHTNING ARRESTOR

SECTION: XVIII

Technical Specification of Lightning Arrestor for 400kV, 220kV, 66kV & 33kV systems

1.0 GENERAL

- 1.1 The Surge Arrestor shall consist of Zinc Oxide Elements and should be designed in accordance with the relevant IS/IEC. The Surge Arrestor shall be provided with hermetically sealed discharge counter to indicate the number of discharges through the surge diverter. A leakage current detector as an integral part of the discharge counter shall be supplied.

2.0 STANDARDS

- 2.1 The design, manufacture and performance of metal oxide arrestor shall comply with latest edition of the following IS/IEC specification:-

IS-3070	Lightning Arrestors for alternating current system
IS-4004	Application Guide for Surge Arresters for alternating current systems
IEC- 99-4 and IEC 99-5	IEC on metal oxide Arrestors without gaps for A.C. systems
IS-5621	IS for hollow insulators
IEC-60815-1	High voltage insulators intended for use in polluted conditions

- 2.2 Equipment complying with any other authorized standard can also be offered if it ensures performance equivalent to and better than Indian standards specifications detailed above.

3.0 CONSTRUCTIONAL FEATURES

- 3.1 The Surge Arrestor furnished shall be single phase unit suitable for outdoor installation.
- 3.2 The non-linear blocks shall be of metal oxide and these shall be provided in such a manner as to obtain robust construction with excellent mechanical and electrical properties which should not get affected even after repeated operations.
- 3.3 The arrestor shall be fitted with a pressure relief device suitable to prevent shattering of the porcelain/polymer housing and providing a path for venting out the excess pressure. In the event of the explosion and the shattering of the porcelain/polymer housing, the particles/pieces of the porcelain/polymer housing after the explosion shall fall within the radius stipulated in the relevant IEC specifications.

3.4 The sealing of the arrestor shall be done in such a manner that all seals are effectively maintained even while discharging max lightning current.

3.5 The porcelain/polymer housing of the arrestor shall be coordinated with the arrestor protective characteristics so that external flash-over will not occur due to application of impulse or switching surge voltage before the maximum design value of the arrestor. The porcelain/polymer bushing shall conform to IS 2099 and IS 5621 and the total creepage distance of the bushing shall not be less than 31mm per KV. The fittings shall be made of hot dip galvanized mild steel castings.

4.0 ACCESSORIES

4.1 The arrestor shall be complete with insulating base and have necessary provision for belting to the flat surface of the structure.

4.2 The Arrestor should be provided with discharge counter suitably enclosed for outdoor and the counter should not require any battery or other supply for its operation. The cyclometri counter shall be visible through an inspection window. The counter terminal shall be robust and of adequate size and so located that incoming and outgoing connections are made with minimum possible bends. A milli amp meter as a leakage current detector should form an integral part of the arrestor and shall be in built. The value of the leakage current beyond which the operation of the arrestor is not desired shall be clearly marked in red color on the scale of the milli amp. meter.

5.0 TERMINAL CONNECTOR

The surge arrestor shall be supplied complete with universal type terminal connectors suitable for connecting with ACSR zebra / goat/ Bersimisor HTLS conductor as per site/ scoperequirement and shall form an integral part of the supply.

6.0 MOUNTING ARRANGEMENT

The drawing for recommended mounting arrangement of the Lightning Arrestor along with detailed drawing of the structure thereof shall be enclosed with the tender offer.

7.0 SYSTEM PARAMETERS

7.1 The Surge Arrestor are to be installed on 400kV, 220 kV, 66 kV & 33KV substations/ switchyard.

7.2 The brief particulars of 400kV, 220 kV, 66 kV & 33KV system parameters are given as under:-

S.NO	Technical Parameters	33 kV	66 kV	220 kV	400kV
i)	Rated System Voltage	36 KV	72.5 KV	245 KV	420kV
ii)	System frequency	50 Hz			
iii)	System Earthing	Effectively grounded			
iv)	System fault level and its duration	31.5 KA for 1 sec	31.5 KA for 1 sec	50 KA for 1 sec	63kA for 1sec.
v)	Basic Insulation level of equipment a) Impulse withstand voltage for 1.25/50 micro sec b) One Minute power frequency withstand voltage	170 KVp 70 KVrms	325 KVp 140 KVrms	1050 KVp 460 KVrms	1425KVp 630kV rms
vi)	Rated arrester voltage	30KV	60KV	216KV	360kV
vii)	Max. continuous operating voltage	25KVrms	50KVrms	168 KVrms	267 kVrms
viii)	Current through arresters at operating voltage	Note more than 1 mA	Note more than 1 mA	Note more than 1 mA	Note more than 1 mA
ix)	Nominal discharge current at 8/20 Micro Seconds wave	10KAp	10KAp	10KAp	20KAp
xi	Step current impulse residual voltage	110KVp	220KVp	650KVp	925KVp
xii	Residual voltage at: a) 05KA discharge current b) 10KA discharge current c) 20KA discharge current	85KVp 90 KVp ---	170KVp 200 KVp ---	560KVp 600 KVp ---	--- 800kVp 850KVp
xiii	Long duration discharge class	SM	SM	SM	SH
xiv	High current short duration test value (4/10 micro sec. Wave)	100KA	100KA	100KA	100KA
xv	Pressure Relieve device	Class A	Class A	Class A	Class A

7.3 The surge arrester shall be heavy duty type, station class and gapless type.

- 7.4 The Surge Arrestor shall be capable of discharging over voltages occurring in the system during lighting, switching of unloaded transformers and reactors.
- 7.5 The arrester shall be capable of discharging voltage equivalent to the long duration discharge class as defined in IEC specifications.
- 7.6 The Surge Arrestor shall have an inbuilt capability to withstand against dynamic over-voltages. The manufacturer with furnish the data for duration and per unit over voltage factors which the offered arrester can withstand after initial specified discharge.
- 7.7 The leakage current of the Surge Arrestor shall be adequate to eliminate the influence of grading and static capacitance on measured reference voltage.
- 7.8 The Surge Arrestor should be suitable for protecting the station equipment of the basic insulation levels specified above.
- 7.9 The Lightning Arrestors shall be capable of discharging lightning and switching surges and temporary power frequency over voltages. The surge arrester shall be capable of discharging over voltages occurring during switching of unloaded transformers, reactors and long lines.
- 7.10 The surge arrestors shall be capable of withstanding Maximum Continuous Operating Voltage (MCOV).
- 7.11 The duty cycle of circuit breakers installed in the 420/245/72.5/36kV system shall be O-0.3sec-CO-3 min.-CO. The surge arrester shall be suitable for such circuit breakers in the system.

8.0 TESTS

8.1 Type Tests:

The bidder shall submit all the applicable type test reports of the lightning arrester in line with latest edition of IEC-60099-4 and validity of the type test reports shall be as per latest CEA guidelines. The type test reports shall be submitted along with the bid.

If any applicable type test has not been conducted by the bidder, then the same shall be conducted by the bidder free of cost and without affecting the completion period of the project/tender.

8.2 The lightning arrester shall undergo all required routine and acceptance tests as per latest edition of IEC-60099-4.

GUARANTED TECHNICAL PARTICULARS LIGHTENING ARRESTOR

1. Name of the Manufacturer :
2. Type
3. Model
4. No. of he Units
5. Rated Voltage of Arrestor : KV (rms)
6. Nominal Discharge Current : Amps.
7. Minimum Power frequency
discharge voltage : KV (rms)
8. Dry & wet power frequency withstand
voltage of arrester insulation : KV (rms)
9. Max. continuous operating voltage : KV (rms)
10. Protective level of the arrester :
11. Ratio of system voltage with stand level
to protection level of surge arrestor :
12. Max. residual voltage for discharge current
of (8/20 micro second wave) :KV (Peak)
 - (i) 5000 Amps.
 - (ii) 10000 Amps.
 - (iii) 20000 mps
13. High current impulse with stand
4/10 micro second peak value :KV
14. Leakage current through Arrestor at COV:
 - (i) Capacitive
 - (ii) Resistive
 - (iii) Total
15. Long Duration current test
 - (i) Current peak :
 - (ii) Virtual duration :
16. Creep age distance (suitable
for heavily polluted atmosphere) :
17. Pressure relief class :
18. Long duration discharge class :
19. Type & specification of the surge counters :
20. Type & range of mili ampere meter :
21. Mounting flanges dimensional details :
22. Earthing arrangement provided
for earthing side of arrestor :
23. Clearance required from grounded
equipment at various heights of arresters unit: mm
24. Min. recommended spacing between
arresters center to center :
25. Height of complete unit from
base to the line side : mm
26. Weight of complete unit :

SECTION-XIX

OPTICAL GROUND WIRE (OPGW)

Technical Specification of OPGW Cable and associated hardware fittings and accessories

Fibre Optic Cabling

This section defines the requirements for G.652D Dual-window Single mode (DWSM) telecommunications grade fibre optic cable. Bidders shall furnish with their bids, detailed description of the fibre & cable(s) proposed.

Required Optical Fibre Characteristics

Physical Characteristics

Dual-Window Single mode (DWSM), G.652D optical fibre shall be provided in the fibre optic cables. DWSM optical fibre shall meet the requirements defined in Table 2-1(a).

Attenuation

The attenuation coefficient for wavelengths between 1525 nm and 1575 nm shall not exceed the attenuation coefficient at 1550 nm by more than 0.05 dB/km. The attenuation coefficient between 1285nm and 1330 nm shall not exceed the attenuation coefficient at 1310 nm by more than 0.05 dB/km. The attenuation of the fibre shall be distributed uniformly throughout its length such that there are no point discontinuities in excess of 0.10 dB. The fibre attenuation characteristics specified in table 2-1(a) shall be “guaranteed” fibre attenuation of any & every fibre reel.

The overall optical fibre path attenuation shall not be more than calculated below:

Maximum attenuation @ 1550nm: $0.21 \text{ dB/km} \times \text{total km} + 0.05 \text{ dB/splice} \times \text{no. of splices} + 0.5 \text{ dB/connector} \times \text{no. of connectors}$.

Maximum attenuation @ 1310nm: $0.35 \text{ dB/km} \times \text{total km} + 0.05 \text{ dB/splice} \times \text{no. of splices} + 0.5 \text{ dB/connector} \times \text{no. of connectors}$.

Table 2-1(a)
DWSM Optical Fibre Characteristics

Fibre Description:	Dual-Window Single-Mode
Mode Field Diameter:	8.6 to 9.5 micro meter (± 0.6 micro meter)
Cladding Diameter:	125.0 micro meter ± 1 micro meter
Mode field concentricity error	≤ 0.6 micro meter
Cladding non-circularity	$\leq 1\%$
Cable Cut-off Wavelength	$\leq 1260 \text{ nm}$

1550 nm loss performance	As per ITU-T G.652 D
Proof Test Level	≥ 0.69 Gpa
Attenuation Coefficient:	@ 1310 nm ≤ 0.35 dB/km @ 1550 nm ≤ 0.21 dB/km
Chromatic Dispersion; Maximum: Zero Dispersion Slope:	18 ps/(nm x km) @ 1550 nm 3.5 ps/(nm x km) 1288-1339 nm 5.3 ps/(nm x km) 1271-1360 nm Zero dispersion wavelength: 1300 to 1324 nm 0.092 ps/(nm ² xkm) maximum
Polarization mode dispersion coefficient	≤ 0.2 ps/km ^{1/2}
Temperature Dependence:	Induced attenuation ≤ 0.05 dB (-60deg. C - +85 deg.C)
Bend Performance:	@ 1310 nm (75 \pm 2 mm dia Mandrel), 100 turns; Attenuation Rise ≤ 0.05 dB @ 1550 nm (30 \pm 1 mm radius Mandrel), 100 turns; Attenuation Rise ≤ 0.05 dB @ 1550 nm (32 \pm 0.5 mm dia Mandrel, 1 turn; Attenuation Rise ≤ 0.50 dB

Fibre Optic Cable Construction

Overhead Fibre Optic Cables shall be OPGW (Optical Ground Wire). The OPGW cable is proposed to be installed on the 400kV/220kV EHV transmission lines in the DTL network. The design of cable shall account for the varying operating and environmental conditions that the cable shall experience while in service. The OPGW cable to be supplied shall be designed to meet the overall requirements of all the transmission lines. The tower span of the lines shall be as per the scope of the scheme/ project. The exact details shall be collected by the Contractor during survey. The Contractor shall supply & install the optical fibre cable as required based on detailed site survey to be carried out by the Contractor during the project execution. The Contractor shall verify the transmission line route length during the survey.

Optical Fibre Identification

Individual optical fibre within a fibre unit and fibre units shall be identifiable in accordance with EIA/TIA 598 or IEC 60304 or Bell core GR-20 color-coding scheme. Coloring utilized for color coding optical fibre shall be integrated into the fibre coating and shall be homogenous. The color shall not bleed from one fibre to another and shall not fade during fibre preparation for termination or splicing.

Each cable shall have traceability of each fibre back to the original fibre manufacturer's fibre number and parameters of the fibre. If more than the specified number of fibre is included in any cable, the spare fibre shall be tested by the cable manufacturer and any defective fibre shall be suitably bundled, tagged and identified at the factory by the vendor.

Buffer Tube

Loose tube construction shall be implemented. The individually coated optical fibre(s) shall be surrounded by a buffer for protection from physical damage during fabrication, installation and operation of the cable. The fibre coating and buffer shall be strippable for splicing and termination. Each fibre unit shall be individually identifiable utilizing color coding. Buffer tubes shall be filled with a water-blocking gel.

Optical Fibre Strain & Sag-Tension chart

The fibre optic cable shall be designed and installed such that the optical fibre experience no strain under all loading conditions defined in IS 802. Zero fibre strain condition shall apply even after a 25 year cable creep.

For the purpose of this specification, the following definitions shall apply:

- Maximum Working Tension (MWT) is defined as the maximum cable tension at which there is no fibre strain.
- The no fibre strain condition is defined as fibre strain of less than or equal to 0.05%, as determined by direct measurements through IEC/ ETSI (FOTP) specified optical reflectometry techniques.
- The Cable strain margin is defined as the maximum cable strain at which there is no fibre strain.
- The cable Maximum Allowable Tension (MAT) is defined as the maximum tension experienced by the Cable under the worst case loading condition.
- The cable max strain is defined as the maximum strain experienced by the Cable under the worst case loading condition.
- The cable Every Day Tension (EDT) is defined as the maximum cable tension on any span under normal conditions.
- The Ultimate / Rated Tensile Strength (UTS / RTS / breaking strength) is defined as the maximum tensile load applied and held constant for one minute at which the specimen shall not break.

While preparing the Sag-tension charts for the OPGW cable the following conditions shall be met:

- The Max Allowable Tension (MAT) / max strain shall be less than or equal to the MWT/Strain margin of the cable.
- The sag shall not exceed the earth wire sag in all conditions.
- The Max Allowable Tension shall also be less than or equal to 25% of the UTS.
- The 25 year creep at 25% of UTS (creep test as per IEEE 1138) shall be such that the 25 year creep plus the cable strain at Max Allowable Tension (MAT) is less than or equal to the cable strain margin.
- The everyday tension (EDT) shall not exceed 20% of the UTS for the OPGW cable.

The Sag-tension chart of OPGW cable indicating the maximum tension, cable strain and sag shall be calculated and submitted along with the bid under various conditions mentioned below:

1. 53° C , no wind and no ice
2. 32° C, no wind and no ice
3. 0°C, no wind and no ice
4. 32° C, full wind and no ice
5. 32° C, 75% full wind and no ice
6. 0° C, 2/3rd / 66% of full wind (IS 802:1977/1995)

The above cases shall be considered for the spans from 100 m to 1100 m span length in the range of 50 m spans. Maximum vertical sag, maximum tension and maximum sag at 0° C & no wind shall be considered in line with the design parameter of transmission line. The full wind load shall be considered as the design wind load for all the specified transmission lines as per relevant IS 802 version and the sag-tension chart shall be submitted considering the transmission lines. In case of any span higher than 600 m, suitable OPGW cable meeting sag-tension requirement of transmission line shall also be provided by the Contractor. The Contractor shall submit the stringing chart for review by DTL. The stringing chart shall be submitted by Tower Contractor(s) for new lines if identified during the engineering / execution stage.

Cable Materials

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

Filling Materials

The interstices of the fibre optic unit and cable shall be filled with a suitable compound to prohibit any moisture ingress or any water longitudinal migration within the fibre optic unit or along the fibre optic cable. The water tightness of the cable shall meet or exceed the test performance criteria as per IEC 60794-1-F-5. The filling compound used shall be a non-toxic homogenous waterproofing compound that is free of dirt and foreign matter, non-hygroscopic, electrically non-conductive and non-nutritive to fungus. The compound shall also be fully compatible with all cable components it may come in contact with and shall inhibit the generation of hydrogen within the cable. The water proofing filling materials shall not affect fibre coating, color coding, or encapsulant commonly used in splice enclosures, shall be dermatologically safe, non-staining and easily removable with a non-toxic cleaning solvent.

Metallic Members

When the fibre optic cable design incorporates metallic elements in its construction, all metallic elements shall be electrically continuous.

Marking, Packaging and Shipping

- (a) **Drum Markings:** Each side of every reel of cable shall be permanently marked in white lettering with the vendors' address, the Purchaser's destination address, cable part number and specification as to the type of cable, length, number of fibre, a unique drum number including the name of the transmission line & segment no., factory inspection stamp and date.
- (b) **Cable Drums:** All optical fibre cabling shall be supplied on strong drums provided with lagging of adequate strength, constructed to protect the cabling against all damage and displacement during transit, storage and subsequent handling during installation. Both ends of the cable shall be sealed as to prevent the escape of filling compounds and dust & moisture ingress during shipment and handling. Spare cable caps shall be provided with each drum as required.

The spare cable shall be supplied on sturdy, corrosion resistant, steel drums suitable for long periods of storage and re-transport & handling. There shall be no factory splices allowed within a continuous length of cable. Only one continuous cable length shall be provided on each drum. The lengths of cable to be supplied on each drum shall be determined by a "schedule" prepared by the Contractor.

OPGW cable installation requirements

Most of the OPGW fibre optic cables to be installed under this project shall be installed under off line conditions, However, some of OPGW cables may be installed in live line conditions i.e. with all the circuits of the transmission line charged to their rated voltage. The tentative bill of quantities for off line/live-line OPGW cable system installations have been specified in the BOQ and the actual quantities for both types shall be finalized during project execution after detailed survey.

For existing transmission lines the OPGW cable shall be installed at the top of the tower by replacing the existing ground wire. The Contractor shall carry out re-tensioning of the existing earth wire wherever required to maintain the adequate clearances for live line stringing of fibre optic cables.

For some of the new Transmission line if identified during the engineering / execution stage, the stringing of OPGW cable shall be carried out by Transmission Line Tower Package Contractor(s) as per the stringing chart/procedure submitted by them and approved by DTL.

While handing over the OPGW drums, the testing (fibre loss and length measurement using OTDR) of OPGW in each drum shall be carried out by Fibre Optic Cabling Package Contractor in presence of Tower package contractor(s) and DTL representative, as applicable. After installation of OPGW cable, the testing of each section shall be carried out again by the Fibre Optic Cabling Package Contractor in presence of Tower package contractor(s) and DTL representative. In case of any damage/high loss in the fibre, the total length of that particular section of OPGW cable shall be replaced by OPGW package Contractor(s). Fibre Optic Cabling Package Contractor shall supply new OPGW cable in place of damaged cable.

Supervision of Installation - The Contractor shall supervise the stringing at site as per the approved stringing procedure. Site visit for supervision shall be carried out as required. The Supervision/Inspection work in Contractor's scope shall mainly include inspection as per stringing procedure, proper location of drum site, installation of stringing blocks/pulleys, proper sagging, proper installation of hardware, proper tension as per Sag-Tension chart, provision of service loops of OPGW in jointing locations etc.

Optical Ground Wire (OPGW)

OPGW cable construction shall comply with IEEE-1138, 2009. The cable provided shall meet both the construction and performance requirements such that the ground wire function, the optical fibre integrity and optical transmission characteristics are suitable for the intended purpose. The cable shall consist of optical fibre units as defined in this specification. There shall be no factory splices within the cable structure of a continuous cable length. The composite fibre optic overhead ground wire shall be made up of multiple buffer tubes embedded in a water tight aluminium/aluminium alloy/stainless steel with aluminium coating protective central fibre optic unit surrounded by concentric-lay stranded metallic wires in single or multiple layers.

Each buffer tube shall have maximum 12 no. of fibre. All fibre in single buffer tube or directly in central fibre optic unit is not acceptable. The dual purpose of the composite cable is to provide the electrical and physical characteristics of conventional overhead ground wire while providing the optical transmission properties of optical fibre.

Central Fibre Optic Unit

The central fibre optic unit shall be designed to house and protect multiple buffered optical fibre units from damage due to forces such as crushing, bending, twisting, tensile stress and moisture. The central fibre optic unit and the outer stranded metallic conductors shall serve together as an integral unit to protect the optical fibre from degradation due to vibration and galloping, wind and ice loadings, wide temperature variations, lightning and fault current, as well as environmental effects which may produce hydrogen.

The OPGW design of dissimilar materials such as stainless steel tube with aluminium or aluminium-clad-steel wire strands are not allowed. Central fibre optic unit may be of aluminium or stainless steel tube with aluminium protective coating. In case of aluminium protective coating, the coating must completely cover the tubes leaving no exposed areas of tubing that can make electrical contact either directly or indirectly through moisture, contamination, protrusions, etc with the surrounding stranded wires. The tube may be fabricated as a seamless tube, seam welded, or a tube without a welded seam.

Basic Construction

The cable construction shall conform to the applicable requirements of this specification, applicable clauses of IEC 61089 related to stranded conductors and Table 2.2(a) OPGW Mechanical and Electrical Characteristics. In addition, the basic construction shall include bare concentric-lay-stranded metallic wires with the outer layer having left hand lay. The wires may be of multiple layers with a combination of various metallic wires within each layer. The direction of lay for each successive layer shall be reversed. The finished wires shall contain no joints or splices unless otherwise agreed to by DTL and shall conform to all applicable clauses of IEC 61089 as they pertain to stranded conductors. The wires shall be so stranded that when the complete OPGW is cut, the individual wires can be readily regrouped and then held in place by one hand.

Breaking Strength

The rated breaking strength of the completed OPGW shall be taken as not more than 90 percent of the sum of the rated breaking strengths of the individual wires, calculated from their nominal diameter and the specified minimum tensile strength. The rated breaking strength shall not include the strength of the optical unit. The fibre optic unit shall not be considered a load bearing tension member when determining the total rated breaking strength of the composite conductor.

Electrical and Mechanical Requirements

Table 2-2(a) provides OPGW Electrical and Mechanical Requirements for the minimum performance characteristics. Additionally, the OPGW mechanical & electrical characteristics shall be similar to that of the earthwire being replaced (If applicable as per scheme) such that there is no or minimal consequential increase in stresses on towers. For the purposes of determining the appropriate Maximum Working Tension limit for the OPGW cable, latest edition of IS 802:1995 and IS 875: 1987 shall be applied. However the OPGW installation sag & tension charts shall be based on IS 802 version to which the line is originally designed. For the OPGW cable design selection and preparation of sag tension charts, the limits specified in this section shall also be satisfied. The Bidder shall submit sag-tension charts for the above cases with the bids.

Table 2.2(a)
OPGW Electrical and Mechanical
Requirements

(1)	Everyday Tension	$\leq 20\%$ of UTS of OPGW
(2)	D.C. Resistance at 20°C:	< 1.0 ohm/Km
(3)	Short Circuit Current	≥ 6.32 kA for 1.0 second

Operating conditions

Since OPGW shall be located at the top of the transmission line support structure, it will be subjected to Aeolian vibration, Galloping and Lightning strikes. It will also carry ground fault currents. Therefore, its electrical and mechanical properties shall be same or similar as those required of conventional ground conductors.

Installation

When OPGW installed under live line condition, i.e. with all circuits charged to the rated line voltage as specified in this section shall be generally in accordance with the IEEE Guide to the Installation of Overhead Transmission Line Conductors (IEEE STD. 524 with latest revisions), with additional instructions and precautions for live line working and fibre optic cable handling. Some of the cable may be installed in off-line condition also. The stringing procedure shall be submitted by the Contractor prior to stringing for Employer's approval.

A tower structural analysis shall be carried out by the Contractor wherever required, based on the relevant data to be provided by Employer, to ensure that with the replacement of existing earth wire with the OPGW cable, the tower members remain within the statutory safety limits as per Indian Electricity rules and CEA guidelines/regulations and if required the Contractor shall carry out the tower strengthening as necessary at no additional cost to DTL. The OPGW cable sections shall normally be terminated & spliced only on tension towers. In exceptional circumstances, and on DTL specific approval, cable may be terminated on Suspension towers, but in this case tower strength shall be examined to ensure that tower loads are within safe limits and if required, necessary tower strengthening shall be carried out by the Contractor at no additional cost to DTL.

Installation Hardware

The scope of supply of the optical cable includes the assessment, supply and installation of all required fittings and hardware such as Tension assembly, Suspension assembly, Vibration dampers, Reinforcing rods, Earthing clamps, Down lead clamps, splice enclosure etc. The Bidder shall provide documentation justifying the adequacy and suitability of the hardware supplied. The quantity of hardware & fittings to meet any eventuality during site installation minimum @ 1% shall also be provided as part of set/km for each transmission line without any additional cost to DTL. The unused quantity of hardware & fittings out of this (1%) quantity shall be returned to DTL. The Contractor shall determine the exact requirements of all accessories required to install and secure the OPGW.

The OPGW hardware fittings and accessories shall follow the general requirements regarding design, materials, dimensions & tolerances, protection against corrosion and markings as specified in clause 4.0 of EN 61284: 1997 (IEC 61284). The shear

strength of all bolts shall be at least 1.5 times the maximum installation torque. The OPGW hardware & accessories drawing & Data Requirement Sheets (DRS) document shall consist of three parts: (1) A technical particulars sheet (2) An assembly drawing i.e. level 1 drawing and (3) Component level drawings i.e. level 2 & lower drawings. All component reference numbers, dimensions and tolerances, bolt tightening torques & shear strength and ratings such as UTS, slip strength etc shall be marked on the drawings. The fittings and accessories described herein are indicative of installation hardware typically used for OPGW installations and shall not necessarily be limited to the following:

- (a) Suspension Assemblies: Preformed armour grip suspension clamps and aluminium alloy armour rods/ reinforcing rods shall be used. The suspension clamps shall be designed to carry a vertical load of not less than 25 kN. The suspension clamps slippage shall occur between 12kN and 17 kN as measured in accordance with type test procedures of relevant IS/IEC. The Contractor shall supply all the components of the suspension assembly including shackles, bolts, nuts, washers, split pins, etc. The total drop of the suspension assembly shall not exceed 150 mm (measured from the centre point of attachment to the centre point of the OPGW). The design of the assembly shall be such that the direction of run of the OPGW shall be the same as that of the conductor.
- (b) Dead End Clamp Assemblies: All dead end clamp assemblies shall preferably be of performed armoured grip type and shall include all necessary hardware for attaching the assembly to the tower strain plates. Dead end clamps shall allow the OPGW to pass through continuously without cable cutting. The slip strength shall be rated not less than 95% of the rated tensile strength of the OPGW.
- (c) Clamp Assembly Earthing Wire: Earthing wire consisting of a 1500 mm length of aluminium or aluminium alloy conductor equivalent in size to the OPGW shall be used to earth suspension and dead end clamp assemblies to the tower structure. The earthing wire shall be permanently fitted with lugs at each end. The lugs shall be attached to the clamp assembly at one end and the tower structure at the other.
- (d) Structure Attachment Clamp Assemblies: Clamp assemblies used to attach the OPGW to the structures, shall have two parallel grooves for the OPGW, one on either side of the connecting bolt. The clamps shall be such that clamping characteristics do not alter adversely when only one OPGW is installed. The tower attachment plates shall locate the OPGW on the inside of the tower and shall be attached directly to the tower legs/cross-members without drilling or any other structural modifications.
- (e) Vibration Dampers: Vibration dampers type 4R Stockbridge or equivalent, having four (4) different frequencies spread within the Aeolian frequency bandwidth corresponding to wind speed of 1m/s to 7 m/s, shall be used for suspension and tension points in each span. The Contractor shall determine

the exact numbers and placement(s) of vibration dampers through a detailed vibration analysis as specified in technical specifications.

One damper minimum on each side per OPGW cable for suspension points and two dampers minimum on each side per OPGW cable for tension points shall be used for nominal design span of 400 meters. For all other ruling spans, the number of vibration damper shall be based on vibration analysis.

The clamp of the vibration damper shall be made of high strength aluminum alloy of type LM-6. It shall be capable of supporting the damper and prevent damage or chaffing of the conductor during erection or continued operation. The clamp shall have smooth and permanent grip to keep the damper in position on the OPGW cable without damaging the strands or causing premature fatigue failure of the OPGW cable under the clamp. The clamp groove shall be in uniform contact with the OPGW cable over the entire clamping surface except for the rounded edges. The groove of the clamp body and clamp cap shall be smooth, free from projections, grit or other materials which could cause damage to the OPGW cable when the clamp is installed. Clamping bolts shall be provided with self locking nuts and designed to prevent corrosion of threads or loosening in service. The messenger cable shall be made of high strength galvanized steel/stainless steel. It shall be of preformed and post formed quality in order to prevent subsequent droop of weight and to maintain consistent flexural stiffness of the cable in service. The messenger cable other than stainless steel shall be hot dip galvanized in accordance with the recommendations of IS:4826 for heavily coated wires. The damper mass shall be made of hot dip galvanized mild steel/cast iron or a permanent mould cast zinc alloy. All castings shall be free from defects such as cracks, shrinkage, inclusions and blow holes etc. The surface of the damper masses shall be smooth.

The damper clamp shall be casted over the messenger cable and offer sufficient and permanent grip on it. The messenger cable shall not slip out of the grip at a load less than the mass pull-off value of the damper. The damper masses made of material other than zinc alloy shall be fixed to the messenger cable in a suitable manner in order to avoid excessive stress concentration on the messenger cables which shall cause premature fatigue failure of the same. The messenger cable ends shall be suitably and effectively sealed to prevent corrosion. The damper mass made of zinc alloy shall be casted over the messenger cable and have sufficient and permanent grip on the messenger cable under all service conditions. The contractor must indicate the clamp bolt tightening torque to ensure that the slip strength of the clamp is maintained between 2.5 kN and 5 kN. The clamp when installed on the OPGW cable shall not cause excessive stress concentration on the OPGW cable leading to permanent deformation of the OPGW strands and premature fatigue failure in operation.

The vibration analysis of the system, with and without damper and dynamic characteristics of the damper as detailed in Technical Specification, shall have to be submitted. The technical particulars for vibration analysis and damping design of the system are as follows:

SI No.	Description	Technical Particulars
1	Span Length in meters (i) Ruling design span: (ii) Maximum span: (iii) Minimum Span:	400 meters 1100 meters 100 meters
2	Configuration:	As per Specifications
3	Tensile load in each:	As per sag tension calculations
4	Armour rods used:	Standard preformed armour rods/AGS
5	Maximum permissible dynamic strain:	+/- 150 micro strains

The damper placement chart for spans ranging from 100m to 1100m shall be submitted by the Bidder. Placement charts should be duly supported with relevant technical documents and sample calculations. The damper placement charts shall include the following:

- (1) Location of the dampers for various combinations of spans and line tensions clearly indicating the number of dampers to be installed per OPGW cable per span.
- (2) Placement distances clearly identifying the extremities between which the distances are to be measured.
- (3) Placement recommendation depending upon type of suspension clamps (viz Free center type/Armour grip type etc.)
- (4) The influence of mid span compression joints, repair sleeves and armour rods (standard and AGS) in the placement of dampers.

Fibre Optic Splice Enclosures (Joint Box)

All splices shall be encased in Fibre Optic Splice Enclosures. Suitable splice enclosures shall be provided to encase the optical cable splices in protective, moisture and dust free environment. Splice enclosures shall comply with ingress protection class IP 66 or better. The splice enclosures shall be designed for the storage and protection of required number of optical fibre splices and equipped with sufficient number of splice trays for splicing all fibre in the cable. No more than 12 fibre shall be terminated in a single splice tray. They shall be filled with suitable encapsulate that is easily removable should re-entry be required into the enclosures. Splice enclosures shall be suitable for outdoor use with each of the cable types provided under this contract. Splice enclosures shall be appropriate for mounting on transmission line towers above anti-climb guard levels at about 10 meter from top of the tower and shall accommodate pass-through splicing. The actual mounting

height and location shall be finalized after Survey. Contractor shall be responsible for splicing of fibre and installation of splice enclosures.

Optical Fibre Splices

Splicing of the optical fibre cabling shall be minimized through careful Contractor planning. There shall be no mid-span splices allowed. All required splices shall be planned to occur on tower structures. All optical fibre splicing shall comply with the following:

- (a) All fibre splices shall be accomplished through fusion splicing.
- (b) Each fibre splice shall be fitted with a splice protection sheath fitted over the final splice.
- (c) All splices and bare fibre shall be neatly installed in covered splice trays.
- (d) For each link, bi-directional attenuation of single mode fusion splices, shall not average more than 0.05 dB and no single splice loss shall exceed 0.1 dB when measured at 1550 nm.
- (e) For splicing, fibre optic cable service loops of adequate length shall be provided so that all splices occurring at tower structures can be performed at ground level.

Fibre Optic Approach Cables

For purposes of this specification, a fibre optic approach cable is defined as the Armoured underground fibre optic cable required to connect Overhead Fibre Optic Cable (OPGW) between the final in line splice enclosure on the gantry / tower forming the termination of the fibre cable on the power line and the Fibre Optic Distribution Panel (FODP) installed within the building. However, the Contractor shall supply & install the optical fibre approach cable as required based on detailed site survey to be carried out by the Contractor during the project execution and the Contract price shall be adjusted accordingly.

Basic Construction

The cable shall be suitable for direct burial, laying in trenches & PVC/Hume ducts, laying under false flooring and on indoor or outdoor cable raceways.

Jacket Construction & Material

The Approach Cable shall be a UV resistant, rodent proof, armoured cable with metallic type of armouring. The outer cable jacket for approach cable shall consist of carbon black polyethylene resin to prevent damage from exposure to ultra-violet light, weathering and high levels of pollution. The jacket shall conform to ASTM D1248 for density.

Optical, Electrical and Mechanical Requirements

Approach cable shall contain fibre with identical optical/ physical characteristics as those in the OPGW cables. The cable core shall comprise of tensile strength member(s), fibre support/bedding structure, core wrap/bedding, and an overall impervious jacket.

Installation of Approach Cable

The existing cable trenches/ cable raceways proposed to be used shall be identified in the survey report. The Contractor shall make its best effort to route the cable through the existing available cable trenches. Where suitable existing cable trenches are not available, suitable alternatives shall be provided after DTL approval. However, the approach cable shall be laid in the HDPE pipe in all condition. Suitable provisions shall be made by the Contractor to ensure adequate safety earthing and insulated protection for the approach cable. All required fittings, supports, accessories, ducts, inner ducts, conduits, risers and any item not specially mentioned but required for laying and installation of approach cables shall be supplied and installed by the Contractor.

Optical Fibre Termination and Splicing

Optical fibre terminations shall be installed in Fibre Optic Distribution Panels (FODP) designed to provide protection for fibre splicing of preconnectorized pigtails and to accommodate connectorized termination and coupling of the fibre cables. The Contractor shall provide rack /wall mounted Fibre Optic Distribution Panels (FODPs) sized as per requirement in scheme and shall terminate the fibre optic cabling up to the FODPs. The location of FODP rack shall be fixed by the Contractor, with DTL's approval.

Fibre Optic Distribution Panel

At each location requiring the termination of at least one fibre within a cable, all fibre within that cable shall be connectorized and terminated in Fibre Optic Distribution Panels in a manner consistent with the following:

- (a) All fibre optic terminations shall be housed using FODPs provisioned with splice organizers and splice trays. All fibre within a cable shall be fusion spliced to preconnectorized pigtails and fitted to the "Back-side" of the provided fibre optic couplings.
- (b) FODPs shall be suitable for use with each of the cable types provided as part of this contract. FODPs shall accommodate pass-through splicing and fibre terminations.
- (c) FODPs for indoor use shall be supplied in suitable cabinets/racks with locking

arrangement.

- (d) All FODPs shall be of corrosion resistant, robust construction and shall allow both top or bottom entry for access to the splice trays. Ground lugs shall be provided on all FODPs and the Contractor shall ensure that all FODPs are properly grounded. The FODP shall meet or exceed ingress protection class IP55 specifications.
- (e) Flexible protection shall be provided to the patch cord bunches going out from FODP to other equipment.

Optical Fibre Connectors

Optical fibre shall be connectorized with FC-PC type connectors preferably. Alternatively connector with matching patch cord shall also be acceptable. Fibre optic couplings supplied with FODPs shall be appropriate for the fibre connectors to be supported. There shall be no adapters.

Service Loops

For purposes of this specification, cable and fibre service loops are defined as slack (extra) cable and fibre provided for facilitating the installation, maintenance and repair of the optical fibre cable plant.

- (a) Outdoor Cable Service Loops: In-line splice enclosures installed outdoors and mounted on the utility towers, shall be installed with sufficient fibre optic cable service loops such that the recommended minimum bend radius is maintained while allowing for installation or maintenance of the cable to be performed in a controlled environment at ground level.
- (b) Indoor Cable Service Loops: FODPs shall provide at least three (3) meter of cable service loop. Service loops shall be neatly secured and stored, coiled such that the minimum recommended bend radius' are maintained.
- (c) Fibre Units Service Loops: For all fibre optic cable splicing, the cable shall be stripped back a sufficient length such that the fan-out of fibre units shall provide for at least one (1) meter of fibre unit service loop between the stripped cable and the bare fibre fan-out.
- (d) Pigtail Service Loops : Connectorized pigtails spliced to bare fibre shall provide at least 1 meter of service loop installed in the FODP fibre organizer and at least one (1) meter of service loop to the couplings neatly stored behind the FODP coupling panels.
- (e) Fibre Service Loops : At least 0.5 meter of bare fibre service loop shall be provided on each side of all fibre splices. The bare fibre service loops shall be neatly and safely installed inside covered splice trays.

Methodology for Installation and Termination

All optical fibre cable termination, installation, stringing and handling plans, guides and procedures, and engineering analysis (e.g. tension, sag, vibration etc.) shall be submitted to DTL for review and approval in the engineering/design phase of the project, prior to establishing the final cable lengths for manufacture. Installation procedures including details of personnel and time required shall be documented in detail and submitted to DTL for approval. All installation practices shall be field proven and ISO accredited.

All cable segments shall include service loops as specified in this specification. The maximum allowable stringing tension, maximum allowable torsional shear stress, crush strength and other physical parameters of the cable shall not be exceeded. The preventative measures to be taken shall be documented in detail and submitted to DTL in advance of installation.

Optical fibre attenuation shall be measured after installation and before splicing. Any increase in attenuation or step discontinuity in attenuation shall not be acceptable and shall constitute a cable segment failure. In the event of cable damage or any fibre damage, the complete section (tension location to tension location) shall be replaced as mid-span joints are not acceptable.

Any or all additional steel work or modifications required to attach the fibre cabling to the overhead transmission/ distribution line towers shall also be carried out by the Contractor. It shall be the Contractor's responsibility to provide adequate communications among all crew members and support staff to ensure safe and successful installations.

Cable Raceways

To the extent possible, existing cable raceways shall be utilized. The Contractor is required to provide and install any additional indoor cable raceways which may be required for proper implementation of the fibre optic cabling system. This requirement shall be finalized during survey. The cable raceways shall conform to the following:

- (a) All cable raceways shall be sized to support full loading requirements plus at least a 200% safety loading factor.
- (b) Indoor cable raceways shall be fabricated from construction grade aluminium, galvanized iron or anodized sheet metal or any other suitable material approved by DTL. Suitable anti-corrosion measures shall be provided. Steel fabricated raceways shall be finished inside and out, treated to resist rust and to form a metal-to-paint bond.
- (c) Mechanical construction drawings of the cable raceways shall be submitted for DTL's information & review.

Tests:

- (a) **Type Tests:** The bidder shall submit all the applicable type test reports of OPGW as per latest edition of IEC 60794-4 and also for the associated hardware fittings and

accessories in line with latest edition of applicable IS/IECs and validity of the type test reports shall be as per latest CEA guidelines. The type test reports shall be submitted along with the bid.

If any applicable type test has not been conducted by the bidder, then the same shall be conducted by the bidder free of cost and without affecting the completion period of the project/tender.

(b) Routine, Acceptance and sample Tests:

The OPGW and associated hardware fittings and accessories shall undergo all the applicable routine, acceptance and sample tests in line with latest edition of applicable IS/IECs.

Guaranteed Technical Particulars

S.No.	Parameter:	As per TS for 24 fibers	As per TS for 48 fibers	Bidder's offering
1.	No. of Fibers Dual Window Single-Mode:	24	48	
2.	Buffer Type :	Loose Tube	Loose Tube	
3.	Buffer Tube material	Non-metallic	Non-metallic	
4.	No. of buffer Tubes	Minimum Two	Minimum Four	
5.	No. of Fiber per buffer Tube:	Maximum Twelve	Maximum Twelve	
6.	Expected Cable Life:	25 year	25 years	
7	Fiber Manufacturer (s)/Type:			
8	Attenuation Coefficient @1310 nm: @1550 nm:	≤ 0.35 dB/km ≤ 0.21 dB/km	≤ 0.35 dB/km ≤ 0.21 dB/km	
9	Point Discontinuity @1310 nm: @1550 nm	≤ 0.05 dB ≤ 0.05 dB	≤ 0.05 dB ≤ 0.05 dB	
10	Nominal Mode Field Diameter	8.6 to 9.5 μm (\pm)	8.6 to 9.5 μm (\pm)	

	@1310 nm: @1550 nm	0.6 μm)	0.6 μm)	
11	Chromatic Dispersion Coefficient @ 1310 (1288-1339) nm: @ 1310 (1271-1360) nm: @ 1550 nm:	3.5 ps/ (nmxkm) 5.3 ps/ (nmxkm) 18 ps/ (nmxkm)	3.5 ps/ (nmxkm) 5.3 ps/ (nmxkm) 18 ps/ (nmxkm)	
12	Zero Dispersion wavelength :	1300 to 1324 nm	1300 to 1324 nm	
13	Cutoff wavelength :	≤ 1260 nm	≤ 1260 nm	
14	Bend Performance : (37.5 mm radius, 100 turns) @ 1310 (30 mm radius, 100 turns) @ 1550 nm (16mm radius, 1 turn) @ 1550nm	≤ 0.05 dB ≤ 0.05 dB ≤ 0.50 dB	≤ 0.05 dB ≤ 0.05 dB ≤ 0.50 dB	
15	Cladding Diameter (nominal ± deviation):	125.0 μm ± 1 μm	125.0 μm ± 1 μm	
16	Polarization mode dispersion coefficient	≤ 0.2 ps/km ^{1/2}	≤ 0.2 ps/km ^{1/2}	
17	Proof test level	≥ 0.69 Gpa	≥ 0.69 Gpa	
18	Short circuit current rating	≥ 6.32kA for 01 second	≥ 6.32kA for 01 second	

SECTION-XX

TRANSFORMER

SECTION: XX

TECHNICAL SPECIFICATION OF POWER/AUTO TRANSFORMERS IN DTL

1.0 GENERAL

- 1.1 This section covers specification for design, engineering, manufacture, testing, delivery at site including all materials, accessories, unloading, handling, proper storage at site, erection, testing and commissioning of the Transformer.
- 1.2 The design and workmanship shall be in accordance with the best engineering practices to ensure satisfactory performance throughout the service life.
- 1.3 Any material and equipment not specifically stated in this specification but which are necessary for satisfactory operation of the equipment shall be deemed to be included unless specifically excluded and shall be supplied without any extra cost.
- 1.4 Components having identical rating shall be interchangeable.

2.0 SPECIFIC TECHNICAL REQUIREMENTS

The technical parameters of the Transformer are detailed in **Annexure-A: Specific Technical Requirements**.

3.0 GUARANTEED AND OTHER TECHNICAL PARTICULARS

The manufacturer shall furnish all the Guaranteed and other technical particulars for the offered transformer as called for in **Annexure-C: Guaranteed and Other Technical Particulars**. The particulars furnished by the manufacturer in this Annexure shall make basis for the design review. Any other particulars considered necessary may also be given in addition to those listed in that Annexure.

4.0 STANDARD RATINGS OF TRANSFORMER

Standard ratings of transformer covered in this specification are as under:

Power Transformer /Auto Transformer:

S.No.	MVA Rating	Line Voltage rating	Phase	Type
1	500MVA	400/220/33kV	Three phase	Auto Transformer
2	315MVA	400/220/33kV	Three phase	Auto Transformer

3	160MVA	220/66/11kV	Three phase	Power Transformer
4	160MVA	220/66kV	Three phase	Power Transformer
5	100MVA	220/33/11kV	Three phase	Power Transformer
6	100MVA	220/33kV	Three phase	Power Transformer
7	31.5MVA	66/11kV	Three phase	Power Transformer

5.0 PERFORMANCE

5.1 Transformer

- 5.1.1 The power and auto transformers shall be used for bi-directional flow of rated power. The major technical parameters of three phase transformer units are defined at **Annexure – A**.
- 5.1.2 Transformers shall be capable of operating under natural cooled condition up to the specified load. The forced cooling equipment, wherever specified, shall come into operation by pre-set contacts of winding temperature indicator and the transformer shall operate in forced cooling mode initially as ONAF up to specified load and then as OFAF. The Cooling system shall be so designed that the transformer shall be able to operate at full load for at least **ten (10) minutes** in the event of total failure of power supply to cooling fans and oil pumps without the calculated winding hot spot temperature exceeding **140 deg C**. If the Transformer is fitted with two cooler banks, each capable of dissipating 50 per cent of the loss at continuous maximum rating, it shall be capable of operating for **20 minutes** at full load /continuous maximum rating in the event of failure of the oil circulating pump or fans/blowers associated with one cooler bank without the calculated winding hot spot temperature exceeding 140 deg C. The contractor shall submit supporting calculations for the above and the same shall be reviewed during design review.
- 5.1.3 The transformer shall be free from any Electrostatic Charging Tendency (ECT) under all operating conditions and maximum oil velocity shall be such that it does not lead to static discharges inside the transformer while all coolers are in operation.
- 5.1.4 The transformers shall be capable of operating continuously at the rated MVA without danger, at any tapping with voltage variation of **+/-10%** corresponding to the voltage of that tapping.
- 5.1.5 The transformers shall be capable of being over loaded in accordance with IEC 60076-7. There shall be no limitation imposed by bushings, tap changers etc. or any other associated equipment.
- 5.1.6 The hotspot temperature in any location of the tank shall not exceed **110 degree Celsius** at rated MVA. This shall be measured during temperature rise test at manufacturer's works.

5.1.7 The maximum flux density in any part of the core and yoke at the rated MVA, voltage and frequency shall be such that **under 10 % continuous** over-voltage condition it does not exceed **1.9 Tesla** at all tap positions.

5.1.8 The transformer and all its accessories including bushing/built in CTs etc. shall be designed to withstand the thermal and mechanical effects of any external short circuit to earth and of short circuits at the terminals of any winding without damage. The transformer shall be designed to withstand the thermal stress due to short circuit for a **duration of 2 seconds** and the same shall be verified during design review.

5.1.9 The following short circuit level shall be considered for the HV & IV System to which the transformers will be connected:

400kV system	- 63 kA for 1 sec (sym, rms, 3 phase fault)
220kV system	- 50 kA for 1 sec (sym, rms, 3 phase fault)
66kV system	- 31.5 kA for 1 sec (sym, rms, 3 phase fault)

However, for transformer design purpose, the through fault current shall be considered limited by the transformer self-impedance only (i.e. $Z_s = 0$).

5.1.10 Transformer shall be capable of withstanding thermal and mechanical stresses due to symmetrical or asymmetrical faults on any terminals. Mechanical strength of the transformer shall be such that it can withstand 3-phase and 1- phase through fault with rated voltage applied to HV and/or IV terminals of transformer. The short circuit shall alternatively be considered to be applied to each of the HV, IV and tertiary (LV) transformer terminals as applicable. The tertiary terminals shall be considered not connected to system source. For short circuit on the tertiary terminals, the in-feed from both HV & IV system shall be limited by the transformer self-impedance only and the rated voltage of HV and IV terminals shall be considered.

5.1.11 Transformers shall withstand, without damage, heating due to the combined voltage and frequency fluctuations which produce the following over fluxing conditions:

110 % continuously
125 % for 1 minute
140 % for 5 seconds

Withstand time for 150% & 170% over fluxing condition shall be indicated. Over fluxing characteristics up to 170 % shall be submitted.

5.1.12 The air core reactance of HV winding of transformer of 400 kV voltage class shall not be less than 20%. External or internal reactors shall not be used to achieve the specified HV/IV, HV/LV and IV/LV impedances.

5.2 Tertiary Windings (if applicable as per Annexure - A)

The tertiary windings shall be suitable for connection of reactors or capacitors which would be subjected to frequent switching and shall be suitable for connection to LT Transformer for auxiliary supply. All the windings shall be capable of withstanding the stresses which may be caused by such switching. The tertiary winding shall be designed to withstand mechanical and thermal stresses due to dead short circuit on its terminals and for 1/3rd of the MVA capacity of the transformer although the cooling for continuous thermal rating of the tertiary winding shall be for 5MVA capacity. Tertiary, if not loaded, i.e. not connected to reactor, capacitor or LT transformer etc., its terminals shall be insulated to avoid any accidental short circuiting.

5.3 Radio Interference and Noise Level

The transformer shall be designed with particular attention to the suppression of harmonic voltage, especially the third and fifth harmonics so as to minimize interference with communication circuits.

The noise level of transformer, when energized at normal voltage and frequency with fans and pumps running shall not exceed the values specified at **Annexure- A**, when measured under standard conditions.

6.0 MAXIMUM LOSSES

The maximum permissible losses (No load loss, I^2R loss, auxiliary loss and load loss) at rated voltage/current (at 75 deg C) have been specified in **Annexure-A** for various ratings of transformers covered under this specification. Following penalties shall be levied on the manufacturer/contractor (as the case may be) if losses measured during routine test are found to be within +2% tolerance of the losses specified in **Annexure-A**, beyond which the transformer shall be liable for rejection. No benefit shall be given for supply of transformer with losses (measured during routine tests) less than the losses specified in **Annexure -A**.

S.No.	Differential of specified losses vs Measured losses	Rate (in INR/kW
1	No load loss	Rs.10,00,000/kW
2	I^2R Losses/ Load Losses (differential of whichever loss is higher shall be considered for penalty)	Rs.8,00,000/kW
3	Auxiliary Losses	Rs.8,00,000/kW
Note: For a fraction of a KW, the penalty shall be applied on pro-rata basis		

7.0 DYNAMIC SHORT CIRCUIT TEST REQUIREMENT AND VALIDITY

The Transformer the design of which is similar to the offered transformer, should have been successfully tested for short circuit withstand capability as per IS 2026 Part-5/ IEC-60076-5. The criteria for similar transformers shall be as per latest CEA guidelines. The relevant Test Report / Certificate shall be enclosed with the bid. **The validity of Dynamic Short Circuit test for transformer shall be as per CEA's letter dated 26.06.2023 or further amendments in guidelines/regulations by CEA in this regard, whichever is latest.**

Further design review of the offered transformer shall be carried out based on the design of reference transformer, which has already been subjected to short circuit test. In case manufacturer has not conducted the short circuit test earlier, the same shall be carried out on offered transformer at his own cost.

The requirement of conduction of Dynamic short circuit (DSC) test on 400kV 500MVA transformer shall be as per CEA letter dated 26.06.2023 or further amendments in guidelines/regulations by CEA in this regard, whichever is latest.

For these transformers, theoretical evaluation of the ability to withstand the dynamic effects of short circuit, based on calculation and consideration of the design characteristic and manufacturing practices, shall be carried out as per IS 2026 Part (5) / IEC-60076-5 and any amendment thereof. The criteria for selection of similar reference transformer for dynamic short circuit withstand test shall be as per CEA guidelines.

(Note: Bidder is required to submit details in format as per CEA guidelines for comparison of characteristics in order to verify the similarity criteria which shall be evaluated/ considered during techno-commercial evaluation of the bid)

8.0 TYPE TESTS REQUIREMENT AND VALIDITY

The offered transformer or the transformer, the design of which is similar to the offered transformer, should have been successfully type tested within last 5 years as on the last date of submission of bid. Manufacturer may use same or different approved make of Bushings, Tap changer and other accessories used in type tested or short circuit tested unit in their transformer. Further, type test report of transformer shall only be acceptable provided the offered transformer has been manufactured from the same plant.

Central Electricity Authority's "Guidelines for the validity period of type tests conducted on major electrical equipment in power transmission system" shall be followed for details regarding the validity of type tests.

9.0 DESIGN REVIEW

- 9.1 The transformer shall be designed, manufactured and tested in accordance with the best international engineering practices under strict quality control to meet the requirement stipulated in the technical specification. Adequate safety margin w.r.t. thermal, mechanical, dielectric and electrical stress etc. shall be maintained during design, selection of raw material, manufacturing process etc. in order to achieve long life of transformer with least maintenance.
- 9.2 Design reviews shall be conducted by the purchaser during the procurement process; however, the entire responsibility of design shall be with the manufacturer. Purchaser may also visit the manufacturers works to inspect design, manufacturing and test facilities. The scope of such design review shall include but not limited to the requirement as mentioned at **Annexure-N**.
- 9.3 The design review shall be finalized before commencement of manufacturing activity and shall be conducted generally following the “CIGRE TB 529: Guidelines for conducting design reviews for power transformers”.
- 9.4 The manufacturer shall provide all necessary information and calculations to demonstrate that the transformer meets the requirements of mechanical strength and inrush current.
- 9.5 The manufacturer will be required to demonstrate the use of adequate safety margins for thermal, mechanical, dielectric and vibration etc. in design to take into account the uncertainties of his design and manufacturing processes. The scope of such design review shall include but not limited to the requirement.
- 9.6 Each page of the design review document shall be duly signed by the authorized representatives of manufacturer and purchaser and shall be provided to the purchaser for record and reference before commencement of manufacturing.

10.0 SERVICE CONDITION

The transformer/reactor shall be designed for the following service conditions as specified hereunder:

Sr. No.	Description	Parameters
i)	Site altitude	Less Than 1000meters
ii)	Maximum ambient temperature	50 Degree Celsius
iii)	Yearly weighted average cooling air ambient temperature	43.3 Degree Celsius
iv)	Monthly average cooling air temperature of hottest month	45 Degree Celsius
v)	Minimum cooling air temperature	0 degree Celsius
vi)	Wave shape of supply voltage	Sinusoidal
vii)	Total Harmonic current	As per IEC
viii)	Seismic zone and ground acceleration (both in horizontal & vertical direction)	Zone-IV, Horizontal :0.3g

ix)	Combined voltage and frequency variation	As per CEA guidelines
x)	Wind zone as per wind map provided in National Building Code	Wind Zone Five (05)
xi)	Maximum humidity	100% RH
xii)	Minimum humidity	10% RH
xiii)	Specific Creepage Distance of insulation in air	31mm/kV

11.0 CONSTRUCTION DETAILS

The construction details and features of transformer shall be in accordance with the requirement stated hereunder.

11.1 Tank & tank cover

11.1.1 The tank shall be of proven design of either Bell type with bolted/ welded joint or conventional (**preferable**) with bolted/welded top cover. Bell type tank, if provided, shall have joint as close as possible to the bottom of the tank.

11.1.2 The tank shall be designed in such a way that the Transformer can be rested on concrete plinth foundation directly or on roller assembly.

11.1.3 Tank shall be fabricated from tested quality low carbon steel of adequate thickness. Unless otherwise approved, metal plate, bar and sections for fabrication shall comply with IS 2062.

11.1.4 The base of each tank shall be so designed that it shall be possible to move the complete transformer unit by skidding in any direction without damage when using plates or rails and the base plate shall have following minimum thickness.

Length of tank (m)	Minimum plate thickness (mm)
Flat bases	
Over 2.5 m but less than 5m	20
Over 5 m but less than 7.5m	26
Over 7.5 m	32

11.1.5 Tank shall be capable of withstanding, without damage, severe strains that may be induced under normal operating conditions or forces encountered during lifting, jacking and pulling during shipping and handling at site or factory. Tank, tank cover and associated structure should be adequately designed to withstand, without damage or permanent deflection / deformation, the forces arising out of normal oil pressure, test pressures, vacuum, seismic conditions and short circuit forces specified.

- 11.1.6 All seams and joints which are not required to be opened at site, shall be factory welded, and shall be double welded [i.e. with a continuous cord on both sides of the plate (inside and outside of the tank), bottom & cover of the tank, turrets, flanges, etc.] to ensure adequate strength. Butt welds on parts that are mechanically stressed or under pressure must have full penetration. Welding shall conform to IS 9595. The requirement of post weld heat treatment of tank/stress relieving shall be based on recommendation of IS 10801.
- 11.1.7 The welded joint shall be provided with flanges suitable for repeated welding. The joint shall be provided with a suitable gasket to prevent weld splatter inside the tank. Proper tank shielding shall be done to prevent excessive temperature rise at the joint.
- 11.1.8 Tank stiffeners shall be provided for general rigidity and welded to the tank continuously along its ends and sides (Intermittent welds will not be accepted). These shall be designed to prevent retention of water. Sharp edges on stiffeners should be avoided for better paint adhesion.
- 11.1.9 Tank MS plates of thickness **>12 mm** should undergo Ultrasonic Test (UT) to check lamination defect, internal impurities in line with ASTM 435 & ASTM 577.
- 11.1.10 After fabrication of tank and before painting, Non-destructive test (dye penetration test) is mandatory on the load bearing members such as base plate joints, jacking pads and lifting devices etc.
- 11.1.11 Suitable guides shall be provided for positioning the various parts during assembly or dismantling. Adequate space shall be provided between the covers & windings and the bottom of the tank for collection of any sediment.
- 11.1.12 Tank should be provided with adequately sized inspection covers, either in circular shape or in rectangular shape, preferably at diagonally opposite sides of the tank to access the active part and one at each end of the tank cover for easy access of the lower end of the bushings, earthing connections and tap changers etc. for inspection. Inspection covers shall be bolted type and shall not weigh more than 25 kgs. Handles shall be provided on the inspection cover to facilitate its lifting.
- 11.1.13 The tank cover shall be provided with pockets for oil and winding temperature indicators. The location of pockets (for OTI, WTI & RTDs including two spare pockets) shall be in the position where oil reaches maximum temperature. Further, it shall be possible to remove bulbs/probes of OTI/WTI/RTD without lowering the oil in the tank. The thermometer shall be fitted with a captive screw to prevent the ingress of water.
- 11.1.14 It should be possible to inspect Buchholz relay or Oil surge relay, standing on tank cover or suitable arrangement shall be made to access Buchholz relay safely.
- 11.1.15 The tank cover shall be designed to prevent retention of rain water Bushing turrets, covers of inspection openings, thermometer pockets etc. shall be designed to prevent ingress of

water into or leakage of oil from the tank.

- 11.1.16 Minimum four symmetrically placed lifting lugs of adequate size shall be provided so that it will be possible to lift the complete transformer/reactor when filled with oil & without structural damage to any part of the transformer/reactor. The factor of safety at any lug shall not be less than 2. Suitable haulage holes shall also be provided.
- 11.1.17 A minimum of four jacking pads (not fouling with rail, rollers or other accessories) shall be provided in accessible position to enable the transformer complete with oil to be raised or lowered using hydraulic jacks. The location shall be such that it should not interfere with loading & unloading from trailer.
- 11.1.18 Each jacking pad shall be designed with an adequate factor of safety to support at least half of the total mass of the transformer filled with oil in addition to maximum possible misalignment of the jacking force to the centre of the working surface.
- 11.1.19 The tank shall be provided with suitable valves as specified in Clause: “Valves” and Clause: “Fittings and accessories” of this section. Location of valves shall be finalized during design review.
- 11.1.20 The tank cover and bushing turret shall be fixed to the transformer using copper links in such a way that good electrical contact is maintained around the perimeter of the tank and turrets.
- 11.1.21 The transformer shall be provided with a suitable diameter pipe flange, butterfly valve, bolted blanking plate and gasket at the highest point of the transformer for maintaining vacuum in the tank.
- 11.1.22 Gas venting: The transformer cover and generally the internal spaces of the transformer and all pipe connections shall be designed so as to provide efficient venting of any gas in any part of the transformer to the Buchholz relay. The space created under inspection /manhole covers shall be filled with suitable material to avoid inadvertent gas pockets. The Covers shall be vented at least at both longitudinal ends. The design for gas venting shall take into accounts the slopes of the plinth (if any) on which the transformer is being mounted.

11.2 Gasket for tank & cover

All gasketed joints shall be designed, manufactured and assembled to ensure long-term leak proof and maintenance free operation. All gasketed joints shall preferably be O-ring and designed with gasket-in-groove arrangement. If gasket/O-rings is compressible, metallic stops/other suitable means shall be provided to prevent over- compression. All bolted connections shall be fitted with weather proof, hot oil resistant, resilient gasket in between for complete oil tightness. All matching flanges of gasket sealing joints should be machined (except curb joints). Gasket with intermediate stops are not acceptable. To the extent possible, the seamless gasket should be used for openings on tank/cover such as turrets, bushing, inspection covers etc. All tank gaskets/O-rings used shall be of NBR (Acrylonitrile Butadiene Rubber) suitable for temperature conditions expected to be encountered during operation. The gasket

material and additives should be fully compatible with transformer insulating fluid/oil. The gasket should not contain oil soluble sulphur compounds. The properties of all the above gaskets/O-Rings shall comply with the requirements of type-IV rubber of IS-11149. Gaskets and O-rings shall be replaced every time whenever the joints are opened.

11.3 Foundation, Roller Assembly and Anti Earthquake Clamping Device

11.3.1 Transformer shall be placed on foundation either directly or on roller assembly.

11.3.2 For transformer to be placed directly on foundation, one set of rollers shall be provided for movement within the yard. The rollers for transformer are to be provided with flanged bi-directional wheels and axles. This set of wheels and axles shall be suitable for fixing to the under carriage of transformer to facilitate its movement on rail track. Suitable locking arrangement along with foundation bolts shall be provided for the wheels to prevent accidental movement of transformer.

11.3.3 The rail track gauge shall be 1676 mm. 3-Phase auto transformers of 400kV class shall have four (4) rails and other voltage class transformers shall have two (2) rails.

11.3.4 To prevent movement during earthquake, suitable clamping devices shall be provided for fixing the transformer to the foundation.

11.3.5 In case rail is not required for smaller rating transformers, arrangement of unidirectional roller mounted on channel shall be provided and channel shall be locked with the plinth suitably.

11.3.6 For foundation of separately mounted cooler bank of transformer, fixing of cooler support shall be through Anchor Fastener with chemical grouting and no pockets for bolting shall be provided.

11.3.7 For support of cooler pipes, Buchholz pipe (if required) and fire-fighting pipe pylon supports, Pre-fabricated metallic support from pit shall be provided which shall be further encased with concrete to prevent rusting.

11.3.8 All control cubicles shall be mounted at least **one meter** above Finished Ground Level (FGL) to take care of water logging during flooding. Suitable arrangement (ladder and platform) shall be provided for safe access to control cubicles.

11.4 Conservator

11.4.1 The conservator of main tank shall have air cell type constant oil pressure system to prevent oxidation and contamination of oil due to contact with moisture. Conservator shall be fitted with magnetic oil level gauge with potential free high and low oil level alarm contacts and prismatic oil level gauge.

- 11.4.2 The conservator shall preferably be on the left side of the tank while viewing from HV side.
- 11.4.3 Conservator tank shall have adequate capacity with highest and lowest visible-levels to meet the requirements of expansion of total cold oil volume in the transformer and cooling equipment from minimum ambient temperature to top oil temperature of **110 deg C**. The capacity of the conservator tank shall be such that the transformer shall be able to carry the specified overload without overflowing of oil.
- 11.4.4 The conservator shall be fitted with lifting lugs in such a position so that it can be removed for cleaning purposes. Suitable provision shall be kept to replace air cell and cleaning of the conservator as applicable.
- 11.4.5 The conservator shall be positioned so as not to obstruct any electrical connection to transformer.
- 11.4.6 Contact of the oil with atmosphere is prohibited by using a flexible air cell of nitrile rubber reinforced with nylon cloth. The temperature of oil in the conservator is likely to rise up to **110 Deg C** during operation. As such air cell used shall be suitable for operating continuously at this temperature.
- 11.4.7 The connection of air cell to the top of the conservator is by air proof seal preventing entrance of air into the conservator. The main conservator tank shall be stenciled on its underside with the words "Caution: Air cell fitted". Lettering of at least 150 mm size shall be used in such a way to ensure clear legibility from ground level when the transformer/reactor is fully installed. To prevent oil filling into the air cell, the oil filling aperture shall be clearly marked. The transformer rating and diagram plate shall bear a warning statement that the "Main conservator is fitted with an air cell".
- 11.4.8 The transformer manual shall give clear instructions on the operation, maintenance, testing and replacement of the air cell. It shall also indicate shelf life, life expectancy in operation, and the recommended replacement intervals.
- 11.4.9 The conservator tank and piping shall be designed for complete vacuum/ filling of the main tank and conservator tank. Provision must be made for equalizing the pressure in the conservator tank and the air cell during vacuum/ filling operations to prevent rupturing of the air cell.
- 11.4.10 The contractor shall furnish the leakage rates of the rubber bag/ air cell for oxygen and moisture. It is preferred that the leakage rate for oxygen from the air cell into the oil will be low enough so that the oil will not generally become saturated with oxygen. Air cells with well proven long life characteristics shall be preferred.
- 11.4.11 OLTC shall have conventional type conservator (without air cell) with magnetic oil level gauge with potential free oil level alarm contact and prismatic oil level gauge.

- 11.4.12 Conservator Protection Relay (CPR)/Air cell puncture detection relay shall be externally installed on the top of conservator to give alarm in the event of lowering of oil in the conservator due to puncture of air cell in service.

11.5 Piping works for conservator

- 11.5.1 Pipe work connections shall be of adequate size preferably short and direct. Only radiused elbows shall be used.
- 11.5.2 The feed pipe to the transformer tank shall enter the cover plate at its highest point and shall be straight for a distance not less than five times its internal diameter on the transformer side of the Buchholz relay, and straight for not less than three times that diameter on the conservator side of the relay. This pipe shall rise towards the oil conservator, through the Buchholz relay, at an angle of not less than **5 degrees**. The feed pipe diameter for the main conservator shall be not less **than 80mm**. The Gas-venting pipes shall be connected to the final rising pipe between the transformer and Buchholz relay as near as possible in an axial direction and preferably not less than five times pipe diameters from the Buchholz relay.
- 11.5.3 No metal corrugated bellow (Flexible metal system) should be used in the feed pipe connecting main tank to conservator.
- 11.5.4 A double flange valve of preferably 50 mm and 25 mm size shall be provided to fully drain the oil from the main tank conservator and OLTC conservator tank respectively.
- 11.5.5 Pipe work shall neither obstruct the removal of tap changers for maintenance or the opening of inspection or manhole covers.

11.6 Dehydrating Silica gel Filter Breather

Conservator of Main Tank and OLTC shall be fitted with dehydrating silica gel filter breathers of adequate size. Connection shall be made to a point in the oil conservator not less than 50 mm above the maximum working oil level by means of a pipe with a minimum diameter of 25 mm. Breathers and connecting pipes shall be securely clamped and supported to the transformer, or other structure supplied by the manufacturer, in such a manner so as to eliminate undesirable vibration and noise. The design shall be such that:

- a) Passage of air is through silica gel.
- b) Silica gel is isolated from atmosphere by an oil seal.
- c) Moisture absorption indicated by a change in color of the crystals.
- d) Breather is mounted approximately 1200 mm above rail top level.
- e) To minimize the ingress of moisture three breathers (of identical size) for 220kV and above voltage class transformer and two breathers (of identical size) for below 220kV class transformer shall be connected in series for main tank conservator. Manufacturer shall provide flexible connection pipes to be used during replacement of any silica gel breather.

- f) To minimize the ingress of moisture, two breather in series of identical size shall be connected to OLTC Conservator. Manufacturer shall provide flexible connection pipes to be used during replacement of any silica gel breather.

11.7 Pressure Relief Device (PRD)

One PRD of 150 mm Diameter is required for every 30000 Litres of oil. However, at least two numbers PRDs shall be provided. Its mounting should be either in vertical or horizontal orientation, preferably close to bushing turret or cover. PRD operating pressure selected shall be verified during design review.

PRD shall be provided with special shroud to direct the hot oil in case of fault condition. It shall be provided with an outlet pipe which shall be taken right up to the soak pit of the transformer/reactor. The size (Diameter) of shroud shall be such that it should not restrict rapid release of any pressure that may be generated in the tank, which may result in damage to equipment. Oil shroud should be kept away from control cubicle and clear of any operating position to avoid injury to personnel in the event of PRD operation.

The device shall maintain its oil tightness under static oil pressure equal to the static operating head of oil plus 20 kPa.

It shall be capable of withstanding full internal vacuum at mean sea level. It shall be mounted directly on the tank. Suitable canopy shall be provided to prevent ingress of rain water. One set of potential free contacts (with plug & socket type arrangement) per device shall be provided for tripping. Following routine tests shall be conducted on PRD:

- a) Air pressure test
- b) Liquid pressure test
- c) Leakage test
- d) Contact operation test
- e) Dielectric test on contact terminals

11.8 Sudden Pressure Relay/ Rapid Pressure Rise Relay (for 220kV and above transformer)

One number of Sudden Pressure Relay/ Rapid Pressure Rise Relay with alarm or trip contact (Terminal connection plug & socket type arrangement) shall be provided on tank of transformer. Operating features and size shall be reviewed during design review. Suitable canopy shall be provided to prevent ingress of rain water.

Pressurized water ingress test for Terminal Box (routine tests) shall be conducted on Sudden Pressure Relay/ Rapid Pressure Rise Relay.

11.9 Buchholz Relay

Double float, reed type Buchholz relay complying with IS:3637 shall be connected through pipe between the oil conservator and the transformer tank with minimum distance of five times pipe diameters between them. Any gas evolved in the transformer shall be collected in this relay. The relay shall be provided with a test cock suitable for a flexible pipe connection for checking its operation and taking gas sample. A copper tube shall be connected from the gas collector to a valve located about 1200 mm

above ground level to facilitate sampling while the transformer in service. Suitable canopy shall be provided to prevent ingress of rain water. It shall be provided with two potential free contacts (Plug & socket type arrangement), one for alarm/trip on gas accumulation and the other for tripping on sudden rise of pressure.

The Buchholz relay shall not operate during starting/stopping of the transformer oil circulation under any oil temperature conditions. The pipe or relay aperture baffles shall not be used to decrease the sensitivity of the relay. The relay shall not mal-operate for through fault conditions or be influenced by the magnetic fields around the transformer during the external fault conditions. Pressurized water ingress test for Terminal Box (routine tests) shall be conducted on Buchholz relay.

11.10 Oil Temperature Indicator (OTI)

The transformer shall be provided with a dial type thermometer of about 150mm diameter for top oil temperature indication with angular sweep of 270°. Range of temperature should be 0-150°C with accuracy of $\pm 1.5\%$ (or better) of full scale deflection. The instruments should be capable of withstanding high voltage of 2.5kV AC rms, 50Hz for 1 minute. The terminal provided for auxiliary wiring should be Press-fit type.

The thermometer shall have adjustable, potential free alarm and trip contacts besides that required for control of cooling equipment (if any), maximum reading pointer and resetting device, switch testing knob & anti-vibration mounting grommets (for projection mounting). Type of switch (NO/NC) shall be heavy duty micro switch of 5A at 240V AC/DC. Adjustable range shall be 20-90% of full scale range. The instruments case should be weather proof with epoxy coating at all sides. Instruments should meet degree of protection of IP55 as per IS/IEC- 60529. A temperature sensing bulb located in a thermometer pocket on tank cover should be provided to sense top oil. This shall be connected to the OTI instrument by means of flexible stainless steel armour to protect capillary tubing. Temperature indicator dials shall have linear gradations to clearly read at least every 2 deg C. The setting of alarm and tripping contacts shall be adjustable at site.

The OTI shall be so mounted that the dials are about 1200 mm from ground level. Glazed door of suitable size shall be provided for convenience of reading.

In addition to the above, the following accessories shall be provided for remote indication of oil temperature:

Temperature transducer with PT100 sensor

RTD shall be provided with PT100 temperature sensor having nominal resistance of 100 ohms at zero degree centigrade. The PT100 temperature sensor shall have three wire ungrounded system. The calibration shall be as per IS 2848 or equivalent. The PT100 sensor may be placed in the pocket containing temperature sensing element. RTD shall include image coil for OTI system and shall provide dual output 4-20mA for SCADA system. The transducer shall be installed in the Individual Marshalling Box. Any special cable required for shielding purpose, for connection between PT100 temperature sensor and transducer, shall be in the scope of manufacturer. 4-20mA signal shall be wired to Digital RTCC panel/BCU for further transfer data to SCADA through IS/IEC 61850 compliant communications.

11.11 Winding Temperature Indicator (WTI)

The transformer shall be provided with a dial type hot spot indicator of about 150mm diameter for measuring the hot spot temperature of each winding [HV, IV & Tertiary (if applicable)]. It shall have angular sweep of 270°. Range of temperature should be 0- 150°C with accuracy of ±1.5% (or better) of full scale deflection. The instruments should be capable of withstanding high voltage of 2.5kV AC rms, 50Hz for 1 minute. The terminal provided for auxiliary wiring should be Press-fit type.

The thermometer shall have adjustable, potential free alarm, trip contacts besides that required for control of cooling equipment, if any. Instrument should be provided with maximum reading pointer and resetting device, switch testing knob & anti-vibration mounting grommets (for projection mounting). Type of switch (NO/NC) shall be

heavy duty micro switch of 5A at 240V AC/DC. Adjustable range shall be 20-90% of full scale range. The instruments case should be weather proof and epoxy coating at all sides. Instruments should meet degree of protection of IP55 as per IEC60529. A temperature sensing bulb located in a thermometer pocket on tank cover should be provided to sense top oil. This shall be connected to the WTI instrument by means of flexible stainless steel armour to protect capillary tubing. WTI shall have image coil and auxiliary CTs, if required to match the image coil mounted in local control box. The setting of alarm and tripping contacts shall be adjustable at site.

The WTI shall be so mounted that the dials are about 1200 mm from ground level. Glazed door of suitable size shall be provided for convenience of reading.

In addition to the above, the following accessories shall be provided for remote indication of winding temperature:

Temperature transducer with PT100 sensor for each winding

RTD shall be provided with PT100 temperature sensor having nominal resistance of 100 ohms at zero degree centigrade. The PT100 temperature sensor shall have three wire ungrounded system. The calibration shall be as per IS 2848 or equivalent. The PT100 sensor may be placed in the pocket containing temperature sensing element. RTD shall include image coil, Auxiliary CTs, if required to match the image coil, for WTI system and shall provide dual output 4-20mA for remote WTI and SCADA system individually. The transducer and Auxiliary CT shall be installed in the Individual Marshaling Box. Any special cable required for shielding purpose, for connection between PT100 temperature sensor and transducer, shall be in the scope of Contractor. 4-20mA signal shall be wired to Digital RTCC / BCUpnl for further transfer data to SCADA through IS/IEC 61850 compliant communications.

11.12 Earthing Terminals

11.12.1 Two (2) earthing pads (each complete with two (2) nos. holes, M16 bolts, plain and spring washers) suitable for connection to 75 x 12 mm galvanized steel grounding flat shall be provided each at position close to earth of the two (2) diagonally opposite bottom corners of the tank.

11.12.2 Two earthing terminals suitable for connection to 75 x 12 mm galvanized steel flat shall also

be provided on each cooler, individual/common marshalling box and any other equipment mounted separately. For the tank-mounted equipment like online drying/Online DGA/Optical Sensor Box etc., (if provided), double earthing shall be provided through the tank for which provision shall be made through tank and connected through two flexible insulated copper link.

- 11.12.3 Equipotential flexible copper links of suitable size shall be provided between turret & tank, between tank & cover or between Bell & lower tank. Other components like - pipes, conservator support etc. connected to tank may also be provided with equipotential flexible copper link.
- 11.12.4 Each transformer unit should have provision for earthing and connection to grounding mat when not in service.

11.13 Core

- 11.13.1 The core shall be constructed from non-ageing, cold rolled high permeability grade or better grain oriented silicon steel laminations. Indian transformer manufacturers shall use core material as per above specification with BIS certification.
- 11.13.2 The design of the magnetic circuit shall be such as to avoid static discharges, development of short circuit paths within itself or to the earthed clamping structure and production of flux component at right angles to the plane of laminations which may cause local heating. The step-lap construction arrangement is preferred for better performance in respect of noise, no-load current and no-load loss.
- 11.13.3** The hot spot temperature and surface temperatures in the core shall be calculated for over voltage conditions specified in the document and it shall not exceed **125 deg C and 120 deg C respectively.**
- 11.13.4 Core and winding shall be capable of withstanding the shock during transport, installation and service. Adequate provision shall be made to prevent movement of core and winding relative to tank during these conditions.
- 11.13.5 All steel sections used for supporting the core shall be thoroughly sand/ shot blasted after cutting, drilling and welding.
Each core lamination shall be insulated with a material that will not deteriorate due to pressure and hot oil.
- 11.13.6 The supporting frame work of the core shall be so designed as to avoid presence of pockets which would prevent complete emptying of tank through drain valve or cause trapping of air during oil filling.
- 11.13.7 Adequate lifting lugs shall be provided to enable lifting of active part (core & winding).

- 11.13.8 Core assembly shall be manufactured in such a way that lamination shall remain flat and finally assembled core shall be free from distortion.
- 11.13.9 Single point core earthing should be ensured to avoid circulating current. Core earth should be brought separately on the top of the tank to facilitate testing after installation on all transformers. The removable links shall have adequate section to carry ground fault current. Separate identification name plate/labels shall be provided for the 'Core' and 'Core clamp'. Cross section of Core earthing connection shall be of minimum size 80 sq.mm copper with exception of the connections inserted between laminations which may be reduced to a cross-sectional area of 20 sq. mm tinned copper where they are clamped between the laminations.
- 11.13.10 In case core laminations are divided into sections by insulating barriers or cooling ducts parallel to the plane of the lamination, tinned copper bridging strips shall be inserted to maintain electrical continuity between sections.
- 11.13.11 Insulation of core to clamp/frame shall be tested at 2.5 kV DC for 1 minute without breakdown after the transformer is filled with liquid and insulation resistance should be at least 1 giga ohm for new transformer.

11.14 Windings

- 11.14.1 The manufacturer shall ensure that windings of all transformers are made in clean, dust proof (Clean room class ISO 9 or better as per ISO 14644-1), humidity controlled environment with positive atmospheric pressure.
- 11.14.2 The conductors shall be of electrolytic grade copper free from scales and burrs. Oxygen content shall be as per IS 12444. Epoxy bonded Continuously Transposed Conductor (CTC) shall be used in main winding for rated current of 400 A or more.
- 11.14.3 The conductor shall be transposed at sufficient intervals in order to minimize eddy currents and to equalize the distribution of currents and temperature along the winding.
- 11.14.4 The conductor insulation shall be made from high-density (at least 0.75 gm /cc) paper having high mechanical strength. The characteristics for the paper will be reviewed at the time of design review.
- 11.14.5 The insulation of transformer windings and connections shall be free from insulating compounds which are liable to soften, ooze out, shrink or collapse and shall be non-catalytic and chemically inactive in transformer oil during service.
- 11.14.6 Coil assembly and insulating spacers shall be so arranged as to ensure free circulation of oil and to reduce the hot spot of the winding.

- 11.14.7 The coils would be made up, shaped and braced to provide for expansion and contraction due to temperature changes.
- 11.14.8 The windings shall be designed to withstand the dielectric tests specified. The type of winding used shall be of time tested. An analysis shall be made of the transient voltage distribution in the windings, and the clearances used to withstand the various voltages. Margins shall be used in recognition of manufacturing tolerances and considering the fact that the system will not always be in the new factory condition.
- 11.14.9 The barrier insulation including spacers shall be made from high- density pre-compressed pressboard (1.15 gm/cc minimum for load bearing and 0.95 gm/cc minimum for non-load bearing) to minimize dimensional changes. Kraft insulating paper used on conductor should have density of >0.75 g/cc.
- 11.14.10 Wherever required, electrostatic shield, made from material that will withstand the mechanical forces, will be used to shield the high voltage windings from the magnetic circuit.
- 11.14.11 All insulating materials and structures shall be protected from contamination and the effects of humidity during and after fabrication, and after receipt, by storing them in a separate, climate-controlled area. All blocks shall be installed such that the grain is oriented in the horizontal direction, perpendicular to the winding compressive forces. Aspect ratio of selected conductor shall be chosen suitably based on manufacturer experience to result in stable winding under normal and abnormal service condition after assembly.
- 11.14.12 All winding insulation shall be processed to ensure that there will be no detrimental shrinkage after assembly. All windings shall be pre- sized before being clamped.
- 11.14.13 Winding paper moisture shall be less than 0.5%.
- 11.14.14 Windings shall be provided with clamping arrangements which will distribute the clamping forces evenly over the ends of the winding.
- 11.14.15 Either brazing/crimping type of connections are permitted for joints. It shall be time proven and safely withstand the cumulative effect of stress which may occur during handling, transportation, installation and service including line to line and line to ground faults /Short circuits. Manufacturer shall have system which allows only qualified personnel to make brazing or crimping joints.

11.15 Current carrying connections

The mating faces of bolted connections shall be appropriately finished and prepared for achieving good long lasting, electrically stable and effective contacts. All lugs for crimping shall be of the correct size

for the conductors. Connections shall be carefully designed to limit hot spots due to circulating eddy currents.

11.16 Winding terminations into bushings

- 11.16.1 Winding termination interfaces with bushings shall be designed to allow for repeatable and safe connection under site conditions to ensure the integrity of the transformer in service.
- 11.16.2 The winding end termination, insulation system and transport fixings shall be so designed that the integrity of the insulation system generally remains intact during repeated work in this area.
- 11.16.3 Allowances shall be made on the winding ends for accommodating tolerances on the axial dimensions of the set of bushings and also for the fact that bushings may have to be rotated to get oil level inspection gauges to face in a direction for ease of inspection from ground level. In particular, rotation or straining of insulated connections shall be avoided during the fastening of conductor pads (or other methods) on the winding ends onto the termination surfaces of the bushing.
- 11.16.4 Suitable inspection and access facilities into the tank in the bushing oil-end area shall be provided to minimize the possibility of creating faults during the installation of bushings.

12.0 PAINT SYSTEM AND PROCEDURES

The typical painting details for transformer main tank, pipes, conservator tank, radiator, control cabinet/ marshalling box / oil storage tank etc. shall be as given in **Annexure–H**. The proposed paint system shall generally be similar or better than this. The quality of paint should be such that its color does not fade during drying process and shall be able to withstand temperature up to 120 deg C. The detailed painting procedure shall be finalized during award of the contract.

13.0 INSULATING OIL

The insulating oil shall be unused inhibited (Type A, High Grade) Transformer Oil conforming to **IEC-60296-2020** & all parameters specified at **Annexure–I**, while tested at oil supplier's premises. The contractor shall furnish test certificates from the supplier against the acceptance norms as mentioned at **Annexure–I**, prior to despatch of oil from refinery to site. Under no circumstances, poor quality oil shall be filled into the transformer and thereafter be brought up to the specified parameter by circulation within the transformer. The Unused Insulating Oil parameters including parameters of oil used at manufacturer's works, processed oil, oil after filtration and settling are attached at **Annexure–I**. The oil test results shall form part of equipment test report.

A minimum of **10% (Ten percent)** of the oil quantity shall be supplied as spare (in addition to first filling) for maintaining required oil level in case of leakage in tank, radiators, conservator etc.

Oil used for first filling, testing and impregnation of active parts at manufacturer's works shall be of same type of oil which shall be supplied at site and shall meet parameters as per specification.

13.1 Particles in the oil (For 400 kV voltage class transformer)

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. After filtration the oil is to be flushed and particle count to be measured.

Limiting value for the particle count are 1000 particle/100 ml with size $\geq 5 \mu\text{m}$; 130 particle/100 ml with size $\geq 15 \mu\text{m}$.

14.0 BUSHINGS

14.0 For various voltage class of transformer, type of bushings shall be as follows:

Voltage Rating	Bushing Type
245 kV and 420 kV bushings for 400 kV and below voltage class transformers	RIP/RIS
Bushings of 36 kV and below	Solid porcelain or oil communicating type OIP (For high current requirement)
Bushings of other rating	OIP/RIP/RIS

OIP: Oil Impregnated Paper (with porcelain/polymer housing); RIP: Resin Impregnated Paper (with polymer housing); RIS: Resin Impregnated Synthetic (with polymer housing)

14.1 Bushings shall be robust and designed for adequate cantilever strength to meet the requirement of seismic condition, substation layout and movement along with the spare transformer/reactor with bushing erected and provided with proper support from one foundation to another foundation within the substation area. The electrical and mechanical characteristics of bushings shall be in accordance with IS/IEC: 60137. All details of the bushing shall be submitted for approval and design review.

14.2 Oil filled condenser type bushing shall be provided with at least following fittings:

- a) Oil level gauge
- b) Tap for capacitance and tan delta test. Test taps relying on pressure contacts against the outer earth layer of the bushing is not acceptable
- c) Oil filling plug & drain valve (if not hermetically sealed)

14.3 Porcelain used in bushing manufacture shall be homogenous, 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.

14.4 Bushing shall be provided with tap for capacitance and tan delta test. Test taps relying on pressure contacts against the outer earth layer of the bushing is not acceptable.

14.5 Where current transformers are specified, the bushings shall be removable without disturbing the current transformers.

14.6 Bushings of identical rating of different makes shall be interchangeable to optimize the requirement of spares..

14.7 Polymer insulator shall be seamless sheath of a silicone rubber compound. The housing & weather sheds should have silicon content of minimum 30% by weight. It should protect the bushing against environmental influences, external pollution and humidity. 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 technique being followed with detailed procedure and sampling shall be finalized during finalization of MQP. The weather sheds of the insulators shall be of alternate shed profile as per IS 16683-3/IEC 60815-3. The weather sheds shall be vulcanized to the sheath (extrusion process) or moulded 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 IS 9947. The strength of the weather shed to sheath interface shall be greater than the tearing strength of the polymer. The polymer insulator shall be capable of high pressure washing.

14.8 End fittings shall be free from cracks, seams, shrinks, air holes and rough edges. End fittings should be effectively, sealed to prevent moisture ingress, effectiveness of sealing system must be supported by test documents. All surfaces of the metal parts shall be perfectly smooth with the projecting points or irregularities which may cause corona. All load bearing surfaces shall be smooth and uniform so as to distribute the loading stresses uniformly.

- 14.9 The hollow silicone composite insulators shall comply with the requirements of IEC-61462 and the relevant parts of IEC-62217. The design of the composite insulators shall be tested and verified according to IEC-61462 (Type & Routine test).
- 14.10 Clamps and fittings shall be of hot dip galvanized/stainless steel.
- 14.11 Bushing turrets shall be provided with vent pipes, to route any gas collection through the Buchholz relay.
- 14.12 No arcing horns shall be provided on the bushings.
- 14.13 Corona shield, wherever required, shall be provided at bushing terminal (air end) to minimize corona.
- 14.14 Bushing shall be specially packed to avoid any damage during transit and suitable for long storage, with non-returnable packing wooden boxes with hinged type cover. Without any gap between wooden planks. Packing Box opening cover with nails/screws type packing arrangement shall not be acceptable. Manufacturer shall submit drawing/ documents of packing for approval during detail engineering. Detail method for storage of bushing including accessories shall be brought out in the instruction manual.
- 14.15 Oil end portion of RIP/RIS type bushings shall be fitted with metal housing with positive dry air pressure and a suitable pressure monitoring device shall be fitted on the metal housing during storage to avoid direct contact with moisture with epoxy. The pressure of dry air need to be maintained in case of leakage.
- 14.16 The terminal marking and their physical position shall be as per IS 2026.
- 14.17 Tan delta measurement at variable frequency (in the range of 20 Hz to 350 Hz) shall be carried out on each condenser type bushing (OIP & RIP/ RIS) at Transformer manufacturing works as routine test before despatch and the result shall be compared at site during commissioning to verify the healthiness of the bushing.
- 14.18 Tan δ value of RIP/RIS condenser bushing shall be 0.005 (max.) in the temperature range of 20°C to 90°C. The measured Tan δ value at site of in service bushing should not exceed by 0.001 w.r.t factory results (measured at approx. similar temperature conditions) during warrantee period. No temperature correction shall be allowed.**
- 14.19 Tan δ value of OIP bushing shall be 0.004 (max.) measured at ambient temperature. The measured Tan δ value at site of in service bushing should not exceed by 0.001 w.r.t factory results. No temperature correction shall be allowed.**

15 NEUTRAL FORMATION AND EARTHING ARRANGEMENT

15.0 For 3-Phase Unit

The neutral of the transformer shall be brought out through bushing. The neutral terminal of transformer shall be brought to the ground level by a brass/tinned copper grounding bar, supported from the tank by using porcelain insulators. The end of the brass/tinned copper bar shall be brought to a convenient location at the bottom of the tank, for making connection (using bimetallic strip of adequate size) to grounding mat through separate earth pits using two (2) numbers 75 x 12 mm galvanized steel flats. Aluminium clamps & connectors of suitable size shall be provided for connection with neutral of the transformer.

16 COOLING EQUIPMENT AND ITS CONTROL

16.0 Radiator based cooling for Power/Auto transformer

The transformer shall be designed with cooler system as specified in **Annexure-A** and with following provisions, as applicable:

- 16.0.1 The cooler shall be designed using separately mounted radiator banks or tank mounted radiators. Design of cooling system shall satisfy the performance requirements.
- 16.0.2 In case of separately mounted radiator bank arrangement, radiator bank shall generally be placed on left side of the tank while watching from HV side of the transformer. However, the main tank shall have provision such that cooler banks can be placed on either side of the main tank by simple reconnection without the need of any extra member/pipe maintaining the electrical clearances.
- 16.0.3 The radiator shall be of sheet steel complying with IS 513 and minimum thickness 1.2 mm. Each radiator bank shall be provided with the following accessories:
 - (a) Cooling Fans, Oil Pumps, Oil Flow Indicator (as applicable)
 - (b) Top and bottom shut off valve of at least 80mm size
 - (c) Drain Valve and sampling valve
 - (d) Top and bottom oil filling valves
 - (e) Air release plug at top
 - (f) Two grounding terminals suitable for termination of two (2) Nos. 75x12 mm galvanized steel flats.
 - (g) Thermometer pockets fitted with captive screw caps at cooler inlet and outlet.
 - (h) Lifting lugs
- 16.0.4 Each radiator bank shall be detachable and shall be provided with flanged inlet and outlet

branches. Expansion joint (for separately/ ground mounted cooler banks) shall be provided on top and bottom cooler pipe connection.

- 16.0.5 One number standby fan shall be provided with each radiator bank.
- 16.0.6 Cooling fans shall not be directly mounted on radiator. The supporting frames for the cooling fans shall be fixed preferably on separate support or to the main tank in such a manner that the fan vibration does not affect the performance of the radiators and its valves. Fans shall be located so as to prevent ingress of rain water. Each fan shall be suitably protected by galvanized wire guard. The exhaust air flow from cooling fan shall not be directed towards the main tank in any case.
- 16.0.7 Two (2) nos., 100% centrifugal or axial in line oil pumps, if applicable, (out of which one pump shall be standby) shall be provided with each radiator bank. Measures shall be taken to prevent mal- operation of Buchholz relay when all oil pumps are simultaneously put into service. The pump shall be so designed that upon failure of power supply to the pump motor, the pump impeller will not limit the natural circulation of oil.
- 16.0.8 The changeover to standby oil pump in case of failure of service oil pump shall be automatic.
- 16.0.9 An oil flow indicator shall be provided for the confirmation of the oil flow direction. An indication in the flow indicator and potential free contacts for remote alarm shall be provided.
- 16.0.10 Valves shall be provided across the pump and oil flow indicator to avoid oil drain and long outage during maintenance / replacement of pump and oil flow indicator.
- 16.0.11 Cooling fans and oil pump motors shall be suitable for operation from 415 volts, three phase 50 Hz power supply and shall be of premium efficiency class IE3 conforming to IS: 12615. Each cooling fan and oil pump motors shall be provided with starter, thermal overload and short circuit protection. The motor winding insulation shall be conventional class 'B' type. Motors shall have hose proof enclosure equivalent to IP: 55 as per IS/IEC 60034-5.
- 16.0.12 The cooler pipes, support structure including radiators and its accessories shall be hot dip galvanized or corrosion resistant paint should be applied to external surface of it.
- 16.0.13 Air release device and oil plug shall be provided on oil pipe connections. Drain valves shall be provided in order that each section of pipe work can be drained independently.
- 16.0.14 Automatic operation control of fans/pumps shall be provided (with temperature change) from contacts of winding temperature indicator. The manufacturer shall recommend the setting of WTI for automatic changeover of cooler control over entire operating range depending on types of cooling system like ONAN/ONAF/OFAF (or ODAF) or ONAN/ONAF1/ONAF2. The setting shall be such that hunting i.e. frequent start-up operations for small temperature differential do not occur.

16.0.15 Suitable manual control facility for cooler fans and oil pumps shall be provided. Selector switches and push buttons shall also be provided in the cooler control cabinet to disconnect the automatic control and start/stop the fans and pump manually.

16.0.16 Following lamp indications shall be provided in cooler control cabinet:

- a) Cooler Supply failure (main)
- b) Cooler supply changeover
- c) Cooler Supply failure (standby)
- d) Control Supply failure
- e) Cooling fan supply failure for each bank
- f) Cooling pump supply failure for each pump
- g) Common thermal overload trip
- h) Thermal overload trip for each fan/pump
- i) No oil flow/reverse flow for pumps
- j) Stand by fan/pump ON

One potential free initiating contact for all the above conditions shall be wired independently to the terminal blocks of cooler control cabinet and for single phase unit connection shall be extended further to Common Marshalling Box.

16.0.17 The Cooler Control Cabinet/ Individual Marshalling Box shall have all necessary devices meant for cooler control and local temperature indicators. All the contacts of various protective devices mounted on the transformer and all the secondary terminals of the bushing CTs shall also be wired up to the terminal board in the Cooler Control Cabinet/Individual Marshalling Box. All the CT secondary terminals in the Cooler Control Cabinet shall have provision for shorting to avoid CT open circuit while it is not in use.

16.0.18 All the necessary terminations for remote connection to Purchaser's panel shall be wired upto the Common Marshalling Box (in case of 1- Ph unit) or Marshalling Box (3-Ph unit).

16.0.19 AC power for Cooler Control Circuitry shall be derived from the AC feeder. In case auxiliary power supply requirement for Cooler Control Mechanism is different than station auxiliary AC supply, then all necessary converters shall be provided.

17 VALVES

17.0 Type of valves shall be used for transformer as per following table. The location and size of valves for other application shall be finalized during design review. DTL may specify any other valve required for some other applications.

Sr. No.	Description of Valve	Type
1	Drain Valve	Gate

2	Filter valve	Gate
3	Sampling Valve	Globe
4	Radiator isolation valve	Butterfly
5	Buchholz relay isolation valve	Gate
6	Sudden pressure relay	Gate
7	OLTC- tank equalizing valve	Gate / Needle
8	OLTC Drain cum filling valve	Gate
9	Valve for vacuum application on Tank	Gate
10	Conservator Drain valve	Gate
11	Aircell equalizing valve	Gate/Globe/Ball
12	Valve for Conservator vacuum (top)	Gate
13	Filter valve for Cooler Bank (Header)	Gate
14	Cooler Bank isolation valve	Butterfly
15	Pump Isolation valve	Butterfly
16	Valve for N2 injection (NIFPS)	Gate
17	Valve for NIFPS Drain	Gate
18	Valve for UHF Sensors (applicable for 400kV voltage class Trans- former only)	Gate

- 17.1 All valves up to and including 50 mm shall be of gun metal or of cast steel. Larger valves may be of gun metal or may have cast iron bodies with gun metal fittings. They shall be of full way type with internal screw and shall open when turned counter clock wise when facing the hand wheel.
- 17.2 Suitable means shall be provided for locking the valves in the open and close positions. Provision is not required for locking individual radiator valves.
- 17.3 Each valve shall be provided with the indicator to show clearly the position (open/close) of the valve.
- 17.4 Gland packing/gasket material shall be of “O” ring of nitrile rubber for all the valve’s flanges. All the flanges shall be machined.

- 17.5 Drain valves/plugs shall be provided in order that each section of pipe work can be drained independently.
- 17.6 All valves in oil line shall be suitable for continuous operation with transformer oil at 115 deg C.
- 17.7 After testing, inside surface of all cast iron valves coming in contact with oil shall be applied with one coat of oil resisting paint/varnish with two coats of red oxide zinc chromate primer followed by two coats of fully glossy finishing paint conforming to IS: 2932 and of a shade (Preferably red or yellow) distinct and different from that of main tank surface. Outside surface except gasket setting surface of butterfly valves shall be painted with two coats of red oxide zinc chromate conforming to IS: 2074 followed by two coats of fully glossy finishing paint.
- 17.8 The oil sampling point for main tank shall have two identical valves put in series. Oil sampling valve shall have provision to fix rubber hose of 10 mm size to facilitate oil sampling.
- 17.9 Valves or other suitable means shall be provided to fix various on line condition monitoring systems, if specified, to facilitate continuous monitoring. The location & size of the same shall be finalized during detail design review.
- 17.10 All hardware used shall be hot dip galvanized/stainless steel.
- 17.11 Flow sensitive conservator Isolation valve
- a) In order to restrict the supply of oil in case of a fire in transformer, flow sensitive valve shall be provided to isolate the conservator oil from the main tank. The valve shall be flow sensitive and shut off when the flow in the pipe is more than the flow expected in the permissible normal operating conditions. It shall not operate when oil pumps are switched on or off. This valve shall be located in the piping between the conservator and the buchholz relay and shall not affect the flow of oil from and to the conservator in normal conditions.
 - b) When the flow from conservator to main tank is more than the normal operating conditions, the valve shall shut off by itself and will have to be reset manually. It shall be provided with valve open/close position indicator along with alarm contact indication in control room during closing operation of valve. This valve shall be provided with locking arrangement for normal position and oil filling / filtration position. A suitable platform or ladder shall be provided to approach the valve for manual reset.

18 CABLING

- 18.0 All interconnecting control and power cables emanating from various parts of transformer like turret CT, MBs, Fans, pumps, Buchholz, PRD etc. shall be routed through covered cable tray or GI conduit and shall be properly dressed. All cables shall be armoured type. Un-armoured cables (if provided) in any circuitry, shall be through GI conduit and no part shall be exposed. Cable terminations shall be through stud type TB and ring type lugs. Type tested cables from approved sources shall be provided. Both ends of all the wires (control & power) shall be provided with proper ferrule numbers for tracing and maintenance. Further, any special cables (if required) shall also be considered included in the scope. All cable accessories such as glands, lugs, cable tags/ numbers etc. as required shall be considered included in the scope of supply. Typical technical specification for cables is attached at **Annexure-K**. The cross section of “control cable” shall

be 1.5 sq.mm (minimum) except for CT circuits which should be 2.5 sq.mm (minimum).

- 18.1 Cabling of spare unit of transformer with isolator switching arrangement shall be in such a way that spare unit can be brought into service in case of failure/ outage of a healthy unit without physically shifting. All control, protection, indication signals of spare unit shall be brought to the Common Marshalling Box (CMB) of all the banks. From CMB all the control, protection and indication signals of R, Y, B and Spare units shall be transferred to Purchaser's Control panels/SCADA. Change-over of spare unit signals with faulty unit shall be done through Purchaser's C & R panels / SCADA level. Changeover of RTCC signals shall be carried out in CMB. Plug & socket arrangement shall be provided for quicker transition of faulty unit to spare unit to avoid interconnection errors.

19 TAP CHANGING EQUIPMENT

The transformer shall be provided with On Load Tap changing equipment as specified in **Annexure-A** and shall comply with IS 8468-1/IEC 60214-1.

19.0 On Load Tap Changing (OLTC) Equipment

19.0.1 Main OLTC Gear Mechanism

- 19.0.2 Three phase transformer as specified in **Annexure-A** shall be provided with voltage control equipment of the tap changing type for varying its effective transformation ratio whilst the transformers are on load. The OLTC shall conform to IS 8468/IEC 60214 (Part 1& 2). The requirement of voltage regulation (on HV or LV sides), location (physical and electrical) of tap winding (end of common/ series winding or at neutral end), range of voltage variation, no. of

- 19.0.3 steps etc. shall be as given in **Annexure-A**.

- 19.0.4 The OLTC shall be of high speed transition resistor type. OLTC shall be motor operated suitable for local as well as remote operation. The diverter switch or arcing switch shall be designed so as to ensure that its operation once commenced shall be completed independently of the control relays or switches, failure of auxiliary supplies etc. To meet any contingency which may result in incomplete operation of the diverter switch, adequate means shall be provided to safeguard the transformer and its ancillary equipment. The current diverting contacts shall be housed in a separate oil chamber not communicating with the oil in main tank of the transformer and the chamber shall be designed to withstand the vacuum. The contacts shall be accessible for inspection without lowering oil level in the main tank and the contacts shall be replaceable.

- 19.0.5 The voltage class, maximum tapping current, step voltage of OLTC shall have adequate design margin for safe & reliable service life of both OLTC and transformer. OLTC shall have long contact life, quick & easy to disassemble diverter switch inserts, simple to adjust & control and easy to replace diverter's contacts etc.

- 19.0.6 Necessary safeguards shall be provided to avoid harmful arcing at the current diverting contacts in the event of operation of the OLTC gear under overload conditions of the transformer.

- 19.0.7 The OLTC oil chamber shall have oil filling and drain valve, oil sampling valve, relief vent and level glass. Oil sampling valve, accessible from ground, shall be provided to take sample of oil from the OLTC chamber. It shall also be fitted with an oil surge relay which shall be connected between OLTC oil chamber and OLTC conservator tank. Provision of a suitable device like tie-in-resistor has to be made, wherever required, to limit the recovery voltage to a safe value.

The use of tie-in-resistor (if used) shall be clearly marked in rating and diagram plate of the transformer. The whole of the driving mechanism shall be of robust design and capable of giving satisfactory service without undue maintenance.

19.0.8 Tap changer shall be so mounted that bell cover of transformer can be lifted without removing connections between windings and tap changer.

19.0.9 Local OLTC Control Cabinet (Drive Mechanism Box)

19.0.8.1 OLTC shall be suitable for manual (handle operated) and electrical (motor operated) operation. For local manual operation from Local OLTC Control cabinet (Drive Mechanism Box), an external handle shall be provided.

19.0.8.2 OLTC's Local control cabinet shall be mounted on the tank in accessible position. The cranking device/handle for manual operation for OLTC gear shall be removable and suitable for operation by a man standing at ground level (preferably at a height less than 1800mm). The mechanism shall be complete with the following:

- (a) Mechanical tap position indicator, which shall be clearly visible near the transformer.
- (b) A mechanical operation counter of at least five digits shall be fitted to indicate the number of operations completed and shall have no provision for resetting.
- (c) Mechanical stops to prevent over-cranking of the mechanism beyond the extreme tap positions.
- (d) The manual control, considered as back up to the motor operated on load tap changer control, shall be interlocked with the motor to block motor start-up during manual operation.
- (e) The manual operating mechanism shall be labelled to show the direction of operation for raising the voltage and vice-versa.
- (f) An electrical interlock to cut-off a counter impulse for reverse step change being initiated during a progressing tap change, until the mechanism comes to rest and resets circuits for a fresh position.

19.0.8.3 For electrical operation from local as well as remote, motor operated mechanism shall be provided. It shall not be possible to operate the electric drive when the manual operating gear is in use. It shall not be possible for any two controls to be in operation at the same time. Transfer of source in the event of failure of operating AC supply shall not affect the tap changer. Thermal device or other means shall be provided to protect the motor and control circuit.

19.0.8.4 The Local OLTC Drive Mechanism Box shall house all necessary devices meant for OLTC control and indication. It shall be complete with the following:

- (g) A circuit breaker/contactors with thermal overload devices for controlling the AC Auxiliary supply to the OLTC motor
- (h) Emergency Push Button to stop OLTC operation

- (i) Cubicle light with door switch
- (j) Anti-condensation metal clad heaters to prevent condensation of moisture
- (k) Padlocking arrangement (or locking arrangement suitable for long term operation) for hinged door of cabinet
- (l) All contactors relay coils and other parts shall be protected against corrosion, deterioration due to condensation, fungi etc.
- (m) The cabinet shall be tested at least IP 55 protection class.

19.0.8.5 In case auxiliary power supply requirement for OLTC Drive Mechanism (DM) Box is different than station auxiliary AC supply, then all necessary converters shall be provided.

19.0.8.6 Operating mechanism for on load tap changer shall be designed to go through one step of tap change per command only, until the control switch is returned to the off position between successive operations/ repeat commands.

19.0.8.7 Limit switches shall be provided to prevent overrunning of the mechanism and shall be directly connected in the control circuit of the operating motor provided that a mechanical de-clutching mechanism is incorporated. In addition, a mechanical stop shall be provided to prevent over-running of the mechanism under any condition. An interlock to cut-out electrical control when it tends to operate the gear beyond either of the extreme tap positions.

19.0.8.8 OLTC local control cabinet shall be provided with tap position indication for the transformer. Drive Mechanism shall be equipped with a fixed resistor network capable of providing discrete voltage steps or provide 4-20mA transducer outputs for tap position indication and input to digital RTCC/relevant BCU (as applicable)/SCADA system. The tap position indicator shall also be provided in control room.

19.0.8.9 Local-remote' selector switch shall be provided in the local OLTC control cabinet. In Local mode, all electrical commands from remote (i.e. from CMB, digital RTCC, SCADA, SAS etc.) shall be cut- off/blocked. Electrical operations to change tap positions shall be possible by using raise/lower push buttons under local mode from Driving Mechanism (DM) Box. In remote mode electrical commands from CMB/ digital RTCC/SCADA/SAS etc. shall be executed. The remote-local selector switch shall be having at-least two spare contacts per position.

19.0.8.10 For 3-phase transformer, the following minimum LED indications shall be provided in DM box:

- (n) INCOMPLETE STEP
- (o) OLTC motor overload protection operated
- (p) Supply to DM Motor fail
- (q) OLTC IN PROGRESS
- (r) Local / Remote Selector switch positions of DM
- (s) OLTC upper/lower limits reached

- (t) 415V Main AC supply ON
- (u) 415V Standby AC supply ON

19.0.8.11 The following minimum contacts shall be available in DM Box. For three phase unit, and these contacts shall be further wired to digital RTCC panel/relevant BCU (as applicable):

- (v) INCOMPLETE STEP which shall not operate for momentary loss of auxiliary power.
- (w) OLTC motor overload protection
- (x) Supply to DM Motor fail
- (y) OLTC IN PROGRESS
- (z) Local/Remote Selector switch position
- (aa) OLTC upper/lower limits reached

19.0.8.12 All relays, switches, fuses etc. shall be mounted in the OLTC local control cabinet and shall be clearly marked/ labelled for the purpose of identification. Both ends of all the wires (control & power) connected to Drive Mechanism Box must be provided with proper ferrule nos. for tracing and maintenance.

19.0.8.13 A permanently legible lubrication chart and control circuit drawing shall be fitted within the OLTC local control cabinet.

19.0.10 Remote Control & Monitoring of OLTC (through Bay Control Unit/Digital RTCC Relay, as applicable)

Requirement of digital RTCC relays may be specified by DTL for existing conventional substations. For substations having Substation Automation System, Control & monitoring of OLTC shall be carried out through Substation Automation System. All the functionalities specified for digital RTCC shall be realized in soft logic in Substation Automation System. All hardwire signals from/to OLTC shall be wired to Bay Control Units (BCUs) provided by DTL/contractor, as applicable. Wherever, digital RTCC relay is required following specification may be followed.

- a) The digital RTCC relay shall have Automatic Tap Changer control and monitoring relay with Automatic Voltage Regulating features to remotely control and monitor OLTC.
- b) Each digital RTCC relay shall be used to control 1 bank of transformers (i.e. 1 No. 3-Phase unit). No. of relays including spare relay, if any, shall be specified by the utility as per requirement.
- c) All digital relays can be housed in a single digital RTCC panel in control room or in the BCU panel in kiosks located in the switchyard.
- d) For existing substations, the requirement of digital RTCC panel and relays shall be specified. However, availability of existing RTCC schemes /Digital RTCC relays need to be specified to finalize matching digital RTCC relays. The Digital RTCC relays envisaged for existing transformers shall be integrated for parallel operations. All required cables for the same shall be deemed to be included in the scope.
- e) Digital RTCC relay shall be microprocessor based adopting the latest state of the art design &

technology with in-built large LCD (or better) display for ease of programming and viewing. The unit supplied shall be field programmable so that in the event of change in transformer/location, it could be customized to suit site conditions without sending back to works. The programming shall be menu driven and easily configurable. If it is designed with draw out type modules, it should take care of shorting all CT inputs automatically while drawing out. The CT/VT ratio shall be field programmable and Relay shall display the actual HV Voltage and current considering suitable multiplying factors. The system shall be self-sufficient and shall not require any additional devices like parallel balancing module etc.

- f) It shall be possible to communicate/integrate with all digital RTCC relays of different make located at different locations in the substation by making hardwire and using IS/IEC 61850 communication link. The integration of existing conventional RTCC panel with digital RTCC panel of different make shall also be possible.
- g) The digital RTCC relay shall have Raise/Lower push buttons, Manual/ Automatic mode selection feature, Local/Remote selection feature, Master / Follower/ Independent/ Off mode selection feature for control of OLTC. Touch screen option in the relay (instead of electrical push button/switch) is also acceptable.
- h) The digital RTCC Relay shall have multiple selectable set point voltages and it shall be possible to select these set points from SCADA/ SAS, with a facility to have the possibility of additional set points command from SCADA/ SAS.
- i) **In Manual Mode:** In this mode, power system voltage based automatic control from digital RTCC relay shall be blocked and commands shall be executed manually by raise/lower push buttons.
- j) **In Auto Mode:** In Auto mode, digital RTCC relay shall automatically control OLTC taps based on power system voltage and voltage set points. An interlock shall be provided to cut off electrical control automatically upon recourse being taken to the manual control in emergency.
- k) **Master/Follower/Independent/Off mode :** Master/Follower/Independent/Off mode is required in Digital RTCC relay for parallel/group operation of transformers. Master-follower scheme implies that controlled decision shall be taken by the Master and control actions (Raise/Lower tap position) shall be executed simultaneously by Master & Follower units. Same logic needs to be implemented in digital RTCC relays.
- l) **Master Position:** If the digital RTCC relay is in master position, it shall be possible to control the OLTC units of other parallel operating transformers in the follower mode by operation from the master unit.
- m) **Follower Position:** If the digital RTCC relay is in Follower position, control of OLTC shall be possible only from panel where master mode is selected.
- n) **Independent Position:** In independent position of selector switch, control of OLTC shall be possible only from the panel where independent mode is selected.
- o) Suitable interlock arrangement shall be provided to avoid unwanted/inconsistent operation of OLTC of the transformer
- p) **Raise/Lower control:** The remote OLTC scheme offered shall have provision to raise or lower taps for the complete bank of three 1-phase transformers / 3-Phase Transformers. Individual 1-phase OLTC operation shall not be possible from the remote control panel.
- q) Digital RTCC relays shall communicate with SCADA using IS/IEC 61850 through fibre optic port to monitor, parameterise and control the OLTC. Any software required for this purpose shall be supplied. The supplied software shall not have restriction in loading on multiple computers for downloading and analyzing the data. Software shall indicate the current overview of all measured parameters of the connected transformer in real time.

- r) Communication between the Digital RTCC relays to execute the commands for parallel operation shall be implemented using required communication protocol. Suitable communication hardware shall be provided to communicate up to distance of 1 km between digital RTCC relays. Scope shall also include communication cables between digital RTCC relays. Cables as required for parallel operation of OLTCs of all transformers (including existing transformers wherever required) from Digital RTCC relays shall be considered included in the scope.
- s) The Digital RTCC relay shall have additional programmable Binary Inputs (minimum 7 Nos.) and Binary outputs (minimum 7 Nos.) for future use. It shall be possible to have additional module for Binary Input / output as well as Analogue input module depending upon requirement.
- t) The relays shall ensure completion of lowering/raising of the OLTC tap, once the command is issued from the relay. "Step-by-Step" operation shall be ensured so that only one tap change from each tap changing pulse shall be effected. If the command remains in the "operate" position, lock-out of the mechanism is to be ensured.
- u) The relay shall incorporate an under voltage / over voltage blocking facility which shall make the control inoperative if voltage falls/ rises by percentage value of set point value with automatic restoration of control when nominal voltage rises / falls to value.
- v) The relay shall have facility to monitor operating hours of tap changer and register the tap changer statistics. In the statistics mode, the relay shall display the no. of tap changing operations occurred on each tap.
- w) The relay shall have self-check of power on and shall continually monitor all functions and the validity of all input values to make sure the control system is in a healthy condition. Any monitoring system problem shall initiate the alarm.
- x) Following minimum indications/alarms shall be provided in Digital RTCC relay either through relay display panel or through relay LEDs:
 - INCOMPLETE STEP alarm
 - OLTC motor overload protection alarm
 - Supply to DM Motor fail alarm
 - OLTC IN PROGRESS alarm
 - Local / Remote Selector switch positions in DM Box
 - OLTC upper/lower limits reached alarm
 - OLTC Tap position indications for transformer units
 - Independent-combined-remote selector switch positions of CMB (in case of single phase transformer)
 - 415V, AC Main Supply Fail.
 - 415V, AC Standby Supply Fail

20.0 SCADA INTEGRATION (if applicable)

All the online monitoring equipment i.e. Optical Temperature Sensors & Measuring Unit, Online Dissolved Gas (Multi-gas) and Moisture Analyzer, On-line insulating oil drying system (Cartridge type) etc. provided for individual transformer unit including spare unit (if any), shall be IS/IEC 61850 compliant (either directly or through a Gateway). These monitoring equipment are required to be integrated with SAS through managed Ethernet switch conforming to IS/IEC 61850. This Ethernet switch shall be provided in IMB (for 3-Ph unit) / CMB (for 1-Ph unit). The switch shall be powered by redundant DC supply (as per available Station DC supply). Ethernet switch shall be suitable for operation at ambient temperature of 50 Deg C. All required power & control cables including optical cable, patch chord

(if any) up to IMB (for 3-Ph unit) / CMB (for 1-Ph unit), all the cables from RTCC to DM and any special cable between IMB (for 3-Ph unit) / CMB (for 1-Ph unit) to switchyard panel room/control room shall be in the scope.

However, fiber optic cable, power cable, control cables, as applicable, between IMB (for 3-Ph unit) / CMB (for 1-Ph unit) to switchyard panel room/control room and power supply (AC & DC) to MB and integration of above said IS/IEC-61850 compliant equipment with Substation Automation System may be a part of sub-station contract.

Cooling and OLTC of transformers shall also be monitored and controlled from SCADA. List of Signal exchange between Transformer and SCADA may be mutually agreed between the owner and manufacturer. Owner/contractor, as applicable, shall ensure provision of adequate number of redundant Bay control Units (BCUs).

21.0 CONSTRUCTIONAL FEATURES OF COOLER CONTROL CABINET/ INDIVIDUAL MARSHALLING BOX/ COMMON MARSHALLING BOX/ OUTDOOR CUBICLE/DIGITAL RTCC PANEL

- 21.1 Each transformer unit shall be provided with local OLTC Drive Mechanism Box (DMB), Cooler Control Cabinet/Individual Marshalling Box, Digital RTCC panel (as applicable). Each reactor unit shall be provided with Individual Marshalling Box.
- 21.2 Individual Marshalling Box (IMB) and Cooler Control Box shall be tank mounted or ground mounted. All cabinets shall be tank mounted. All separately mounted cabinets and panels shall be free standing floor mounted type and have domed or sloping roof for outdoor application. The gland plate shall be at least 450 mm above ground level.
- 21.3 The Cooler Control Cabinet (CCC)/Individual Marshalling Box (IMB), Common Marshalling Box (CMB), and all other outdoor cubicles (except OLTC Drive Mechanism box) shall be made of stainless steel sheet of minimum Grade SS 304 and of minimum thickness of 1.6 mm. Digital RTCC panel shall be made of CRCA sheet of minimum thickness of 2.0 mm and shall be painted suitably as per **Annexure– K**.
- 21.4 The degree of protection shall be IP: 55 for outdoor and IP: 43 for indoor in accordance with IS/IEC: 60947.
- 21.5 All doors, removable covers and plates shall be gasketed all around with suitably profiled. All gasketed surfaces shall be smooth straight and reinforced if necessary to minimize distortion to make a tight seal. For Control cubicle/Marshalling Boxes etc. which are outdoor type, all the sealing gaskets shall be of EPDM rubber or any other (approved) material of better quality, whereas for all indoor control cabinets/Digital RTCC panel, the sealing gaskets shall be of neoprene rubber or any other (approved) material of better quality. The gaskets shall be tested in accordance with

approved quality plan and IS: 3400.

21.6 All the contacts of various protective devices mounted on the transformer and all the secondary terminals of the bushing CTs shall also be wired up to the terminal board in the Marshalling Box. All the CT secondary terminals in the Marshalling Box shall have provision for shorting to avoid CT open circuit while it is not in use. All the necessary terminations for remote connection to Purchaser's panel shall be wired up to the Common Marshalling Box.

21.7 Ventilating Louvers, if provided, shall have screen and filters. The screen shall be fine wire mesh of brass. All the control cabinets shall be provided with suitable lifting arrangement. Thermostat controlled space heater and cubicle lighting with ON-OFF switch shall be provided in each panel.

22.0 AUXILIARY POWER SUPPLY FOR OLTC, COOLER CONTROL AND POWER CIRCUIT

22.1 For Three Phase Transformer

22.1.1 Two auxiliary power supplies of 415 volt, three phase four (4) wire shall be provided by the Purchaser at Cooler Control Cabinet / Marshalling Box. All loads shall be fed by one of the two sources through an electrically interlocked automatic transfer scheme housed in the Cooler Control Cabinet/Marshalling Box.

22.1.2 For each circuit, suitably rated power contactors, MCBs/MCCBs as required for entire auxiliary power supply distribution scheme including distribution to DM boxes, Online Gases and moisture monitoring system, Online drying system and Fibre optic sensor Box etc. (as applicable), shall be provided in cooler control cabinet/ Marshalling Box.

22.1.3 Auxiliary power supply distribution scheme shall be submitted for approval. Supply and laying of Power, Control and special cables from marshalling box to all accessories is in the scope of the manufacturer/contractor (as applicable). Further any special cable (if required) from MB to Owner's Control Panels/Digital RTCC panels is also in the scope of the manufacturer/contractor (as applicable).

22.1.4 All relays and operating devices shall operate correctly at any voltage within the limits specified below:

Normal Voltage	Variation in voltage	Frequency (in Hz)	Phase/Wire	Neutral connection
415 V	±10%	50±5%	3 Phase 4Wire	Solidly earthed
240 V	±10%	50±5%	1 Phase 2 Wire	Solidly earthed
220 V	190 V to 240 V	DC	Isolated 2 wire system	--

110 V	95 V to 120 V	DC	Isolated 2 wire system	--
48 V	--	DC	2 wire system (+) earthed	--

Combine variation of voltage and frequency shall be limited to $\pm 10\%$.

22.1.5 Design features of the transfer scheme shall include the following:

- a) Provision for the selection of one of the feeder as normal source and other as standby.
- b) Upon failure of the normal source, the loads shall be automatically transferred after an adjustable time delay to standby sources.
- c) Indication to be provided at cooler control cabinet/Individual Marshalling Box/Common Marshalling Box for failure of normal source and for transfer to standby source and also for failure to transfer.
- d) Automatic re-transfer to normal source without any intentional time delay following re-energization of the normal source.
- e) Both the transfer and the re-transfers shall be dead transfers and AC feeders shall not be paralleled at any time.

22.1.6 For spare unit which is not connected through isolator switching arrangement, 415 volt, three phase four (4) wire AC supply shall be provided for heater, On line drying system, On line DGA etc. as applicable.

23.0 BUSHING CURRENT TRANSFORMER AND NEUTRAL CURRENT TRANSFORMER

23.1 Current transformers shall comply with IS 16227 (Part 1 & 2)/IEC 61869 (part 1 & 2).

23.2 It shall be possible to remove the turret mounted current transformers from the Transformer tank without removing the tank cover. Necessary precautions shall be taken to minimize eddy currents and local heat generated in the turret.

23.3 Current transformer secondary leads shall be brought out to a weather proof terminal box near each bushing. These terminals shall be wired out to common marshalling box using separate cables for each core.

23.4 Technical Parameters of Bushing CTs and Neutral CTs are provided at **Annexure–B**. The CTs used for REF protection must have the identical parameters in order to limit the circulating current under normal condition for stability of protection. Bushing Current Transformer parameters indicated in this specification are tentative and liable to change within reasonable limits. DTL's approval shall be obtained before proceeding with the design of bushing current transformers.

- 23.5 Secondary resistance and magnetizing current characteristics of PS class (protection) CT of same rating shall be similar. This is applicable for Neutral CT (outdoor) also and shall be reviewed during detail engineering.

24.0 TOOLS & TACKLES

Each transformer shall be supplied with a full kit of tools & spanners of required sizes; bushing handling & lifting tools with nylon rope/belt, with a rack for holding them; required numbers of hydraulic jacks for lifting the transformers, and for changing the plane of rotation of wheels. All spanners shall be single ended and case hardened. Tirfors with wire rope and slings with grippers etc. for hauling the transformer to the plinth are to be supplied along with each transformer.

25.0 FITTINGS & ACCESSORIES

The following fittings & accessories shall be provided with each transformer covered in this specification. The fittings listed below are not exhaustive and other fittings which are required for satisfactory operation of the equipment are deemed to be included.

For Transformer

- (a) Conservator for main tank with air cell, oil filling hole and cap, isolating valves, drain valve, magnetic oil level gauge, prismatic oil level gauge and dehydrating silica gel filter breather with flexible connection pipes to be used during replacement of any silica gel breather.
- (b) Conservator for OLTC (for transformer) with drain valve, oil surge relay, filling hole with cap, magnetic oil level gauge, prismatic oil level gauge and dehydrating breather (for transformer only) with flexible connection pipes to be used during replacement of any silica gel breather.
- (c) Pressure relief devices with special shroud to direct the hot oil
- (d) Sudden pressure relief relay (for 220 kV and above Transformer)
- (e) Buchholz relay (double float, reed type) with isolating valves on both sides, bleeding pipe with pet cock at the end to collect gases and alarm/trip contacts.
- (f) Conservator air cell rupture detection relay
- (g) Air release plug
- (h) Inspection openings and covers
- (i) Bushing of each type with metal parts and gaskets to suit the termination arrangement
- (j) Winding & Oil temperature indicators (local & remote)

- (k) Cover lifting eyes, transformer/reactor lifting lugs, jacking pads, towing holes and core and winding lifting lugs
- (l) Protected type alcohol in glass thermometer or magnetic or micro- switch type dial type temperature indicator as applicable (mercury should not be used)
- (m) Rating and diagram plates (in English & Hindi or as specified by the utility) on transformers and auxiliary apparatus
- (n) Roller Assembly (flanged bi-directional wheels)
- (o) One complete set of all metal blanking plates & covers
- (p) On load tap changing gear, OLTC DM Box, individual marshalling box/Common Marshalling Box, Cooler control cabinet, and Digital RTCC Panel as applicable.
- (q) Cooling equipment including fans & pumps (as applicable)
- (r) Bushing current transformers, Neutral CT (as applicable)
- (s) Oil/water flow indicators (as applicable)
- (t) Terminal marking plates
- (u) Valves schedule plate
- (v) Bottom oil sampling valve, Drain valves (provided to drain each section of pipe work independently), Filter valves at top and bottom with threaded male adaptors, Shut off valves on the pipe connection between radiator bank & the main tank, Shut off valves on both sides of Buchholz relay, Sampling gas collectors for Buchholz relay at accessible height, Valves for Radiators, Valve for vacuum application, Valves for cable box (if applicable), Valve for on line DGA (if applicable), valves for Drying out system (if applicable), water inlet and outlet valves (applicable for water cooled transformers), Flow sensitive Conservator Isolation Valve (if applicable), Gate Valve (4 Nos. of min. 50 NB) for UHF sensors for PD Measurements (applicable for 400kV and above voltage class Transformer only), valves for firefighting system (as applicable) and other valves as specified in the specification.
- (w) Ladder (suitably placed to avoid fouling with bushing or piping) to climb up to the transformer tank cover with suitable locking arrangement to prevent climbing during charged condition. Additional ladder for conservator in case it is not tank mounted .
- (x) Suitable platform for safe access of flow sensitive non-return valve and buchholz relay shall be provided, in case these are not accessible from transformer/reactor top.
- (y) Haulage/ lifting lugs
- (z) Suitable terminal connectors on bushings

- (aa) Suitable neutral bus connection
 - (bb) Suitable terminal connectors of surge arrester
 - (cc) Brass/tinned copper grounding bar supported from the tank by using porcelain insulator and flexible conductor for earthing of neutral, HV & IV terminals as per specification
 - (dd) On line insulating oil drying system (in 400 kV and above level Transformers) if given in BPS.
- (Annexure-P)**
- (ee) Oil Sampling Bottle & Oil Syringe (if specified) **(Annexure-M)**
 - (ff) NIFPES system as per scope and in line with specifications of DTL.

26.0 Quality Assurance Programme, Inspection and Testing

The manufacturer shall draw up and carry out a comprehensive inspection and testing programme in the form of detailed quality plan duly approved by DTL for necessary implementation during manufacture of the equipment. The Quality Assurance programme shall be generally in line with latest ISO-9001 (Quality Management System), ISO-14001 (Environmental Management System) and OHSAS 18001 (Occupational Health and Safety Management System). The manufacturer shall use state-of-the-art technology and dirt, dust and humidity controlled environment during various processes of manufacturing and testing to ensure that end product is of good quality and will provide uninterrupted service for intended life period. An indicative list for facilities needed to be available at manufacturer's works has been provided at *Annexure-E*.

26.1 Inspection and Testing

The inspection envisaged by the purchaser is given below. However, the manufacturer shall draw up and carry out a comprehensive inspection and testing programme in the form of detailed quality plan duly approved by Purchaser for necessary implementation during manufacture of the equipment. All accessories and components of transformer shall be purchased from source, approved by the purchaser. All process tests, critical raw material tests and witness/ inspection of these testing shall be carried out as per approved Manufacturing Quality Plan (MQP) by the purchaser.

26.2 Factory Tests

- a) The manufacturer shall carry out all type & routine tests specified in “**Annexure-D**”. All tests shall be done in line with latest IS: 2026/IEC 60076 or as per procedure specified in this document. Complete test report shall be submitted to purchaser after proper scrutiny and signing on each page by the test engineer of the manufacturer.
- b) The manufacturer shall be fully equipped to perform all the required tests as specified. He shall confirm the capabilities of the proposed manufacturing plant in this regard. Any limitations shall be clearly stated.
- c) The manufacturer shall bear all additional costs related to tests which are not possible to carry

out at his own works.

- d) In case, any failure observed during factory testing involving winding/ winding shield/ static shield ring, then affected winding of all phases shall be replaced by new one mutually agreed between manufacturer & DTL.

26.3 Tank Tests

(A) Oil Leakage Test

All tanks and oil filled compartments shall be completely filled with air or oil of a viscosity not greater than that of insulating oil conforming to IEC 60296 at the ambient temperature and subjected to a pressure equal to normal head of oil plus 35 kN/sq.m (5 psi) measured at the base of the tank. This pressure shall be maintained for a period of not less than 12 hours for oil and 1 hour for air during which no leakage shall occur.

(B) Vacuum Test

All transformer tanks shall be subjected to the specified vacuum. The tank designed for full vacuum (760 mm of mercury at sea level) shall be tested at an internal pressure of 3.33 KN/Sq.m absolute (25 torr) for one hour. The permanent deflection of flat plate after the vacuum has been released shall not exceed the values specified below:

Horizontal Length of flat plate (in mm)	Permanent deflection (in mm)
Up to And including 750	5.0
751 To 1250	6.5
1251 To 1750	8.0
1751 To 2000	9.5
2001 To 2250	11.0
2251 To 2500	12.5
2501 to 3000	16.0
Above 3000	19.0

(C) Pressure Test

All transformer tanks, its radiator, conservator and other fittings together or separately shall be subjected to a pressure corresponding to twice the normal head of oil or normal oil head pressure plus 35 KN/ sq.m whichever is lower, measured at the base of the tank and maintained for eight hours. The permanent deflection of flat plates after the excess pressure has been released shall not exceed the figure specified above for vacuum test.

26.4 Stage Inspection

- a) Stage inspection will be carried out by the Inspector on Core, Winding, core-coil assembly & Tank during the manufacturing stages of the transformer. The manufacturer will have to call for the stage inspection and shall arrange the inspection at manufacturer's premises or manufacturer's sub-supplier's premises, as applicable, free of cost.
- b) **Stage inspection shall be carried out on all the Transformers to be supplied .Final decision to waive of any of stage inspection on any of the transformers to be supplied shall be with DTL and not with the bidder .** On the basis of satisfactory stage inspection, manufacturer will proceed further.
- c) The manufacturer will offer the core for stage inspection and get approval from purchaser during manufacturing stage. The BIS certified prime core materials are only to be used. The manufacturer has to produce following documents at the time of stage inspection for confirmation of use of prime core materials.
 - Invoice of supplier
 - Mill's approved test certificates
 - Packing list
 - Bill of lading
 - Bill of entry certificate by custom
 - Description of material, electrical analysis, physical inspection, certificate for surface defects, chemical composition certificate, thickness and width of the materials.
 - Place of cutting of core materials.

To avoid any possibility of mixing of 'Prime material' with any other second grade/ defective material, the imported packed slit coils of CRGO materials shall be opened in the presence of the Inspector. Only after the inspection and approval from DTL, the core material will be cut in-house or sent to external agency for cutting individual laminations. In case the core is sent to external agency for cutting, the Inspector will have full access to visit such agency for the inspection of the cutting of core. Core material shall be directly procured either from the manufacturer or through their accredited marketing organization of repute and not through any agent.

26.5 Type Tests on fittings

Following fittings shall conform to type tests and the type test reports shall be furnished along with drawing of the equipment/fittings.

- a) Bushing (Type test as per IS/IEC:60137) (Seismic withstand test for 400 kV and above voltage class)
- b) OLTC (Test as per IS 8468/IEC:60214 and degree of protection test for IP-55 on Driving mechanism box)
- c) Buchholz relay
- d) OTI and WTI
- e) Pressure Relief Device (including degree of protection test for IP 55 in terminal box)
- f) Sudden Pressure Relay (including degree of protection test for IP 55 in terminal box)
- g) Magnetic Oil Level gauge & Terminal Box degree of protection test for IP-55.
- h) Air Cell (Flexible air separator) - Oil side coating, Air side under Coating, Air side outer coating

- and coated fabric as per IS: 3400/ BS: 903/ IS: 7016
- i) Marshalling & common marshalling box and other outdoor cubicle (IP-55 test)
- j) Bus post Insulators
- k) Oil pump
- l) Cooling fan & motor assembly
- m) RTCC Panel (IP-43 test)

26.6 Pre-Shipment Checks at Manufacturer's Works

The following pre-shipment checks shall be done at manufacturer's works:

- Check for inter-changeability of components of similar transformers for mounting dimensions.
- Check for proper packing and preservation of accessories like radiators, bushings, dehydrating breather, rollers, Buchholz relay, fans, control cubicle, connecting pipes, conservator etc.
- Ensure following setting of impact recorder at the time of installation with transformer unit before despatch from factory:

1g: Start recording

2g: Warning

3g: Alarm

Further, drop-out setting shall be 1g and threshold setting shall be in the range of 5g to 10g.

- Check for proper provision for bracing to arrest the movement of core and winding assembly inside the tank.
- Gas tightness test to confirm tightness and record of dew point of dry air inside the tank. Derivation of leakage rate and ensure the adequate reserve dry air capacity.
- Due security arrangements to be ensured during transportation to avoid pilferage and tempering with the valves and other accessories used while dry air filling.

27.0 DRAWINGS/DOCUMENTS/CALCULATIONS

The list of drawing/documents/calculations to be submitted by the manufacturer is given in **Annexure-H**.

28.0 RATING & DIAGRAM PLATE

The transformer shall be provided with a rating plate of weatherproof material, fitted in a visible position, showing the appropriate items indicated below. The entries on the plate shall be in English in indelibly marked.

Information to be provided on the plate for Transformer:

Manufacturer's name, country and city where the transformer was assembled				
MVA Rating, Voltage ratio, Type of transformer (for example 315MVA 400/220/33kV Auto Transformer)				
Type of Cooling			Applicable Standard	
Rated Power at different cooling			Rated frequency	Hz
HV/IV	MVA	--/-- /--	Number of phases	
LV	MVA		% Impedance / Ohmic Impedance	
Rated Voltage			(a) HV-IV	
HV	kV		Min. tap	%
IV	kV		Principal Tap	%
LV	kV		Max. Tap	%
Rated Current			(b) HV-LV	%
HV	A		(c) IV-LV	%
IV	A		Vector Group	
LV	A		Core mass	kg
Rated Thermal Short Circuit withstand capability Current and Duration	kA		Copper Mass	
	(sec)			
Basic Insulation Level (Lightening Impulse/Switching Impulse/Power Frequency Withstand Voltage)			(a) HV	kg
HV	kVp/ kVp/ kVrms		(b) IV	kg

IV	kVp/ kVp/ kVrms		(c) LV	kg
LV	kVp/ kVp/ kVrms		(d) Regulating	kg
Neutral	kVp/ kVp/ kVrms		Core & Coil Mass	kg
Guaranteed Temperature rise over ambient temperature of 50 Deg. C			Transportation Mass	kg
(a) Top Oil	0C		Tank & Fitting mass	
(b) Winding	0C		Type & total mass of insulating oil	kg
Vacuum withstand Capability of the tank	mm of Hg		Total mass	kg
OLTC make and rating (current & Voltage class)			Quantity of oil in OLTC	Ltrs
Noise level at rated voltage and at principal tap	dB		Transformer oil Quantity	Ltrs
Tan delta of winding			Paint Shade	
Moisture content	ppm		No load loss at rated voltage & frequency	KW

Manufacturer's Serial number			Load loss at rated current & frequency (at 75 ⁰ C) for HV & IV/LV winding	KW
Year of Manufacture			I ² R loss at rated current & frequency (at 75 ⁰ C) for HV & IV/LV winding	KW
Work Order No.			Auxiliary loss at rated voltage & frequency	KW
Purchaser's Order No. & Date				
OGA Drg. No.				
Vector Group Diagram				
Winding Connection diagram (Connection between all windings including tap windings, ratings of built-in current transformers, etc. shall be presented on the diagram)				
Table giving details of OLTC like tap position Nos. and corresponding tapping voltage, tapping current & connection between terminals for different tap positions etc.				
Details of Current Transformers (e.g. Bushing CTs, CT for WTI) installed in transformer like the location, core Nos., ratio(s), accuracy class, rated output (VA burden), knee point voltage, magnetizing current, maximum CT secondary resistance, terminal marking and application of the current transformer				
Warning: "Main conservator is fitted with an air cell"				
Tie-in-resistor has been used in OLTC (if applicable)				
Purchaser's Name				

Plates with identification and characteristics of auxiliary equipment according to standards for such components (bushings, tap-changers, current transformers, cooling equipment etc.) shall be provided on the components themselves

29.0 RESPONSIBILITIES OF MANUFACTURER DURING WARRANTY PERIOD OF TRANSFORMER:

- 29.1 The long term performance of transformer depends on design/technology, quality of material used, robustness & consistency of manufacturing process, installation, operation and maintenance etc. The erection, testing and commissioning of transformer shall be performed under strict supervision of representative of OEM and DTL in line with the provisions specified in **Annexure-O**
- 29.2 When failures or operational problems occur within the warranty period, the manufacturer must take all necessary measures to help minimize operational difficulties and outages whenever possible. The following abnormalities, if occurs, will be brought to the notice of manufacturer and the manufacturer shall respond/ attend immediately, investigate and rectify the problem to avoid undue outage in the DTL network.
- a) Fault inside the transformer and OLTC (including oil migration) involving a shutdown of transformer at site after commissioning is to be attended by manufacturer immediately. It is the responsibility of the OEM to take immediate necessary action (e.g. any replacement/repair of component required with co- ordination from any third party, if required) for bringing back the transformer into service. The root cause analysis shall be undertaken by OEM and details shall be shared with DTL for the benefit of both user and OEM.
 - b) In case of DGA Status 3 (as per IEEE-C57.104) i.e. the concentration of any fault gas is exceeding the values in Table -2 of IEEE-C57.104 or the abnormal trend in variation of key fault gases is observed.
 - c) In case, the winding tan delta goes beyond 0.005 or increases more than 0.001 per annum w.r.t. pre-commissioning values.
 - d) In case, the tan delta of bushing(s) goes beyond 0.005 or increases more than 0.001 per annum w.r.t. pre-commissioning values.
 - e) In case, the moisture content goes above 10 ppm at any temperature during operation including full load.
 - f) Any major deviation in Sweep Frequency Response Analysis (SFRA).
 - g) Leakage of Oil from transformer shall be construed as a serious quality lapse on the part of the Original Equipment Manufacturer (OEM). No leakage of oil is expected during the operating life of the transformer and that should be ensured accordingly by OEM during design & construction of tank & other gasketed joints. In case of any leakage of oil during warranty period, the same shall be reported in writing to the OEM immediately and OEM shall have to attend and rectify the leakage within a period of 30 days from the date of notice, at the cost of the OEM.

30.0 LIST OF CODES/ STANDARDS/ REGULATIONS/ PUBLICATIONS

The list of Codes/Standards/Regulations/Publications which are generally used for manufacturing, testing, installation, maintenance, operation etc. of transformer is given at **Annexure-Q**.

31.0 Transportation, Erection, Testing and Commissioning:

The details of transportation, erection at site, testing and commissioning are detailed in **Annexure-O**.

SPECIFIC TECHNICAL REQUIREMENT OF TRANSFORMERS**1.0 500MVA, 400/220/33 kV 3-Ph Auto Transformer**

S. No.	Description	Unit	Technical Parameters
1.	Voltage ratio (Line-to-Line)	kV	(a) 400/220/33
2.	Rated Capacity		
	HV	MVA	500
	IV	MVA	500
	LV (Tertiary)	MVA	5 MVA active loading
3.	No of phases		3-phase
4.	Vector Group		YNaoD11
5.	Type of Transformer		Auto Transformer
6.	Applicable Standard		IEC 60076 / IS 2026
7.	Cooling		ONAN / ONAF / OFAF or ONAN / ONAF / ODAF or ONAN / ONAF1 / ONAF2
8.	Rating at different cooling	%	60 / 80 / 100
9.	Cooler Bank Arrangement		2 X 50%
10.	Frequency	Hz	50
11.	Tap Changer (OLTC)		+10% to -10% in 1.25% steps on common end of series winding for 400kV side voltage variation
12.	Impedance at 75°C, at highest MVA base		Constant Ohmic type
i)	HV – IV		
	Max. Voltage tap	%	10.3
	Principal tap	%	12.5
	Min. Voltage tap	%	15.4
ii)	HV – LV		
	At principal tap	%	60.0 (minimum)
iii)	IV – LV	%	45.0 (minimum)
13.	Tolerance on Impedance	%	As per IEC, unless specified Otherwise
14.	Service		Outdoor
15.	Duty		Continuous
16.	Overload Capacity		IEC-60076-7

17.	Temperature rise over 50°C ambient temp		
i)	Top oil measured by thermometer	O C	45
ii)	Average winding measured by resistance method	O C	50
18.	Winding hot spot rise over yearly weighted temperature of 32 °C	O C	61
19.	Tank Hotspot Temperature	O C	110
20.	Maximum design ambient temperature	O C	50
21.	Windings		
i)	Lightning Impulse withstand Voltage		
	HV	kVp	1300
	IV	kVp	950
	LV	kVp	250
	Neutral	kVp	95
ii)	Chopped Wave Lightning Impulse Withstand Voltage		
	HV	kVp	1430
	IV	kVp	1045
	LV	kVp	275
iii)	Switching Impulse withstand Voltage		
	HV	kVp	1050
	IV	kVp	850
iv)	One Minute Power Frequency withstand Voltage		
	HV	kVrms	570
	IV	kVrms	395
	LV	kVrms	95
	Neutral	kVrms	38
v)	Neutral Grounding		Solidly grounded
vi)	Insulation		
	HV		Graded
	IV		Graded
	LV		Uniform
vii)	Tertiary Connection		Ungrounded Delta
viii)	Tan delta of winding	%	≤0.5
22.	Bushing		
i)	Rated voltage		
	HV	kV	420
	IV	kV	245

	LV	kV	52
	Neutral	kV	36
ii)	Rated current		
	HV	A	1250
	IV	A	2000
	LV	A	3150
	Neutral	A	3150
iii)	Lightning Impulse withstand Voltage		
	HV	kV _p	1425
	IV	kV _p	1050
	LV	kV _p	250
	Neutral	kV _p	170
iv)	Switching Impulse withstand Voltage		
	HV	kV _p	1050
	IV	kV _p	850
v)	One Minute Power Frequency withstand Voltage		
	HV	kV _{rms}	695
	IV	kV _{rms}	505
	LV	kV _{rms}	105
	Neutral	kV _{rms}	77
vi)	Tan delta of bushing at ambient Temperature	%	As per clause no.14.17 and 14.18 of this specification
vii)	Minimum total creepage distances		(Specific creepage distance: 31mm/kV corresponding to the line to line highest system voltage)
	HV	Mm	13020
	IV	Mm	7595
	LV	Mm	1612
	Neutral	Mm	1116
viii)	Maximum Partial discharge level at U _m		
	HV	pC	10
	IV	pC	10
	LV	pC	10
23.	Maximum Partial discharge level at $1.58 * U_R / \sqrt{3}$	pC	100
24.	Maximum Noise level at rated voltage, at principal tap & no load and all cooling active	dB	80
25.	Maximum Permissible Losses of Transformers		Same for constant ohmic and constant percentage type

i)	Max. No Load Loss at rated voltage and frequency	kW	90
ii)	Max. Load Loss at rated current and at 75°C for HV and IV windings, at principal tap position	kW	500
iii)	Max I ² R loss at rated current and at 75°C for HV and IV at principal tap position	kW	375
iv)	Max. Auxiliary Loss at rated voltage and frequency	kW	15

2.0 315 MVA, 400/220/33kV 3-Ph Auto Transformer

S. No.	Description	Unit	Technical Parameters
1.	Voltage ratio (Line-to-Line)	kV	(a) 400/220/33
2.	Rated Capacity		
	HV	MVA	315
	IV	MVA	315
	LV (Tertiary)	MVA	5 MVA active loading
3.	No of phases		3-phase
4.	Vector Group		YNaOd11
5.	Type of Transformer		Auto Transformer
6.	Applicable Standard		IEC 60076 / IS 2026
7.	Cooling		ONAN / ONAF / OFAF or ONAN / ONAF / ODAF or ONAN / ONAF1 / ONAF2
8.	Rating at different cooling	%	60 / 80 / 100
9.	Cooler Bank Arrangement		2 X 50%
10.	Frequency	Hz	50
11.	Tap Changer (OLTC)		+10% to -10% in 1.25% steps on common end of series winding for 400kV side voltage variation
12.	Impedance at 75°C at highest MVA base		Constant Ohmic type
i)	HV – IV		
	Max. Voltage tap	%	10.3
	Principal tap	%	12.5
	Min. Voltage tap	%	15.4
ii)	HV – LV		
	At principal tap	%	60.0 (minimum)

iii)	IV – LV	%	45.0 (minimum)
13.	Tolerance on Impedance	%	As per IEC, unless specified otherwise
14.	Service		Outdoor
15.	Duty		Continuous
16.	Overload Capacity		IEC-60076-7
17.	Temperature rise over 50°C ambient temp		
i)	Top oil measured by thermometer	O C	45
ii)	Average winding measured by resistance method	O C	50
18.	Winding hot spot rise over yearly weighted temperature of 32°C	O C	61
19.	Tank Hotspot Temperature	O C	110
20.	Maximum design ambient temperature	O C	50
21.	Windings		
i)	Lightning Impulse withstand Voltage		
	HV	kVp	1300
	IV	kVp	950
	LV	kVp	250
	Neutral	kVp	95
ii)	Chopped Wave Lightning Impulse Withstand Voltage		
	HV	kVp	1430
	IV	kVp	1045
	LV	kVp	275
iii)	Switching Impulse withstand Voltage		
	HV	kVp	1050
	IV	kVp	850
iv)	One Minute Power Frequency withstand Voltage		
	HV	kVrms	570
	IV	kVrms	395
	LV	kVrms	95
	Neutral	kVrms	38
v)	Neutral Grounding		Solidly grounded
vi)	Insulation		
	HV		Graded
	IV		Graded
	LV		Uniform
vii)	Tertiary Connection		Ungrounded Delta
viii)	Tan delta of winding	%	≤0.5
22.	Bushing		
i)	Rated voltage		

	HV	kV	420
	IV	kV	245
	LV	kV	52
	Neutral	kV	36
ii)	Rated current		
	HV	A	1250
	IV	A	1250
	LV	A	3150
	Neutral	A	3150
iii)	Lightning Impulse withstand Voltage		
	HV	kVp	1425
	IV	kVp	1050
	LV	kVp	250
	Neutral	kVp	170
iv)	Switching Impulse withstand Voltage		
	HV	kVp	1050
	IV	kVp	850
v)	One Minute Power Frequency withstand Voltage		
	HV	kVrms	695
	IV	kVrms	505
	LV	kVrms	105
	Neutral	kVrms	77
vi)	Tan delta of bushing at ambient Temperature	%	As per clause no.14.17 and 14.18 of this specification
vii)	Minimum total creepage distances		(Specific creepage distance: 31mm/kV corresponding to the line to line highest system voltage)
	HV	Mm	13020
	IV	Mm	7595
	LV	Mm	1612
	Neutral	Mm	1116
viii)	Maximum Partial discharge level at U_m		
	HV	pC	10
	IV	pC	10
	LV	pC	10
23.	Maximum Partial discharge level at $1.58 * U_R / \sqrt{3}$	pC	100
24.	Maximum Noise level at rated voltage, at principal tap & no load and all cooling active	dB	80
25.	Maximum Permissible Losses of Transformers		Same for constant ohmic and constant percentage type

i)	Max. No Load Loss at rated voltage and frequency	kW	75
ii)	Max. Load Loss at rated current and at 75° C for HV and IV windings, at principal tap position	kW	440
iii)	Max I ² R loss at rated current and at 75° C for HV and IV at principal tap position	kW	330
iv)	Max. Auxiliary Loss at rated voltage and frequency	kW	10

3.0 160 MVA, 220/66/11 kV 3-ph Power Transformer

Sl. No.	Description	Unit	TECHNICAL PARAMETERS
1.	Voltage ratio (Line to Line)	kV	220/66/11
2.	Rated Capacity		
	HV	MVA	160
	IV	MVA	160
	LV (Tertiary)	MVA	5 MVA active loading
3.	No of phases		3 (Three)
4.	Vector Group		YNyn0d11
5.	Type of Transformer		Power Transformer
6.	Applicable Standard		IEC 60076 /IS 2026
7.	Cooling type		ONAN / ONAF / OFAF or ONAN / ONAF / ODAF or ONAN / ONAF1 / ONAF2
8.	Rating at different cooling	%	60 / 80 / 100
9.	Frequency	Hz	50
10.	Cooler Bank Arrangement		2 X 50%
11.	Tap changer		
i)	Type		On load tap changer (CFVV)
ii)	Tapping range and steps		–15% to +5% in steps of 1.25% for HV variation
iii)	Location of tapping		at Neutral end of HV

12.	HV-IV Impedance at 75° C, at highest MVA base	%	
i)	Max. Voltage tap	%	16.2 (Tolerance as per IEC)
	Principal tap	%	15.0 (Tolerance as per IEC)
	Min. Voltage tap	%	14.0 (Tolerance as per IEC)
ii)	HV-LV (At Principal tap)	%	27.0 (Tolerance ±10%)
iii)	IV-LV	%	12.0 (Tolerance ±15%)
iv)	Tolerance on Impedance	%	As mentioned above
13.	Service		Outdoor
14.	Duty		Continuous
15.	Overload Capacity		IEC 60076-7
16.	Temperature rise over 50°C ambient Temp		
i)	Top oil measured by thermometer	O C	45
ii)	Average winding measured by resistance method	O C	50
17.	Winding hot spot rise over yearly weighted temperature of 32 °C	O C	61
18.	Tank Hotspot Temperature	O C	110
19.	Maximum design ambient temperature	O C	50
20.	Windings		
i)	Lightning Impulse withstand Voltage		
	HV	kVp	950
	IV	kVp	325
	LV	kVp	170
	Neutral	kVp	170
ii)	Chopped Wave Lightning Impulse Withstand Voltage		
	HV	kVp	1045
	IV	kVp	358

	LV	kVp	187
iii)	Switching Impulse withstand Voltage		
	HV	kVp	850
iv)	One Minute Power Frequency withstand Voltage		
	HV	kVrms	395
	IV	kVrms	140
	LV	kVrms	70
	Neutral	kVrms	70
v)	Neutral Grounding		
	HV		Solidly grounded
	IV		Solidly grounded
vi)	Insulation		
	HV		Graded
	IV		Graded
	LV		Uniform
vii)	Tertiary Connection		Ungrounded Delta
viii)	Tan delta of winding	%	≤0.5%
21.	Bushings		
i)	Rated voltage		
	HV	kV	245
	IV	kV	72.5
	LV	kV	36
	Neutral	kV	36
ii)	Rated current		
	HV	A	1250
	IV	A	3150
	LV	A	3150
	Neutral	A	3150

iii)	Lightning Impulse withstand Voltage		
	HV	kVp	1050
	IV	kVp	325
	LV	kVp	170
	Neutral	kVp	170
iv)	Switching Impulse withstand Voltage		
	HV	kVp	850
v)	One Minute Power Frequency withstand Voltage		
	HV	kVrms	505
	IV	kVrms	155
	LV	kVrms	77
	Neutral	kVrms	77
vi)	Tan delta of bushing at ambient Temperature	%	As per clause no.14.17 and 14.18 of this specification
vii)	Minimum total creepage distances		(Specific creepage distance: 31mm/kV corresponding to the line to line highest system voltage)
	HV	Mm	7595
	IV	Mm	2248
	LV	Mm	1116
	Neutral	Mm	1116
viii)	Maximum Partial discharge level at U_m		
	HV	pC	10
	IV	pC	10
	LV	pC	10
22.	Maximum Partial discharge level at $1.58 \cdot U_r / \sqrt{3}$	pC	100

23.	Maximum Noise level at rated voltage, at principal tap & no load and all cooling active	dB	75
24.	Maximum Permissible Losses of Transformers		
i)	Max. No Load Loss at rated voltage and frequency	kW	60
ii)	Max. Load Loss at rated current and at 75°C for HV and IV windings at principal tap position	kW	320
iii)	Max. I ² R Loss at rated current and at 75°C for HV and IV windings at principal tap position	kW	265
iv)	Max. Auxiliary Loss at rated voltage and frequency	kW	8

4.0 100 MVA, 220/33/11 kV 3-ph Power Transformer

Sl. No.	Description	Unit	Technical Parameters
1.	Voltage ratio (Line-to-Line)	kV	(a) 220/33/11
2.	Rated Capacity		
	HV	MVA	100
	IV	MVA	100
	LV (Tertiary)	MVA	5MVA active loading
3.	No of phases		3 (Three)
4.	Vector Group		YNyn0d11
5.	Type of transformer		Power transformer
6.	Applicable Standard		IEC 60076 / IS 2026
7.	Cooling type		ONAN / ONAF / OFAF or ONAN/ONAF / ODAF or ONAN / ONAF1 /ONAF2
8.	Rating at different cooling	%	60 / 80 / 100
9.	Frequency	Hz	50
10.	Cooler Bank Arrangement		2 X 50%
11.	Tap Changer		
i)	Type		On-load tap changer

ii)	Tap range and steps		-15% to +5% in steps of 1.25% for HV variation
iii)	Location of tap changer		On HV neutral end
12.	Impedance at 75°C, at highest MVA Base		
i)	Max. Voltage tap	%	16.2
	Principal tap	%	15.0
	Min. Voltage tap	%	14.0
ii)	HV-LV (At principal tap)	%	24%
iii)	IV-LV	%	12%
iv)	Tolerance on Impedance		As per IEC
13.	Service		Outdoor
14.	Duty		Continuous
15.	Overload Capacity		IEC-60076-7
16.	Temperature rise over 50°C ambient Temp		
i)	Top oil measured by thermometer	O C	45
ii)	Average winding measured by resistance method	O C	50
17.	Winding hot spot rise over yearly weighted temperature of 32°C	O C	61
18.	Tank Hotspot Temperature	O C	110
19.	Maximum design ambient temperature	O C	50
20.	Windings		
i)	Lightning Impulse withstand Voltage		
	HV	kV _p	950
	IV	kV _p	170
	LV	kV _p	170
	Neutral	kV _p	170
ii)	Chopped Wave Lightning Impulse Withstand Voltage		
	HV	kV _p	1045
	IV	kV _p	187
	LV	kV _p	187
iii)	Switching Impulse withstand Voltage		
	HV	kV _p	850
iv)	One Minute Power Frequency withstand Voltage		
	HV	kV _{rms}	395
	IV	kV _{rms}	70
	LV	kV _{rms}	70
	Neutral	kV _{rms}	70
v)	Neutral Grounding (HV & IV)		Solidly grounded

vi)	Insulation		
	HV		Graded
	IV		Uniform
	LV		Uniform
vii)	Tan delta of winding	%	< 0.5
21.	Bushing		
i)	Rated voltage		
	HV	kV	245
	IV	kV	36
	LV	kV	36
	Neutral	kV	36
ii)	Rated current		
	HV	A	1250
	IV	A	3150
	LV	A	3150
	Neutral	A	3150
iii)	Lightning Impulse withstand Voltage		
	HV	kV _p	1050
	IV	kV _p	170
	LV	kV _p	170
	Neutral	kV _p	170
iv)	Switching Impulse withstand Voltage		
	HV	kV _p	850
v)	One Minute Power Frequency withstand Voltage		
	HV	kV _{rms}	505
	IV	kV _{rms}	77
	LV	kV _{rms}	77
	Neutral	kV _{rms}	77
vi)	Tan delta of bushing at ambient Temperature	%	As per clause no.14.17 and 14.18 of this specification
vii)	Minimum total creepage distances		(Specific creepage distance: 31mm/kV corresponding to the line to line highest system voltage)
	HV bushing	Mm	7595
	IV bushing	Mm	1116
	LV	Mm	1116
	Neutral	Mm	1116
viii)	Maximum Partial discharge level at U _m		
	HV	pC	10

	IV	pC	10
	LV	pC	10
22.	Maximum Partial discharge level at $1.58 * U_R / \sqrt{3}$	pC	100
23.	Maximum Noise level at rated voltage, at principal tap & no load and all cooling active	dB	80
24.	Maximum Permissible Losses of Transformers		
i)	Max. No Load Loss at rated voltage and frequency	kW	43
ii)	Max. Load Loss at rated current and at 75°C for HV and LV windings at principal tap position	kW	245
iii)	Max. I^2R Loss at rated current and at 75°C for HV and LV windings at principal tap position	kW	200
iv)	Max. Auxiliary Loss at rated voltage and frequency	kW	5

5.0 160 MVA, 220/66kV 3-ph Power Transformer

Sl. No.	Description	Unit	TECHNICAL PARAMETERS
1.	Voltage ratio (Line to Line)	kV	220/66
2.	Rated Capacity		
	HV	MVA	160
	LV	MVA	160
3.	No of phases		3 (Three)
4.	Vector Group		YNyn0
5.	Type of Transformer		Power Transformer
6.	Applicable Standard		IEC 60076 /IS 2026

7.	Cooling type		ONAN / ONAF / OFAF or ONAN / ONAF / ODAF or ONAN / ONAF1 / ONAF2
8.	Rating at different cooling	%	60 / 80 / 100
9.	Frequency	Hz	50
10.	Cooler Bank Arrangement		2 X 50%
11.	Tap changer		
i)	Type		On load tap changer (CFVV)
ii)	Tapping range and steps		-15% to +5% in steps of 1.25% for HV variation
iii)	Location of tapping		at Neutral end of HV
12.	HV-LV Impedance at 75 ^o C, at highest MVA base	%	
i)	Max. Voltage tap	%	16.2
	Principal tap	%	15.0
	Min. Voltage tap	%	14.0
iv)	Tolerance on Impedance	%	As per IEC
13.	Service		Outdoor
14.	Duty		Continuous
15.	Overload Capacity		IEC 60076-7
16.	Temperature rise over 50 ^o C ambient Temp		
i)	Top oil measured by thermometer	O C	45
ii)	Average winding measured by resistance method	O C	50
17.	Winding hot spot rise over yearly weighted temperature of 32 °C	O C	61
18.	Tank Hotspot Temperature	O C	110
19.	Maximum design ambi- ent temperature	O C	50
20.	Windings		
i)	Lightning Impulse with- stand Voltage		
	HV	kVp	950
	LV	kVp	325

	HV-Neutral	kV _p	170
	LV-Neutral	kV _p	170
ii)	Chopped Wave Lightning Impulse Withstand Voltage		
	HV	kV _p	1045
	LV	kV _p	358
iii)	Switching Impulse withstand Voltage		
	HV	kV _p	850
iv)	One Minute Power Frequency withstand Voltage		
	HV	kV _{rms}	395
	LV	kV _{rms}	140
	HV Neutral	kV _{rms}	38
	LV Neutral	kV _{rms}	38
v)	Neutral Grounding		
	HV		Solidly grounded
	LV		Solidly grounded
vi)	Insulation		
	HV		Graded
	LV		Graded
vii)	Tertiary Connection		Ungrounded Delta
viii)	Tan delta of winding	%	≤0.5%
21.	Bushings		
i)	Rated voltage		
	HV	kV	245
	LV	kV	72.5
	HV Neutral	kV	36
	LV Neutral	kV	36
ii)	Rated current		
	HV	A	1250

	LV	A	3150
	HV Neutral	A	3150
	LV Neutral	A	3150
iii)	Lightning Impulse with-stand Voltage		
	HV	kV _p	1050
	LV	kV _p	325
	HV Neutral	kV _p	170
	LV Neutral	kV _p	170
iv)	Switching Impulse with-stand Voltage		
	HV	kV _p	850
v)	One Minute Power Frequency withstand Voltage		
	HV	kV _{rms}	505
	LV	kV _{rms}	155
	HV Neutral	kV _{rms}	77
	LV Neutral	kV _{rms}	77
vi)	Tan delta of bushing at ambient Temperature	%	As per clause no.14.17 and 14.18 of this specification
vii)	Minimum total creepage distances		(Specific creepage distance: 31mm/kV corresponding to the line to line highest system voltage)
	HV	Mm	7595
	LV	Mm	2248
	Neutral	Mm	1116
viii)	Maximum Partial discharge level at U _m		
	HV	pC	10
	IV	pC	10

	LV	pC	10
22.	Maximum Partial discharge level at $1.58 \cdot U_r / \sqrt{3}$	pC	100
23.	Maximum Noise level at rated voltage, at principal tap & no load and all cooling active	dB	75
24.	Maximum Permissible Losses of Transformers		
i)	Max. No Load Loss at rated voltage and frequency	kW	60
ii)	Max. Load Loss at rated current and at 75°C for HV and LV windings at principal tap position	kW	320
iii)	Max. I^2R Loss at rated current and at 75°C for HV and LV windings at principal tap position	kW	265
iv)	Max. Auxiliary Loss at rated voltage and frequency	kW	8

6.0 100 MVA, 220/33 kV 3-ph Power Transformer

Cl. No.	Description	Unit	Technical Parameters
1.	Voltage ratio (Line-to-Line)	kV	220/33
2.	Rated Capacity		
	HV	MVA	100
	LV	MVA	100
3.	No of phases		3 (Three)
4.	Vector Group		YNyn0
5.	Type of transformer		Power transformer
6.	Applicable Standard		IEC 60076 / IS 2026
7.	Cooling type		ONAN / ONAF / OFAF or ONAN/ONAF / ODAF or ONAN / ONAF1 / ONAF2
8.	Rating at different cooling	%	60 / 80 / 100
9.	Frequency	Hz	50
10.	Cooler Bank Arrangement		2 X 50%

11.	Tap Changer		
i)	Type		On-load tap changer
ii)	Tap range and steps		-15% to +5% in steps of 1.25% for HV variation
iii)	Location of tap changer		On HV neutral end
12.	Impedance at 75°C, at highest MVA Base		
i)	Max. Voltage tap	%	16.2
ii)	Principal tap	%	15.0
iii)	Min. Voltage tap	%	14.0
iv)	Tolerance on Impedance		As per IEC
13.	Service		Outdoor
14.	Duty		Continuous
15.	Overload Capacity		IEC-60076-7
16.	Temperature rise over 50°C ambient Temp		
i)	Top oil measured by thermometer	O C	45
ii)	Average winding measured by resistance method	O C	50
17.	Winding hot spot rise over yearly weighted temperature of 32°C	O C	61
18.	Tank Hotspot Temperature	O C	110
19.	Maximum design ambient temperature	O C	50
20.	Windings		
i)	Lightning Impulse withstand Voltage		
	HV	kV _p	950
	LV	kV _p	170
	HV Neutral	kV _p	170
	LV neutral	kV _p	170
ii)	Chopped Wave Lightning Impulse Withstand Voltage		
	HV	kV _p	1045
	LV	kV _p	187
iii)	Switching Impulse withstand Voltage		
	HV	kV _p	850
iv)	One Minute Power Frequency withstand Voltage		
	HV	kV _{rms}	395
	LV	kV _{rms}	70
	HV Neutral	kV _{rms}	70
	LV Neutral	kV _{rms}	70

v)	Neutral Grounding (HV & LV)		Solidly grounded
vi)	Insulation		
	HV		Graded
	LV		Uniform
vii)	Tan delta of winding	%	≤ 0.5
21.	Bushing		
i)	Rated voltage		
	HV	kV	245
	LV	kV	36
	HV Neutral	kV	36
	LV Neutral	kV	36
ii)	Rated current		
	HV	A	1250
	LV	A	3150
	HV Neutral	A	3150
	LV Neutral	A	3150
iii)	Lightning Impulse withstand Voltage		
	HV	kV _p	1050
	LV	kV _p	170
	HV Neutral	kV _p	170
	LV Neutral	kV _p	170
iv)	Switching Impulse withstand Voltage		
	HV	kV _p	850
v)	One Minute Power Frequency withstand Voltage		
	HV	kV _{rms}	505
	LV	kV _{rms}	77
	HV Neutral	kV _{rms}	77
	LV Neutral	kV _{rms}	77
vi)	Tan delta of bushing at ambient Temperature	%	As per clause no.14.17 and 14.18 of this specification
vii)	Minimum total creepage distances		(Specific creepage distance: 31mm/kV corresponding to the line to line highest system voltage)
	HV bushing	mm	7595
	LV bushing	mm	1116
	HV Neutral	mm	1116
	LV Neutral	Mm	1116
viii)	Maximum Partial discharge level at U _m		

	HV	pC	10
	LV	pC	10
22.	Maximum Partial discharge level at $1.58 * U_T / \sqrt{3}$	pC	100
23.	Maximum Noise level at rated voltage, at principal tap & no load and all cooling active	dB	80
24.	Maximum Permissible Losses of Transformers		
i)	Max. No Load Loss at rated voltage and frequency	kW	43
ii)	Max. Load Loss at rated current and at 75°C for HV and LV windings at principal tap position	kW	245
iii)	Max. I ² R Loss at rated current and at 75°C for HV and LV windings at principal tap position	kW	200
iv)	Max. Auxiliary Loss at rated voltage and frequency	kW	5

7.0 31.5 MVA, 66/11 kV 3-ph Power Transformer

S. No.	Description	Unit	TECHNICAL PARAMETERS
1.	Voltage ratio (Line-to-Line)	kV	66/11
2.	Rated Capacity (HV and LV)	MVA	31.5
3.	No of phases		3 (Three)
4.	Vector Group		Dyn11
5.	Type of transformer		Power Transformer
6.	Applicable Standard		IEC 60076 / IS 2026
7.	Frequency	Hz	50
8.	Cooling type		ONAN/ONAF
9.	Tap Changer		

i)	Type		On-load tap changer (CFVV)
ii)	Tap Range and no. of steps		–5% to +15% of HV variation in the step of 1.25%
iii)	Location of Tap changer		On HV neutral end
10.	HV-LV Impedance at 75°C	%	
	Max. Voltage Tap		11.2
	Principal Tap		10
	Min. Voltage Tap		9
11.	Tolerance		As per IEC
12.	Service		Outdoor
13.	Duty		Continuous
14.	Overload Capacity		IEC 60076-7
15.	Temperature rise over 50°C Ambient Temp		
i)	Top oil measured by thermometer	O C	45
ii)	Average winding measured by resistance method	O C	50
16.	Winding hot spot rise over yearly weighted temperature of 32 °C	O C	61
17.	Tank Hotspot Temperature	O C	110
18.	Maximum design ambient Temperature	O C	50
19.	Windings		
i)	Lightning Impulse withstand Voltage		
	HV	kV _p	325
	LV & LV Neutral	kV _p	75
ii)	Chopped Wave Lightning Impulse Withstand Voltage		
	HV	kV _p	358
	LV	kV _p	83
iii)	One Minute Power Frequency withstand Voltage		
	HV	kV _{rms}	140
	LV & LV Neutral	kV _{rms}	28
iv)	Insulation		Solidly grounded
	HV		Uniform
	LV		Uniform
v)	Tan delta of winding	%	≤0.5
20.	Bushings		
i)	Rated voltage		

	HV	kV	72.5
	LV & LV Neutral	kV	17.5
ii)	Rated current		
	HV	A	800
	LV & LV neutral	A	2000
iii)	Lightning Impulse withstand Voltage		
	HV	kV _p	350
	LV & LV Neutral	kV _p	95
iv)	One Minute Power Frequency withstand Voltage		
	HV	kV _{rms}	155
	LV & LV Neutral	kV _{rms}	42
v)	Tan delta of bushing at ambient Temperature	%	As per clause no.14.17 and 14.18 of this specification
vi)	Minimum total creepage distances		(Specific creepage distance: 31mm/kV corresponding to the line to line highest system voltage)
	HV	mm	2248
	LV & LV Neutral	mm	543
vii)	Maximum Partial discharge level on HV bushing at U _m	pC	10
21.	Maximum Partial discharge level at $1.58 \cdot U_r / \sqrt{3}$	pC	100
22.	Maximum Noise level at rated voltage, at principal tap & no load and all cooling active	dB	70
23.	Maximum Permissible Losses of Transformers		31.5 MVA
i)	Max. No Load Loss at rated voltage and frequency	kW	18.0
ii)	Max. Load Loss at rated current and frequency and at 75°C, at principal tap position	kW	110.0
iii)	Max. I ² R Loss at rated current and frequency and at 75°C, at principal tap position	kW	93.5

Notes: (for all transformers ratings)

- 1. For parallel operation with existing transformer, percentage impedance, OLTC connection and range, vector group and the winding configuration (if necessary) are to be matched.**
- 2. No external or internal Transformers/ Reactors are to be used to achieve the specified HV/IV, HV/LV and IV/LV impedance**
- 3. Tan delta of windings shall be measured at ambient temperature. No temperature correction factor shall be allowed.**
- 4. External minimum clearance in air for phase to phase and phase to earth shall be provided as per IS 2026 (part-03)/ IEC 60076-03.**
- 5. All parameters as detailed above shall be in line with relevant IS/IEC and will be approved during design review and detailed engineering.**

ANNEXURE –B

TECHNICAL PARAMETERS OF BUSHING CURRENT TRANSFORMERS & NEUTRAL CURRENT TRANSFORMERS

1.0 Parameters of Current Transformer for (a) 500MVA (3-ph), 400/220/33 kV;

Description	Current Transformer Parameters			
	HV Side	IV Side	Neutral Side	Outdoor type Neutral Current Transformer (NCT) in common neutral side
Ratio				
CORE 1	1600/1	1600/1	1600/1	1600/1
CORE 2	1000/1	1600/1	-	-
Minimum knee point voltage or burden and accuracy class				
CORE 1	1600V, PX/PS	1600V, PX/PS	1600V, PX/PS	1600V, PX/PS
CORE 2	0.2S Class 20VA ISF<5	0.2S Class 20VA ISF<5	-	-
Maximum CT Secondary Resistance				
CORE 1	4.0 Ohm	4.0 Ohm	4.0 Ohm	4.0 Ohm
CORE 2	-	-	-	-
Application				
CORE 1	Restricted Earth Fault (REF)	REF	REF	REF (high Impedance)
CORE 2	Metering	Metering	-	-
Maximum magnetization current (at knee point voltage)				
CORE 1	25 mA	25 mA	25 mA	25 mA
CORE 2	-	-	-	-

Notes:

1. Parameters of WTI CT for each winding shall be provided by the manufacturer / contractor.
2. The CTs used for REF protection must have the identical parameters in order to limit the circulating current under normal condition for stability of protection.
3. Parameters to be approved and finalized during design review and detailed engineering.

2.0 Parameters of Current Transformer for (a) 315 MVA(3-ph), 400/220/33kV

Description	Current Transformer Parameters			
	HV Side	IV Side	Neutral Side	Outdoor type Neutral Current Transformer (NCT) in common neutral side
Ratio				
CORE 1	1000/1	1000/1	1000/1	1000/1
CORE 2	600/1	1000/1	-	-
Minimum knee point voltage or burden and accuracy class				
CORE 1	1000V, PX/PS	1000V, PX/PS	1000V, PX/PS	1000, PX/PS
CORE 2	0.2S Class 20VA ISF<5	0.2S Class 20VA ISF<5		
Maximum CT Secondary Resistance				
CORE 1	2.5 Ohm	2.5 Ohm	2.5 Ohm	2.5 Ohm
CORE 2	-	-	-	-
Application				
CORE 1	Restricted Earth Fault (REF)	REF	REF	REF (high impedance)
CORE 2	Metering	Metering	-	-
a) Maximum magnetization current (at knee point voltage)				
CORE 1	60 mA	60 mA	60 mA	60 mA
CORE 2	-	-	-	-

Notes:

1. Parameters of WTI CT for each winding shall be provided by the manufacturer / contractor.
2. The CTs used for REF protection must have the identical parameters in order to limit the circulating current under normal condition for stability of protection.
3. Parameters to be approved and finalized during design review and detailed engineering.

3.0 Parameters of Current Transformer for 160 MVA (3-Ph), 220/66/11 kV and 160MVA, 220/66kV Transformers

Description	Current Transformer Parameters			
	HV Side	HV Neutral Side	LV Side	LV Neutral Side
Ratio				
CORE 1	600/1	600/1	1600/1	1600/1
CORE 2	600/1	-	-	-
Minimum knee point voltage or burden and accuracy class				
CORE 1	600V, PX/PS	600V, PX/PS	1600V, PX/PS	1600V, PX/PS
CORE 2	0.2S Class 20VA ISF≤5	-	-	-
Maximum CT Secondary Resistance				
CORE 1	1.5 Ohm	1.5 Ohm	4 Ohm	4 Ohm
CORE 2	-	-	-	-
Application				
CORE 1	Restricted Earth Fault (REF)	REF	REF	REF
CORE 2	Metering	-	-	-
Maximum magnetization current (at knee point voltage)				
CORE 1	100 mA	100 mA	25 mA	25 mA
CORE 2	-	-	-	-

Notes:

1. Parameters of WTI CT for each winding shall be provided by the manufacturer / contractor.
2. The CTs used for REF protection must have the identical parameters in order to limit the circulating current under normal condition for stability of protection.

- Parameters to be approved and finalized during design review and detailed engineering.

4.0 Parameters of Current Transformer for 100MVA (3-ph), 220/33/11 kV and 100MVA 220/33kV Transformers

Description	Current Transformer Parameters			
	HV Side	HV Neutral Side	LV Side	LV Neutral Side
Ratio				
CORE 1	600/1	600/1	2000/1	2000/1
CORE 2	600/1	-	-	-
Minimum knee point voltage or burden and accuracy class				
CORE 1	600V, PX/PS	600V, PX/PS	2000V, PX/PS	2000V, PX/PS
CORE 2	0.2S Class 15VA ISF ≤ 5	-	-	-
Maximum CT Secondary Resistance				
CORE 1	1.5 Ohm	1.5 Ohm	4 Ohm	4 Ohm
CORE 2	-	-	-	-
Application				
CORE 1	Restricted Earth Fault (REF)	REF	REF	REF
CORE 2	Metering	-	-	-
Maximum magnetization current (at knee point voltage)				
CORE 1	100 mA	100 mA	25 mA	25 mA
CORE 2	-	-	-	-

Notes:

- Parameters of WTI CT for each winding shall be provided by the manufacturer / contractor.
- The CTs used for REF protection must have the identical parameters in order to limit the circulating current under normal condition for stability of protection.
- Parameters to be approved and finalized during design review and detailed engineering.

5.0 Parameters of Current Transformer for 31.5MVA (3-ph), 66/11 kV Transformers

Description	Current Transformer Parameters		
	HV Side	LV Side	LV Neutral Side
Ratio			
CORE 1	400/1	2000/1	2000/1
CORE 2	400/1	1000/1	-
Minimum knee point voltage or burden and accuracy class			
CORE 1	400V, PX/PS	2000V, PX/PS	2000V, PX/PS
CORE 2	0.2S Class 15VA ISF < 5	0.2S Class 15VA ISF < 5	-
Maximum CT Secondary Resistance			
CORE 1	1.5 Ohm	4 Ohm	4 Ohm
CORE 2	-	-	-
Application			
CORE 1	Protection	Metering	REF
CORE 2	Metering	-	-
Maximum magnetization current (at knee point voltage)			
CORE 1	100 mA	25 mA	25 mA
CORE 2	-	-	-

Notes:

- Parameters of WTI CT for each winding shall be provided by the manufacturer / contractor.
- The CTs used for REF protection must have the identical parameters in order to limit the circulating current under normal condition for stability of protection.
- Parameters to be approved and finalized during design review and detailed engineering.

Guaranteed and other technical Particulars**(To be filled by the manufacturer)****A. GENERAL**

S. No	DESCRIPTION	Unit	Specified by Buyer	Offered by manufacturer
1.	General Information i) Supplier ii) Name of Manufacturer iii) Place of Manufacture (Country & City) iv) Type of transformer (Core/Shell)			
2.	Applications i) Indoor/Outdoor ii) 2wdg/3wdg/Auto iii) GT/Step-down/ICT/Station Start-up/ Auxiliary/ Rail Tracksides Supply			
3.	Corrosion Level at Site i)Light ii) Medium iii) Heavy iv) Very Heavy			
4.	Site altitude above mean sea level	m		
5.	Seismic zone and ground acceleration at site (both in horizontal & vertical direction)			
6.	Maximum and minimum ambient temperature at site			
7.	Applicable Standards i) IEC: 60076 ii) IS : 2026 iii) Any other, please specify			
8.	Rated Capacity / Full load rating (HV/IV/LV)	MVA		
9.	3-Phase/Bank of Three Single Phase (A,B,C)			
10.	Rated No Load Voltages (HV/IV/LV)	kV		
11.	Currents at normal tap (HV/IV/LV)	Amp		
12.	Rated Frequency	Hz		
13.	Connections and phase displacement symbols (Vector Group)			

14.	Weight Schedules (Minimum with no negative tolerance)			
	i) Active part (Core + coil)	Kg		
	ii) Insulating Oil (excluding mass of extra oil)	Kg		
	iii) Tank and Fittings	Kg		
	iii) Total weight	Kg		
	iv) Transportaion Weight	Kg		
	v) Overall dimensions L x B x H	Mm		
	vi) Size of heaviest package L x B x H	Mm		
	vii) Weight of heaviest package	Kg		
	viii) Weight of 5% extra oil	Kg		
	ix) Weight of core	Kg		
	x) Weight of copper (HV/IV/LV/ Regulating)	Kg		
	xi) Insulating Oil volume (excluding 5% extraoil)	Ltrs		
	xii) Quantity of oil in OLTC	Ltrs		
15.	Transport limitation			
16.	LV Winding i) Stabilizing tertiary (Yes/No) ii) Loaded (Yes/No)			
17.	Tappings i)Type (OLTC/OCTC) and make of tap changer ii)Position of Tapping on the winding iii)Variation on i v)Range of variation v)No. of Steps vi) Whether control suitable for : <ul style="list-style-type: none"> Remote/local operation Auto/manual operation vi)Parallel Operation Requirements 	%		
18.	Impedance and Losses			
	i) Guaranteed No load loss at rated voltage and frequency	kW		
	Tolerance (to be considered for loss evaluation)	%		
	ii) Guranteed I ² R Loss at rated current & frequency (at 75°C) at principal tap	kW		

	Tolerance (to be considered for loss evaluation)	%		
	iii) Eddy current and stray loss at rated current & frequency (at 75°C) at principal tap	kW		
	iv) Load Loss(I^2R +Eddy and Stray) at rated current & frequency (at 75°C) at principal tap	kW		

	v) Guaranteed Auxiliary loss at rated voltage and frequency	kW		
	Tolerance (to be considered for loss evaluation)	%		
	vi) Calculated Fan Loss	kW		
	vii) Calculated Pump Loss	kW		
	viii) Air core reactance of HV winding	%		
	ix) Guaranteed Impedance (at Highest MVA base)	%		
	(a) HV-IV (at Principal tap)			
	(b) HV-LV(at Principal tap)			
	(c) IV-LV(at Principal tap)			
	Tolerance			
	x) Impedance at extreme tap-pings at Highest MVA base [for HV-IV for 3 winding transformer (or) HV-LV for two winding transformer] a) Max. Voltage tap b) Min. Voltage tap	%		
	Tolerance	%		
	xi) Zero sequence impedance at principal tap (for 3-phase transformers)			
19.	Capacitance to earth for HV/IV/LV	pF		
20.	Regulation at full load at 75 °C winding temperature at: a) upf b) 0.8 pf			
21.	Guaranteed maximum Magnetizing Current at rated Voltage	%		

22.	Efficiency : At 100% load upf 0.8 lead 0.8 lag At 75% load upf 0.8 Lead 0.8 lag At 50% load upf 0.8 lead 0.8 lag	%		
23.	Load at Maximum efficiency	%		
24.	Any limitations in carrying out the required test? If Yes, State limitations			
25.	Fault level of system (in kA) and its duration (in sec)	kA (sec)		
26.	Calculated short Circuit current (in kA) withstand capability for 2 seconds (3 seconds for generator transformers) without exceeding temperature limit (i.e. Thermal ability to withstand SC current)	kA		
27.	Test current (in kA) and duration (in ms) for short Circuit current test (i.e. Dynamic ability to withstand SC)	kA & msec		
28.	Over fluxing withstand time (due to combined voltage & frequency fluctuations): 110% 125% 140% 150% 170%	msec		
29.	Free space required above the tank top for removal of core			
30.	Maximum Partial discharge level at $1.58 U_T/\sqrt{3}$	pC		

B. MAGNETIC SYSTEM

Sl. No.	Description	Unit	Specified by Buyer	Offered by manufacturer
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1.	Core Type: i) 3 Phase 3 Limb (3 wound limbs) ii) 3 Phase 5 Limb (3 wound limbs) iii) 1 Phase 2 Limb (2 wound limbs) iv) 1 Phase 3 Limb (1 wound limb) v) 1 Phase 4 Limb (2 wound limbs) vi) 1 Phase 5 Limb (3 wound Limbs)			
2.	Type of Core Joint: i) Mitred ii) Step Lap			
3.	CRGO : i) Make & Country of Origin ii) Thickness, mm iii) Max. Specific loss at 1.7 T, 50Hz, in Watts/kg iv) Grade of core as per BIS v) Insulation between core lamination vi) BIS certified (Yes/No)			
4.	Minimum Gross & Net Area of: i) Core ii) Limb iii) Yoke iv) Unwound limb (May be verified during manufacturing stage – at the discretion of buyer)	cm ²		
5.	Stacking Factor	%		
6.	Voltage per turn	V		
7.	Apparent Core Density for Weight Calculation			
8.	Minimum Net Weight of Silicon Steel Lamination CRGO (may be verified during manufacturing stage by calculation)	kg		
9.	Maximum Flux density at 90%, 100% and 110% voltage and frequency (may be verified during manufacturing stage by calculation)	T		
10.	W/kg at working flux density			
11.	Building Factor Considered			

12.	Calculated No Load Loss at rated voltage and Frequency (Net Weight x W/kg x Building factor)	kW		
13.	Magnetizing inrush current	Amp		
14.	No load current at normal ratio and frequency for : 85% of rated voltage 100% of rated voltage 105% of rated voltage	Amp		
15.	Core Isolation test	kV		
16.	Core bolt in limb / yoke	Yes/No		
17.	Core bolt insulation withstand voltage for one minute	kV		
18.	Maximum temperature rise of any part of core or its support structure in contact with oil	°C		

C. CONDUCTING SYSTEM

Sl. No.	Description	Unit	Offered by manufacturer			
			HV	IV	LV	Regulating
1.	Type of Winding Helical/Disc/Layer/inter wound					
2.	Type of Conductor PICC/CTC/CTCE/CTCEN/BPI CC					
3.	Minimum Yield Strength of Conductor for 0.2% elongation	N/mm ²				
4.	Maximum Current density at CMR and conductor area at any tap: i) HV ii) IV iii) LV	A/mm ² & sq. mm				
5.	Maximum current density under short circuit: i) HV ii) IV iii) LV	A/mm ²				
6.	Bare Weight of copper without	Kg				

	paper insulation and lead (Minimum)					
7.	Per Phase Maximum resistance of winding at rated tap at 75 °C	ohm				
8.	Number of Turns/Phase					
9.	Insulating material used for HV/IV/LV winding					
10.	Insulating material used between : i) HV and IV winding ii) IV and LV winding iii) LV winding and core iv) Regulating winding and adjacent winding/core					
11.	Details of special arrangement provided to improve surge voltage distribution in the winding					
12.	Dielectric Shielding used: i) Interleaved winding ii) Wound in Shield iii) Others					
13.	Magnetic Shielding used: i) Yoke Shunt on core clamp ii) Magnetic shunt on tank iii) Electromagnetic (Copper/Aluminum) shield on tank iv) Others					
14.	Noise level when energized at normal voltage and frequency without load	dB				

D.COOLING SYSTEM

Sl. No.	Description	Unit	Specified by Buyer	Offered by manufacturer
1.	Type of Cooling [ONAN (or) ONAN/ONAF (or) ONAN / ONAF / OFAF (or) ONAN / ONAF/ ODAF (or)			

8.	<p>Cooling Fans:</p> <p>i) Type ii) Size iii) Rating (kW) iv) Supply voltage v) Quantity (Running + Standby) per cooler bank vi) Whether fans are suitable for continuous operation at 85% of their rated voltage calculated time constant:</p> <ul style="list-style-type: none"> • natural cooling • forced air cooling <p>vii) Degree of Protection of terminal box</p>			
9.	<p>Oil Pumps:</p> <p>i) Type ii) Size iii) Rating (lpm and kW) iv) Supply voltage v) Quantity (Running + Standby) per cooler bank vi) Efficiency of motor at full load vii) Temperature rise of motor at full load viii) BHP of driven equipment</p>			
10.	<p>Coolers (Oil to Air):</p> <p>i) Quantity (Running + Standby) ii) Type and Rating</p>			
11.	<p>Coolers (Oil to Water):</p> <p>i) Quantity (Running + Standby) ii) Type and Rating iii) Oil flow rate (lpm) iv) Water flow rate (lpm) v) Nominal Cooling rate (kW) vi) Material of tube</p>			

12.	Radiators: i) Width of elements (mm) ii) Thickness (mm) iii) Length (mm) iv) Numbers			
13.	Cooler loss at rated output, normal ratio, rated voltage, rated frequency at ambient temperature of 50°C	kW		

E. DIELECTRIC SYSTEM

Sl. No.	Description	Unit	Offered by manufacturer				
1.	Geometric Arrangement of winding with respect to core e.g: Core-LV-IV-HV-Reg Coarse-Reg Fine						
2.	Regulating Winding: i) Body Tap ii) Separate						
3.	HV Line Exit point in winding: i) Top ii) Center						
4.	Varistors used across Windings If yes, Details	Yes/No					
5.	Insulation Levels of windings		HV	IV	LV	HV-N	IV-N
	i) Lightning Impulse withstand voltage (1.2/50μs)	kV _p					
	ii) Chopped wave Lightning Impulse withstand voltage	kV _p					
	iii) Switching Impulse withstand voltage (250/2500μs)	kV _p					

	iv) Power frequency withstand voltage	kV _{rms}					
	(one minute / 5 minutes)						
6.	Tan delta of windings at ambient temperature	%					

F. ACCESSORIES

Sl. No.	Description	Unit	Offered by manufacturer	Specified by Buyer
1.	Tap Changers			
	i) Control a-Manual b-Au- tomatic c-Remote d-Lo- cal			
	ii) Voltage Class and Current Rating of Tap Changers			
	iii) Make and Model			
	iv) Make and Type of Automatic Voltage Regulator (AVR)			
	v) Tie-in resistor requirement (to limit the recovery voltage to a safe value) and its value			
	vi) OLTC control and monitoring to be carried out through Substation Automation System	Y/N		
	vii) Power Supply for control motor (No. of Phases/Voltage/Frequency)			
	viii) Rated Voltage for control circuit (No. of Phases/Voltage/Frequency)	V		
2.	Tank			
	i) Tank Cover: Conventional/Bell/Bottom Plate			
	ii) Material of plate for tank			

	iii) Plate thickness : side, bottom, cover	mm				
	iv) Rail Gauge	mm				
	v) Minimum Clearance height from rail for lifting Active Part	mm				
	vi) Wheels : Numbers/Plane/Flanged/Uni-Directional/Bi-Directional/Locking Details					
	vii) Vacuum withstand Capability (a) Tank (b) Radiators/Conservator/Accessories	mm of Hg				
	viii) High Pressure withstand Capability (a) Tank (b) Radiators/Conservator/Accessories	mm of Hg				
	ix) Radiator fins/ conservator plate thickness	mm				
	x) Tank Hot spot temperature	°C				
3. Bushings:			HV	IV	LV	HV-N LV-N
	i) Termination Type a-Outdoor b-Cable Box (oil/Air/SF ₆) c-Plug in Type					
	ii) Type of Bushing: OIP/RIP/RIS/oil communicating					
	iii) Bushing housing - Porcelain / polymer					
	iv) Rated Voltage Class	kV				
	v) Rated Current	A				
	vi) Lightning Impulse withstand voltage (1.2/50µs)	kV _p				
	vii) Switching Impulse withstand voltage (250/2500µs)	kV _p				
	viii) One minute Power frequency withstand voltage (dry & wet)	kV _{rms}				
	ix) Minimum Creepage Distance	mm				

	x) Quantity of oil in bushing and specification of oil used				
	xi) Make and Model				
	xii) Tan delta of bushings	%			
	xiii) Max Partial discharge level at Um	pC			
	xiv) Terminal Pad details				
	xv) Weight of assembled bushings	kg			
	xvi) Whether terminal connector for all bushings included in the scope of supply				
4.	Minimum clearances between bushings (for HV, IV and LV) (a) Phase to phase (b) Phase to ground				
5.	Indicator / Relay				
	i) Winding temperature thermometer/ indicator: Range Accuracy				
	ii) Oil temperature thermometer/ indicator: Range Accuracy				
	iii) Temperature sensors by fiber optic (if provided)				
	iv) Oil actuated/gas operated relay				
	v) Oil level Indicators: Main Conservator OLTC Conservator				
	vi) Oil Sight Window: Main Tank Main Conservator OLTC Conservator				
6.	Conservator: i) Total volume ii) Volume between highest and lowest visible oil levels				
7.	Conservator Bag (air cell) i) Material of air cell ii) Continuous temperature withstand capacity of air cell				

8.	Air cell rupture relay provided	Yes / No		
9.	Pressure Relief Device: i) Number of PRDs provided ii) Location on the tank iii) Operating pressure of relief device			
10.	Sudden Pressure Relay / Rapid Pressure rise relay provided; if yes, i) Location on the tank ii) Operating pressure	Y/N		
11.	Dehydrating Breathers(Type & No. of breathers) (a) For main Conservator tank (b) For OLTC conservator			
12.	Flow sensitive Conservator Isolation Valve Provided	Y/N		
13.	Tap Changer protective device			
14.	Type and material of gaskets used at gasketed joints			
15.	Bushing CTs: (HV side and IV/LV side) i) Voltage class ii) No. of cores iii) Ratio iv) Accuracy class v) Burden vi) Accuracy limit factor vii) Maximum resistance of secondary winding viii) Knee point voltage ix) Current rating of secondaries	kV VA Ω V A		
16.	Neutral CTs:			

	i) Voltage class ii) No. of cores iii) Ratio iv) Accuracy class v) Burden vi) Accuracy limit factor vii) Maximum resistance of secondary winding viii) Knee point voltage ix) Current rating of secondaries	kV VA Ω V A		
17.	Transformer Oil i) IS 335 / IEC60296 / as per specification ii) Inhibited/ un-inhibited iii) Mineral / Natural Ester / Synthetic Ester iv) Spare oil as percentage of first filling v) Manufacturer vi) Quantity of oil (before filling and before commissioning) vii) Moisture content (mg/L or ppm) viii) Tan delta (Dielectric Dissipation Factor) at 90°C ix) Resistivity (Ω -cm))			
	x) Breakdown Voltage (before and after treatment) (kV) xi) Interfacial tension at 20 °C (N/m) xii) Pour point (°C) xii) Flash point(°C) xiii) Acidity (mg KOH/gm) xiv) Inhibitors (for inhibited oil) (%) xv) Oxidation Stability			
18.	Press Board: i) Make ii) type			
19.	Conductor Insulating Paper i) Kraft paper ii) Thermally upgraded Kraft paper iii) Nomex			
20.	Provision for fire protection system (as per spec), if yes, provide	Y/N		

	details			
21.	Insulation of core bolts, washers, end plates etc.			
22.	Weights and Dimensions: i) Weights: a. Core b. Windings c. Tank d. Fittings e. Oil f. Total weights of complete transformers with oil and fittings ii) Dimensions; a. Overall Height above track b. Overall length c. Overall breadth iii) Minimum bay width required for installation of the transformer iv) Weight of the heaviest package of the transformer arranged for transportation			
23.	Lifting Jacks i) Number of jacks included ii) Type and Make iii) Capacity iv) Pitch v) Lift vi) Height in close position			
24.	Rail Track gauges i) 2 Rails or 3 rails or 4 rails ii) Distance between adjacent rails on shorter axis iii) Distance between adjacent rails on longer axis			

ANNEXURE –D

TEST PLAN AND PROCEDURES

Tests for Transformers

No.	Test	Um ≤ 170kV	Um > 170kV
1.	Measurement of winding resistance at all taps	Routine	Routine
2.	Measurement of voltage ratio at all taps	Routine	Routine
3.	Check of phase displacement and vector group	Routine	Routine
4.	Measurement of no-load loss and current measurement at 90%, 100% & 110% of rated voltage and rated frequency	Routine	Routine
5.	Magnetic balance test (for three phase Transformer only) and measurement of magnetizing current	Routine	Routine
6.	Short Circuit Impedance and load loss measurement at principal tap and extreme taps	Routine	Routine
7.	Measurement of insulation resistance & Polarization Index	Routine	Routine
8.	Measurement of insulation power factor and capacitance between winding to earth and between windings	Routine	Routine
9.	Measurement of insulation power factor and capacitance of bushings	Routine	Routine
10.	Tan delta of bushing at variable frequency (Frequency Domain Spectroscopy)	Routine	Routine
11.	Full wave lightning impulse test for the line terminals (LI)	Type (for $U_m \leq 72.5\text{kV}$) Routine (for $U_m > 72.5\text{kV}$)	-

		Um≤170 kV)	
12.	Chopped wave lightning impulse test for the line terminals (LIC)	Type	Routine
13.	Lightning impulse test for the neutral terminals (LIN)	Type	Type
14.	Switching impulse test for the line terminal (SI) (Not applicable for Um≤72.5 kV)	Type	Routine
15.	Applied voltage test (AV)	Routine	Routine
16.	Line terminal AC withstand voltage test (LTAC) (Not applicable for Um≤72.5 kV)	Routine	Type
17.	Induced voltage withstand test (IVW)	Routine	-
18.	Induced voltage test with PD measurement (IVPD)	Routine*	Routine
19.	Measurement of transferred surge on Tertiary due to HV lightning impulse and IV lighting impulse	-	Type
20.	Measurement of transferred surge on Tertiary due to HV Switching impulse and IV Switching impulse	-	Type
21.	Test on On-load tap changer (Tap changer fully assembled on the transformer)	Routine	Routine
22.	Measurement of dissolved gasses in dielectric liquid	Routine	Routine
23.	Check of core and frame insulation	Routine	Routine
24.	Leak testing with pressure for liquid immersed transformers (tightness test)	Routine	Routine
25.	Appearance, construction and dimension check	Routine	Routine
26.	Measurement of no load current & Short circuit Impedance with 415 V, 50 Hz AC.	Routine	Routine
27.	Frequency Response analysis (Soft copy of test report to be submitted to site along with test reports)	Routine	Routine
28.	High voltage withstand test on auxiliary equipment and wiring after assembly	Routine	Routine
29.	Tank vacuum test	Routine	Routine
30.	Tank pressure test	Routine	Routine
31.	Check of the ratio and polarity of built-in current transformers	Routine	Routine
32.	Temperature rise test	Type	Type

33.	Overload testing in short-circuit method (applicable for 765 kV transformer only)	-	Type
34.	Short duration heat run test (Not Applicable for unit on which temperature rise test is performed)	Routine	Routine
35.	Over excitation test (applicable for 765 kV transformer only)	-	Routine
36.	Measurement of Zero seq. reactance (for three phase Transformer only)	Type	Type
37.	Measurement of harmonic level in no load current	Type	Type
38.	Determination of acoustic sound level	Type	Type
39.	Measurement of power taken by fans and liquid pump motors (Not applicable for ONAN)	Type	Type
40.	Dynamic Short circuit withstand test	as specified in this specification	

*The requirements of the IVW test can be incorporated in the IVPD test so that only one test is required.

Note: All routine tests shall be carried out on all the units and type tests mentioned in above tables shall be conducted on one unit.

Test Procedures (for Transformer)

General

Tests shall be carried out as per following procedure. However, IS 2026/IEC 60076 (with latest amendments) shall be followed in general for other tests. Manufacturer shall offer the transformer unit for type testing with all major fittings including radiator bank, Marshalling Box, Common Marshalling Box, RTCC (as applicable) assembled.

1. Core assembly dielectric and earthing continuity test

After assembly each core shall be tested for 1 minute at 2000 Volts between all yoke clamps, side plates and structural steel work (core to frame, frame to tank & core to tank).

The insulation of core to tank, core to yoke clamp (frame) and yoke clamp (frame) to tank shall be able to withstand a voltage of 2 kV (DC) for 1 minute. Insulation resistance shall be minimum 1 GΩ for all cases mentioned above.

2. Measurement of winding resistance

After the transformer has been under liquid without excitation for at least 3 h, the average liquid temperature shall be determined and the temperature of the winding shall be deemed to be the same as the average liquid temperature. The average liquid temperature is taken as the mean of the top and bottom liquid temperatures. Measurement of all the windings including compensating (in case terminal is available at outside) at normal and extreme taps.

In measuring the cold resistance for the purpose of temperature-rise determination, special efforts shall be made to determine the average winding temperature accurately. Thus, the difference in temperature between the top and bottom liquid shall not exceed 5 K. To obtain this result more rapidly, the liquid may be circulated by a pump.

3. No-load loss and current measurement

As per IEC 60076-1:2011 clause 11.5

4. Measurement of short-circuit impedance and load loss

The short-circuit impedance and load loss for a pair of windings shall be measured at rated current & frequency with voltage applied to the terminals of one winding, with the terminals of the other winding short-circuited, and with possible other windings open circuited. The difference in temperature between the top and bottom liquid shall not exceed 5 K. To obtain this result more rapidly, the liquid may be circulated by a pump. Loss measurement for all combinations (HV-IV, HV-LV, IV-LV and at Normal and extreme taps).

5. Short term heat run test (Not Applicable for unit on which temperature rise test is performed)

In addition to the type test for temperature rise conducted on one unit, each cooling combination shall routinely be subjected to a short term heat run test to confirm the performance of the cooling system and the absence of manufacturing defect such as major oil flow leaks that may bypass the windings or core.

DGA samples shall be taken at intervals to confirm the gas evolution.

For ODAF or OFAF cooling, the short term heat run test shall be done with the minimum number of pumps for full load operation in order to shorten the temperature build up. Each short term heat run test is nevertheless expected to take about 3 hours.

For ODAF or OFAF cooled transformers an appropriate cross check shall be performed to prove the effective oil flow through the windings. For this purpose the effect on the temperature decay by switching the pumps off/ on at the end of the heat run should demonstrate the effectiveness of the additional oil flow. Refer to SC 12, 1984 cigre 1984 SC12-13 paper by Dam, Felber, Preiniger et al.

Short term heat run test may be carried out with the following sequence:

- Heat run test with pumps running but oil not through coolers.
- Raise temperature to 5 deg less than the value measured during temperature rise test.
- Stop power input and pumps for 6 minutes and observe cooling down trend
- Restart pumps and observe increased cooling trend due to forced oil flow

This test is applicable for the Transformer without Pump also (ONAN or ONAF rating). For such type of transformer test may be carried out with the following sequence:

Arrangement shall be required with pump of suitable capacity (considering the oil velocity) without cooler bank.

- Raise the oil temperature 20-25 deg C above ambient.
- Stop power input and pumps for 6 minutes and observe cooling down trend.
- Restart pumps and observe increased cooling trend due to forced oil flow.

6. Over excitation test (for 765kV class transformer)

A routine over excitation test at 1.05 p.u voltage for 12 hours shall be done on the tap position giving the highest flux. This test shall be carried out immediately after the routine short-term heat run test on the transformer. The rate of gas development during the test shall be evaluated using IEEE/IEC/CIGRE guidelines.

7. Temp. Rise Test as per IEC: 60076

Headspace extraction and Gas chromatographic analysis on oil shall also be conducted before, during and after this test and the values shall be recorded in the test report. The sampling shall be in accordance with IEC 60567.

The temperature rise test shall be conducted at a tap for the worst combination of loading (3-Winding Loss) for the Top oil of the transformer.

3-Winding Loss = HV (Max MVA) + IV(Max MVA) + LV (Max MVA).

The Contractor before carrying out such test shall submit detailed calculations showing losses on various taps and for the three types of ratings of the transformer and shall recommend the combination that results in highest temperature rise for the test.

The Temperature rise type test results shall serve as a “finger print” for the units to be tested only with short term heat run test.

Headspace extraction and Gas chromatographic analysis on oil shall also be conducted before, during and after this test and the values shall be recorded in the test report. The sampling shall be in accordance with IEC 60567.

Oil sample shall be drawn before and after heat run test and shall be tested for dissolved gas analysis. Oil sampling to be done 2 hours prior to commencement of temperature rise test. Keep the pumps running for 2 hours before and after the heat run test. Take oil samples during this period. For

ONAN/ONAF cooled transformers, sample shall not be taken earlier than 2 hours after shut down. The acceptance norms with reference to various gas generation rates shall be as per IEC 61181.

The DGA results shall generally conform to IEC/IEEE/CIGRE guidelines.

i. Test conditions for temperature rise test:

- This test shall be generally carried out in accordance with IEC 60076-2
- For each cooling combination with cooler bank, tests shall be done on the maximum current tap for a minimum of 12 hours for ONAN/ONAF or ONAF1 and 24 hours for ODAF or OFAF or ONAF2 with saturated temperature for at least 4 hours while the appropriate power and current for core and load losses are supplied.
- The total testing time, including ONAN heating up period, steady period and winding resistance measurements is expected to be about 48 hours.
- DGA tests shall be performed before and after heat run test and DGA results shall generally conform to IEC/IEEE/CIGRE guidelines.

ii. Test records:

Full details of the test arrangements, procedures and conditions shall be furnished with the test certificates and shall include at least the following.

iii. General:

- Purchaser's order number and transformer site designation.
- Manufacturer's name and transformer serial number.
- Rating of transformer
- MVA
- Voltages and tapping range
- Number of phases
- Frequency
- Rated currents for each winding
- Vector Group
- Cooling Type
- Measured no-load losses and load losses at 75° C.
- Altitude of test bay.
- Designation of terminals supplied and terminals strapped.

iv. Top oil temperature rise test:

A log of the following quantities taken at a minimum of 30 minute intervals:

- time
- Voltage between phases
- Current in each phase and total power
- Power in each phase and total power
- Ambient temperature
- Top oil temperature
- Cooler inlet and outlet oil temperatures
- Hot spot temperatures (make use of probes) (if applicable)
- Colour photographs of the four sides and top of the transformer together with the corresponding series of thermal images (colour) during starting of the test then after every four hours till the temperature stabilised and finally during temperature stabilised for each rating (ONAN/ONAF/OFAF or ONAN/ONAF1/ONAF2).

Notes:

The probes may be left in position provided the reliability and integrity of unit will not be jeopardized during its long life expectancy.

v. Winding temperature rise test

- Record the ‘cold’ resistance of each winding and the simultaneous top oil and ambient air temperatures, together with the time required for the effect to disappear.
- Record the thermal time constant of the winding.
- Log the half-hourly readings of the quantities as for the top oil temperature rise test.
- Provide a table of readings, after shut-down of power, giving the following information;

- a) Time after shut- down:
- b) Time increment:
- c) Winding resistance: At least 20 minutes reading
- d) Resistance increment:
- e) X , where x is the time after shut-down divided by the thermal time constant of the winding: and
- f) Y , where $Y = 100 (1 - e^{-x})$

(Any graphical/computer method used to determine the temperature of a winding by extrapolation to the instant of power shut-down shall produce a linear curve.)

- Provide a record of all calculations, corrections and curves leading to the determination of the winding temperatures at the instant of shut- down of power.
- Record any action taken to remedy instability of the oil surge device during initiation of the oil circulating pumps.

Temperature measurements as per special probes or sensors (fibre optic) placed at various locations shall also be recorded.

8. Overload testing in short-circuit method (for 765kV class transformer)

The test shall be carried out on the tapping position that will cause the highest current under normal conditions. Hot spot temperature measurement shall be done by using temperature probes or sensors in approved locations.

The transformer shall be fully erected as for service with all cooling equipment.

i. Testing option 1:

Pre-load the unit with 100% of full load current for a period long enough to stabilise the top oil temperature with cooling as for service conditions.

- Increase the loading to 120% overload rating. Forced cooling shall be activated as per service conditions.
- Scan and record infra-red images of all four sides and the top of the transformer at the interval of every one hour.
- Hold the overload current for a period of 4 hours.
- Measure and record the hotspot temperatures.

ii. Testing option 2:

Pre-load the unit with 100% of full load current for a period long enough to stabilise the top oil temperature with 100% cooling as per service conditions.

- Increase the loading to 130% overload rating.
- Scan and record infra-red images of all four sides and the top of the transformer every 30 minutes.
- Hold the current at 130% for a period of 2 hours.
- Measure and record the hotspot temperature.

iii. Acceptance criteria:

Winding hotspot temperatures shall not exceed 130°C for option 1 and 135°C for option 2.

The temperature rise recorded by infra-red shall be not more than 10°K above top oil temperature or 15°K above the local oil temperature.

The rate of gas development as determined from oil samples shall be determined. Samples shall be taken before and after the test and acceptance criteria shall be in accordance with IEC/IEEE guidelines.

iv. Test records:

Full details of the test arrangements, procedures and conditions shall be supplied with the test certificates and shall include the following:

- Purchaser's reference number and site designation
- Manufacturer's name and transformer serial number
- MVA rating and voltage ratio
- Vector group
- Altitude of test bay
- Designation of terminals supplied and terminals strapped
- Colour photographs of the four sides and top of the transformer.

v. Overload test:

A log of the following quantities taken at a minimum of 30-minute intervals:

- time
- voltage between phases
- current in each phase
- power in each phase and total power
- ambient temperature
- top oil temperature
- cooler inlet and outlet temperatures
- average winding temperatures
- hot spot temperatures (make use of probes)

Notes:

Measurement methods for hot spots, their location and the number of sensors shall be agreed with Purchaser prior to the test. The probes may be left in position provided the reliability and integrity of the unit will not be jeopardized during its long life expectancy.

9. Dielectric Tests

Following Test shall be performed in the sequence given below as per IEC 60076-3:2013 clause 7.2.3 shall be followed:

- a) Lightning impulse tests (LIC, LIN)
- b) Switching impulse (SI)
- c) Applied voltage test (AV)
- d) Line terminal AC withstand test (LTAC)
- e) Induced voltage test with partial discharge measurement (IVPD)

10. Measurement of transferred surge on LV or Tertiary due to HV & IV Lightning impulse

Following tests shall be carried out with applying 20% to 80% of rated Impulse & Switching impulse (up to 60% for IV, Sr. No. 7 & 8 of below table) voltage. Finally, measured value shall be extrapolated for 100% rated voltage.

Table for Transfer surge (Impulse) at Max, Nor. and Min. Voltage Tap

Sr. No.	Impulse Type	Voltage applied	Earthed Points	Open / not earthed point	Measurement Point
1	FW	1.1	2.1, N & 3.2	-	3.1
2	FW	1.1	2.1, N & 3.1	-	3.2
3	SW	1.1	N & 3.2	2.1	3.1
4	SW	1.1	N & 3.1	2.1	3.2
5	FW	2.1	1.1, N & 3.2	-	3.1
6	FW	2.1	1.1, N & 3.1	-	3.2
7	SW	2.1	N & 3.2	3.2	3.1
8	SW	2.1	N & 3.1	3.1	3.2

Similar tests to be conducted for switching surge transformer at Max, Nor. and Min. Voltage Tap.

Where 1.1 : HV Terminal

2.1 : IV Terminal

3.1 & 3.2 : LV or Tertiary Terminal

Acceptance criteria

Transfer surge at Tertiary should not exceed 250kVp at any conditions for 400kV Voltage class Transformer. For other transformer it shall be below the impulse level of LV winding.

11. Chopped wave & full wave lightning impulse test for the line terminals (LIC & LI) and Switching impulse test

Chopped wave lightning impulse and Switching impulse test shall be performed at normal and extreme taps on Unit-1, Unit-2 and Unit-3 respectively for 1-Ph unit, otherwise R ph, Y Ph and B Ph respectively for 3- Ph unit. All the parameters as per IEC shall be mentioned in the report.

12. Measurement of power taken by fans and oil pumps (100 % cooler bank)

Losses of each fan and pumps including spare shall be measured at rated voltage and frequency. Fans and Pumps shall be mounted with cooler bank as per approved drawing during measurement. Serial No, Applied voltage, measured current, frequency and make shall be furnished in the test report.

13. Short duration (LTAC) AC withstand test (LTAC)

For 765kv Class transformer, the IV terminal voltage shall be shall be raised to 570kVrms or below so that maximum HV voltage shall be shall be limited to 970kV rms. Test method shall be as per IEC.

14. Dynamic short circuit withstand test

The test shall be carried out as per IEC 60076-5. Dynamic short circuit test shall be carried out in HV-IV combination at nominal & extreme tap positions. For LV winding, dynamic short circuit shall be carried out either on HV-LV or IV-LV combination, whichever draws higher short circuit current as per calculation. Type tests shall be carried out before short circuit test. Following shall also be conducted before and after Short Circuit test:

- i) Dissolved gas analysis
- ii) Frequency response analysis
- iii) All routine tests

Detail test procedure shall be submitted by contractor & shall be approved before short circuit test.

15. Routine test on bushings shall be done as per IEC 60137.

BASIC MANUFACTURING FACILITY & MANUFACTURING ENVIRONMENT

Customer/Purchaser always desires that transformer manufactured and delivered is of good quality and must perform trouble free service for its “Specified Design Life”. The consistency in quality of material used & manufacturing process are main cause for variation in quality of transformer. It is also equally very important that transformer is manufactured in a clean dust free and humidity controlled environment. Any compromise on this aspect will have adverse effect in expected design life of transformer/reactor, however good is the quality of material used. A broad list of facilities the transformer/reactor manufacturers should have are given below:

Basic manufacturing facility

Following manufacturing facility should be available for use with transformer manufacturer:

1. EOT Crane for main manufacturing bay and other shops (With LoadCell).
2. Vapor Phase Drying Oven (adequately sized to accommodate offered transformer and have facility to record temperature, vacuum, moisture etc.)
3. Air Casters for material handling
4. Core cutting line (if applicable)
5. Vacuum auto claves
6. Air oven
7. Adjustable Horizontal and vertical winding machine
8. Winding Mandrels
9. Hydraulic Press
10. Brazing equipment
11. Mechanical platform
12. Tools and fixtures
13. Mechanical power press
14. Welding machines
15. Crimping tools
16. Faraday’s cage
17. Motor Generator Set/ Static Power System Set
18. Testing transformer
19. Capacitor bank
20. Impulse voltage generator

21. Capacitance & Tan delta bridge
22. Power Analyzer
23. Current & Voltage transformer
24. Partial Discharge (PD) measuring kit (for all manufacturers) & PD Diagnostic Kit (for 400 kV & above voltage class Transformer manufacturer)
25. Temperature data logger
26. Noise measurement kit
27. Thermo vision camera
28. Loss measurement kit
29. Insulation tester
30. Winding resistance meter
31. Turn ratio meter
32. Transformer oil test lab
33. Dissolved Gas Analysis (DGA) test kit
34. Sweep Frequency Response Analyzer (SFRA) kit
35. Frequency Domain Spectroscopy (FDS) kit
36. NABL Accredited laboratory for testing
37. Oil Storage tanks
38. Oil filter plant with requisite level of vacuum and filter
39. Tensometer for Oil Surface tension
40. Particle Count Kit (for 400 kV & above Transformer)
41. Multimeters

Manufacturing environment (Clean, dust free and humidity controlled environment)

A. Transformer must be manufactured in a bay having positive pressure w.r.t. external environment. Winding shall be manufactured in a clean, dust free and humidity controlled environment. The dust particle shall be monitored regularly in the manufacturing areas. Further, there shall be positive atmospheric pressure, clean, dust free and humidity controlled environment for following:

1. Insulation storage
2. Core storage
3. Glue stacking area
4. Core cutting line

5. Winding manufacturing bay
6. Core building area
7. Core coil assembly area
8. Testing lab
9. Packing & dispatch area

B. Following accessories to be kept in clean and covered location:

1. Piping
2. Radiator
3. Tank
4. Bushing (as per manufacturer's guideline)
5. Marshalling box
6. Turret
7. Conservator
8. Insulating oil

LIST OF DRAWINGS/DOCUMENTS TO BE SUBMITTED BY THE MANUFACTURER

1.0 Each drawing shall be identified by a drawing number and each subsequent resubmission/revision or addition to the drawing shall be identified by a revision number. All drawings shall be thoroughly checked for accuracy & completeness and signed. Any mistakes or errors in drawings shall not form a basis for seeking extension of delivery period.

2.0 In addition to any other drawings which the manufacturer may like to supply, the following drawings/calculations/documents/ catalogues shall be submitted in hard and soft copy:

- (a) Guaranteed Technical Particulars (GTPs) and other Technical particulars
- (b) Rating and Diagram Plate giving details of terminal marking and connection diagram
- (c) General Arrangement (GA) drawing (as built drawing) of transformer/reactor showing Plan, Elevation, End view (left side & right side view looking from HV side) and 3D view identifying various fittings & accessories, dimensions, weight, clearances, quantity of insulating oil, centre of gravity etc.
- (d) View showing maximum lifting height of core-coil assembly and maximum clearance over tank top required for taking out the bushing.
- (e) List of all accessories, description, make, weight and quantity
- (f) Bill of Materials (BoM) with description, make & quantity
- (g) Drawing relating to Neutral formation of 1-phase units of three phase bank
- (h) Drawing relating to Delta formation of 1-phase units of 3- phase bank
- (i) Foundation Plan (combined foundation drawing for 1-phase transformers) showing Rail gauge, fixing details of foundation bolts, clamping arrangement to restrict movement during earthquake & location of jacking pads and loading details
- (j) Bushing Drawing showing dimensions, electrical & mechanical characteristics, mounting details and test tap details (as applicable)
 - i) HV Bushing
 - ii) IV Bushing
 - iii) LV Bushing
 - iv) Neutral Bushing
- (k) Transport Dimension Drawing indicating transport weight, transport condition (oil filled/gas filled), lifting bollards, jacking pads, pulling eyes, quantity and location of impact recorder etc.
- (l) General Arrangement Drawing of Cooler Control Cabinet, Marshalling box
- (m) GA drawing for bus duct termination (if applicable) indicating position of bus duct mounting flanges
- (n) General Arrangement Drawing of RTCC panel (if applicable)
- (o) GA drawing for Junction Box (if applicable)
- (p) GA drawing for Cable Box (if applicable)

- (q) Cooler Control Scheme: Schematic wiring diagram of cooling arrangement along with write up on scheme
- (r) Tap Changer Control Scheme (if applicable): Schematic wiring diagram of OLTC along with write up on scheme
- (s) Mounting Arrangement and wiring diagram of remote WTI along with write up.
- (t) Alarm/Trip Indication Scheme
- (u) Valve Schedule Plate drawing showing all valves, air vents, drain plugs etc. with type, size, material and quantity of valves
- (v) Technical literature of all fittings and accessories
- (w) Calculation in support of thermal withstand capability of transformer due to short circuit
- (x) Calculation of hot spot temperature
- (y) Value of air core reactance with a typical write-up of calculation
- (z) Magnetisation Characteristics of bushing CTs and neutral CTs
- (aa) Hysteresis Characteristics of iron core (bb) Over fluxing withstand duration curve (cc) Typical heating and cooling curves
- (dd) Drawing showing winding arrangement & geometrical sequence w.r.t core with winding ID/OD, height & separation distance between windings etc.
- (ee) Twin bi-directional roller assembly drawing (ff) Oil Flow Diagram
- (gg) List of spares
- (hh) Connection diagram of all protective devices to marshalling box showing physical location
- (ii) Insulating oil storage tank drawing (jj) Oil sampling Bottle details
- (kk) Customer inspection schedule
- (ll) Test procedure of transformer
- (mm) Manufacturer Quality Program (MQP) and Field Quality Plan (FQP)
- (nn) Field Welding Schedule for field welding activities (if applicable)
- (oo) Type test reports
- (pp) O&M manual (hard copy and soft copy) of transformer/reactor inter-alia including instructions for Aircell, Oil filling, Bushing removal and Core Coil Assembly un-tanking etc

ANNEXURE –G

Short Circuit Test Requirement of Transformers.

The manufacturer shall be required to submit report on Dynamic Short Circuit Test carried out on the transformer of similar design as the one offered. (Criteria for similar design to be taken as per CEA guidelines). **The validity of Dynamic Short Circuit test for transformer shall be as per CEA's letter dated 26.06.2023 or further amendments in guidelines/regulations by CEA in this regard, whichever is latest.** In case, if the dynamic short circuit test has not been carried out then the manufacturer shall submit an undertaking that in the event of order being awarded to him, he shall get Dynamic Short Circuit Test done on any one of the offered transformer at the works of CPRI or at the works of any Government approved agency at his own expense and will submit the report before its supply. If Dynamic Short Circuit Test on sample fails, the whole quantity of supplied transformers shall be replaced by manufacturer without any cost to DTL.

However, the requirement of conduction of Dynamic short circuit (DSC) test on 400kV 500MVA transformer shall be as per CEA letter dated 26.06.2023 or further amendments in guidelines/regulations by CEA in this regard, whichever is latest.

If required, DTL (Purchaser) have also the right to perform Dynamic Short Circuit Test on any of the transformer at the works of CPRI or at the works of any Government approved agency on randomly selected transformer at DTL's own cost. If sample fails, the whole quantity of supplied equipments shall be replaced by manufacturer without any cost to DTL and the cost incurred by DTL on conducting of dynamic short circuit test shall also be recoverable from the supplier.

ANNEXURE –H

PAINTING PROCEDURE

PAINT- ING	Surface prepara- tion	Primer coat	Intermediate undercoat	Finish coat	Total Dry Film Thick- ness (DFT)	Color shade
<u>External surfaces:</u> Main tank, pipes, con- servator tank, oil storage tank & Driving Mechanism (DM) Box etc. ()	Shot Blast cleaning Sa 2 ½*	Epoxy base Zinc primer (30- 40µm)	Epoxy high build Mica- ceous iron ox- ide (HB MIO) (75µm)	Ali- phatic polyu- reth ane (PU) (Mini- mum 50µm)	Mini- mum 155µm	RAL 7035
<u>Internal surfaces:</u> Main tank, pipes (above 80 NB#), conservat or tank, oil storage tank & DM Box etc. ()	Shot Blast cleaning Sa 2 ½*	Hot oil re- sistant, non- corro- sive paint, low vis- cosity varnish or epoxy	--	--	Mini- mum 30µm	Glossy white for paint
Radiator (external surfaces)	Chemical / Shot Blast cleaning Sa 2 ½*	Epoxy base Zinc primer (30- 40µm)	Epoxy base Zinc primer (30-40µm)	PU paint (Mini- mum 50µm)	Mini- mum 100µm	Matching shade of tank/ dif- ferent shade aes- thetic ally matching to tank

	Manufacturer may also offer Radiators with hot dip galvanized (in place of painting) with minimum thickness of 40µm (min)					
Radiator and pipes up to 80 NB (Internal surfaces)	Chemical cleaning, if required	Hot oil proof, low viscosity varnish or Hot oil resistant, non-corrosive Paint	--	--	--	--
Digital RTCC Panel	Seven tank process as per IS:3618 & IS:6005	Zinc chromate primer (two coats)	--	EPOXY paint with PU top coat or POWDER Coated	Minimum 80µm / for powder Coated Minimum 100µm	RAL 7035 shade for exterior and Glossy white for interior
Control cabinet / Marshalling Box - No painting is required.						

Note:

*indicates Sa 2 ½ as per Swedish Standard SIS 055900 of ISO 8501 Part-1. #NB: Nominal Bore

Annexure–I

I. UNUSED INHIBITED HIGH GRADE INSULATING OIL PARAMETERS

Sl. No.	Property	Test Method	Limits
A Function			
1a.	Kinematic Viscosity at 40 °C	IS 1448 Part 25 or ISO 3104 or ASTM D7042	12 mm ² /s (Max.)
1b.	Kinematic Viscosity at 30 °C		1800 mm ² /s (Max.)
2.	Appearance	A representative sample of the oil shall be examined in a 100 mm thick layer, at ambient temperature	The oil shall be clear and bright, transparent and free from suspended matter or sediment
3.	Pour point	IS 1448 Part 10/Sec 2 or ISO 3016	-40 °C (Max.)
4.	Water content a) for bulk supply b) for delivery in drums	IEC 60814	30 mg/kg (Max.) 40 mg/kg (Max.)
5.	Electric strength (breakdown voltage)	IS 6792 or IEC 60156	Minimum 30 kV (new unfiltered oil) / 70 kV (after treatment)
6.	Density at 20 °C	IS 1448 Part 16 or ISO 12185 or ISO 3675 or ASTM D7042	895 kg/m ³ (Max.)
7.	Dielectric dissipation factor (tan delta) at 90 °C	IS 16086 or IEC60247 or IEC 61620	0.0025 (Max.)
8.	Negative impulse testing KVp @ 25 °C	ASTM D3300	145 (Min.)
9.	Carbon type composition (% of Aromatic, Paraffins and Naphthenic compounds)	IEC 60590 and IS 13155 or ASTM D2140	Maximum Aromatic : 4 to 12 % Paraffins : <50% & balance shall be Naphthenic compounds.
B Refining/Stability			
1.	Colour	ISO 2049	L0.5 (less than 0.5)

2.	Appearance	–	Clear, free from sediment and suspended matter
3.	Neutralization Value (Total Acidity)	IEC 62021-1 or IEC 62021-2	0.01 mg KOH/g (Max.)
4.	Interfacial tension at 27°C	IEC 62961 or ASTM D971	0.043 N/m (Min.)
5.	Total sulphur Content	ISO 14596 or ISO 8754	0.05 % (Max.) (before oxidation test)
6.	Corrosive sulphur	DIN 51353	Not Corrosive
7.	Potentially corrosive sulphur	IEC 62535	Not Corrosive
8.	Presence of oxidation inhibitor	IS 13631 or IEC 60666	0.08% (Min.) to 0.4% (Max.)
9.	DBDS	IEC 62697-1	Not detectable (<5 mg/kg)
10.	Metal passivator Additives	IEC 60666	Not detectable (<5 mg/kg)
11.	2-Furfural and related compound Content	IS 15668 or IEC 61198	Not detectable (<0.05 mg/kg) for each individual Compound
12.	Stray gassing under thermo-oxidative stress	Procedure in Clause A.4 of IEC 60296- 2020 (oil saturated with air) in the presence of copper	Non stray gassing: < 50 µl/l of hydrogen (H2) and < 50 µl/l methane (CH4) and < 50 µl/l ethane (C2H6)
C Performance			
1.	Oxidation stability	IEC 61125 (method c) Test duration: 500 hours	
	-Total acidity*	4.8.4 of IEC 61125:2018	0.3 mg KOH/g (Max.)
	-Sludge*	4.8.1 of IEC 61125:2018	0.05 % (Max.)
	-Dielectric Dissipation Factor* (tan delta) at 90 °C	4.8.5 of IEC 61125:2018	0.05 (Max.)
	*values at the end of oxidation stability test		
D Health, safety and environment (HSE)			

1.	Flash point	IS 1448 Part 21 or ISO 2719	135 °C(Min.)
2.	Poly Aromatic Content	Cyclic (PCA)	IP 346
3.	Poly Chlorinated Biphenyl content	(PCB)	IS 16082 or IEC 61619
			Not detectable (< 2 mg/kg)

Note: Supplier shall declare the chemical family and function of all additives and the concentrations in the cases of inhibitors, antioxidants and passivators.

II. Oil used for first filling, testing and impregnation of active parts at manufacturer's works shall meet parameters as mentioned below

1	Break Down voltage (BDV)	-	70kV (Min.)
2	Moisture content	-	5 ppm (Max.)
3	Tan-delta at 90°C	-	0.005 (Max.)
4	Interfacial tension	-	0.04 N/m (Min.)

III. Each lot of the oil shall be tested prior to filling in main tank at site for the following:

1	Break Down voltage (BDV)	-	70 kV (Min.)
2	Moisture content	-	5 ppm (Max.)
3	Tan-delta at 90°C	-	0.0025 (Max.)
4	Interfacial tension	-	0.04 N/m (Min.)

IV. After filtration & settling and prior to energization at site oil shall be tested for following:

1	Break Down voltage (BDV)	-	70 kV (Min.)
2	Moisture content at hot Condition	-	5 ppm (Max.)
3	Tan-delta at 90°C	-	0.005 (Max.)
4	Interfacial tension	-	0.04 N/m (Min.)
5	*Oxidation Stability	-	

	a) Acidity		0.3 (mg KOH /g) (Max.)-For Inhibited Oil 1.2 mg KOH/g (Max.)-For Uninhibited Oil
	b) Sludge	-	0.05 % (Max.) - For Inhibited Oil 0.8 % (Max.) - For Uninhibited Oil
	c) Tan delta at 90 °C	-	0.05 (Max.) - For Inhibited Oil 0.5 (Max.) - For Uninhibited Oil
6	Total PCB content*		Not detectable (< 2 mg/kg)
	* Separate oil sample shall be taken and test results shall be submitted within 45 days after commissioning for approval of the utility		

PHYSICAL INTERCHANGEABILITY OF TRANSFORMERS OF DIFFERENT MAKES

- 1.0 One of the objectives of standardization is to achieve physical interchangeability of transformers of different makes, procured by DTL, by standardizing the minimum foundation loading to be considered for civil foundation design of transformers. In case of failure of any transformer, outage time to replace a failed unit by a spare unit/new unit of different make would be minimized as it can be accommodated in the same space without/minor modification in existing foundation.
- 2.0 In general, the foundation layout & design of transformer depends on weight of the transformer (with oil and all fittings & accessories), design of soak pit (with or without remote oil collecting pit) with trans rack/grating & gravels and free space to be kept below the transformer/reactor to accommodate oil and water in case of fire. The number of rails, number & location of jacking pads of transformers are also equally important.
- 3.0 The foundation design should take into account the following points:
 - a) The foundations of transformer should be of block type foundation. Minimum reinforcement should be governed by IS: 456.
 - b) Transformer can be placed on foundation either directly or on roller assembly (with suitable locking arrangement) along with suitable anti Earthquake Clamping Device as specified in this specification.
 - c) The plinth height of transformer foundation may be kept from 300 mm to 500 mm above finished ground level of the substation/switchyard depending upon the size of the transformer. Pulling blocks should be provided for shifting of transformer for maintenance purposes.
 - d) The pedestal support should be provided for supporting the cooler bank, firefighting system etc. The RCC Rail-cum-road system integrated with the transformer foundation may be provided to enable installation and the replacement of any failed unit. The transfer track system should be suitable to permit the movement of any failed unit fully assembled (including OLTC, bushings) with oil.

This system should enable the removal of any failed unit from its foundation to the nearest road. If trench/drain crossings are required, then suitable R.C.C. culverts should be provided in accordance with I.R.C. standard/relevant IS.

- e) Foundation of each transformer including oil conservator tank and cooler banks etc. should be placed in a self-sufficient pit surrounded by RCC retaining walls (Pit walls). The retaining wall of the pit from the transformer should be such that no part of transformer is outside the periphery of retaining wall.
- f) An oil soak pit of adequate capacity should be provided below each oil filled transformer to accommodate at least 150% of full quantity of oil contained in the transformer and minimum 300 mm thick layer of gravels/pebbles of approximately 40 mm size (spread over a steel iron grating/trans rack) providing free space below the grating. Alternatively, an oil soak pit should be provided below each transformer to accommodate 1/3rd of total quantity of oil contained in the transformer and minimum 300 mm thick layer of gravels/pebbles of approximately 40 mm size (spread over a steel iron grating/trans rack) providing free space below the grating provided a common remote oil collecting pit of capacity at least equal to oil quantity in the largest size transformer is provided for a group of transformers. Bottom of the soak pit below the transformer should be connected to the common oil collecting pit with drain pipe (two or more Hume/concrete pipes) of minimum 150 mm diameter with a slope not less than 1/96 for fast draining of oil and water through gravity from soak pit to the burnt oil collecting pit, which is generally located away from transformers.
- g) Every soak pit below a transformer should be suitably designed to contain oil dropping from any part of the transformer/reactor.
- h) The common remote oil collecting pit and soak pit (when remote oil collecting pit is not provided) should be provided with suitable automatic pumping facility, to always keep the pit empty and available for an emergency.
- i) The disposal of transformer oil should be carried out in an environmental friendly manner.
- j) The minimum height of the retaining walls of pit should be 150 mm to 200 mm above the finished ground level to avoid outside water pouring inside the pit. The bottom of the pit is generally made of PCC M15 grade and should have a uniform slope towards the sump pit. While designing the oil collection pit, the movement of the transformer must be taken into account.
- k) The grating shall be made of MS flat of size 30 mm x 5 mm at spacing of 30 mm and MS bar of 6 mm dia at spacing of 150 mm at right angle to each other. Maximum length & width of grating should be 2000 mm & 500 mm respectively. The gratings, supported on ISMB 150 mm, should be placed at

the formation level and will be covered with 300 mm thick layer of stone aggregate having size 40 mm (approximate). All steel work used for grating and supports should be painted with epoxy based zinc phosphate primer (two packs) confirming to IS: 13238-1991, thereafter with two or more coat of bituminous paint of approved quality should be applied.

- l) In case of transformers with separately mounted cooler / radiator bank, the position of the cooler / radiator bank has been recommended on the left side of the transformer when viewing from HV side. However, transformer shall be designed in such a way that cooler / radiator bank can be positioned on either side of the main tank. Similarly the conservator shall be on the left side of the tank while viewing from HV side.
- m) The separation wall(s) or fire barrier wall(s) of four hours fire withstand rating shall be provided between the transformers and/or reactors or between the transformer(s)/reactor(s) & the adjacent wall of a building if wall of the building do not have the capability to withstand fire for a duration of four (4) hours as per Central Electricity Authority (Measures relating to Safety and Electric Supply) Regulations.
- n) Other requirement related to civil construction of foundation may be specified by DTL in line with relevant BIS standards and best practices.

4.0 It is a fact that maximum weight of transformer (with oil and all fittings & accessories) and outline dimension do not vary much from manufacturer to manufacturer for same rating. Hence a common foundation layout plan with soak pit (with oil and all fittings & accessories) with loading details would facilitate the interchangeability of transformers of different make of similar/same ratings. The DTL will strive to standardize the foundation plan for different rating of transformers so that transformers of different makes could be accommodated in the same space with minor modification/without any modification in the existing foundation resulting in reduction in the outage time of replacement of old transformer.

5.0 The rail track gauge shall be 1676 mm. 3-Phase auto transformers of 400kV class shall have four (4) rails and other voltage class transformers shall have two (2) rails.

6.0 The manufacturers have different arrangement of jacking and different spacing between jacking pads. Hence, it is difficult to standardize the civil foundation drawing based on jacking pad locations arrangement. Design of block foundation based on weight of transformer for a particular MVA/MVAR rating along with no. of rails as mentioned above and provision of suitable size of portable metal plate for jacking [(400 mm x 400 mm x 32 mm thick)/(300 mm x 300 mm x

30 mm thick)] would facilitate the physical interchangeability of transformers of different make on same foundation block. One set of metal plates for jacking of transformer shall be provided by OEM/contractor. Minimum size of metal plates for jacking and minimum weight of transformer to be considered for design of foundation block shall be as follows:

Rating of Transformer (MVA, Voltage ratio, no. of Phases)	Weight of transformer (in metric Tons)	Minimum size of removable metal plates for Jacking of transformer
500MVA,400/220/33kV 400/230/33kV,3-Phase Auto Transformer	450	400 mm x 400 mm x 32 mm thick
315MVA, 400/220/33kV 400/230/33kV 3-Phase Auto Transformer	375	400 mm x 400 mm x 32 mm thick
315 MVA,400/132/33 kV 3-Phase Auto Transformer	375	400 mm x 400 mm x 32 mm thick
160MVA, 220/66kV,or 20/66kV, 3-Phase Power Transformer	225	400 mm x 400 mm x 32 mm thick
100MVA, 220/33kV or 230/33kV, 3-Phase Power Transformer	200	400 mm x 400 mm x 32 mm thick
31.5MVA, 132/33kV or 110/33kV, 3-Phase Power Transformer	100	300 mm x 300 mm x 30 mm thick
31.5MVA/20MVA/12.5MVA, 66/11kV, 3-Phase	75	300 mm x 300 mm x 30 mm thick

1100 V GRADE POWER & CONTROL CABLES

- 1.1 Separate cables shall be used for AC & DC.
- 1.2 Separate cables shall be used for DC1 & DC2.
- 1.3 At least one (1) core shall be kept as spare in each copper control cable of 4C, 5C or 7C size whereas minimum no. of spare cores shall be two (2) for control cables of 10 core or higher size.
- 1.4 The Aluminium/Copper conductors used for manufacturing the cables shall be true circular in shape before stranding; shall be of good quality, free from defects and shall conform to IS 8130.
- 1.5 The fillers and inner sheath shall be of non-hygrosopic, fire retardant material, shall be softer than insulation and outer sheath shall be suitable for the operating temperature of the cable.
- 1.6 Progressive sequential marking of the length of cable in metres at every one metre shall be provided on the outer sheath of all cables.
- 1.7 Strip wire armouring method (a) mentioned in Table 5, Page-6 of IS: 1554 (Part 1) – 1988 shall not be accepted for any of the cables. For control cables only round wire armouring shall be used.
- 1.8 The cables shall have outer sheath of a material with an oxygen index of not less than 29 and a temperature index of not less than 250°C.
- 1.9 All the cables shall conform to fire resistance test as per IS: 1554 (Part - I).
- 1.10 The normal current rating of all PVC insulated cables shall be as per IS: 3961.
- 1.11 Repaired cables shall not be accepted.
- 1.12 Allowable tolerance on the overall diameter of the cables shall be ± 2 mm.

1.13 PVC Power Cables

- 1.13.1 The PVC insulated 1100V grade power cables shall be of Fire Retardant Low Smoke Halogen (FRLSH) type, C2 category, conforming to IS: 1554 (Part-I) and its amendments read along with this specification and shall be suitable for a steady conductor temperature of 85°C. The conductor shall be stranded aluminium of H2 grade conforming to IS 8130. The insulation shall be extruded PVC of type-C of IS: 5831. A distinct inner sheath shall be provided in all multi core cables. For multi core armoured cables, the inner sheath shall be of extruded PVC. The outer sheath shall be extruded PVC of Type ST-2 of IS: 5831 for all cables. The copper cable of required size can also be used.

1.14 PVC Control Cables

- 1.14.1 The 1100V grade control cables shall be of FRLSH type, C2 category conforming to IS: 1554 (Part-1) and its amendments, read along with this specification. The conductor shall be stranded copper. The insulation shall be extruded PVC of type A of IS: 5831. A distinct inner sheath shall be provided in all cables whether armoured or not. The outer sheath shall be extruded PVC of type ST-1 of IS: 5831 and shall be grey in colour except where specifically advised by the purchaser to be black.
- 1.14.2 Cores shall be identified as per IS: 1554 (Part-1) for the cables up to five cores and for cables with more than five (5) cores the identification of cores shall be done by printing legible Hindu Arabic Numerals on all cores as per clause 10.3 of IS : 1554 (Part - 1).

ANNEXURE –L

SPECIFICATION FOR OIL STORAGE TANK (Quantity as per scope)

1. Oil storage tank shall be of adequate capacity as specified by the utility along with complete accessories. The oil storage tank shall be designed and fabricated as per relevant Indian Standards e.g. IS: 803 or other internationally acceptable standards. Transformer oil storage tanks shall be towable on pneumatic tyres and rested on manual screw jacks of adequate quantity & size. The tank shall be cylindrical in shape and mounted horizontally and made of mild steel plate of adequate thickness. Diameter of the tank shall be 2.0 meter approximately. The tank shall be designed for storage of oil at a temperature of 100⁰C.
2. The maximum height of any part of the complete assembly of the storage tank shall not exceed 4.0 metres above road top.
3. The tank shall have adequate number of jacking pad so that it can be kept on jack while completely filled with oil. The tank shall be provided with suitable saddles so that tank can be rested on ground after removing the pneumatic tyres.
4. The tank shall also be fitted with manhole, outside & inside access ladder, silica gel breather assembly, inlet & outlet valve, oil sampling valve with suitable adopter, oil drainage valve, air vent etc. Pulling hook on both ends of the tank shall be provided so that the tank can be pulled from either end while completely filled with oil. The engine capacity in horse power to pull one tank completely fitted with oil shall be indicated.
5. Oil level indicator shall be provided with calibration in terms of litre so that at any time operator can have an idea of oil in the tank.
6. Solenoid valve (Electro-mechanically operated) with Centrifugal pump shall be provided at bottom inlet so that pump shall be utilized both ways during oil fill up and draining. Suitable arrangement shall also be provided to prevent overflow and drain from the tank.

7. The following accessories shall also form part of supply along with each Oil storage tank.
- (a) Four numbers of 50 NB rubber hoses suitable for Transformer oil application up to temperature of 100°C, full vacuum and pressure up to 2.5 Kg/cm² with couplers and unions each not less than 10 metre long shall be provided.
 - (b) Two numbers of 100 NB rubber hose suitable for full vacuum without collapsing & kinking vacuum hoses with couplers & unions, each not less than 10 metre long, shall also be provided.
 - (c) One number of digital vacuum gauge with sensor capable of reading up to 0.001 torr, operating on 240V 50Hz AC supply shall be supplied. Couplers and unions for sensor should block oil flow in the sensor. Sensor shall be provided with at-least 8 meter cable so as to suitably place the Vacuum gauge at ground level.
 - (d) The painting of oil storage tank and its control panel shall be as per **Annexure-K**.

The tank shall contain a self-mounted centrifugal oil pump with inlet and outlet valves, with couplers -suitable for flexible rubber hoses and necessary switchgear for its control. There shall be no rigid connection to the pump. The pump shall be electric motor driven, and shall have a discharge of not less than 6.0 kl/hr. with a discharge head of 8.0m. The pump motor and the control cabinet shall be enclosed in a cubicle with IP-55 enclosure

TS of oil sampling bottle (Quantity as per scope)

1. Oil sampling bottles shall be supplied as specified by the utility and shall be suitable for collecting oil samples from transformers and shunt reactors, for Dissolved Gas Analysis (DGA). Bottles shall be robust enough, so that no damage occurs during frequent transportation of samples from site to laboratory.
2. Oil sampling bottles shall be made of stainless steel having a capacity of one litre. Oil Sampling bottles shall be capable of being sealed gas-tight and shall be fitted with cocks on both ends.
3. The design of bottle & seal shall be such that loss of hydrogen shall not exceed 5% per week.
4. An impermeable oil-proof, transparent plastic or rubber tube of about 5 mm diameter, and of sufficient length shall also be provided with each bottle along with suitable connectors to fit the tube on to the oil sampling valve of the equipment and the oil collecting bottles respectively.

SPECIFICATION FOR OIL SYRINGE (Quantity as per scope)

1. If specified by the utility, the glass syringe of capacity 50 ml (approx.) and three way stop cock valve shall be supplied. The syringe shall be made from Heat resistant borosilicate Glass, shall have metal luer lock tip and shall comply with BS EN ISO 595-2 and ISO 80369-7. The material and construction should be resistant to breakage from shock and sudden temperature changes, reinforced at luer lock tip Centre and barrel base.
The cylinder-plunger fitting shall be leak proof and shall meet the requirement of IEC-60567. Plunger shall be grounded and fitted to barrel for smooth movement with no back flow. Barrel rim should be flat on both sides to prevent rolling and should be wide enough for convenient finger tip grip. The syringe shall be custom fit and uniquely numbered for matching. The syringe shall be clearly marked with graduations of 2.0 ml and 10.0 ml and shall be permanently fused for life time legibility.

SCOPE OF DESIGN REVIEW

Description
Core and Magnetic Design
Over-fluxing characteristics up to $1.7 U_m$ (for transformer)
Inrush-current characteristics while charging
Winding and winding clamping arrangements
Characteristics of insulation paper
Typical data and parameters mentioned in GTP
Short-circuit withstand capability including thermal stress / withstand capability for 2 seconds
Thermal design including review of localized potentially hot area
Structural design
Cooling design
Overload capability
Calculations of losses, flux density, core quantity etc.
Calculations of hot spot temperature
Eddy current losses
Seismic design, as applicable
Insulation co-ordination
Tank and accessories
Bushings
Mechanical layout design including lead routing and bushing termination
Tapping design (as applicable)
Protective devices
Number, locations and operating pressure of PRD
Location, Operating features and size of Sudden Pressure Relay/ Rapid Pressure Rise Relay
Radiators ,Fans and Pumps (as applicable)
Sensors and protective devices– its location, fitment, securing and level of redundancy

Oil and oil preservation system
Corrosion protection
Electrical and physical Interfaces with substation
Earthing (Internal & External)
Processing and assembly
Testing capabilities
Inspection and test plan
Transport and storage
Sensitivity of design to specified parameters
Acoustic Noise
Spares, inter-changeability and standardization
Maintainability
Conservator capacity calculation
Winding Clamping arrangement details with provisions for taking it “in or out of tank”
Conductor insulation paper details
Location and numbers of Optical temperature sensors (if provided)
The design of all current connections
Location & size of the Valves
Manufacturing facilities and manufacturing environment (clean, dust free, humidity controlled environment)

ANNEXURE –O

TRANSPORTATION, ERECTION, TESTING AND COMMISSIONING

1.0 Transportation

- 1.1. The supplier shall be responsible to select and verify the route, mode of transportation and make all necessary arrangement with the appropriate authorities for the transportation of the equipment. The dimension of the equipment shall be such that when packed for transportation, it shall comply with the requirements of loading and clearance restrictions for the selected route. It shall be the responsibility of the supplier to coordinate the arrangement for transportation of the transformer/reactor for all the stages from the manufacturer's work to site.
12. The supplier shall carry out the route survey along with the transporter and finalize the detail methodology for transportation of transformer/reactor and based on route survey; any modification/extension/improvement to existing road, bridges, culverts etc. if required, shall be in the scope.
13. The inland transportation of the transformer/reactor shall be on multi-axel low platform trailers of adequate capacity and equipped with GPS system for tracking the location of transformer at all times during transportation from manufacturer works to designated site. The supplier shall intimate to purchaser about the details of transporter engaged for transportation of the transformer/reactor for tracking the units during transit. Requirement of Hydraulic trailer is envisaged for a load of more than 40 T. The transportation during monsoon period should be avoided as far as possible.
14. All metal blanking plates and covers which are specifically required for transportation and storage of the transformer/ reactor shall be considered as part of the transformer/reactor and shall be handed over to the Purchaser after completion of the erection. Bill of quantity of these items shall be included in the relevant drawing/document.
15. The supplier shall despatch the transformer/reactor filled with dry air conforming to EN 12021 or filled with Nitrogen at positive pressure. The necessary arrangement shall be ensured by the supplier to take care of pressure drop of dry air/Nitrogen during transit and storage till completion

of oil filling during erection. A dry air/Nitrogen pressure testing valve with necessary pressure gauge and adaptor valve shall be provided. The duration of the storage of transformer/reactor at site with dry air/ Nitrogen, shall preferably be limited to three months (including the duration of transportation), after which the recommendation of manufacturer is to be followed if it is not filled with oil. The dry air/Nitrogen cylinder(s) (with regulating valves) provided to maintain positive pressure can be taken back by the supplier after oil filling.

In case turret, having insulation assembly, is transported separately then positive dry air/Nitrogen pressure shall be ensured.

16. The largest / heaviest package of transformer / reactor shall be sufficiently lashed and same shall be checked before dispatch from the manufacturing unit.
17. Transformer/reactor shall also be fitted with at least 2 numbers Electronic impact recorders (on returnable basis) in diagonally opposite position (to eliminate chances of loss of data to failure of recorder) during transportation to measure the magnitude and duration of the impact in all three directions. The impact recorder shall be mounted on the upper side of the tank (width wise). The acceptance criteria and limits of impact, which can be withstood by the equipment during transportation and handling in all three directions, shall not exceed “3g” for 50 msec (20Hz) or as per OEM standard, whichever is lower.

Following setting of impact recorder shall be ensured at the time of installation with transformer/reactor unit before despatch from factory:

- 1g: Start recording
- 2g: Warning
- 3g: Alarm

Further, drop-out setting shall be 1g and threshold setting shall be in the range of 5g to 10g.

- 2.0 Points to be checked after receipt of transformer/reactor at site in presence of manufacturer's and purchaser's representative:

21. The transformer/reactor unloading and handling work at site should be carried out by skilled

people, under the supervision of manufacturer's representative.

22. A careful external inspection must be made when transformer/reactor arrives at site. Condition of each package and its contents and visible parts of transformer/reactor etc. shall be checked for any damage and recorded.
23. Pressure and Dew point of dry air/Nitrogen shall be checked after receipt of transformer/reactor at site. It should be within permissible band as per relevant standards.
24. In case of transportation of transformer/reactor in oil filled condition, oil level & leakage (if any) shall be checked.
25. In case of any damage or dry air/ oil leakage beyond permissible limit, the manufacturer shall be informed immediately.
26. In case of dry air/ nitrogen leakage is beyond permissible limit, the dry air pressurization to be done on a continuous basis to safe guard the transformer Core Coil Assembly (CCA) condition till the problem is located and solved.
27. Core Insulation Test shall be carried out to check healthiness of insulation between core to tank, core to yoke clamp (frame) and yoke clamp (frame) to tank. (Not applicable for Air Core Reactors)
28. The data of impact recorder shall be analyzed jointly by the purchaser in association with the manufacturer. In case the impact recorder indicates shocks of $\geq 3g$ during shipment, further course of action for internal inspection shall be taken jointly by the manufacturer & supplier. Impact Recorder should be detached from the Transformer/ Reactor, preferably after the main unit has been placed on its foundation.
29. Unpacking and inspection of all accessories shall 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 shall be ensured after unpacking in line with the OEM's recommendation. Fragile instruments like oil level gauge, temperature indicators, etc. are to be stored indoor. Any damaged or missing components shall be reported to equipment manufacturer and insurance agency so that the same

can be investigated or shortage made up as per the terms/ conditions of the contract. All accessories for long storage shall be packed by OEM in special packing case.

3.0 Storage of the main unit and the accessories at site:

3.1 If erection work cannot start immediately due to some reasons, then accessories shall be repacked into their own crates properly and packing list should be retained.

3.2 All packing cases shall be kept above ground by suitable supports so as to allow free air flow underneath. The storage space area shall be such that it is accessible for inspection, water does not collect on or around the area and handling/transport is 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.

3.3 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 has to be recommended by OEM.

3.4 If the transformer/reactor is to be stored up to three (3) months (including the duration of transportation) after arrival at site, it can be stored with dry air filled condition. Dry air pressure shall be monitored on daily basis so that chances of exposure of active part to atmosphere may be avoided. In case of drop in dry air pressure, dew point of dry air shall be measured to check the dryness of the transformer/reactor. If there is drop in dew point, fresh dry air need to be filled. Leaks shall be identified and rectified and dry air shall be filled to the required pressure.

3.5 In case the transformer/reactor is to be stored for more than 3 months, it shall be stored in oil filled condition. Processed oil shall be filled which complies with the required specification with moisture content $\leq 5\text{ppm}$ and BDV $\geq 70\text{kV}$. In case of storage of transformer/reactor in oil-filled condition, the oil filled in the units shall be tested for BDV and moisture contents once in every three months. The oil sample shall be taken from bottom valve. If BDV is less and moisture content is more than as given for service condition, then oil shall be filtered.

4.0 Internal Inspection

4.1 Before starting erection, thorough internal inspection of transformer/reactor shall be carried out

by engineer along with manufacturer's representative.

4.2 Internal inspection shall preferably be carried out in dry and sunny weather along with circulation of dry air (With working person inside the tank, a minimum of 20 cfm/0.56 cubic-meter/minute of breathable air and additional 5 cfm/0.14 cubic-meter/minute for each additional person should be purged in the tank. Entry of person inside the tank should be avoided if adequate space is not available as in case of smaller rating of transformer.) using dry air generator of dew point -40°C or better and shall be completed as quickly as possible to avoid ingress of moisture. If the Ambient humidity exceeds 65 % the internal inspection is to be avoided.

4.3 Prior to making any entry into the transformer/reactor tank, a foreign material exclusion programme shall be established to avoid the danger of any foreign objects falling into the transformer/reactor:

- Loose articles should be removed from the pockets of anyone working on the transformer/reactor cover.
- All jewelry, 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/reactor should be recorded and checked before closing inspection cover to assure all items were removed.

If any object is accidentally dropped into the transformer/reactor and cannot be retrieved, the manufacturer should be notified.

4.4 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 De-energized Tap Changer (DETC) and in-tank On-Load Tap Changers (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.

- Any other suspected damage based on impact recorder readings

In case of any abnormality noticed during internal inspection, same shall be referred to manufacturer immediately before starting erection activities. Detailed photographs of all visible parts/ components as per above shall be taken during internal inspection and shall be attached with pre-commissioning report.

5.0 Precautions during erection

- 5.1 During all erection activities, a well-qualified and experienced representative of manufacturer shall be present at the site for supervision and other necessary activities.
- 5.2 During erection, efforts shall 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.
- 5.3 For transformer/reactor with a gas pressure of 2.5-3 PSI, the acceptable limits of dew point shall be as under:

TABLE 1- Variation of dew point of dry air/N₂ Gas filled in transformer/reactor tank w.r.t temperature

Temperature of Insulation in ⁰ F	Permissible dew point in ⁰ F	Temperature of Insulation in ⁰ C	Permissible dew point in ⁰ 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

5.4 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/reactor tank by applying vacuum. After vacuum is applied to a transformer/reactor main tank without oil, leakage test must be carried out to ensure that there are no leaks on the tank which would result in ambient air being drawn into the transformer/reactor.

6.0 Drying of wet winding of transformer/reactor by application of vacuum, dry nitrogen gas filling and heating

The drying of a new transformer/reactor is required on the first commissioning and when the moisture gets absorbed by the solid insulation used in transformer/reactor due to various reasons.

6.1 After completion of drying process, oil filling and hot oil circulation is to be carried out before commissioning. Recommended standing time as per Table-2 given below before charging.

Table – 2

Voltage class	Application of Vacuum & holding for (before oil filling)*	STANDING TIME After Oil circulation and before energizing
Up to 145kV	12 HRS	12 HRS
145 kV and up to 420kV	24 HRS	48 HRS
Above 420 kV	36 HRS	120 HRS

*Without running the vacuum pump and leakage rate to be $\leq 40\text{mbar-lit/sec}$

After the completion of standing time, air release operation is to be carried out in Buchholz relays, turrets and other release points given by the manufacturers before charging. If the transformer has oil pumps, then the oil pumps are to be operated for a duration of 10 minutes before conducting the air release.

7.0 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.

After filtration, particle count shall be done (Limiting value for the particle count are 1000 particle/100 ml with size $\geq 5 \mu\text{m}$; 130 particle/100 ml with size $\geq 15 \mu\text{m}$.) and oil sample is tested for meeting specification for new oil.

Prior to filling in main tank at site, it shall be tested for:

- (a) Break Down voltage (BDV) : 70 kV (min.)
- (b) Moisture content : 5 ppm (max.)
- (c) Tan-delta at 90 °C : Less than 0.0025
- (d) Interfacial tension : More than 0.04 N/m

For transformer/reactor dispatched with dry air filled from the works, the filling of oil inside the tank shall be done under vacuum. Transformer/reactor of high voltage ratings and their tanks are designed to withstand full vacuum.

When the oil filling, under vacuum of the transformer/reactor main tank 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 and the top cooler filter valve with air release valve kept open to atmosphere. As the oil level reaches the top vent, then top valve and air release valve are to be closed and the processing plant can be shut down.

Note: Care must be taken not to pressurize the coolers/radiators.

Before filling oil into the conservator, the air cell/bellow to be inflated to 0.5 PSIG i.e. 0.035 kg/cm² max. or upto the value recommended by the manufacturer 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 may be connected over the flange of the pipe to prevent entry of any insect inside the pipe.

After Oil filling, Hot Oil Circulation has to be applied to 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 dry air 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

8.0 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 shall be circulated through the vacuum filter. The temperature of the oil from the filter to the transformer/reactor should be around 60° C and in no case it should go beyond 70° C otherwise this may cause oxidation of oil.

9.0 Safety measures and precautions

The following safety measures and precautions shall be followed:

- (a) Keep recommended fire extinguishers at site.
- (b) During hot oil circulation, keep fire extinguisher ready near transformer.
- (c) Carry out all pre-commissioning test and final commissioning check as elaborated in this document before energizing transformer.
- (d) Take precaution while handling PRV devices having heavy springs in compression to safeguard person and system.
- (e) Provide adequately rated cables & fuses.
- (f) Never apply voltage when transformer is under vacuum
- (g) Oil spillage shall be inspected regularly and attended, if any. Oil shall not be allowed to fall on ground.
- (h) Keep all combustible items at safe distance to reduce risk of fire.
- (i) No welding work shall be taken up near transformer.
- (j) Welding on oil filled transformer shall be avoided as far as possible. If, under special circumstances, welding is absolutely necessary, it shall be done as per instruction of manufacturer only.
- (k) All erection personnel must use Personal Protective Equipment like, helmet, safety shoe, boiler suit, etc.
- (l) Electrical equipment like filter machine, dry air generator etc., must be earthed.
- (m) First Aid box shall be kept ready at site.
- (n) Adequate lighting must be available for clear visibility

- (o) Cordon off the working area, particularly when transformer augmentation work in a switchyard is taken up.
- (p) All major erection activity like bushing, conservator and radiators must be carried out with crane of adequate capacity and boom size.
- (q) Never carry out work with unskilled workers.
- (r) Safety posters, like “No Smoking”, “Wear Helmet”, etc., must be displayed.
- (s) Use approved and tested Earth rods
- (t) Safety Nodal Officer to make sure that site is cleared on daily basis to prevent fire hazards.

10.0 Pre-Commissioning checks and tests for Transformers and Reactors

Once oil filling is completed, following pre-commissioning checks and tests are performed to ensure the healthiness of the Transformer/ Reactor prior to its energization.

The following checks should be carried out before commencement of the pre-commissioning tests:

- (a) Ensure that transformer/reactor and its auxiliaries are free from visible defects on physical inspection
- (b) Ensure cleanliness of transformer and the surrounding areas
- (c) Ensure that all fittings are as per out line General Arrangement Drawing
- (d) Ensure that bushings are clean and free from physical damages
- (e) Ensure that oil level is correct in all bushings
- (f) Ensure that oil level in Main/OLTC Conservator tank in MOG is as desired.
- (g) Ensure gear box oil level in OLTC
- (h) Ensure that OTI and WTI pockets are filled with transformer oil
- (i) Ensure that cap in the tan delta measurement point in the bushing is tight and grounded
- (j) Ensure unused secondary cores of Bushing CT's, if any, has been shorted
- (k) Ensure CT secondary star point has been formed properly and grounded at one end only as per scheme
- (l) Ensure that Buchholz Relay is correctly mounted with arrow pointing towards conservator
- (m) Ensure all power and control cable terminals are tightened
- (n) Ensure all cables and ferrules are provided with number as per cable schedule
- (o) Ensure that external cabling from junction box to relay/control panel is completed
- (p) Ensure operation of cooling fans, oil pumps etc.
- (q) Ensure correct operation of all protection devices and alarms/trip :
 - i) Buchholz relay
 - ii) Pressure Relief Device
 - iii) Sudden Pressure Relay (if applicable)
 - iv) Excessive winding temperature

- v) Excessive oil temperature
 - vi) Low oil flow
 - vii) Low oil level indication
 - viii) Fan and pump failure protection (as applicable)
-
- (r) Check for the adequate protection on the electric circuit supplying the accessories.
 - (s) Ensure operation of OLTC manually & electrically at local and remotely by RTCC/BCU/SAS
 - (t) Ensure that indication of tap position on Diverter switch, Drive mechanism & RTCC are same.
 - (u) Ensure working of numerical AVR
 - (v) Ensure that the cable glands have been packed properly. The unused holes if any have also been blanked.

The following pre-commissioning tests shall be carried out before energization:

- (a) Insulation resistance measurement for the following:
 - i) Control wiring
 - ii) Cooling system motor and control circuit
 - iii) Main windings (PI & DAI)
 - iv) Tap changer motor and control (as applicable)
- (b) Test on Bushing CTs
- (c) 2 kV for 1 minute test between bushing CT terminal and earth
- (d) Polarity and vector group test (for transformer)
- (e) Ratio test on all taps (for transformer)
- (f) Magnetising current test
- (g) Magnetic balance test (for 3 phase transformer/reactor)
- (h) Capacitance and Tan delta measurement of winding and bushing
- (i) Tan delta of bushing at variable frequency (Dielectric frequency response)
- (j) Frequency response analysis (FRA).
- (k) Measurement of vibration and noise level (for reactor)
- (l) Short circuit impedance test
- (m) Contact resistance measurement
- (n) Measurement of resistance of all windings on all steps of the tap changer
- (o) Protection relay settings
- (p) Measurement of safety clearances
- (q) Measurement of earth pit resistance

11.0 Final commissioning checks

The following commissioning checks should be carried out before energization of the transformer/ reactor:

- (a) All the pre-commissioning test results of unit are verified and compared with factory results before commissioning.
- (b) No leakage of oil in any part of unit.
- (c) Ensure safe electrical clearance of conductor jumpers in the switchyard with transformer/ reactor

body, gantry, column, jumpers, fire wall etc.

- (d) Ensure that tertiary winding terminals are insulated, when they are not used/ connected to any system.
- (e) Ensure earthing of Neutral, main tank body, radiator frame structure, fans and motor.
- (f) Neutral earthing conductor of suitable size must run through support insulator and connected to two separate earthing pits which are in turn connected to main earth mat of switchyard.
- (g) Ensure that conductor jumpers connected to HV, LV and tertiary terminals are not tight and should have the allowance for contraction. Also ensure that connectors are properly tightened at bushing terminal.
- (h) Ensure that R.Y.B designated terminals of transformer/ reactor are matching with R,Y,B buses of switchyards on HV and LV side.
- (i) Ensure oil level in the Bushings.
- (j) Ensure continuity of OLTC operation at all taps.
- (k) In a transformer bank of three single phase units, ensure master-slave OLTC scheme.
- (l) In a transformer bank of three single phase units, ensure tertiary connection and protection scheme (if provided).
- (m) Ensure oil filling in conservator tank according to temperature scale in MOG and also ensure oil level in prismatic glass.
- (n) Ensure that all valves between main tank and radiator banks are opened.
- (o) Ensure those radiator valves connected to header are open.
- (p) Ensure that valve to conservator tank via Buchholz relay is open.
- (q) Ensure physical operation of local protections like Buchholz, PRV, Surge relay of OLTC etc.
- (r) Ensure OTI and WTI settings of fan & pumps operation, Alarm and Trip as per approved drawings. Fan and pump operation shall be ensured locally and remotely.
- (s) Review and ensure protection scheme of power transformer/ reactor with over all protection scheme at remote end in control room.

For Transformer:

- Differential Protection
- Restricted Earth Fault (REF) Protection.
- Over current and Earth fault protection / impedance protection.
- Over fluxing Protection
- Tertiary Protection (if applicable)
- Over load alarm
- OTI & WTI- alarm and trip
- RTCC panel/relay interface with protection system
- Local protection like Buchholz, PRV etc.
- MOG-low oil alarm
- Integration of on-line condition monitoring equipment (if applicable).
- Integration of RTCC with BCU/SCADA system

For Reactor:

- Differential Protection
- Restricted Earth Fault (REF) Protection.
- Reactor backup protection (impedance protection/ Over current and Earth fault protection)
- OTI & WTI- alarm and trip
- Local protection like Buchholz, PRV etc.
- MOG-low oil alarm

- Integration of on-line condition monitoring equipment (if applicable).
- (t) Ensure the common earthing of tank, frame and core provided in transformer.
- (u) Ensure the shorting of spare cores of bushing CT's.
- (v) Ensure that cap in the tan delta measurement point in the bushing is put back.
- (w) Ensure Fire Protection System and oil drain valve operation before charging and commissioning.
- (x) Oil test results after filtration must be within specified limit.
- (y) Spares like bushings shall be tested and kept ready before charging and commissioning.
- (z) Allow minimum period of 24 hrs. after filtration for oil temperature to settle down.
- (aa) Ensure release of air from plugs provided on top of main tank, conservator and radiator headers.
- (bb) Take charging clearance certificate from all erection agencies for removal of man, material and T&P from site.
- (cc) Ensure healthiness of Air Cell.
- (dd) Ensure availability of oil in the breather cup in main tank/ OLTC tank.
- (ee) Ensure all rollers are locked with rails if transformer is on rollers
- (ff) Ensure door seals of Marshalling Box are intact and all cable gland plate's unused holes are sealed.
- (gg) Ensure change over operation of AC supply from source- I to source-II in local master control cubicle.
- (hh) Ensure that all associated equipment of the bay e.g. CB, Isolator/Earth switch, CT/PT/CVT etc. has been checked properly as per OEM's recommendations and utility practice.

12.0 Energization of transformer/ reactor

Commissioning of transformer / reactor is not complete unless it is put into regular service. Following activities to follow:

- (a) Perform DGA just before commissioning
- (b) Initially charge the transformer under no load.
- (c) Continuously observe the transformer operation at no load for at least 24 hours.
- (d) Gradually put the transformer on load, check and measure increase in temperature in relation to the load and check the operation with respect to temperature rise (monitor OTI & WTI), vibration, oil leakage, oil level indicators & gas detector relay and noise level etc.
- (e) Check OLTC operation.
- (f) Carry out Thermo-vision scanning of HV/LV terminals and tank body.[This test should be carried out once the transformer/reactor is stabilised and operating at higher temperature (> 60 deg.C)]
- (g) Carry out DGA of oil after 24 hours, one week, 15 days, one month & 3 months of energisation at site, thereafter as per normal frequency of 6 months / as and when required based on the trend analysis.

Contractor shall prepare a comprehensive commissioning report and hand over testing and commissioning records to DTL for future reference and record.

**SPECIFICATION FOR ON-LINE INSULATING OIL DRYING SYSTEM
(CARTRIDGE TYPE)
(For 400 kV transformer and as per scope)**

In addition to provision of air cell in conservators for sealing of the oil system against the atmosphere, each transformer of 400 kV voltage class shall be provided with an on line insulating oil drying system of adequate rating with proven field performance. This system shall be separately ground mounted and shall be housed in metallic (stainless steel) enclosure. The bidder shall submit the mounting arrangement. This on line insulating oil drying system shall be:

1. Designed for very slow removal of moisture that may enter the oil system or generated during cellulose decomposition. Oil flow to the equipment shall be controlled through pump of suitable capacity (at least 5 litres/minute).
2. The equipment shall display the moisture content in oil (PPM) of the inlet and outlet oil from the drying system.
3. In case, drying system is transported without oil, the same shall be suitable for withstanding vacuum to ensure that no air/ contamination is trapped during commissioning.
4. In case, drying system is transported with oil, the oil shall conform to the specification for unused oil. Before installation at site, oil sample shall be tested to avoid contamination of main tank oil.
5. Minimum capacity of moisture extraction shall be 10 Litres before replacement of cartridge. Calculation to prove the adequacy of sizing of the on line insulating oil-drying system along with make and model shall be submitted for approval of purchaser during detail engineering.
6. The installation and commissioning at site shall be done under the supervision of OEM representative or OEM certified representative.
7. The equipment shall be capable of transferring data to substation automation system confirming

to IEC 61850 through FO port. Necessary interface arrangement shall be provided by the contractor for integration with the automation system.

8. The equipment shall be supplied with Operation Manual (2 set for every unit), Software (if any), and CD/DVD giving operation procedures of Maintenance Manual & Trouble shooting instructions.

ANNEXURE Q

LIST OF CODES/STANDARDS/REGULATIONS/PUBLICATIONS

A list of Codes/Standards/Regulations/Publications which shall be used for design review, manufacturing, testing, erection, transportation etc. has been given below. In case of revision/amendment of these, revised/amended versions shall be followed.

IS 2026: Part 1 : 2011 (Reaffirmed Year : 2016)	-	Power transformers: Part 1 General
IS 2026: Part 2 : 2010 (Reaffirmed Year : 2020)	-	Power transformers Part 2 Temperature-rise
IS 2026: Part 3 : 2018	-	Power Transformers Part 3 Insulation Levels, Dielectric Tests and External Clearances in Air (Fourth Revision)
IS 2026: Part 4 : 1977 (Reaffirmed Year : 2016)	-	Power transformers: Part 4 Terminal marking, tapplings and connections
IS 2026 : Part 5 : 2011 (Reaffirmed Year : 2016)	-	Power Transformers Part 5 Ability to Withstand Short Circuit
IS 2026 : Part : 2017 6	-	Power Transformers Part 6 Reactors
IS 2026 : PART 7 : 2009 (Reaffirmed Year : 2019)	-	Power Transformers Part 7 Loading Guide for Oil-Immersed Power Transformers
IS 2026 : Part 8 : 2009 (Reaffirmed Year : 2019)	-	Power Transformers : Part 8 Applications guide
IS 2026 : Part 10 : 2009 (Reaffirmed Year : 2019)	-	Power Transformers : Part 10 Determination of sound levels
IS 2026 : Part 10 : Sec 1 : 2018	-	Power Transformers part 10 Determination of Sound Levels Section 1 Application guide
IS 2026 : Part 14 : 2018	-	Power Transformers Part 14 Liquid- Immersed Power Transformers Using High- Temperature Insulation Materials
IS 2026 : Part 18 : 2018	-	Power Transformers Part 18 Measurement of Frequency Response

IEC 60076 All parts	-	Power Transformers
IS 3024 : 2015	-	Grain Oriented Electrical Steel Sheet and Strip (Third Revision)
IS 8468 : Part 1 : 2018 IEC 60214-1 : 2014	-	Tap-Changers Part 1 Performance Requirements and Test Methods (First Revision)
IEC / IEEE 60214- 2:2019		Tap-changers- Part 2: Application guidelines
IS 8478 : 1977 (Reaffirmed Year : 2016)	-	Application guide for on-load tap changers
IS 649 : 1997 (Reaffirmed Year : 2018)	-	Methods for testing steel sheets for magnetic circuits of power electrical apparatus
IS-10028 (Part 1, 2 & 3)	-	Code of practice for selection, installation & maintenance of transformer
IS 3639 : 1966 (Reaffirmed Year : 2016)	-	Fittings and Accessories for Power Transformers
IS 3637 : 1966 (Reaffirmed Year : 2016)	-	Gas Operated Relays
IS 335 : 2018	-	New Insulating Oils — Specification (Fifth Revision)
IEC 60296-2020	-	Fluids for electrotechnical applications – Mineral insulating oils for electrical equipment
IEC 60422 : 2013	-	Mineral insulating oils in electrical equipment - Supervision and maintenance guidance
IS 6792 : 2017	-	Insulating Liquids - Determination of the Break-down Voltage at Power Frequency - Test Method (Second Revision)
IS/IEC 60137 : 2017	-	Bushings for alternating voltages above 1000 Volts

IS 12676 : 1989 (Reaffirmed Year : 2016)	-	Oil Impregnated Paper Insulated Condenser Bushings - Dimensions and Requirements
IS 4257 : Part 1 : 1981 (Reaffirmed Year : 2019)	-	Dimensions for Clamping Arrangements for Porcelain Transformer Bushings - Part I : For 12 kV to 36 kV Bushings
IS 4257 : Part 2 : 1986 (Reaffirmed Year : 2019)	-	Dimensions for clamping arrangements for porcelain transformer bushings: Part 2 For 72.5 kV and 123 kV bushings
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CIGRE TB 436		Experiences in service with new insulating liquids

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ISO	9001: Quality System –		Model	Quality		
Assurance Design/Development.						
ISO-14001 (Environmental Management System)						
OHSAS 18001 (Occupational Health and Safety Management System)						

SECTION-XXI

NITROGEN INJECTION FIRE PREVENTION CUM EXTINGUISHING SYSTEM (NIFPES)

SECTION: XXI

Technical Specifications of Nitrogen Injection Fire Prevention & Extinguishing System (Applicable for Transformer and Reactors)

A. Preamble

Electrical Transformers are the main pillars of the power system network for enabling the transformation of voltage/current and transfer of power so that the utilities are able to supply the electricity to consumers with proper quality and reliability. At the same time the utilities endeavor to keep their assets in safe and secure conditions by providing protective equipment/systems which would help in properly maintaining the health and prevent damage to the equipment being protected.

Any failure of transformer would have the adverse impact on supply of power and satisfactory operation and performance of the system. Power outage and also the possible fire incidences are the common consequences. Transformer may fail because of many reasons. Sometimes the failure of transformer lead to the emergence of fire, which becomes quite dangerous. In addition of loss of asset and money, a transformer, if it catches fire may lead to severe accidental damages to nearby equipment, living being, assets and ecology. With proper fire prevention arrangement provided on the transformers/reactors, the damage on account of incidences of fires in transformer/reactor could be avoided/ reduced. Nitrogen Injection Fire Prevention and Extinguishing System (NIFPES) is one such system which is helpful in this regard.

B. Scope

Supply of NIFPES, installation, laying of pipes and cables, termination, testing and commissioning including fixation of all interconnecting cables between instruments, junction boxes, local panel. Transformer manufacturer/supplier will provide all the necessary support for effective installation of NIFPES, including making available the transformer tripping signal required for successful functioning of the NIFPES.

C. Specifications

1. Nitrogen Injection Fire Prevention and Extinguishing System (NIFPES) shall be designed to prevent the fire taking place in the transformer and possible explosion of transformer tank during internal faults/arc. In case of internal fire in the transformer, the NIFPES shall be capable of extinguishing the fire, minimize the damage to the transformer and thus avoiding the spread of fire. In case of fire whose source is external to the transformer, other fire control/extinguishing devices/systems such as water spray system, water mist system etc will be provided by the utility separately.
2. NIFPES system shall work on the principle of drain and stir of transformer oil. On activation of NIFPES, it shall drain a pre-determined quantity of oil from the tank top through drain valve to reduce the tank pressure, isolate conservator tank oil from the oil in the main transformer tank and inject nitrogen gas at high pressure from the bottom side of the tank through inlet valves to create stirring action and reduce the temperature

of oil to prevent/extinguish the fire. On operation of NIFPES, the quantity of oil removed from the tank shall be such that adequate amount of oil shall remain in the transformer to cover active part of the transformer i.e. the core coil assembly.

3. Arrangement for sensing Pre-fire condition shall be provided along with the alarm which would be site configurable as per the site requirements.

Electrical isolation of transformer shall be an essential pre-condition for activation of NIFPES system.

4. Operational Controls

The system operation shall be automatic and will be activated when the pre-set conditions of activation of the system are attained/ triggered. Maximum time period for extinction of fire from commencement of nitrogen injection into the transformer shall be 30 seconds. In addition to automatic operation, remote operation from the control room/remote centre/local control in the fire extinguishing cubicle (FEC) shall also be provided. System shall operate in the following situations:

4.1 System Activation in Fire Prevention Mode

To prevent fire and explosion in the transformer including that from internal fault, signals from the following shall be used to activate the NIFPES:

- (i) Operation of either of the protective relays i.e. differential or restricted earth fault or over current;

AND

- (ii) Operation of either 'Buchholz Relay or Pressure Relief Valve (PRV)' or the signal from Rapid Pressure Rise Relay (RPRR) operation

AND

- (iii) For operation of NIFPES the tripping of circuit breakers of High Voltage (HV), Intermediate Voltage (IV) and Low Voltage [LV (tertiary)] of the transformer is a must i.e. transformer should be electrically isolated and then only the NIFPES should operate.

However, the exact logic for system activation shall be finalized during detailed engineering.

4.2 System Activation in Fire Detection Mode

In case of fire detection mode, signals from the following shall be used to activate the NIFPES:

- (i) Fire/heat detectors/sensors;

AND

- (ii) Operation of either of the protective relays [Buchholz relay or Pressure Relief Valve (PRV) or Rapid Pressure Rise Relay (RPRR)]

AND

- (iii) For operation of NIFPES the tripping of circuit breakers of High Voltage (HV), Intermediate Voltage (IV) and Low Voltage [LV (tertiary)] of the transformer is a must i.e. transformer should be electrically isolated and then only the NIFPES should operate.

However, the exact logic for system activation in fire detection mode shall be finalized during detailed engineering.

In case of fire in the transformer, the NIFPES shall be activated in auto or manual mode only after complete electrical isolation of the transformer, confirmed by HV, IV and LV (tertiary) circuit breakers trip.

If the fire detection is not associated with any other fault, the system activation shall be manual. Manual operation switch and local manual control with a proper cover to avoid accidental operation of the switch, shall be provided in the control room/remote centre. Interlock shall be provided so that manual operation will work only when HV, IV and LV (tertiary) circuit breakers have tripped.

The manual operation of NIFPES shall override the automatic mode and will ensure the complete isolation of the transformer before coming of the NIFPES in to service.

The NIFPES manufacturer should provide the warning information on the Control Box and FEC that “Ensure that HV, IV and LV breakers are open before operating in Manual Mode” both in Hindi and English or the English and the local language as prevalent.

5. Operation of System

On receiving activation signal, the system shall:

- i) Open the quick opening drain valve of transformer to drain its top layer oil (pre-determined quantity);
- ii) Shut off the transformer conservator isolation valve (TCIV) to prevent flow of oil from the conservator tank to the main transformer tank; and
- iii) Open the valve to inject Nitrogen into the transformer tank to create stirring of oil.

There shall be interlock to prevent activation of the system if the transformer is not electrically isolated. There shall also be provision for isolating the system during maintenance and/or testing of the transformer.

The system shall be designed in such a manner that Nitrogen purging shall commence only after ensuring that the oil draining has commenced.

6. Technical Particulars

The contractor shall be responsible for design of the complete system and shall submit the drawings and design calculations for the number of Fire/heat detectors/sensors, pipe sizing of drain pipe, Nitrogen injection pipe, Nitrogen cylinder capacity, number of injection points, etc and get approval from the user. The facility shall be provided to test the system by operation of valves [Nitrogen injection valve, TCIV and Oil Drain Valve (ODV)]when the transformer is in service, without actually draining the oil and injecting Nitrogen in real time operation by obtaining the feedback from valve. The Nitrogen injection scheme shall be designed in such a way that the Nitrogen shall not enter the transformer tank even in case of passing/leakage of valve. The oil drain mechanism may or may not be a part of the fire extinguishing cubicle.

Owner shall provide two distinct station auxiliary DC & AC supplies for control power supply purposes. The system shall work on station DC & AC supply with voltage variation as per relevant standards. The control box of fire prevention and extinguishing system shall have facility to receive these DC & AC supplies for auto changeover of supply. It shall be the contractor's/NIFPES supplier's responsibility to further distribute power to the required locations. In case auxiliary DC & AC power supply requirement is different than station auxiliary DC & AC supply, then all necessary converters shall be provided by the Contractor.

Following minimum indications and alarms shall be provided in the control cubicle in the control room:

- a) DC & AC supply 'ON'
- b) Total System Healthy
- c) DC & AC supply fail
- d) System out of Service
- e) Differential trip
- f) PRV trip/RPRR trip
- g) Buchholz Relay trip
- h) Master Relay trip[(HV,IV and LV (Tertiary Voltage))]
- i) Restricted Earth Fault (E/F) Relay Trip
- j) Over current Relay Trip
- k) Nitrogen cylinder pressure low
- l) Pre-fire alarm
- m) Heat/Fire detector/Sensor faulty Signal
- n) Heat/Fire Detector/Sensor alarm/signal
- o) Nitrogen injection Valve open
- p) Nitrogen injection Valve close
- q) Nitrogen injection Valve leakage
- r) Oil drain Valve open
- s) Oil drain Valve Close
- t) Leakage in Oil drain valve
- u) TCIV Open
- v) TCIV Closed
- w) Cable fault signal for interconnecting cable for transformer trip signals
- x) Auto operation failed

Other indicator which supplier/user consider necessary shall also be provided.

The following push buttons shall be provided as a minimum:

- a) Mode Selection Switch, Auto/Manual/Off
- b) Lamp test push buttons
- c) System reset push button
- d) Detector reset push button, if applicable.
- e) Manual extinction push-button for manual operation of the system
- f) Hooter mute push button
- g) Hooter reset push button

Apart from the above list Nitrogen cylinder pressure indication manometer with sufficient number of adjustable 'Normally Opened (NO)' contacts shall also be provided in FEC. In case of fire in the transformer and fulfilling the conditions of defined logic for NIFPES operation for fire extinguishing mode and fire prevention mode alarm (Audio & Visual) will be generated in control room as well FEC.

Technical Data Sheet:

Sl. No.	Item	Requirements
1.	Fire detection period on commencement of fire	Maximum 10seconds
2.	Fire Extinction period on commencement of Nitrogen injection	Maximum 30seconds
3.	Fire detectors'/sensors' "heat sensing" temperature	Flash point of the transformer oil minus 5 °C with tolerance of +/-1 °C.
4.	Power source for: a) Control Box b) Fire extinguishing cubicle	110/220 VDC (+10%&-15%) / 230 V AC 110/220 VDC (+10%&-15%) / 230VAC
5.	Nitrogen Cylinder and Valve (PESO approved)	As per IS:7285(Part2) and IS:3224 (latest)
6.	Degree of protection of Control Box and FEC	IP 55
7.	Steel Sheet of FEC , Control Box and Signal Box	Steel sheet shall be as per grade CR2 of IS:513,Part-1.Thickness shall not be less than 2mm.
8.	Color of all panels and Nitrogen Injection pipes	Shade 538 of IS:5

7. Details of Supply of System/Equipment and Other Related Activities:

Nitrogen injection fire protection system shall broadly consist of the following components/ devices. However, all other components that are necessary for fast, reliable, complete, and effective working of the fire protection system shall deemed to be included in the scope of supply.

A. Fire extinguishing cubicle with base frame and containing at least the following:

- i. Nitrogen gas cylinder having the Petroleum and Explosive Safety Organization (PESO) certificates of sufficient capacity with pressure regulator and manometer with sufficient number of adjustable 'Normally Open (NO)' contacts;
- ii. Oil Drain Assembly including oil drain valve and its equipment for operation, oil drainpipe extension of suitable size for connecting pipes to Oil Storage Tank, along with level switch for detecting leakage in oil drain valve;
- iii. Mechanical release device for oil drain and nitrogen gas release;
- iv. Limit switches for monitoring of the systems;
- v. Panel lighting;
- vi. Flanges on top of the panel for connecting oil drain in case of oil drain mechanism is part of fire extinguishing cubicle and nitrogen injection pipes for transformer;
- vii. Pressure indicators for Nitrogen pressure of the cylinder and actual injection through Nitrogen regulator;
- viii. Fire Extinguishing Cubicle (FEC) shall have LED lights for indicators.
- ix. The heater with thermostat shall be provided in the FEC. Heater should be operated as per the setting of thermostat.
- x. FEC shall have minimum IP55 degree of protection;
- xi. Following mandatory spares shall also be supplied by the manufacturer/ supplier with the system:
 - 01no. fitted nitrogen cylinder
 - 01 set of hose pipes with fittings
 - Heat sensor assembly for fire detectors
 - Fire survival cable sufficient for one system
 - 01no. PNRBV
 - Limit switch for fire detectors (03nos. of each type)
 - 01 set of fire detectors
 - 01 no. thermostat
 - 01no. heating element

In case if oil drain mechanism is not a part of FEC – the related items shall be as per the Original Equipment Manufacturer (OEM) design, however functional requirements have to be met with.

B. Control box/cubicle to be installed in the control room of the substation for monitoring the NIFPES operation, automatic control, and remote operation, with alarms, indications, switches, push buttons, audio signal etc. Control Box/Cubicle should be microprocessor based /PLC based compatible to be interfaced with Supervisory Control and data Acquisition (SCADA) system.

Required number of fire/heat detectors/sensors to be located at strategic locations and to be finalized during detailed engineering. Fire/heat detector/sensor shall be IP 65 approved or to be mounted in an IP 65 approved enclosure. IP certificate to mention the details of Fire/Heat detector/Sensor. All the control/power cables between the NIFPES panel and the transformer, from the control room to FEC, from the Control and Relay Panel to the Control Box/cubicle,

Control Box/cubicle to DC/AC supply Source shall be fire/flame retardant low smoke (FRLS) type up to the thermal limit (in case of fire and or explosion). However, Fire survival cables, able to withstand 750°C shall be used for the connection of Fire/Heat detectors/Sensors if operating mechanism of Fire/Heat detector/Sensors mounted on transformer top.

Transformer Conservator Isolation Valve to isolate the conservator oil from the main tank oil is to be provided by the NIFPES supplier. This valve shall be located in the piping between the conservator and the Buchholz relay.

8. SCADA compatibility / accessibility

The NIFPES shall be fully integrated to the SCADA system of the utility/user as applicable in the scope.

9. Drain Oil Storage Tank

Each transformer unit shall be provided with a drain oil storage tank.

The oil storage tank shall have non-corrosive, waterproof, epoxy coated, mild steel (minimum thickness 5mm) to store drained out oil on operation of NIFPES.

The total capacity of storage tank shall be more than 10% of transformer tank oil to avoid overflowing of oil considering that drained oil volume shall be around 10% of transformer tank oil. All the pipes and physical connections from transformer to storage tank shall be in the scope of supplier.

10. Tests

a. Factory Acceptance Test (FAT)

Desired functional verification of NIFPES shall be conducted by the utility at the works of NIFPES manufacturer.

Test procedure – refer **Annexure – A**

b. Type Test of Fire/Heat Detector/Sensors:

Type test report of the Fire/Heat Detector/Sensors shall be submitted to client along with the design/drawing documents. The Fire/Heat detector/Sensors shall be tested as per the procedure given below:

Test	Type	Procedure	Requirement	Observed Value
Testing of the Fire/Heat detectors/Sensors	Type of the Fire/Heat detectors/Sensors along with the make and model number is to be mentioned in this column	<ol style="list-style-type: none"> 1. Fire/Heat detector/sensor is to be tested by immersing it in the heating liquid with temperature measurement or by suspending in hot air oven with temperature measurement. 2. The temperature of the liquid/air is to be increased at the rate of 1 °C per minute and reading of the thermocouples to be noted. 3. Thermocouple for measuring the temperature is to be provided at the tip/surface of the detector. 4. The temperature of the liquid/air is to be increased till the detector bursts/activates. 	The Fire/Heat detectors/Sensors activate at a Temperature of flash point of the transformer oil minus 5 °C with tolerance of +/- 1 °C	The temperature, at which the Fire/Heat detectors/Sensor activates, is to be recorded.

c. Site Acceptance Test (SAT) /Performance Test

SAT/Performance test of the NIFPES shall be carried out after the completion of installation at site. It shall also be ensured that the interfacing of NIFPES with SCADA has been completed by manufacturer / supplier before SAT. These tests shall include simulation and verification of the response of the complete system without actual draining of the oil and injection of the Nitrogen gas. In addition to the above, additional tests as considered necessary shall be conducted. SAT shall also include to test the provisions as specified in item (5) above.

SAT shall also include demonstration of the system checking when transformer is in online condition as mentioned in item (6) above.

11. Installation and pre-commissioning test after installation of the system shall be carried out jointly with the user's representative before the system is put in service.

If the scope is only for supply, erection, testing and commissioning of NIFPES than the warranty shall be for a period of five (5) years from the date of commissioning of NIFPES on individual transformer / reactor. If however the NIFPES is supplied with the procurement of transformer/reactor than the warranty obligation shall be as governed by the T&C of warranty for transformer/reactor.

Post warranty, in order to properly maintain the system, the bidder shall also quote for 3 years AMC of the system. The AMC shall be non-comprehensive with half yearly performance check.

Format for the Factory Acceptance Test

1. **Visual Inspection:** Visual examination of the NIFPES equipment i.e. Fire Extinguishing Cubicle, Control box/cubicle, Signal Box, Transformer Conservator Isolation Valve, Fire detectors, cables, etc shall be made as per the approved drawings.
2. **Functional Test:** Bidder to submit functional test report for approval of client. The report shall cover demonstration of functional test of all the indications as available on control box including interlocks. Functional test shall be carried out on one (1) set out of the total manufactured lot for the respective order as minimum in presence of client/client nominated inspection agency. Following are the list of critical items to be used in FAT out of manufactured lot for the respective Purchaser Order:
 - i) Fire Extinguishing Cubicle with its internals, except nitrogen cylinder. Nitrogen cylinder meant for internal testing can be used during FAT testing. However, connection of cylinder shall be in line with regulator valve intended for dispatch.
 - ii) Control Box with its internal components and accessories.
 - iii) Signal box with its internal components and accessories.
 - iv) Fire/Heat/Detector/sensor.
 - v) TCIV Valve.
 - vi) ODV Valve.
 - vii) SCADA compatibility of all the signals over RS 485/IEC protocol as applicable.
3. Functional Test of Transformer Isolation Conservator Valve (TCIV):

Sl. No.	Test	Procedure	Requirement	Remarks
1.	Leakage Test	Immerse the TCIV (Valve body) in the oil at the inlet pressure of 4kg/cm ² for 6 hours.	There should be no leakage from TCIV body	
2.	TCIV Close test (A or B as per the Design of TCIV)	A. For oil flow rate based TCIV: i. Mount TCIV with approx. 3 degree inclination on test rig ii. Switch ON oil Pump iii. Increase oil flow rate gradually	<ul style="list-style-type: none"> ➤ TCIV should close at flow rate specified by manufacturer. ➤ Flap closing shall be visible through transparent glass inspection window. ➤ Normally open (NO) contacts in TCIV should close/TCIV Close indication in control Box should be reflected. 	

		B. For electrically operated TCIV: i. Mount TCIV with approximately 3 degree inclination on test rig ii. Generate a set of input signal for the activation of NIFPES system	➤ TCIV should close. ➤ Flap closing shall be visible through transparent glass inspection window. ➤ Normally open (NO) contacts in TCIV should close/TCIV Close indication in control Box should be reflected.	
3.	Reset test	Reset the TCIV in the normal position.	➤ Close contact in TCIV should become open/TCIV open indication in control Box should be reflected. ➤ Flap opening shall be visible through transparent glass inspection window.	
4.	High voltage test	Apply 2kV AC for 1 minute between terminals and body	TCIV should withstand.	

4. Functional Tests of Fire/Heat detector/sensors:

1. The operating temperature shall be as per the requirement mentioned in technical data sheet.
2. The NIFPES manufacturer shall submit the declaration from OEM of Fire/Heat detector/sensor that the make and model/design of the Fire/Heat detector/sensor supplied with NIFPES is of proven quality and capable of failsafe operation as per tender requirement.
 - a. Live demonstration test: To verify the working of the system, live demonstration is to be conducted in both fire prevention and extinguishing mode. Following to be ensured:
 - (i) Demonstration is to be carried out at the works of NIFPES Manufacturer. It shall be responsibility of NIFPES manufacturer to arrange a suitable location for live testing.
 - (ii) A dummy tank of minimum 5000 litres oil capacity and filled with oil, should be used as a transformer tank for testing.
 - (iii) The FEC and Control Box manufactured for the said Purchase Order are to be used for live testing.
 - (iv) Separate filled Nitrogen cylinder should be used for live tests.
 - (v) Testing shall be conducted as per procedure mentioned below:

A. Testing in Fire Prevention Mode

1. Procedure:

- a. Oil Drain Pipe, Nitrogen Injection pipe, FEC, Control box/Cubicle, Signal box, TCIV, oil pit with all necessary pipes and cable connections shall be connected with transformer tank.
- b. Nitrogen gas Cylinder pressure should be recorded.
- c. The NIFPES System shall be made ON.
- d. Any one set of input of the fire prevention mode shall be generated by a suitable method.

2. Observations/Result:

- a) After fulfilling of required condition, system gets activated in auto mode.
- b) Oil Drain should be started.
- c) Nitrogen should be injected.
- d) TCIV should close.

Following Indications on control box will turn ON:

a)	Differential trip / PRV trip/RPRR trip / Buchholz Relay trip / Master Relay trip [(HV, IV and Tertiary Voltage to ensure that the Circuit Breakers are open)] Restricted Earth Fault (E/F) Relay Trip / Over current Relay Trip as per logic
b)	Nitrogen Injection valve open
c)	Oil Drain valve open
d)	TCIV Valve closed
e)	Audio Alarm activated

B. Testing in Fire Detection Mode (By igniting the transformer oil of the tank)

1. Procedure:

- a. There should be an opening on the Transformer tank to ignite the transformer oil.
- b. Fire/Heat detector/Sensor should be mounted at the distance of 800mm from the opening (mentioned in point 1 (a) above)
- c. Oil Drain Pipe, Nitrogen Injection pipe, FEC, Control box, Signal box, TCIV, oil pit with all necessary pipes and cable connections shall be connected with transformer tank.
- d. The NIFPES shall be made ON.
- e. The Buchholz Relay or PRV Trip and Master Relay trip (HV, IV and Tertiary

Voltage) Signal shall be activated by a suitable method.

- f. Ignite the transformer oil by any method such as pouring any flammable liquid (example- petrol) or any suitable chemical spray and igniting the flame.
- g. Start the timer /stopwatch on commencement of Fire and Nitrogen injection.

2. Observations:

- a. After fulfilling of required conditions of fire extinguishing mode, system should get activated in auto fire extinguishing mode.
- b. Oil Drain should start.
- c. Nitrogen injection shall begin.
- d. TCIV would close.
- e. Following Indications on control box will turn ON:

a)	PRV trip/RPRR trip / Buchholz Relay trip / Master Relay trip [(HV, LV and Tertiary Voltage to ensure that the Circuit Breakers are open)] / Fire / Heat Detector as per logic
b)	Nitrogen Injection valve open
c)	Oil Drain valve open
d)	TCIV Valve closed
e)	Audio Alarm activated

- f. Stop the timer/stop watch when fire detection (Fire Alarm signal is received) takes place.
- g. Stop the timer/stop watch when fire get extinguished.

3. Results:

Sl. No.	Details	Requirement	Observation
1.	Fire detection period upon commencement of Fire	Maximum 10 secondsSeconds
2.	Fire Extinction period on commencement of Nitrogen injection	Maximum 30 secondsSeconds

SECTION-XXII

TS FOR 33KV & 66KV XLPE **CABLE**

Technical specifications of 33kV & 66kV XLPE Cable & End Termination

A. Technical specifications of 33 kV XLPE Cable & End Termination

This specification covers the design, manufacture, testing at manufacturer's works, supply and delivery of 33 kV XLPE (Cross Linked Poly Ethylene) cable along with end terminations.

1.0 SYSTEM PARAMETERS

The brief particulars of the 33 kV system parameters are given here under:-

i)	Nominal system voltage	33 kV RMS
ii)	Highest system voltage	36 kV
iii)	Impulses withstand voltage 1.2/50 micro seconds wave of positive/negative polarity	170 kV peak
iv)	System Frequency	50 Hz
v)	No. of phase per circuit	Three
vi)	System Earthing	Effectively grounded
vii)	One minute power frequency withstand voltage	70 kV RMS
viii)	Rated short current	31.5 kA
ix)	Duration of fault current	One second

2.0 CONSTRUCTION OF CABLE

The cross linked polyethylene insulated (XLPE) cable (Dry cured) shall be manufactured in accordance with the internationally accepted standards and also conform to the latest relevant IS/IEC with extruded solid dielectric power cables.

The cable shall be suitable for laying in the area likely to be flooded by water and shall be designed to be protected against rodent and termite attack. **The cable can be laid either in trenches or below the ground as per scope of scheme.**

The construction of cable shall generally confirm to the description in this specification. Bidder shall enclose with bid offer required drawing showing cross section of the cable.

The conductors screen (non-metallic semi-conductive), insulation and insulation screen (non-metallic semi-conductive) shall all be extruded in a single one-time process (Common Head Triple Extrusion Process) to ensure homogeneity and absence of voids.

2.1 CONDUCTOR

The Conductor shall be composed of plain copper or aluminum wires complying with latest standard of relevant IS/IEC.

The conductor shall be of stranded compacted circular construction of size 50sq. mm. or above (As per current requirement in the scheme) complying with IEC-60228 and class 2 of IS-8130.

2.2 CONDUCTOR SHIELD

The conductor shield shall consist of extruded semi-conducting XLPE. Semi-conducting separator tapes may be applied between conductor and the extruded semi-conductor XLPE.

2.3 INSULATION

The extruded XLPE insulation shall be of very high degree of purity and dry cured. The insulation shall be an extrusion of dry cured thermosetting cross linked poly ethylene tree retardant material rated for 90 degree Celsius continuous operation.

The average thickness shall not be less than the nominal value as per standard practice. The minimum thickness at any point shall not be less by more than 10% of the nominal value. Eccentricity shall be as per applicable standards.

The insulation shall be so applied that it fits closely on the conductor (or conductor screening or barrier if any) and it shall be possible to remove it without damaging the conductor.

2.4 INSULATION SHIELD

Cable shall be provided with insulation screening. The insulation screening shall consist of two parts namely, metallic and non-metallic.

Non-metallic part shall be applied directly over the insulation and shall consist of extruded semi-conducting XLPE compound. Semi-conducting water swellable tape shall be used under the copper tape.

Metallic part shall be non magnetic material consist of copper tape, or braid, or concentric serving of wires or a combination of wires and tapes shall be applied over the non-metallic part.

2.5 INNER/METALLIC SHEATH

Inner sheath shall be provided between metallic screen and armour by using extruded PVC type ST -2 as per relevant IS.

2.6 ARMOURING

The armouring shall be of non-magnetic material and applied over the inner sheath as per relevant IS. Armour should be able to carry system short circuit rating of 31.5 kA for 1 sec

2.7 OUTER/SHEATH JACKET

The outer sheath shall consist of extruded black colored PVC of ST2 grade (**Category C2**) or **PE of ST7 grade**. The minimum thickness at any point shall not fall below 90% of the nominal. The outer sheath shall be designed for protection against termite and rodent attack and shall be coated with graphite.

3.0 RATING

The cable size shall be suitable to carry the load current on 33 kV continuously followed by a 10% overloading capacity for two hours without exceeding the maximum conductor temperature of 90 deg.C and during short circuit maximum conductor temperature of 250 deg.C (the manufacturer shall specify such final temperature which shall ensure that there is no loss of life of the cable insulation). The cable rating size shall be based on loading of 2 Nos. three phase circuits at ambient temperature of 50 deg. C and soil temperature of 35 deg. C, **if buried in ground or laid in trenches as per requirement of scheme**. A complete set of experimentally verified data and calculations made in arriving at the conductor rating shall be enclosed with the offer.

4.0 CABLE END TERMINATIONS

- 4.1 The cable end termination shall include the end terminating kit and any special tools and tackles required for making these terminations.
- 4.2 The end termination shall be Heat Shrinkable,/Cold Shrinkable or Pre-fabricated type.
- 4.3 The end termination shall be of outdoor polymer type insulators with metal fittings and furnishing material required. The outdoor terminal should be suitable for heavily polluted atmosphere conditions with creep-age distance of **31mm/KV** for highest system voltage.
- 4.4 The end termination where cable is to be terminated at GIS shall be of SF6 gas type suitable for indoor termination in GIS and shall be coordinated with GIS Switchgear.
- 4.5 The detailed description termination procedure shall be furnished along with the tender.
- 4.6 The supplier shall furnish the details of the end termination in service with the period in service.
- 4.7 The components of end termination shall be capable of being stored without deterioration with in temperature range of 10⁰C to 50⁰C and shall have unlimited shelf life.

5.0 SEALING OF CABLE ENDS

A cable pulling eye shall be provided at one end of the cable on each drum to facilitate pulling of cable while laying. Arrangement shall be made for perfect sealing with pulling eye to avoid ingress of moisture through pulling eye. M-seal shall be used for sealing gap between outer sheath and cable pulling eye. 33kV class M seal Polyurethane compound shall be used for filling gaps between core pipes and cable pulling eye. Heat shrinkable sleeves shall be provided on cable pulling eye and outer sheath of cable. The end which is projecting from the drum shall be specially protected against damage. The drums shall be arranged to take a round spindle and be logged with closely fitting strong bottom to prevent damage to cable.

The other end of the cable shall be properly sealed. Polyurethane compound (11 KV class M-seal epoxy compound) shall be filled in the empty space of PVC cap by making a hole. Resin and hardener shall be mixed in such a proportion to keep the compound soft even after setting. Suitable size heat shrink cap shall then be put over the cable end and shrunk in position by heating with either torch or blow lamp. The cap shall be fully shrunk by uniform heating till a small quantity of adhesive flows outside all-round the edge of the cap to form effective water seal. The heat shrink cap shall form the secondary end seal whereas PVC end cap with Polyurethane compound forms the primary end seal, both put together shall totally prevent any ingress of water from the cable end.

6.0 APPLICABLE STANDARDS

The design, Manufacturer and performance of the equipment and services provided under this specification shall comply with the standards, rules, regulations and acts given in this specification.

The equipment shall confirm to latest relevant applicable Indian/International Standards as amended/revised till date as applicable.

IS-8130	Conductor for insulated electric cables & flexible cords
IS-5831	PVC insulation and sheath of electric cables
IS-7098	Cross-lined polyethylene insulated thermoplastic (Part-III) sheathed cables specification
IS-5216	Guide for safety procedures and practices in electric works
IS 7098 (Part 2)	- Cross-linked Polyethylene insulation for Cables.
IS 8130-	Conductors for insulated electrical cables and flexible cords.
IS 10810	(series)-Methods of tests for cables.
IS 10418-	Drums for electric cables.
IS 3975-	Specification for mild steel wires, strips and tapes for armouring of cables.
IS 5831-	Specification for PVC insulation sheath for electric cable.
IS 10462-	Fictitious calculation method for determination of dimensions of protective coverings of cables Part 1 - Elastomeric and thermoplastic insulated cable.
IEC-228	Conductor for insulated cables

IEC-502	Power cables with extruded insulation and their accessories for rated Voltages from 1 kV (Um = 1,2 kV) up to 30 kV (Um = 36 kV) – Part 2: Cables for rated voltages from 6 kV (Um = 7,2 kV) up to 30 kV(Um = 36 kV)"
IEC-229	Tests on cable over sheaths
IEC-230	Impulse tests on cables and their accessories
IEC-270	Partial discharge measurements
IEC-287	Calculation of continuous current carrying capacity and losses
IEC-811	Electric and optical fiber cable-Test methods for no-metallic materials
IEC-332	Flame Retardant, Characteristics of electric cables.
IEC-840	Test for power cables with extruded insulations.
IEEE 48	Test procedure and requirement for high voltage cable termination
IEEE404	Joint for use with solid dielectric cables
	Indian Electricity Rules
	The Electricity Act 2003

The above standards are for guidance and shall be suitably extended for rated voltage of 36kV wherever applicable.

7.0 TESTS

- a. **Type Tests**: The bidder shall submit all the applicable type test reports for evaluation with validity as per CEA guidelines. If any type test, as per latest IS/IEC, is not found in order than the bidder shall conduct the same free of cost and without affecting the delivery schedule of the tender.
- b. **Routine and Acceptance tests**: The cable and accessories shall be subjected to all routine and acceptance tests as per relevant IS/IEC.

8.0 MARKING:

The packed cable drum shall carry the following information, clearly painted or stenciled.

- a. The letters Delhi Transco Ltd
- b. Reference to Standard and ISI mark.
- c. Manufacturer's Name or trade mark.
- d. Type of cable & voltage grade.
- e. Number of cores.
- f. Nominal cross- sectional area of conductor.
- g. Cable code.
- h. Length of cable on the drum.

- i. Direction of rotation.
- j. Gross weight.
- k. Country of Manufacture.
- l. Year of Manufacture.
- m. Purchase order and date.

9.0 PACKING

The packing of cable shall be as per relevant Indian Standards. The packing of end termination kit shall include identification label indicating component name with manufacturer name, number of items, months & year of manufacturing, shelf life of all the components of kit.

Guarantee Technical Particular of 33 KV XLPE CABLE

1. Name of Manufacturer:
2. Country of Manufacturer:
3. Type of Cable : XLPE
4. Standard according to which cable
Is manufactured
5. Rated voltage
6. Nominal cross-sectional area of Conductor.
7. Conductor material
8. Impulse withstand voltage 1.2/50 micro second wave KVp
9. Power frequency withstand voltage KV rms
11. Maximum dielectric stress at the conductor KV/cm
12. Minimum radial thickness of insulation between conductor & screen.
13. Conductor screen
 - a) Material
 - b) Nominal thickness
14. 14.1 Insulation:
 - a. Material
 - b. Minimum nominal thickness
 - c. Eccentricity factor
- 14.2 Insulation screen:
 - a. Non metallic material
 - b. Metallic material
15. Inner sheath :
 - a) Minimum radial thickness
 - b) Composition
 - c) Maximum working stress
 - d) Nominal diameter
16. Armour

- a) Material
 - b) Type
 - c) Thickness
 - d) Short circuit capacity of armour
- 17 Protective outer serving
 - a) Type and composition
 - b) Nominal thickness
 - c) Test voltage at works.
 18. Nominal overall diameter of complete Single core cable.
 19. Nominal weight per meter of complete Cable.
 20. Short circuit capacities with a conductor temperature of 90 degree at the commencement: 0.5 Second duration.
 - a) 1 Second duration.
 - b) 2 Second duration.
 - c) 3 Second duration.
 21. Minimum radius of bend round which Cable can be laid.
 - a) Direct burial in ground
 - b) In ducts
 22. Maximum D.C. resistance of conductor
Per Km.at 20 degree C.
 23. Maximum A.C. resistance of conductor
Per km. At 90 degree C.
 24. Equivalent star reactance per km. Of 3-phase
Circuit at 50 Hz.
 25. Maximum electrostatic capacitance per km.of cable.
 26. Maximum continuous current carrying Capacity per cable when laid in ground
at a depth of 1.5 metres (Ground temp.35 degree C soil thermal resistivity 150
degree C/watt/Cm. Maximum conductor temperature 90 degree C).
 - a) Only one 3-phase ckt. loaded.
 - b) Both the three phase ckts. Loaded.
 - 27 Maximum continuous current carrying capacity per cable when drawn into pipes
(conditions as in item 26 above).
 - a) Only one 3 phase ckt. loaded
 - b) Two 3 phase ckt. loaded.
 28. Continuous current carrying capacity which will permit a further 10% overload
for two hours without exceeding a maximum conductor temp. of 90 degree C laid as in item
26 above.
 - a) Only one 3 phase ckt. loaded.
 - b) Two 3 phase ckts. Loaded.
 29. Continuous current carrying capacity which will permit a further 10% overload for two
hours as in item no.28 above, but with cables drawn into pipes.
 - a) Only one 3 phase ckt. loaded.
 - b) Two 3 phase ckt. loaded.
 30. Maximum dielectric power factor of cable when laid direct in the ground, at normal
Voltage, frequency at conductor temperature of 15, 30, 45, 65, 90 degree C.

31. Maximum dielectric power loss of cable per Km. Of 3 phase ckt., laid direct in ground, at normal voltage, frequency and Maximum conductor temperature.
32. Maximum dielectric power factor of cable at normal frequency and at a conductor temperature of 20 degree C and at 0.5,1.0, 1.5, 2.0 times nominal voltage.
33. Sheath loss of cable per km. Of 3 phase ckt. at normal voltage, frequency, at maximum Continuous current rating.
 - a) laid direct in ground(item 26 above)
 - b) Drawn into ducts (item 27 above)
34. Impedance per km. Of 3 phase ckt. at 50 C/s and maximum conductor temperature.
 - a) positive and negative sequence
 - b) zero sequence
35. a) Phase to ground characteristic impedance at 50 to 200 Kc/s.
- b) Screening factor.
36. Maximum drum length of cable.
37. Appxm. Shipping weight & size of drums
38. For 1-core cables please recommend with reasons:
 - a) Method of laying(trefoil, horizontrol)
 - b) Whether sheaths are to be bounded and Earthed at one end or both ends.
Transposed.

GTP OF END TERMINATION FOR 33 KVXLPE CABLE

- 1 Manufacturer's name
- 2 Size (mm & shape)
- 3 Type of termination kit.
- 4 Rated voltage. KV
- 5 Rated continuous current (Amp.)
- 6 Rated impulse withstand voltage (kV)
- 7 Impulse wave shape in micro-second
- 8 Power frequency withstand voltage (As applicable)
 - (a) Dry (kV rms)
 - (b) Wet (kV rms)
- 9 Impulse (kV peak)
- 10 Mounting details
 - (a) Sealing end / switchyard
 - (b) Link box.
- 11 Name of items in the kit & respective Shelf life

(month/year)

- 12 Guarantee of termination kit
- 13 Test details
- 14 Curing period
- 15 Effects due to rain, polluted and suitability for climatic conditions
- 16 Net volume of kit length / breath / width and weight
- 17 Time required to prepare a termination
- 18 Time required for energization after termination
- 19 Deterioration of component during storage
- 20 Flexibility / reopen ability, if any
- 21 Chemical reaction which may cause health hazards, if any
- 22 Special storage conditions, if any, up to Amb. Temp. of 50 Deg. C and period
- 23 Provision for track resistance for cable
- 24 Provision for stress relief for cable
- 25 Provision for discharge due to uneven surface of cable insulation
- 26 Is there any additional support required for termination kit? If so, give details.
- 27 Provision for sealing system, if any”

B. Technical Specifications of 66 kV XLPE Cable and End Terminations

This specification covers the design, manufacture, testing at manufacturer's works, supply and delivery of 66 kV, XLPE cable along with end terminations.

3.0 SYSTEM PARAMETERS

The brief particulars of the 66 KV system parameters are given here under:-

i)	Nominal system voltage	66 kV RMS
ii)	Highest system voltage	72.5 kV
iii)	Impulses withstand voltage 1.2/50 micro seconds wave of positive/negative polarity	325 kV peak
iv)	System Frequency	50 Hz
v)	No. of phase per circuit	Three
vi)	System Earthing	Effectively grounded
vii)	One minute power frequency withstand voltage	140 kV RMS
viii)	Rated short time current	31.5 kA
ix)	Duration of fault current	One second

4.0 CONSTRUCTION OF CABLE

The cross linked polyethylene insulated (XLPE) cable (Dry cured) shall be manufactured in accordance with the internationally accepted standards and also conform to the latest relevant IS/IEC with extruded solid dielectric power cables.

The cable shall be suitable for laying in the area likely to be flooded by water and shall be designed to be protected against rodent and termite attack. **The cable can be laid either in trenches or below the ground as per scope of scheme.**

The construction of cable shall generally confirm to the description in this specification. Bidder shall enclose with bid offer required drawing showing cross section of the cable.

The conductors screen (non-metallic semi-conductive), insulation and insulation screen (non-metallic semi-conductive) shall all be extruded in a single one-time process (Common Head Triple Extrusion Process) to ensure homogeneity and absence of voids.

2.8 CONDUCTOR

The Conductor shall be composed of plain copper wires complying with latest standard of relevant IS/IEC. The conductor shall be of stranded compacted circular construction of size 95 sq mm. or above (As per current requirement in the scheme) complying with class-2 of IS-8130.

2.9 CONDUCTOR SHIELD

The conductor shield shall consist of extruded semi-conducting XLPE. Semi-conducting separator tapes may be applied between conductor and the extruded semi-conductor XLPE.

2.10 INSULATION

The extruded XLPE insulation shall be of very high degree of purity and dry cured. The insulation shall be an extrusion of dry cured thermosetting cross linked poly ethylene tree retardant material rated for 90 degree Celsius continuous operation.

The average thickness shall not be less than the nominal value as per standard practice. The minimum thickness at any point shall not be less by more than 10% of the nominal value. Eccentricity shall be as per applicable standards.

2.11 INSULATION SHIELD

The insulation shield shall consist of extruded semi-conducting XLPE. Suitable bedding tapes shall be applied over the extruded semi-conducting XLPE.

2.12 METALLIC SHEATH

The metallic sheath shall be of such metal/material (except lead/ lead alloy) designed to meet the requirement of the system short circuit rating of 31.5 kA for 1 sec and provide radial moisture barrier. The minimum thickness at any point shall not fall below the nominal value by more than 10%. Anti-corrosive compound shall be applied over the sheath.

2.13 OUTER JACKET

The outer sheath shall consist of extruded black colored PVC of ST2 grade (**Category C2**) or **PE of ST7 grade**. The minimum thickness at any point shall not fall below 90% of the nominal. The outer sheath shall be designed for protection against termite and rodent attack and shall be coated with graphite.

4.0 RATING

The cable size shall be suitable to carry the load current on 66 KV continuously followed by a 10% overloading capacity for two hours without exceeding the maximum conductor temperature of 90 deg. C (the manufacturer shall specify such final temperature which shall ensure that there is no loss of life of the cable insulation). The cable rating size shall be based on loading of 2 Nos. three phase circuits at ambient temperature of 50 deg. C and soil temperature of 35 deg. C, **if buried in ground or laid in trenches as per requirement of scheme**. A complete set of experimentally verified data and calculations made in arriving at the conductor rating shall be enclosed with the offer.

10.0 CABLE END TERMINATIONS

- 4.8** The cable end termination shall include the end terminating kit and any special tools and tackles required for making these terminations.
- 4.9** The end termination shall be Heat Shrinkable, Cold Shrinkable or Pre-fabricated type.
- 4.10** The end termination shall be of outdoor polymer type insulators with metal fittings and furnishing material required. The outdoor terminal should be suitable for heavily polluted atmosphere conditions with creep-age distance of **31mm/KV** for highest system voltage.
- 4.11** The end termination where cable is to be terminated at GIS shall be of SF6 gas type suitable for indoor termination in GIS and shall be coordinated with GIS Switchgear.
- 4.12** The detailed description termination procedure shall be furnished along with the tender.
- 4.13** The supplier shall furnish the details of the end termination in service with the period in service.
- 4.14** The components of end termination shall be capable of being stored without deterioration with in temperature range of 10⁰C to 50⁰C and shall have unlimited shelf life.

11.0 SEALING OF CABLE ENDS

A cable pulling eye shall be provided at one end of the cable on each drum to facilitate pulling of cable while laying. Arrangement shall be made for perfect sealing with pulling eye to avoid ingress of moisture through pulling eye. M-seal shall be used for sealing gap between outer sheath and cable pulling eye. 66 KV class M seal Polyurethane compound shall be used for filling gaps between core pipes and cable pulling eye. Heat shrinkable sleeves shall be provided on cable pulling eye and outer sheath of cable. The end which is projecting from the drum shall be specially protected against damage. The drums shall be arranged to take a round spindle and be logged with closely fitting strong bottom to prevent damage to cable.

The other end of the cable shall be properly sealed. Polyurethane compound (11 KV class M-seal epoxy compound) shall be filled in the empty space of PVC cap by making a hole. Resin and hardener shall be mixed in such a proportion to keep the compound soft even after setting. Suitable size heat shrink cap shall then be put over the cable end and shrunk in position by heating with either torch or blow lamp. The cap shall be fully shrunk by uniform heating till a small quantity of adhesive flows outside all round the edge of the cap to form effective water seal. The heat shrink cap shall form the secondary end seal whereas PVC end cap with Polyurethane compound forms the primary end seal, both put together shall totally prevent any ingress of water from the cable end.

12.0 APPLICABLE STANDARDS

The design, Manufacturer and performance of the equipment and services provided under this specification shall comply with the standards, rules, regulations and acts given in this specification.

The equipment shall confirm to latest relevant applicable Indian/International Standards as amended/revised till date as applicable.

IS-8130	Conductor for insulated electric cables & flexible cords
IS-5831	PVC insulation and sheath of electric cables
IS-7098	Cross-lined polyethylene insulated thermoplastic (Part-III) sheathed cables specification
IS-5216	Guide for safety procedures and practices in electric works
IEC-228	Conductor for insulated cables
IEC-229	Tests on cable over sheaths
IEC-230	Impulse tests on cables and their accessories
IEC-270	Partial discharge measurements
IEC-287	Calculation of continuous current carrying capacity and losses
IEC-540	Test methods for insulations and sheaths of electric cables and cords.
IEC-332	Flame Retardant, Characteristics of electric cables.
IEC-840	Test for power cables with extruded insulations.
IEEE 48	Test procedure and requirement for high voltage cable termination
IEEE404	Joint for use with solid dielectric cables
	Indian Electricity Rules
	The Electricity Act 2003

The above standards are for guidance and shall be suitably extended for rated voltage of 72.5KV wherever applicable.

13.0 TESTS

- c. **Type Tests**: The bidder shall submit all the applicable type test reports for evaluation with validity as per CEA guidelines. If any type test, as per latest IS/IEC, is not found in order than the bidder shall conduct the same free of cost and without affecting the delivery schedule of the tender.
- d. **Routine and Acceptance tests**: The cable and accessories shall be subjected to all routine and acceptance tests as per relevant IS/IEC.

14.0 MARKING:

The packed cable drum shall carry the following information, clearly painted or stenciled.

- a. The letters Delhi Transco Ltd
- b. Reference to Standard and ISI mark.
- c. Manufacturer's Name or trade mark.
- d. Type of cable & voltage grade.
- e. Number of cores.
- f. Nominal cross- sectional area of conductor.
- g. Cable code.
- h. Length of cable on the drum.
- i. Direction of rotation.
- j. Gross weight.
- k. Country of Manufacture.
- l. Year of Manufacture.
- m. Purchase order and date.

15.0 PACKING

The packing of cable shall be as per relevant Indian Standards. The packing of end termination kit shall include identification label indicating component name with manufacturer name, number of items, months & year of manufacturing, shelf life of all the components of kit.

GTP OF 66 KV XLPE CABLE

- | | | |
|-----|--|--------|
| 10. | Name of Manufacturer: | |
| 11. | Country of Manufacturer: | |
| 12. | Type of Cable : | XLPE |
| 13. | Standard according to which cable
Is manufactured | |
| 14. | Rated voltage | |
| 15. | Nominal cross-sectional area of Conductor. | |
| 16. | Conductor material | |
| 17. | Impulse withstand voltage 1.2/50 micro second wave | KVp |
| 18. | Power frequency withstand voltage | KV rms |
| 11. | Maximum dielectric stress at the conductor | KV/cm |
| 12. | Minimum radial thickness of insulation between conductor & screen. | |
| 17. | Conductor screen | |
| | a) Material | |
| | b) Nominal thickness | |

18. Insulation
 - a) Material
 - b) Nominal thickness
 - c) Eccentricity factor (E_f)
19. Metal sheath:
 - a) Minimum radial thickness
 - b) Composition
 - c) Maximum working stress
 - d) Nominal diameter over metal sheath
20. Nominal radial clearance allowed under Metal sheath.
- 17 Protective outer serving
 - a) Type and composition
 - b) Nominal thickness
 - c) Test voltage at works.
18. Nominal overall diameter of complete Single core cable.
19. Nominal weight per meter of complete Cable.
20. Short circuit capacities With a conductor temperature of 90 degree at the commencement: 0.5 Second duration.
 - d) 1 Second duration.
 - e) 2 Second duration.
 - f) 3 Second duration.
21. Minimum radius of bend round which Cable can be laid.
 - a) Direct burial in ground
 - b) In ducts
22. Maximum D.C. resistance of conductor
Per Km.at 20 degree C.
23. Maximum A.C. resistance of conductor
Per km. At 90 degree C.
24. Equivalent star reactance per km. Of 3-phase
Circuit at 50 Hz.
25. Maximum electrostatic capacitance per km.
of cable.
26. Maximum continuous current carrying
capacity per cable when laid in ground
at a depth of 1.5 metres (Ground temp.35 degree
C soil thermal resistivity 150 degree C/watt/Cm.
Maximum conductor temperature 90 degree C).
 - c) Only one 3-phase ckt. loaded.
 - d) Both the three phase ckts. Loaded.
27. Maximum continuous current carrying capacity
per cable when drawn into pipes (conditions as
in item 26 above).
 - c) Only one 3 phase ckt. loaded
 - d) Two 3 phase ckt. loaded.
28. Continuous current carrying capacity which
will permit a further 10% overload for two
hours without exceeding a maximum conductor
temp. of 90 degree C laid as in item 26 above.
 - c) Only one 3 phase ckt. loaded.

- d) Two 3 phase ckts. Loaded.
- 29. Continuous current carrying capacity which will permit a further 10% overload for two hours as in item no.28 above, but with cables drawn into pipes.
 - c) Only one 3 phase ckt. loaded.
 - d) Two 3 phase ckt. loaded.
- 30. Maximum dielectric power factor of cable when laid direct in the ground, at normal voltage, frequency at conductor temperature of 15, 30, 45, 65, 90 degree C.
- 31. Maximum dielectric power loss of cable per Km. Of 3 phase ckt., laid direct in ground, at normal voltage, frequency and maximum conductor temperature.
- 32. Maximum dielectric power factor of cable at normal frequency and at a conductor temperature of 20 degree C and at 0.5, 1.0, 1.5, 2.0 times nominal voltage.
- 33. Sheath loss of cable per km. Of 3 phase ckt. at normal voltage, frequency, at maximum continuous current rating.
 - c) laid direct in ground (item 26 above)
 - b) drawn into ducts (item 27 above)
- 34. Impedance per km. Of 3 phase ckt. at 50 C/s
 - c) positive and negative sequence
 - d) zero sequence
- 35. a) Phase to ground characteristic impedance at 50 to 200 Kc/s.
 - d) Screening factor.
- 36. Maximum drum length of cable.
- 37. Appxm. Shipping weight & size of drums
- 38. For 1-core cables please recommend with reasons:
 - c) Method of laying (trefoil, horizontal)
 - d) Whether sheaths are to be bonded and Earthed at one end or both ends.
 - e) Transposed.

and maximum conductor temperature.

GTP OF END TERMINATION FOR 66 KV XLPE CABLE

- 1 Manufacturer's name
- 2 Size (mm & shape)
- 3 Type of termination kit.
- 4 Rated voltage. KV
- 5 Rated continuous current (Amp.)
- 6 Rated impulse withstand voltage (kV)
- 7 Impulse wave shape in micro-second
- 8 Power frequency withstand voltage

- (a) Dry (kV rms)
- (b) Wet (kV rms)
- 9 Impulse (kV peak)
- 10 Mounting details
 - (a) Sealing end / switchyard
 - (b) Link box.
- 11 Name of items in the kit & respective Shelf life (month/year)
- 12 Guarantee of termination kit
- 13 Test details
- 14 Curing period
- 15 Effects due to rain, polluted and suitability for climatic conditions
- 16 Net volume of kit length / breath / width and weight
- 17 Time required to prepare a termination
- 18 Time required for energisation after termination
- 19 Deterioration of component during storage
- 20 Flexibility / reopen ability, if any
- 21 Chemical reaction which may cause health hazards, if any
- 22 Special storage conditions, if any, up to Amb. Temp. of 50 Deg. C and period
- 23 Provision for track resistance for cable
- 24 Provision for stress relief for cable
- 25 Provision for discharge due to uneven surface of cable insulation
- 26 Is there any additional support required for termination kit? If so, give details.
- 27 Provision for sealing system, if any”

SECTION-XXIII

MONOPOLE STEEL TOWERS **FOR 400kV & 220kV AC** **TRANSMISSION LINES**

SECTION: XXIII

TECHNICAL SPECIFICATION OF STEEL MONOPOLE FOR 400/220kV AC TRANSMISSION LINE

1.0 General

- 1.1** This specification covers design, engineering, manufacturing, supply, fabrication, galvanizing, proto assembly and testing, inspection before dispatch, supply of various types of steel pole structures for 400 kV / 220 kV AC Transmission Lines (voltage level as per scheme), conductor & earthwire / OPGW and their accessories & fittings, insulators and hardware fittings etc. at site, design of foundations, laying of foundations along with supply of complete foundation material, erection of steel pole structures, complete stringing & sagging, earthing of pole etc. The walkover, preliminary & detailed survey of line route, profiling, spotting/optimization of pole structure location, storage of material at site, soil resistivity measurement and geotechnical investigation shall also be in the scope of the Contractor.
- 1.2** All the raw materials such as steel, zinc for galvanizing, reinforcement steel, cement, super plasticizers and chemicals for pole foundation, earthing rod/wire, coke and salt for pole earthing etc. anchor bolts & their templates, bolts, nuts, washers, D- shackles, hangers, links, danger plates, phase plate, number plate, circuit plate, day and night visual aids/markers and painting (wherever required), anti-climbing devices, step bolts/ladder, platform and handrail (as per requirement), Bird Guard, Bird diverter (if specified in scheme) etc. required for pole structure manufacture and erection shall be included in the Contractor's scope of supply. Bidder shall clearly indicate in the offer, the sources from where he proposes to procure the raw materials and the components.
- 1.3** The details regarding survey, route marking and pole spotting are covered in **Annexure – A**. For survey, erection of poles, stringing of conductors & earthwire/OPGW and patrolling of transmission line in difficult and inaccessible terrains, use of helicopter or Unmanned Aerial Vehicle (UAV) may be considered. The required clearance from Director General Civil Aviation (DGCA) or any other competent authority shall be obtained before taking up such activity.

Note: The terms “Pole” & “Monopole” has been used interchangeably in this document.

2.0 Applicable Standards

CEA (Technical Standards for Construction of Electrical Plants and Electric lines) Regulations and CEA (Measures relating to Safety & Electric Supply) Regulations shall be followed.

The design, manufacturing, fabrication, galvanizing, testing, erection procedure and materials used for manufacture and erection of steel pole structure, design and construction of foundations shall conform

to the relevant Indian Standards (IS). Pole accessories e.g. anti-climbing device, phase plates, circuit plates, danger plate, day and /or night visual aids and markers (wherever required) etc. shall be as per IS 5613. The entire stringing work of conductor and earth wire shall be carried out by standard stringing practice as per relevant standards and this specification.

In case, Indian Standards are not available, International Standards shall be followed. Standards shall be latest revisions with amendments from time to time unless specifically stated otherwise in the Specification. In the event of supply of material conforming to Standards other than specified, the Bidder shall confirm in his bid that these Standards are equivalent or better to those specified. In case of award, salient features of comparison between the Standards proposed by the Contractor and those specified in this document will be provided by the Contractor to establish their equivalence.

A tentative list of applicable standards is given in **Annexure-E**.

3.0 Service and Climatic conditions

a)	Name of transmission line	As per scheme
(b)	Details of starting and destination point (e.g.name, substation, state, co-ordinates etc.)	As per scheme
(c)	Nominal System Voltage	400/220kV
(d)	Highest System voltage	420/245kV
(e)	Conductor (Type, Diameter, Area, No. of strands etc.)	As per scheme
(f)	No. of conductors per phase	As per scheme
(g)	Earth Wire (Type, Diameter, Area, No. of strands etc.)	As per DTL TS
(h)	OPGW (Type, Diameter, Area, No. of fibres etc.)	As per DTL TS
(i)	No. of circuits and voltage level of each circuit (for Multi circuit & multi voltage pole structure)	As per scheme
(j)	Configuration (vertical/horizontal/delta)	As per scheme
(k)	Terrain category	As per standards for NCT of Delhi region
(l)	Wind zone* and corresponding basic wind speed	Wind zone 5 and 50m/s
(m)	Maximum ambient temperature	50 ⁰ C
(n)	Minimum ambient temperature	0 ⁰ C
(o)	Maximum daily average temperature	40 ⁰ C
(p)	Maximum relative humidity (in %)	100%

(q)	Maximum annual rain fall (in mm)	40
(r)	Number of rainy days/year	50
(s)	Average number of thunder storm (days per annum)	40
(t)	Altitude above MSL	300meters
(u)	Atmospheric condition & Pollution level	Heavily polluted with creepage distance to be taken as 31mm/kV
(v)	Seismic zone	Zone-IV
(w)	Type of insulator (porcelain disc/ long rod, polymer or glass)	As per scheme
(x)	Insulator configuration for suspension and tension (single/double/triple/quadruple/V-string)	As per scheme
(y)	No. of discs / long rods in each string <ul style="list-style-type: none"> • Suspension (I/V/Y; single/double) • Tension (single/double/quad) 	As per DTL TS

**Wind zone shall be as per wind map given in National Building Code 2016. In case of further revision in wind map, latest version of it shall be used.*

In addition to above, any other input required for design of Steel pole structure will be provided by DTL during detailed engineering. Any constraint likely to be faced during commissioning of the transmission line due to site conditions, particularly related to electrical clearances shall be referred to the scheme in the tender document. However the bidder is responsible for maintaining all the necessary clearances as detailed in these specifications.

4.0 Steel Monopole Structure

4.1 General Description

- 4.1.1 The steel pole structures can be Single circuit/Double circuit/Multi circuit/ Multi circuit & multi-voltage/any other configuration, as specified in scheme by DTL and shall be used for entire line or a section of line or for few locations of the line.
- 4.1.2 The pole for any particular location can be single pole type or dual pole type depending upon voltage level, no. of conductors per phase and no. of circuits etc.
- 4.1.3 The pole structures shall be self-supporting polygonal steel pole type, designed to support the line conductors with necessary insulators, earth-wires/OPGW and all fittings, hardware & accessories under all loading conditions.

- 4.1.4 The internal and external surface of pole structure shall be fully galvanized. The most efficient grade of structural steel and plates shall be used in order to yield the optimum cost of pole structure and foundation. The type and grade of steel shall conform to latest applicable national standards or as specified elsewhere in the specification.
- 4.1.5 For cross arms also, Polygonal Sections shall be used. However, if desired by DTL in scheme, insulated cross arms may also be used.

4.2 Type of Pole Structures

- 4.2.1 The poles are classified as given below in table-2:

Table-2

Type of Pole	Deviation Limit	Typical Use
Tangent Pole (say PA/DPA/MCPA/ MVPA)	0 - 2 deg.	To be used as tangent/suspension pole with suspension insulator
Tension / Angle Pole (say PB/DPB/MCPB/ MVPB)	0 deg. - 15 deg.	a) Tension/Angle Pole with tension insulator b) To be designed for anti-cascading condition
Tension / Angle Pole (say PC/DPC/MCPC/ MVPC)	0 deg. - 30 deg. / 15 deg. - 30 deg.	a) Tension/Angle pole with tension insulator b) To be designed for anti-cascading condition
Tension / Angle /Dead end Pole (say PD/DPD/MCPD/ MVPD)	30 deg.- 60 deg./ Dead end [For specific site requirement, Tension pole with 60 deg.- 90 deg. Deviation with or without extra auxiliary arm may be used.]	a) Tension/Angle pole with tension insulator b) To be designed for anti-cascading condition c) Dead end with 0 deg to 15 deg deviation both on line and sub-station side(slack span) d) Complete dead end

Note: 1. P: Single Circuit Pole Structure, DP: Double Circuit Pole Structure, MCP: Multi Circuit (more than 2 circuits) Pole Structure, MVP: Multi Circuit & Multi Voltage Pole Structure

2. The angle of deviations given above are for design span. The span may, however, be increased up to an optimum limit with reducing angle of line deviation, if adequate ground and phase clearances are available.

4.2.2 Extensions

The pole structure shall be designed for highest body extension required at the particular site maintaining adequate electrical clearances.

4.3 Spans

4.3.1 Normal Design Span

The Route of transmission line shall be clearly identified as normal section without constraint, section through forest area, and section through urban areas/populated area/approach section near substations and normal design span in these sections for various voltage level of transmission lines as indicated in the Table-3 below shall be adopted.

Table-3

AC Voltage (kV)	Normal design span (m)		
	Normal route without constraint	Forest area	Urban area/ Populated area /approach section near substation
400 kV	150 m-200 m (angle pole/pole structures) and 250 m (tangent pole/pole structures)		
220 kV	300 m-350 m	250 m	200 m

Note: Above values are applicable for up to double circuit lines. For multi circuit (more than two circuits) lines & for Poles with very high extensions span may be less.

4.3.2 Wind Span

The wind span is the sum of the two half spans adjacent to the support under consideration. For normal horizontal spans this equals to normal ruling span.

4.3.3 Weight Span

(a) The weight span is the horizontal distance between the lowest

points of the conductors on the two spans adjacent to the pole structure. For design of structures for plain terrain, the maximum weight span limits given in Table-4 below shall be considered.

Table-4

Voltage Level (kV)	Pole Type	Normal Condition		Broken wire condition	
		Maximum (m)	Minimum (m)	Maximum (m)	Minimum (m)
220	PA/DPA/MCPA/MVPA	450	50	270	0
	(PB/DPB/MCPB/MVPB) or (PC/DPC/MCPC/MVPC) or (PD/DPD/MCPD/MVPD)	450	0	270	-200
400	PA/DPA/MCPA/MVPA	375	50	225	0
	(PB/DPB/MCPB/MVPB) or (PC/DPC/MCPC/MVPC) or (PD/DPD/MCPD/MVPD)	300	0	180	-200

Note: Weight span limits for hilly terrain will be decided by DTL as per requirement.

- (b) In case the actual spotting spans at certain locations exceed the design spans, necessary action shall be taken so that factor of safety of pole is not less than that of designed/tested pole for increased loadings.

4.4 Electrical Clearance

4.4.1 Ground Clearance

Minimum ground clearance for conductor shall be maintained as per requirement of Central Electricity Authority (Measures relating to Safety and Electric Supply) Regulations. However, requirement of maintaining electrostatic & electromagnetic interference, radio interference voltage, audible noise etc. within acceptable limits becomes ruling condition specifically for transmission lines of 220 kV and above voltage class.

The minimum ground clearance from the bottom conductor shall not be

less than the values indicated in the Table-5 below under maximum sag conditions i.e. at maximum temperature for conventional ACSR/AAAC conductor or at temperature as specified for High Temperature Low Sag (HTLS) conductor and still air. An allowance of 150mm shall also be provided to account for errors in stringing.

Table-5

Voltage Level	Minimum Ground Clearance
220/230kV	7015mm
400kV	8840mm

Conductor creep shall be compensated by over tensioning the conductor at a temperature depending on conductor type in consultation with the DTL.

4.4.2 Live metal Clearance

The minimum live metal clearance to be provided between the live parts and steel work of pole structure for transmission lines of voltage level up to 400 kV shall be as per IS: 5613.

For computing the live metal clearances, the dimensions and configuration of suspension/tension insulators which shall actually be used shall be considered as per requirement. The design of the pole shall be such that it should satisfy all the above conditions when clearances are measured from any live point of the strings.

4.4.3 Phase to Phase Spacing

The phase to phase, vertical and horizontal spacing shall be governed by the pole design/geometrical configuration as well as minimum live metal clearances required under different insulator swing angles. However, the values generally adopted are given in Table-7. If there is more than one circuit on the pole, adequate spacing shall be maintained between the circuits for maintenance of one of the circuits when other circuit is live.

Table-7

Voltage level of Line (kV)	Phase to phase spacing between conductors (mm)	
	Vertical	Horizontal
220	4900	8400
400	8000	11000

The staggering of conductors, if required, shall be as per IS: 5613.

4.4.4 Mid Span Clearance

The minimum vertical mid span clearance between the earth-wire/OPGW and the nearest power conductor under all temperatures and still air condition in the normal ruling span shall not be less than the values mentioned in the Table-8 below. Further, the tensions of the earth-wire/OPGW and power conductors shall be so coordinated that the sag of earth-wires/OPGW shall be at least 10% less than that of power conductors under all temperature loading conditions for normal ruling span.

Table-8

Voltage Level	Mid Span Clearance
220 kV	8500 mm
400 kV	9000 mm

***Note:** At restricted locations, suitable technical arrangement like Line arrestors may be adopted for further reduction in Mid-span clearance subject to verification by studies and testing.*

4.5 Crossings

(a) Power line Crossing

- (i) Clearance between power lines crossing each other shall be kept in accordance with the Central Electricity Authority (Measures Relating to Safety and Electric Supply) Regulations. To achieve these clearances poles with suitable extensions may be used, depending upon the merit of the prevailing site condition.
- (ii) The angle of crossing shall be 90° as far as possible, however, it shall not be less than 75°. The crossing shall be as near the support of the line as practicable, and the support of the lower line shall not be erected below the upper line.
- (iii) For crossing of power line of 400kV, large angle poles of deviation angle of 30-60 degree & designed for dead end condition, with required body extension, shall be used on either sides of the power line.
- (iv) For crossing of power line of 110 kV, 132 kV, 220 kV and 230 kV voltage class, the tension poles (with suitable deviation angle) with required body extension shall be used on either sides of the power line and the crossing of power lines of 66kV class shall be done with any type of poles (suspension or tension) with required body extension.
- (v) In general, higher voltage line shall cross from above the lower voltage line. In unavoidable circumstances, higher voltage line can cross below the lower voltage line after due consultation with DTL of the existing line provided all statutory clearances are met.

- (vi) In case of crossing with tension poles proper guying shall be provided to facilitate stringing of the power line crossing sections separately on obtaining line shutdowns.

(b) Telecommunication Line Crossings

- (i) For crossing of overhead telecommunication lines, Central Electricity Authority (Measures Relating to Safety and Electric Supply) Regulations and guidelines of Power and Telecommunication Co-ordination Committee (PTCC) shall be followed.
- (ii) The angle of crossing shall be 90 degree as far as possible. However, under exceptionally difficult situations when the angle of crossing has to be below 60 degree, the matter will be referred to the competent authority in charge of the telecommunication system.
- (iii) In the crossing span, power line support will be as near the telecommunication line as possible, to obtain increased vertical clearance between the wires.

(c) Railway Crossing

All the railway crossings coming en-route the transmission line shall be identified by the Contractor and provisions of the regulation of Railways Authorities shall be followed. Approval from Railway Authorities shall be obtained before proceeding with work of railway crossing.

(d) Road Crossing:

- (i) All the road crossings coming en-route the transmission line shall be identified by the Contractor and provisions of the regulation of Highway Authorities shall be followed.
- (ii) At all important road crossings, the pole shall generally be fitted with tension insulator string.
- (iii) At all National/State Highways, tension type poles (with deviation angle of 30-60 deg.) with tension insulator strings shall be used and crossing span shall not be more than 250 meters, unless higher span is permitted by National Highways Authority.

(e) River Crossing

- (i) Minimum clearance of a power line above a river shall be as per Central Electricity Authority (Measures Relating to Safety and Electric Supply) Regulations and regulations of appropriate River Authorities.

- (ii) In case of major river crossing, river crossing poles shall be of suspension type along with anchor poles of tension type pole (with deviation angle of 30-60 deg.) on either side of the main river crossing poles.
- (f) For river crossings or power line crossings (66kV or above), railways or road crossings (express way, national highway & state highway) minimum two sets of long rod insulators or two sets of disc insulator strings per phase shall be used.
- (g) For PD/DPD/MCPD/MVPD type pole, where jumper is projecting outside of cross arm, bidder shall adopt same cross arm design as that used for dead end angle pole.

4.6 Angle of shielding

The angle of shielding is defined as the angle formed by the line joining the centre lines of the earth wire/OPGW and outer power conductor, in still air, at pole structure supports, to the vertical line through the centre line of the earth-wire/OPGW. Bidders shall design the pole in such a way that the angle of shielding does not exceed 30° for 220kV lines, 20° for 400kV lines.

The drop of the earth-wire clamp should be considered while calculating the minimum angle of protection. For estimating the minimum angle of protection the drop of earth wire suspension clamp along with shackle shall be taken as 150 mm.

4.7 Design of Monopole Structure

Pole structure shall be designed as per following minimum requirement:

4.7.1 Design Criteria

The pole structure shall be designed as per ASCE standard 48-19 (or subsequent revision) as applicable except otherwise specified in this specification considering loading requirement (except wind loading on body of the steel pole) as stipulated in latest versions of IS: 802. Load on the pole body due to wind shall be calculated as per IEC 60826 and relevant formula for calculation is given below for reference. For calculation of wind load, the basic wind speed shall be as per wind map given in National Building Code 2016. Manufacturers shall provide attachment points/devices at various locations on the pole body for application of wind loads during proto type testing of pole.

Wind Load on Cylindrical Members(Monopole) having a large diameter (d >0.2m)

The wind load in the direction of the wind on the member 'Le' long, applied at the center of gravity of the member, is equal to:

$$F_{WT} = P_d \cdot C_{dt} \cdot G_t \cdot d \cdot L_e \cdot \sin^3 \theta'$$

Component in transverse direction

$$F_{WT, TRANS} = [P_d \cdot C_{dt} \cdot G_t \cdot d \cdot L_e \cdot \sin^3 \theta'] \cdot \cos \theta$$

Component in longitudinal direction

$$F_{WT, LONG} = [P_d \cdot C_{dt} \cdot G_t \cdot d \cdot L_e \cdot \sin^3 \theta'] \cdot \sin \theta$$

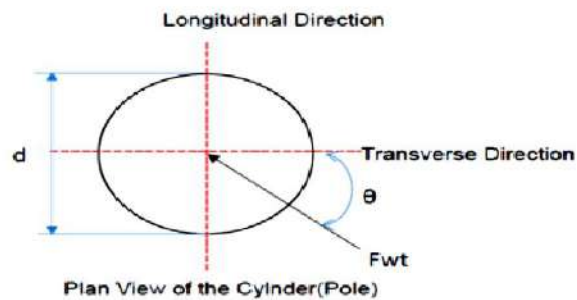
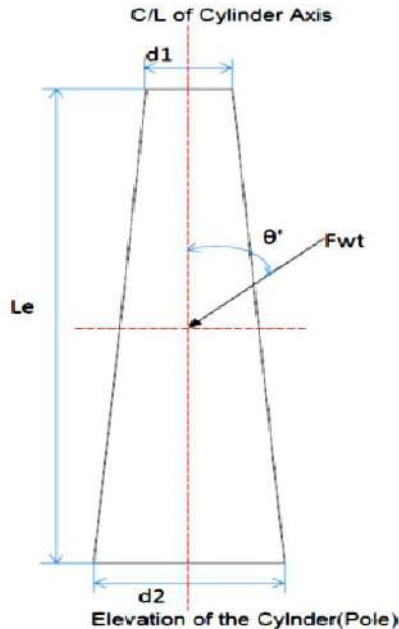


FIG.-1

Where,

F_{WT} = Wind load, in 'N'

$F_{WT, TRANS}$ = Component of wind load (Fwt) in transverse direction, in 'N'.

$F_{WT, LONG}$ = Component of wind load (Fwt) in longitudinal direction, in 'N'.

P_d = Design wind pressure, in N/m^2

C_{dt} = Drag coefficient for wind perpendicular to the axis of the cylinder, given in Table-1

G_t = Gust response factor depending upon the terrain category and height of C.G of the cylinder member above ground level. Values of 'Gt' for the three terrain categories are given in IS:802(Part-1/Sec-1). Table.6.

d = Diameter of the pole, in 'm'. For tapered poles average diameter may be considered.

L_e = Projected length of the member, in 'm'

θ' = Angle formed by the direction of wind and cylinder axis (see Fig.1)

θ = Angle of incidence of the wind direction with perpendicular to longitudinal direction (see Fig.1)

Following Drag Coefficient Values (table-9) shall be used in above mentioned formula for Polygonal Pole sections:

Table-9

Member Shape	Drag Coefficient
16-Sided Polygonal	0.9
12-Sided Polygonal	1.0
8-Sided Polygonal	1.4
6-Sided Polygonal	1.4
Square, Rectangle	2.0

4.7.2 Design Temperature

The following temperature range for the conductors and groundwires shall be adopted for line design.

- a) Minimum temperature (deg C): 0 deg C
- b) Every day temperature of conductor: 32 deg C
- c) Max. temperature of
 - i) Conductor (deg C): As per Conductor used (As per relevant IS for ACSR/AAAC/AL59/Moose/Bersimis conductor and as per manufacturer's data for HTLS & other new generation conductors until IS is available for them).
 - ii) Earth-wire exposed to sun: 53 deg C

4.7.3 Normal Loading Conditions

- 4.7.3.1 The loads on pole structure, conductor, earthwire/OPGW and insulators under different loading conditions viz. Reliability Conditions (Normal Condition), Security Conditions (Broken Wire Condition), Safety Conditions, Anti cascading condition etc. shall be calculated as per latest version of IS: 802 or as specified in this specification considering various combinations of design temperatures & wind loads and loading trees/diagrams/charts shall be prepared. However, due to symmetry of pole structures, the narrow front wind requirements under security condition may be neglected. Further the Reliability level as per following Table-10 shall be considered for design of pole structure of transmission lines:

Table-10

220kV and 400 kV Transmission lines with one / two circuits and one /two conductors per phase	Reliability level 1 corresponding to 50 years return period
(a) 220 kV & 400 kV Transmission lines with more than 2 circuits; (b) 400 kV Transmission lines with more than two conductors per phase	Reliability level 2 corresponding to 150 years return period
(a) Special type pole structures; (b) Tall River crossing (>600 m span) pole structures; (c) Pole structures whose full scale prototype cannot be tested due to limitation of testing facility in India	Reliability level 3 corresponding to 500 years return period

- 4.7.3.2 Any other design criteria and loading condition proposed by the Standing Committee of experts for investigation of transmission pole failure or any other task force constituted by the Government shall also be considered for designing of pole structure.

- 4.7.3.3 The loading trees/diagrams/charts shall be submitted to DTL for approval. The pole structure designs shall be developed by the Contractor as per the approved loading trees/diagram/charts.
- 4.7.3.4 For calculating vertical loads on the pole structure, the weight of suspension insulator and tension insulator shall also be considered for each phase conductor depending on the requirement.
- 4.7.3.5 In case pole structure designed for symmetrical configuration of circuits is used for stringing of circuit(s) on one side of the pole, it shall be ensured that pole is suitable for such scenario.
- 4.7.3.6 Negative directional wind shall be considered for single circuit poles.

4.7.4 Maximum Tension

- 4.7.4.1 Max tension shall be based on either
- a) At 0 deg C (or at a temperature below 0 deg C if so specified by the DTL) with 36% full wind pressure, or
 - b) At 32 deg C with full wind pressure; whichever is more stringent.
- 4.7.4.2 Sag tension calculations are to be carried out by the Contractor considering conductor & earthwire/OPGW parameters & specified conditions and spans.
- 4.7.4.3 The conductor/earthwire/OPGW tension at everyday temperature and without external load should not exceed the following percentage of the ultimate strength of the conductor (table-11):

Table-11

(a)	Initial unloaded tension	35%
(b)	Final unloaded tension	
	(i) below 400kV	25%
	(ii) 400 kV and above	22% (conductor) 20% (earthwire/OPGW)

- 4.7.4.4 The ultimate tension of conductor and earthwire under everyday temperature and 100% design wind pressure, or minimum temperature and 36% design wind pressure shall not exceed 70 per cent of their ultimate tensile strengths. Similarly, the ultimate tension of OPGW under everyday temperature and 100% design wind pressure, or minimum temperature and 36% design wind pressure shall not exceed 40 per cent (up to 60% if verified through relevant tests) of the ultimate tensile strength of OPGW.

4.8 Electro-mechanical strength of insulator

Electro-mechanical strength of insulator shall be selected such that:

- a) under 100% design wind loading conditions, the load on insulator string shall not exceed 70 % of its electro-mechanical strength;
- b) under everyday temperature and nil wind conditions, the load on insulator string shall not exceed 25% of its electro- mechanical strength.

4.9 Conductor and Earth-wire Configuration

4.9.1 Conductor configuration shall be as specified by DTL in the requirement of scheme.

4.9.2 Single earthwire shall be used for transmission lines up to 220 kV and two earth wires shall be used for transmission lines of 400 kV.

4.9.3 The earthwire shall be OPGW or galvanized stranded steel (GSS) or Aluminium Alloy Conductor Steel Reinforced (AACSR) type, as specified by DTL.

4.10 Deflection Criteria (for both suspension and tension Pole structure)

The maximum deflection of 5% (under ultimate load condition) of the height of pole shall be considered in the design where there is no restriction at site. However maximum deflection during testing shall not exceed 8% after testing for 10 critical load cases. Deflection during every day loading conditions should not exceed 2%. However, in any situation, the required electrical clearances at site has to be maintained as per Central Electricity Authority (Measures Relating to Safety and Electric Supply) Regulations.

4.11 D/T and W/T Ratio for Design of pole Structure

While designing the pole structure, the D/T ratio and W/T ratio (D: Diameter of section, W: Width of side, & T: Thickness of sheet), as applicable in line with ACSE 48-19 (or its latest version), shall be maintained properly to avoid buckling and ovality of the individual sections of the pole structure under load during transportation and handling.

5.0 Design Calculation and Drawing

5.1 The detailed design calculations and drawings for different type of pole structure for the transmission line along with design of different type of foundation for the same are required to be furnished to DTL along with the bid. The line diagrams of pole structures and foundations are also to be furnished. The bidder shall also furnish basic assumptions and criteria of pole structure design so that design calculations, even if computerized, could be checked.

- 5.2** After award of contract, the Contractor shall submit detailed design of all polygonal pole structures with all extension along with stress diagram/computer output together with sample calculations, calculations for deflection, and foundation design and drawing etc., anchor bolt templates and loading/rigging arrangement of pole testing to enable the DTL to make a preliminary check regarding structural stability of pole before tests.
- 5.3** The Contractor shall also submit one copy of reproducible of all drawings & Bill of Materials after final approval.
- 5.4** The drawings of accessories of pole structure like number plate, danger plate, phase plate, circuit plate, step bolt, anti-climbing device, pole plate and earthing arrangement, bird guard, D-shackle, aviation day and night markers/painting on pole etc. shall be prepared by the Contractor and shall be submitted to D T L for approval.
- 5.5** After approval of design by D T L /Consultant, the Contractor shall develop structural drawings including all details of cross arms, joints and attachments based on approved design and furnish hard & soft copies of the drawings for scrutiny at DTL's end. If the design/drawings are corrected by DTL, the Contractor shall submit revised designs/drawings within 15 (fifteen) days of issue of corrections. The Contractor shall develop computer aided structural drawings and prepare bills of materials and shop drawings of Pole structure. After thorough scrutiny and upon satisfaction about the soundness/correctness of joints and the drawing as a whole, DTL shall convey his acceptance to the Contractor.
- 5.6** Upon receiving the acceptance of structural drawing from DTL, the Contractor shall develop shop drawings for Pole structure and fabricate them as per the drawings for the purpose of proto assembly and inspection. During proto-assembly inspection, DTL may depute their Engineer for checking the conformity. However, the overall responsibility of ensuring the correctness of the shop & structural drawings and the proto assembly shall lie with the Contractor. At this stage if any modification is required to be carried out on the fabrication shop drawings or on the structural drawings, the same shall be properly incorporated with prior intimation to DTL.
- 5.7** Subsequent to the successful proto assembly of the Pole structure, the pole shall be tested as per IS: 802 and as specified by DTL. The test shall be carried out in presence of DTL's and Contractor's representatives.
- 5.8** At the time of proto assembly and/or proto testing, if any modification are required to be carried out, the same shall be incorporated by the Contractor and the revised structural drawings, bills of materials and shop drawings shall be submitted to DTL within 15 days of completion of testing of poles for approval. After approval, the Contractor shall submit copies of drawings/BOMs and 2 sets of shop drawings. Soft copies of Structural & Shop drawings and BOM's shall also be submitted in CD/DVD/Pen drive for use on computer.

- 5.9** The right of design shall be with DTL. All drawings therefore shall be duly marked with the following:

WARNING: THIS IS PROPRIETARY ITEM AND DESIGN RIGHT IS STRICTLY RESERVED WITH DTL. UNDER NO CIRCUMSTANCES THIS DRAWING SHALL BE USED BY ANYBODY WITHOUT PRIOR PERMISSION FROM DTL IN WRITING.

- 5.10 Loading Trees:** Loading trees shall be prepared by the Contractor for design purposes. The loading trees shall summarize various aspects regarding loading and shall govern the design besides requirements stipulated in IS: 802.

- 5.11** After successful testing of pole structure and subsequent approval of design, drawing and bill of materials, the Contractor shall furnish the soft copies and 4 sets of hard copies of following design calculations, drawings and bill of material to DTL within fifteen (15) days of approval:

- (a) Detailed design calculation including pole deflection calculations and drawing for pole structure & foundations.
- (b) Detailed structural drawings indicating dimension details of sections and cross-arms, sizes of plates and anchor bolt assembly details along with hole to hole distance, joint details etc.
- (c) Bill of materials indicating cutting and bending detail against each part.
- (d) Shop drawings showing all details relevant to fabrication.
- (e) All the drawings for the pole hardware & accessories.

- 5.12** While submitting the designs, structural drawings, bill of materials and any other drawings pertaining to the subject transmission line, the Contractor shall clearly indicate on each drawing Specification No., Name of the transmission line and project, Name of DTL, letter reference No., revision No., and dates on which the submissions are made.

- 5.13** The drawings shall be prepared to the appropriate scale as per the relevant standards. Not To Scale (NTS) drawings shall not be accepted.

6.0 General Construction

6.1 Pole Structure

- 6.1.1** Steel grades having designated yield strength less than or equal to that of IS: 2062 grade E450 or equivalent are to be used in Pole structures, which includes pole shaft, cross arms & arm brackets, base plate etc. The quality of steel shall be BR/B0/C type as per IS 2062. Not more than three grades of steel shall be permitted for use. Steel plates below 6 mm size exclusively used for packing plates/packing washers produced as per IS: 1079 (Grade-HR0) are also acceptable.

- 6.1.2 Pole shall be continuously tapered from top to bottom with uniform slope. However, when required straight sections (without tapered) may be designed/used as extensions.
- 6.1.3 Steel grade of weldable quality only shall be selected. The grades of steel shall be selected to meet the design requirements & climatic conditions keeping in view the overall optimum weight of the pole structure and availability of material.
- 6.1.4 The sheets/plates of monopole shall be from primary steel producers such as TATA/ SAIL/ JSW/ RINL/ POSCO/ Arcelor Mittal Nippon Steel India/ Jindal Steel/ only. If the sheets/plates can not be directly procured from these sources, the same can be procured from dealer/distributors subject to condition that the original maker of the steel are aforementioned suppliers and same should be traceable. The manufacturer shall provide necessary documents for the same.
- 6.1.5 Quality Control Order issued by Ministry of Steel, as applicable, shall be followed.

6.2 Anchor Bolts

Anchor bolts shall generally conform to IS: 5624. The size, grade & numbers of anchor bolts and its thread & nuts selection should be compatible with the required strength as per design. The anchor bolts for the pole shall be provided with top and bottom templates to form cage. This is to get a proper alignment of bolts during casting of foundation. Anchor bolts shall be completely galvanized.

6.3 Fasteners: Bolts, Nuts and Washers

- 6.3.1 All bolts and nuts shall conform to IS: 12427. All bolts and nuts shall be galvanized as per IS: 1367 (Part-XIII)/IS: 2629 and shall have hexagonal head and nuts, the heads being forged out of the solid steel rods & shall be truly concentric, and square with the shank, which must be perfectly straight.
- 6.3.2 The foundation bolts shall be of minimum 16 mm diameter and of property class 6.8/8.8 and the connection bolts shall be of minimum 12 mm and of property class 8.8 specified in IS: 1367 (Part-III). Nuts of property class matching with the property class of mating bolt as specified in IS: 1367 (Part-VI) shall be used.
- 6.3.3 Bolts up to M16 and having length up to 10 times the diameter of the bolt should be manufactured by cold forging and thread rolling process to obtain in good & reliable mechanical properties and effective dimensional control. The shear strength of bolts shall be as per applicable standard. Bolts should be provided with washer in accordance with IS: 1363 (Part-I) to ensure proper bearing.
- 6.3.4 All bolts shall be threaded to take the full depth of the nuts and threaded enough to permit firm gripping of the members. It shall be ensured that the threaded portion of each bolt protrudes not less than 3 mm when fully tightened. All nuts shall fit and tight to the point where the shank of the

bolt connects to the head.

- 6.3.5 To obviate bending stress in bolts or to reduce it to minimum, no bolt shall connect aggregate thickness of more than three (3) times its diameter.
- 6.3.6 Bolts at the joints shall be staggered so that nuts may be tightened with spanners without fouling.
- 6.3.7 Nuts should be double chamfered as per the requirement of IS: 1363 Part- III. It should be ensured by the manufacturer that nuts should not be overlapped beyond 0.4 mm oversize on effective diameter of bolts. The nuts shall be forged and tapped after galvanizing and then lubricated.
- 6.3.8 The bolts and nuts shall be free from forging & threading defects such as cuts, splits, burrs, bulging, taper, eccentricity, loose fit etc.
- 6.3.9 Flat and tapered washers shall be provided wherever necessary.
- 6.3.10 Spring washers shall be provided for insertion under all nuts. These washers shall be of steel and shall be electro-galvanized, positive lock type and 3.5 mm in thickness for 16 mm dia bolt and 4.5 mm for 24 mm bolt. In place of spring washer, double nut or lock nut may be provided with flat washer.
- 6.3.11 The surface of the washers shall be free of scales and burrs. The washers shall be coiled without any kinks (except for the shape with turned-up ends). The ends of the washer shall be so served as to prevent tangling.
- 6.3.12 The spring washers after coiling shall be suitably heat treated so as to result in the finished washer having hardness 43 to 50 HRC when tested in accordance with IS: 1586.
- 6.3.13 To ensure effective in-process Quality Control it is essential that the manufacturer have all the testing facilities for tests like weight of zinc coating, shear strength, other testing facilities etc. in-house. The manufacturer should also have proper Quality Assurance System which should be in line with the requirement of this specification and IS: 14000 series Quality System standard.

6.4 Pole Structure Accessories

6.4.1 Ladders and Step Bolts

- (a) A ladder along with protection rings (caged ladder) of suitable design (preferable) shall be provided to climb on the pole structure. Step bolts or combination of step bolts and ladder may be provided if so specified by the DTL. For access to earth wire peak and horizontal access on cross arms, step bolts/suitable designed hooks/side railings can also be provided. Detailing for providing step bolts/hooks/ladders etc. shall be done so that all parts of pole structures are accessible and installation & maintenance of

insulators, hardware assemblies, conductors etc. is possible.

- (b) The ladder or step bolts shall extend from about 2.5 meters above the ground level to the top of the pole.
- (c) The step bolts, if provided, shall conform to IS: 10238 and shall be of not less than 16 mm diameter & 175 mm long and spaced not more than 450 mm apart. The head diameter shall be 35 mm. The step bolt shall be fixed on two sides of polygon of the pole structure in alternate step arrangement. Each step bolt shall be provided with two hexagon nuts on one end to fasten the bolt securely to the pole and button head at the other end to prevent the feet from slipping away. The step bolts shall be capable of withstanding a vertical load not less than 1.5 kN.

6.4.2 Insulator Strings and Earthwire Clamps Attachments

- (a) Insulators assemblies as approved by DTL shall be used by the Contractor for Suspension and Tension pole structures. For specific application, DTL may consider use of insulated cross arm in place of conventional cross arm.
- (b) For the attachment of suspension insulator string, a suitably dimensioned swinging hanger on the pole, if required, shall be provided so as to obtain specified clearances under respective swinging conditions of the strings.
- (c) The hanger, extension links, D-shackles etc. as required and considered in the design of the pole, shall be of same strength as that of corresponding electromechanical strength/ ultimate tensile strength of insulator string. The design and supply of hanger, extension links, D-shackles are also in the scope of the Contractor.
- (d) At tension pole structures, strain plates of suitable dimensions on the underside of each cross-arm tip and suitable plate at the top of earth-wire peak should be provided for taking the hooks or D-Shackle of the tension insulator strings or earth-wire tension clamps, as the case may be. Full details of the attachments shall be submitted by the Contractor for DTL's approval before starting the mass fabrication.

6.4.3 Earthwire/OPGW Clamps

Suspension and tension clamps conforming to IS 5613 shall be provided by the Contractor. For Suspension and tension clamp for attachment of earthwire/OPGW the Contractor shall supply U- bolts, D-Shackles etc. for attachment of clamp to the pole structure. These items shall be of same rating/strength as that of corresponding rating/Ultimate tensile Strength of earthwiresuspension/tension clamp.

6.4.4 Anti-climbing Device

Barbed wire or spike type anti-climbing device shall be provided and installed by the Contractor for all pole structures. The height of the anti-climbing device shall be provided approximately 3 m above ground level. The barbed wire shall conform to IS: 278 (size designation A1). The barbed wires shall be given chromating dip as per procedure laid down in IS: 1340.

6.4.5 Danger plate, Number plate, Circuit plate and Phase plate

- (a) Each pole shall be fitted with a number plate, danger plate and a set of phase plates per circuit. The arrangement for fixing these accessories shall not be more than 4.5 m above the ground level.
- (b) The number plate, phase plate and circuit plate shall be as per IS 5613.
- (c) The letters, figures and the conventional skull and bones of danger plates shall conform to IS: 2551 and shall be in a signal red on the front of the plate.
- (d) The corners of the number, danger and circuit plates shall be rounded off to remove sharp edges.
- (e) The letters of number & circuit plates shall be red enameled with white enameled background.

6.4.6 Bird Guards

To prevent birds perching immediately above the suspension insulator strings (I-Type/V-Type) and fouling the same with droppings, suitable bird guards shall be provided at cross-arm tips of all suspension poles. Saw type bird guard conforming to IS: 5613 or other bird guard as approved by the DTL shall be provided. The bird guard arrangement shall be such that it shall either prevent bird from perching in position where they are liable to cause damages or ensure that if birds do perch, droppings will fall clear of the insulator string. Suitable provision of cleat/plate to be provided on all suspension poles facilitating installation of bird guard after stringing.

6.4.7 Aviation Requirement

The day and/or night visual aids and markers for denoting transmission line or structures as per requirements of Directorate of Flight Safety or International Civil Aviation Organization shall be provided.

6.5 Pole Structure Fabrication

6.5.1 The Pole Structure along with cross arms, earthwire peaks, base plate and joints shall be fabricated by the Contractor as per the design developed by the Contractor and approved by DTL/Consultant.

6.5.2 The fabrication of Pole structure shall be in conformity with the following:

- (a) Except where hereinafter modified, details of fabrication shall conform

to good industry practices and relevant standards.

- (b) Connections by means of slip joints or flange joints are both acceptable on mutual agreement as per the site requirements and conditions. Joints shall be so designed and fabricated that eccentricity is avoided as far as possible.
- (c) Pole section, if made with telescopic slip joints, shall be suitable for easy assembly either in air or on the ground at the construction site. Overlapping shall not be less than 1.5 times the largest inside diameter of the female section. The taper of each section at a slip joint should match the taper of the adjacent section.
- (d) On slip joints, diameter of the inner and outer part of the pole structure shall be controlled to ensure smooth assembly of the monopole structure.
- (e) In case of flange joints, the flanges welded to pole sections will be joined with Bolts & Nuts.
- (f) The cross arms shall be connected to the monopole by means of suitable flanges welded on the body and cross arms.
- (g) The Pole structures shall be accurately fabricated to connect together easily at site without any undue strain on the structure.
- (h) The diameter of the hole for bolts shall be equal to the diameter of bolt plus 1.5 mm.
- (i) The structure shall be designed so that all parts shall be accessible for inspection and cleaning. Drain holes shall be provided at all points where pockets of depression are likely to hold water. The top end of the pole, earth-wire peaks and cross arms shall be suitably sealed with cover plate bolted to the structure.
- (j) Maximum size of individual fabricated/welded piece shall be so selected to facilitate easy handling transportation and erection of pole structure. Any other specific restriction on length due to site condition shall be as per scheme requirement. The limits of weights & dimensions of individual components shall be finalized at the time of design development and approval.
- (k) All similar parts shall be made strictly inter-changeable. All steel sections before any work is done on them, shall be carefully leveled, straightened and made true to detailed drawings by methods which will not injure the materials so that when assembled, the adjacent matching surfaces are in close contact throughout.
- (l) In case of restriction due to size of hot dip galvanizing bath, pole segments shall be fabricated & galvanized as per following table and shall be seamlessly welded.

Table-12

Sr. No.	Outer Diameter of pole segment (in mm)	Max. permissible no. of fabricated parts per pole segment
1.	Upto 600	1
2.	$600 \leq D < 1200$	2
3.	$1200 \leq D < 1800$	3
4.	$1800 \leq D$	4

- (m) No sharp/rough edges shall be permitted in the entire structure.
- (n) Suitable provisions shall be kept in design and detailing of pole structure for easy erection at site using conventional as well as mechanized methods. Detailed erection procedure/manuals shall be prepared and submitted by the Contractor.
- (o) Design and detailing for providing ladders/step bolts/hooks etc. shall be done so that such provision would facilitate accessibility to all parts of pole structures and installation & maintenance of insulators, hardware assemblies, conductors etc. can be done easily. Design detailing for provision of other accessories viz. Anti climbing device, Danger plate, Number plate, Phase plate etc. shall also be done.
- (p) At base plate and other intermediate flange connections the plate shall be perfectly levelled to ensure uniform and gap free connection.
- (q) Lifting and handling of monopole during galvanization, fabrication etc. shall be done in such a way that each panel of monopole is perfectly straight. Also, spider bracings may be used inside the pole to arrest distortion or bending during handling.

6.5.3 Material Cutting, Forming & Bending

- (a) The required material cutting, forming and bending operations shall be carried out generally in accordance with ASCE standard 48-19 (or subsequent revision) "Design of Steel transmission Pole Structures".
- (b) Before any cutting work is started, all steel shall be carefully straightened & trued by pressure and not by hammering. They shall again be trued after cutting & welding etc.

6.5.4 Drilling and Punching

- (a) Holes for bolts shall be drilled or punched with a jig or made with plasma/gas but drilled holes shall be preferred.
- (b) Holes must be perfectly circular and no tolerance in this aspect is permissible.

- (c) The maximum allowable difference in diameter of the holes on the two sides of plates or angle is 0.8 mm, i.e., the allowable taper in a punched hole should not exceed 0.8 mm on diameter (Not applicable for template holes and lifting holes).
- (d) Holes must be square with the plates and have their walls parallel.
- (e) All burrs left by drills or punch shall be removed completely. When the pole members are in position the holes shall be truly opposite to each other. Drilling or reaming to enlarge holes shall not be permitted.

6.5.5 Welding

- (a) Welding being the key process of pole manufacturing, the manufacturer should have ISO 3834-2 certification for quality of welding.
- (b) All welding shall be in accordance with the latest revision of American Welding Society Structural Welding Code (ANSI/AWS D1.1). Welding terms and symbols should comply with the AWS definitions and symbols.
- (c) Care should be exercised with respect to welding procedures, qualification of welders/operators, electrodes, preheat, notch toughness and minimum yield of the electrodes to ensure conformance with the requirements of the ANSI/AWS D 1.1 code. Preheating shall be done according to the ANSI/AWS code or the steel producer's recommendations, or both. The welding shall be done by the shield metal-arc, gas shielded flux core, gas shield metal arc or submerged-arc processes. The storage of welding consumables (welding wire, electrodes, fluxes and gases) shall be in accordance with AWS D1.1 and as per manufacturer's recommendations. These details shall be included in MQP (Manufacturing Quality Plan) to be prepared and submitted by the Contractor.
- (d) Circumferential and longitudinal welds within the slip joint area of pole sections should be ultrasonically inspected in accordance with AWS D1.1. Longitudinal welds in pole sections where visual inspection is not adequate, magnetic particle tests or dye penetration test should be conducted in accordance with AWS D1.1.
- (e) Pole shaft-to-base plate, and pole shaft-to-flange shall be full penetration welds. Arm shaft-to-arm bracket shall be partial penetration groove weld with fillet overlay, sized to develop the full strength of the shaft. Longitudinal seam welding of pole shaft (not in slip joint area) shall be partial penetration (min. 60%) from outer side.
- (f) Warping of base plate due to exposure to extreme heat during welding shall be avoided.

6.5.6 Erection mark

Each individual member shall have an erection mark conforming to the component number given to it in the fabrication drawings. This mark shall be made with marking dies of 16 mm size before galvanizing and shall be legible after galvanizing. DTL may specify erection mark format as per its requirement.

7.0 Quantities and weight

- (a) The provisional quantities required (including provisional spare for pole structure quantity) shall be as per scheme of the tender. The final quantities of pole structure including spare pole structures shall be confirmed by DTL based on the requirement of quantities of various pole structures after completion of detailed survey.
- (b) DTL reserves the right to order the final quantities including required quantities of spares.
- (c) The rate quoted by the bidder for pole structure / structure parts supply is deemed to be inclusive of galvanizing charges & the cost of zinc.
- (d) The Contractor is to supply up to 2.5% extra fasteners to take care of losses during erection.
- (e) Payment of the pole structures shall be made on per structure basis as per the unit rates in the contract irrespective of any change in weight of structure estimated by the bidder at the time of the bidding vis-à-vis weight of structure as per actual tested and approved design.

8.0 Galvanizing

- 8.1** The pole manufacturer has to submit in writing the suitability of its galvanizing facility/bath where the pole sections are to be galvanized.
- 8.2** Fully galvanized poles structures and anchor plate excluding template shall be used for the transmission lines. Galvanizing of the pole structure shall conform to IS: 2629 and IS: 4759. All galvanized members shall withstand tests as per IS: 2633. For fasteners, the galvanizing shall conform to IS: 1367 (Part-13). Spring washers shall be electro-galvanized as per service grade 4 of IS: 1573.
- 8.3** The galvanizing shall be done after all fabrication work is completed, except that the nuts may be tapped or re-run after galvanizing. Threads of bolts and nuts shall have a neat fit and shall be such that they can be turned with finger throughout the length of threads of bolts and they shall be capable of developing full strength of the bolts.
- 8.4** All fabrication work on pole sections (including welding of base section with base plate) shall be completed in all respect before hot dip

galvanization. No cutting, grinding, welding, fabrication etc. shall be allowed on any pole sections after hot dip galvanization is over except sections that will use metallizing.

8.5 The zinc coating shall be adherent, reasonably uniform, smooth, continuous and free from imperfections such as black/bare spots, ash rust strains, bulky white deposits/wet storage strains and blisters.

8.6 The fabricated pole structure parts shall have a minimum overall mass of Zinc coating and average zinc coating thickness as given below (table-13):

Table-13

	Minimum mass of zinc coating (g/m ²)	Average coating thickness of zinc coating (micron)
For plates and sections below 5 mm	460	65
For plates and sections of 5 mm and above	610	87

8.7 For installation in coastal areas (up to 20 km from sea coast), the fabricated pole parts shall have a minimum overall mass of Zinc coating and average zinc coating thickness as given below (table- 14):

Table-14

	Minimum mass of zinc coating (g/m ²)	Average coating thickness of zinc coating (micron)
For plates and sections below 5 mm	610	87
For plates and sections of 5 mm and above	900	127

8.8 The Contractor shall also take guidelines from the recommended practices for hot dip galvanizing laid down in IS 2629 while deciding and implementing galvanizing procedure. The mandatory requirements however, are specified herein. The surface preparation for fabricated pole structure parts for hot dip galvanizing shall be carried out as indicated herein below:

(a) **Degreasing & Cleaning of Surface:** Degreasing and cleaning of surface, wherever required, shall be carried out in accordance with IS 2629. After degreasing the article shall be thoroughly rinsed. However, if acidic degreasers are used, rinsing is not required.

- (b) **Pickling:** Pickling shall be done using either hydrochloric or sulphuric acid as recommended in IS 2629. The actual concentration of the acids and the time duration of immersion shall be determined by the Contractor depending on the nature of material to be pickled. Suitable inhibitors also shall be used with the acids to avoid over pickling. The acid concentration, inhibitors used, and maximum allowable iron content shall form part of plant standard to be formulated and submitted to DTL along with Quality Assurance Program.
- (c) **Rinsing:** After pickling, the material shall be rinsed, preferably in running water to remove acid traces, iron particles or any other impurities from the surface. Two rinse tanks are preferable, with water cascading from the second tank to the first to ensure thorough cleaning. Wherever single tank is employed, the water shall be periodically changed to avoid acid contamination, and removal of other residues from the tank.
- (d) **Fluxing:** The rinsed article shall be dipped in a solution of Zinc ammonium chloride. The concentration and temperature of the flux solution shall be standardized by the Contractor depending on the article to be galvanized and individual circumstances. These shall form part of plant standard to be formulated and submitted to DTL along with Quality Assurance Program. The specific gravity of the flux solution shall be periodically monitored and controlled by adding required quantity of flux crystals to compensate for drag-out losses. Free acid content of the flux solution also shall be periodically checked and when it is more than two (2) grams of free acid per litre of the solution, it shall be neutralized by adding ammonia solution or by addition of zinc spelter. Alternatively, PH value should be monitored periodically and maintained between 5.0 to 5.5.
- (e) **Drying:** When dry galvanizing is adopted the article shall be thoroughly dried after fluxing. For the purpose of drying, the Contractor may use hot plate, air oven or any other proven method ensuring complete drying of the article after fluxing and prior to dipping in the molten zinc bath. The drying process shall be such that the article shall not attain a temperature at which the flux shall get decomposed. The article thus dried shall be galvanized before the flux coating picks up moisture from the atmosphere or the flux layer gets damaged or removed from the surface. The drying procedure, time duration, temperature limits, time lag between fluxing, drying, galvanizing etc. shall form part of plant standard to be formulated and submitted to DTL along with Quality Assurance Program.
- (f) **Quality of Zinc:** Any one or combination of the grades of zinc specified in IS 209 or IS 13229 or other comparable international standard shall be used for galvanizing. The Contractor shall declare the grade(s) of zinc proposed to be used by them for galvanizing. The molten metal in the zinc bath shall contain minimum 98.5 % zinc by mass. It shall be periodically measured and recorded. Zinc aluminium alloy shall be added as per IS 2629.

- (g) **Dipping Process:** The temperature of the galvanizing bath shall be continuously monitored and controlled. The working temperature of the galvanizing bath shall be maintained at 450+/- 10 degree C. The article should be immersed in the bath as rapidly as possible without Compromising on safety aspects. The galvanizing bath temperature, immersion angle & time, time duration of immersion, rate of withdrawal etc. shall be monitored and controlled depending upon the size, shape, thickness and chemical composition of the article such that the mass of zinc coating and its uniformity meets the specified requirements and the galvanized surface is free from imperfections and galvanizing defects.
- (h) **Post Treatment:** The article shall be quenched in water. The quench water is to be changed/drained periodically to prevent corrosive salts from accumulating in it. If water quenching is not done then necessary cooling arrangements should be made. The galvanized articles shall be dipped in dichromate solution containing sodium dichromate and sulphuric acid or chromic acid base additive at a predetermined concentration and kept at room temperature to retard white rust attack. The temperature of the chromate solution shall not exceed 65 degree C. The articles shall not be stacked immediately after quenching and di-chromating. It shall be ensured that the articles are dry before any further handling operation.
- (i) **Storing, Packing and Handling:** In order to prevent white rust formation sufficient care should be exercised while storing handling and transporting galvanized products. The articles shall be stored in an adequately ventilated area. The articles shall be stored with spacers in between them and kept at an inclination to facilitate easy drainage of any water collected on the articles. Similar care is to be taken while transporting and storing the articles at site. The Contractor shall prepare a detailed galvanizing procedure including Flow Chart with control parameters and all plant standards as required above and submit to DTL for approval as part of Quality Assurance Plan. Whenever, galvanizing of any portion of pole structures is carried out in two or more parts, Zinc Metallizing/cold galvanizing or Zinc Rich Paint, (Pre- mixed type paint, based on organic/inorganic binders specially formulated for steel surfaces may be used after welding of parts so as to have equivalent thickness of specified zinc coating. The dried film of Zinc Rich Paint should contain a minimum of 92 percent Zinc Dust by mass is allowed as per Section -11 of American Welding Society standard AWS WZC/D19.0-72
- (j) **Repair Method:** Repair of damaged & uncoated area of hot dip galvanized coating shall be in accordance with ASTM A780 or Equivalent standard.

8.9 Thermal (zinc) metallizing

(a) **Procedure:**

i) **Surface Cleaning:**

- The surface shall be cleaned by suitable clean cotton waste where the Zinc Metalizing to be applied to remove traces of oil & paint.
- Rust, Mill Scale, Welding Slag & other foreign particles shall be removed by the Shot Blasting/Manual Grinding/Wire Brush.

ii) Use of Equipment:

- The safety & operation instruction provided in the instruction manual for specific make of machine shall be followed.
- Equipment shall not be operated above recommended pressure & flow.

iii) Equipment Handling:

- The equipment should be maintain in first class condition.
- It should be ensured that the gun is pointed away from person & away from material that will burn.
- All air lines, compressor, regulators etc. should be inspected regularly for leaks & loose connections.

iv) Method of Application:

- Suitable size of single zinc wire shall be fed into spray gun. Zinc purity shall be 99.9%.
- Appropriate pressure of Acetylene & Oxygen (or any other gases as required by manufacturer) cylinder to be maintained as per manufacturer recommendation.
- Combination of above gases (e.g. Acetylene & Oxygen) generates the flame and it melts the zinc wire & compressed air blows melted metal onto desire surface.
- Distance & Angle of Spray Gun should be maintained to get the desired bonding of zinc coating with surface.
- Take up the gas lighter and open the gas head valve all the way (straight up).
- Pause for about 3 seconds.
- Close the valve half way until feel it click into the lightning stop.
- Spark the lighter in front of the nozzle
- Immediately open the valve all the way as soon as the gun lights.
- Single layer application of spray will give 45-60 microns.
- Zinc coating can be increases by application of number of layers.
- Apply zinc layers until a uniform, thoroughly wet appearances is obtained.
- To shut the gun down, turn off the gas head valve.

(b) Inspection after Metallizing:

- Visual inspection for smooth finish i.e. free from lumps,

loosely adherence particles.

- Check Dry Film Thickness (DFT) Meter/Elcometer as per requirement.

9.0 Pole structure Foundations

The type of foundation for pole structure shall be designed based on a geotechnical investigation of the soil.

9.1 Geotechnical Investigations

These specifications provide general guidelines for geotechnical investigation of normal soils. Marshy locations and those affected by salt water or saltpetre shall be treated as special locations and the corresponding description in these specifications shall apply. Any other information required for such locations shall be obtained by contractor and furnished to DTL. Detailed Geotechnical Report shall be submitted to DTL.

9.1.1 Scope

- (a) The scope involves soil sampling and tests, the details of which vary according to pole location, in order to develop recommendations concerning foundation types regarding bearing capacity, uplift resistance and settlement constraints, as described hereafter. Detailed soil investigation shall be carried out at various pole locations. Selection of location for conducting the soil investigation and the depth of such test pit/bore holes may be decided in consultation with the foundation designer. Bore log data including depth of the ground water table at each pole location shall be furnished. Contractor shall also collect data regarding variation of subsoil water table along the proposed line route. Based on the soil parameters, Contractor shall recommend the foundation type suitable for each location as qualified herein and as approved by DTL. DTL may modify the field exploration campaign both prior to and during the exploration process based on the actual findings.
- (b) The work shall include mobilization of all necessary tools & equipment and provision of necessary engineering, supervision and technical personnel, skilled & unskilled labour, etc. as required to carry out the entire field investigation as well as laboratory tests, analysis & interpretation of data collected and preparation of the Geotechnical Report. The aforementioned work shall be supervised by a graduate in Civil Engineering having at least 5 years of site experience in geotechnical investigation work.
- (c) Contractor shall make its own arrangements to establish the coordinate system required to position boreholes, tests pits and other field test locations as per the drawings/sketches supplied by DTL. Contractor shall determine the Reduced Levels (RL's) at these locations with respect to benchmarks used in the detailed survey. Two reference lines shall be established based on survey

data/details.

- (d) Contractor shall provide at site all required survey instruments to the satisfaction of DTL so that the work can be carried out accurately according to specifications and drawings.
- (e) Contractor shall arrange to collect the data regarding change of course of rivers, major natural streams and nalas, etc., encountered along the transmission line route from the best available sources and shall furnish complete hydrological details including maximum velocity discharge, highest flood level (H.F.L.), scour depth, etc. of the concerned rivers, major streams and nalas (canals).
- (f) The field and laboratory data shall be recorded on the proforma recommended in relevant Indian Standards. Contractor shall submit to DTL copies of field bore logs (one copy each to DTL's Project and D&E section) and all the field records (countersigned by DTL) soon after the completion of each borehole/test.
- (g) Whenever Contractor is unable to extract undisturbed samples, it shall immediately inform DTL. Special care shall be taken for locations where marshy soils are encountered and Contractor in such cases shall ensure that specified number of vane shear tests are performed and the results correlated with other soil parameters.
- (h) The soft copy of all field records and laboratory test results shall be sent to DTL on regular basis. DTL may observe, at all times, the laboratory testing procedures.
- (i) The Contractor shall interact with DTL to get acquainted with the different types of structures envisaged and in assessing the load intensities on the foundation for the various types of poles in order to enable him to make specific recommendations for the depth, founding stratum, type of foundation and the allowable bearing pressure.
- (j) After reviewing Contractor's geotechnical investigation report, DTL will discuss with Contractor's Geotechnical Engineer and finalize the report.
- (k) Contractor shall carry out all the works expressed and implied in Clause 9.1.1 of these specifications in accordance with requirements of the specification.

9.1.2 General Requirements

- (a) Wherever possible, Contractor shall research and review existing local knowledge, records of test pits, boreholes, etc., types of foundations adopted and the behavior of existing structures, particularly those similar to the present project.
- (b) Contractor shall make use of information gathered from nearby quarries, unlined wells, excavations, etc. Study of the general

topography of the surrounding areas will often help in the delineation of different soil types.

- (c) Contractor shall gather data regarding the removal of overburden in the project area either by performing test excavations, or by observing soil erosion or landslides in order to estimate reconsolidation of the soil strata. Similarly, data regarding recent landfills shall be studied to determine the characteristics of such landfills as well as the original soil strata.
- (d) The water level in neighboring streams and water courses shall be noted. Contractor shall make enquiries and shall verify whether there are abandoned underground works e.g. worked out ballast pits, quarries, old brick fields, mines, mineral workings, etc.
- (e) It is essential that equipment and instruments be properly calibrated at the time of commencement of the work. If DTL so desires, Contractor shall arrange for having the instruments tested/ calibrated at an approved laboratory at its cost and shall submit the test reports to DTL. If DTL desires to witness such tests, Contractor shall arrange for the same.

9.1.3 Specific Requirements for Geotechnical Investigation

- (a) Bore holes shall be executed to specified depth of minimum 20m. If refusal strata is reached (i.e. Standard Penetration Test (SPT)-N value is more than 100 continuously for 5 m depth) with characteristics of rock, the bore hole may be terminated at shallower depth i.e. at 5 m in refusal strata, with prior approval of DTL.
- (b) Laboratory testing shall be conducted on all soil samples to determine grain size distribution, liquid limit and plastic limit of the different soil strata encountered.
- (c) Geotechnical Report must furnish the following:
 - (i) Location map indicating bore hole number with respect to the pole location
 - (ii) Safe Bearing Capacity (SBC) or Ultimate Bearing Capacity (UBC) with factor of safety
 - (iii) Natural moisture content, specific gravity and bulk unit weight
 - (iv) Cohesive Soil: Effective Unit Weight, Un-drained Shear Strength (C_u)/Cohesion, Plasticity, Strain factor etc.
 - (v) Cohesion-less Soil: Effective Unit Weight, N Value, Angle of internal friction, P-Y Modulus etc.
 - (vi) SDR/Fissured Rock/Weak Rock/Hard Rock/Weathered Rock: Effective Unit Weight, Unconfined Compressive Strength, Shear Strength, Initial modulus of Rock mass, porosity and density test, Point load index, Core recovery, RQD index as per relevant IS/IRC standards, etc.
 - (vii) Details of water table, if any
 - (viii) Geotechnical investigation scheme
 - (ix) Bore-logs indicating soil and rock stratification with IS

- classification, sampling details and SPT 'N' values
- (x) Soil cross-sections along various bore holes in two orthogonal directions indicating soil stratification based on field and laboratory tests
- (xi) Settlement characteristics of the foundation
- (xii) Grain size distribution curves
- (xiii) IS classification of soils
- (xiv) Shear tests (UU) to be done on saturated soil samples (Internal friction, cohesion)
- (xv) Presence of carbonates, sulphates, nitrates, organic matter and any other chemicals harmful to the concrete foundation obtained from chemical test on soil sample
- (xvi) Bearing capacity of soil at different levels
- (xvii) Highest Flood Level (H.F.L.); Maximum discharge, velocity etc. (from authenticated source such as CWC or appropriate State authorities)
- (xviii) Recommendations regarding type of foundation to be adopted at the location.

9.1.3.1 Specific requirement for river crossing poles:

- (a) For River Crossing Poles following additional information must be included in the report:
 - (i) Discharge by Irrigation & CAD department
 - (ii) Maximum River Level
 - (iii) Catchment Area
 - (iv) Scouring depth
 - (v) River Cross Section at specified pole location
 - (vi) Recommended Silt Factor or shall be considered as per 703.2.2.1 of IRC 78 as suitably based on geotechnical Investigation report data.
- (b) Contractor is required to mobilize a suitable arrangement (floating pontoon, plant, equipment etc.) to carry out geotechnical investigation work in creek/river locations identified by DTL.
- (c) Contractor shall fully satisfy himself about the conditions of creek/river (depth of water, wave currents, wind conditions, etc.) prevailing in the area of proposed investigation and plan the necessary tools and plant to be deployed before quoting. Any claim resulting from lack of data collection in this respect shall not be entertained.
- (d) Contractor shall make his own arrangements for locating the coordinates and position of boreholes in creek/river with respect to two grid-lines indicated by DTL.
- (e) Boring in creek or river shall be payable only below the bed level and no payment shall be made for lowering the casing in water.
- (f) Contractor shall arrange for necessary transportation on water (e.g. motor boat) to facilitate the supervision of work by officials of DTL.

at its own cost.

- (g) Full details of the construction plant, proposed working method for boring and sampling in water shall be submitted along with the Tender.

9.1.4 Codes and Standards for Geotechnical investigations

- (a) All work shall be carried out in accordance with the Indian Standards and codes (latest revisions) and as amended from time to time.
- (b) All standards, specifications and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions. In case of conflict between the present specifications and those referred to herein, the former shall prevail. Internationally accepted standards which ensure equal or higher performance than those specified shall also be accepted.

9.2 Foundation

- (a) The foundation shall generally be either open cast raft type or pier type/Drilled Concrete Caisson/Steel Caisson/Embedded type or pile/micro piles or screw/Helical pile type/well type etc., based upon the ground water table and type of soil & rock, depending on economy and feasibility of construction at site and shall be in conformity with the present day practices followed in the country or abroad and the specifications laid herein. Plain Cement Concrete/Reinforced Cement Concrete footing shall be used for all types of normal poles.
- (b) The scope of work for foundation shall include design, supply of materials such as cement, sand, aggregates, reinforcement steel as well as all items of work related to supply and installation of foundations such as form work, excavation, anchor bolt setting, concreting, placement of reinforcement, shoring, shuttering, dewatering, stock piling, dressing, curing, backfilling with excavated/borrowed earth (irrespective of leads), consolidation of earth, carriage of surplus earth to the suitable points of disposals required by DTL or any other activity related to completion of foundation work.
- (c) The proposal for these types of foundations shall be submitted by the Contractor based on the detailed soil investigation and approval for the same shall be obtained from DTL.
- (d) The bidder has to furnish along with the bid one sample calculation for each type of foundation offer for verification of correctness of design procedure adopted by the bidder.
- (e) The bidder is required to quote in the relevant schedules of Bid, the composite rate of foundation per pole for the foundations listed in the Bill of quantities. The composite rate quoted shall be deemed to include the complete scope of work as indicated above.

- (f) The bidder is also required to furnish estimated foundation volumes and unit rates for excavation, concreting and reinforcement in the relevant schedules of Bid. The unit rates of excavation, concreting & reinforcement when multiplied with the corresponding estimated volumes shall match with the composite rate quoted for the foundations for the complete scope of work.
- (g) However, if foundations of types/classifications other than those listed in Bill of Quantities, are required to be designed and installed at certain locations due to different soil conditions, the payment for such foundations shall be made based on the unit rates for excavation, concreting and reinforcement, which shall be deemed to include the complete scope of work as indicated above.

9.3 Loads on Foundations

- 9.3.1** The foundation shall be designed for the pole base reactions obtained from structural analysis due to specific loads or load combinations on the superstructure with the relevant load factors in accordance with relevant IS and IRC standards.
- 9.3.2** The reactions on the foundation/pedestal for Pole structure shall be calculated considering following types of the loads:
 - a) Tension (uplift)/Compression (Downward thrust) force
 - b) Horizontal Shear forces
 - c) Longitudinal & Transverse direction base moments
- 9.3.3** The additional weight of concrete over the earth weight in the foundation below ground level and the full weight of concrete above the ground level in the foundation will also be taken into account adding to the down thrust.

9.4 Stability Analysis

In addition to the strength design, stability analysis of the foundation shall be done to check the possibility of loss of contact with soil/rock, failure by over-turning, uprooting, sliding and tilting of the foundation. The maximum bearing pressure on soil should not exceed bearing capacity of soil. The foundation should remain stable under all the possible combinations of loading, to which it is likely to be subjected under the most stringent conditions. The stability of foundations should be checked for the following aspects:

- 9.4.1** The following primary type of soil resistance shall be assumed to act in resisting the loads imposed on the footing in earth:

a) Resistance against uplift

The uplift loads will be assumed to be resisted by the weight of earth volume contained in an inverted frustum of a cone on the footing pad

whose sides make an angle equal to the angle of repose of the earth with the vertical, in average soil. The weight of concrete embedded in earth and that above the ground will also be considered for resisting the uplift.

b) Resistance against down-thrust

The following load combinations shall be resisted by the bearing strength of soil:

- i) The down thrust loads combined with the additional weight of concrete above earth are assumed to be acting on the total area of the bottom of the footing.
- ii) The moment due to side thrust forces at the bottom of the footing.
- iii) Additional moments due to eccentricity of the loads.

The structural design of base slab shall be developed for the above load combination. In case of toe pressure calculation due to above load combination, allowable bearing pressure can be increased by 25%.

c) Resistance against Over Turning Moment

The lateral load capacity of a chimney foundation shall be based on the chimney acting as cantilever aided by the passive earth resistance developed 500 mm below the ground level. The chimney shaft shall be designed as per limit state method for the combined action of axial forces, tension and compression and the associated maximum bending moment. In these calculations, the tensile strength of the concrete shall be ignored.

- 9.4.2** In case the tension develops at the base of the foundation, the base area should be reduced to a size where no tension occurs and base pressure is recalculated. The recalculated maximum pressure on such reduced area should not exceed allowable bearing pressure. Such reduced area shall not be less than 80% of the total base area of the footing/raft under worst load combinations.

9.5 Properties of Concrete & Reinforcement

- 9.5.1** The cement concrete used for the foundations shall be of minimum grade M20 corresponding to 1:1.5:3 nominal mix ratios with 20 mm coarse aggregate. If required higher grade concrete may be used for casting of pole foundations as per site conditions. The concrete of grade M25 or above shall be design mix concrete as per IS: 456. All the properties of concrete regarding its strength under compression, tension, shear, punching and bend etc. as well as workmanship shall conform to IS: 456.

- 9.5.2** Ready Mix Concrete (RMC) from batching plant can also be used. The ready mix concrete shall conform to IS: 4926. The selection and use of Materials for the ready mix concrete shall be in accordance with IS: 456. The minimum cement content shall not be less than 330kg/m³. The transport of concrete and transportation time shall be as per IS:

4926.

- 9.5.3** For foundation in creek or aggressive soil areas, concrete of grade M30 Design Mix conforming to IS: 456 and epoxy coated reinforcement as per IS: 13620 shall be used. In addition, 02 (two) coats of bituminous painting of minimum 1.6 kg/m^2 per coat shall be applied on all the exposed faces of the foundation (i.e. pedestal & base slab).
- 9.5.4** The weight of concrete to be considered for design of foundations shall be as given in Table-15 below:

Table-15

Type of Concrete	Weight of Concrete	
	Weight of dry region KN/m^3 (Kg/m^3)	Weight in presence of sub-soil water KN/m^3 (Kg/m^3)
Plain Concrete	21.96 (2240)	12.16 (1240)
Reinforced	23.54 (2400)	13.73 (1400)

- 9.5.5** a) The Ordinary Portland Cement (OPC) used in the concrete shall conform to:
- (i) IS: 269 - for 33 grade OPC
 - (ii) IS: 8112 - for 43 grade OPC
 - (iii) IS: 12269 - for 53 grade OPC.
- b) The Pozzolana cement, if used in concrete, shall conform to IS:1489.
- 9.5.6** Concrete aggregates shall conform to IS: 383.
- 9.5.7** Reinforcement shall conform to IS: 432 (Part-1) for Mild Steel & Medium Tensile Steel bars and IS:1786 for High Strength Deformed Steel Bars. All reinforcement shall be clean and free from loose mill scales, dust, loose rust, and coats of paint, oil or other coatings, which may destroy or reduce bond. Contractor shall supply, fabricate and place reinforcement to shapes and dimensions as indicated or as required to carry out the intent of drawings and specifications. Only one type of steel shall be used for the design.
- 9.5.8** IS: 2502 - “Code of practice for bending and fixing of bars for concrete reinforcement” shall be complied for reinforcement and IS: 5525 & SP: 34 to be read in conjunction with IS: 456, shall be followed for reinforcement detailing.
- 9.6 Design of Foundations**
- 9.6.1** Structural design of the foundations shall be done by Limit State Method as per IS: 456.

9.6.2 The physical properties of soil under various conditions furnished in table-16 to be considered for the design of foundations. However, it may be noted that these properties are tentative in nature. These soil properties shall be measured by the Contractor at the various locations in conformity with the standard method of testing. After soil investigations, if it is found that the design of foundations based on above soil properties cannot be used at that location, new foundation design shall be developed based on properties furnished in soil report.

Table-16

1.	Properties of soil	Ultimate bearing capacity KN/m ² (Kg/m ²)	Angle of Repose Degree
	(a) Normal Dry Soil (b) Sandy Dry Soil (c) Wet soil due to presence of sub-soil water/surface water (d) Wet Black cotton soil	268 (27350) 268 (27350) 134 (13675) 134 (13675)	30 20 15
2.	Weight of Earth	Unit	Value
	(a) Dry (b) Sandy (c) In presence of surface water (d) In presence of subsoil water	KN/m ³ (Kg/m ³) KN/m ³ (Kg/m ³) KN/m ³ (Kg/m ³) KN/m ³ (Kg/m ³)	14.12 (1440) 14.12 (1440) 14.12 (1440) 9.22 (940)
3.	Fissured Rock		
	(a) Ultimate bearing capacity (both for dry as well as submerged fissured rock) (b) Weight of fissured rock i) Dry ii) In presence of subsoil water c) Angle of repose i) Dry Fissured rock ii) submerged fissured rock	KN/m ² (Kg/m ²) KN/m ² (Kg/m ²) KN/m ² (Kg/m ²) Degree Degree	612.19 (62500) 14.12 (1440) 9.22 (940) 20 deg. 10 deg.
4.	Hard rock		
	a) Ultimate Bearing Capacity	KN/m ² (Kg/m ²)	1225.83 (125000)

	b) Ultimate bond between steel and concrete	KN/m ² (Kg/m ²)	0.147 (15)
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- 9.6.3** Particulars of the foundations, along with the estimated volumes of concrete and excavation volumes for the various types of poles shall be given in the bid.
- 9.6.4** The thickness of concrete in the pedestal portion of the pole foundation would be such that it provides minimum clear cover of not less than 50 mm from any part of the reinforcement to the nearest outer surface of the concrete in respect of all dry locations and not less than 75 mm, in case of all wet, partially submerged & fully submerged locations.
- 9.6.5** While working out the volume of soil resisting uplift in Desert areas, upper 500 mm depth of soil/sand shall not be considered.
- 9.6.6** The chimney top or muffing must be at least 300 mm above ground level or above Highest Flood Level (whichever is higher).
- 9.6.7** The centroid axis of the concrete slab shall coincide with the axis of the Pole/pedestal and pass through the center line of foundation base. The design of the foundations (base slab and its reinforcement) shall take into account the additional stresses in the foundation resulting from the eccentricity introduced due to non-compliance of this requirement.
- 9.6.8** At least 100 mm thick pad of size equal to the base of raft with its sides vertical shall be provided below the raft for P.C.C. type foundations and 150 mm for R.C.C. type foundation. Also, at least 75 mm thick lean concrete (1:3:6) pad shall be provided below bottom slab. The size of the lean concrete shall be 75 mm beyond base of bottom slab on all sides.
- 9.6.9** The thickness of base slab at centre i.e., at the point of maximum bending shall not be less than 300 mm in case of RCC type foundation.
- 9.6.10** The minimum distance between the lowest edge of the anchor bolt and the bottom surface of concrete footing shall not be less than 200 mm.
- 9.6.11** The portion of the anchor bolt/anchor plate in the pedestal/raft/ chimney (or slab) shall be designed to take full down-thrust & uplift loads by the anchor bolt/anchor plate combined with concrete. The Contractor shall furnish the calculation for uprooting of anchor bolt and design for bending of anchor plate along with the foundation design.
- 9.6.12** Pile foundation design shall be based on IS: 2911 and non-destructive integrating test shall be as per IS: 14893.
- 9.6.13** **Over Load Factor:** The overload factor for foundations shall be considered as 1.1 i.e. the reaction on foundations shall be increased by 10 per cent.
- 9.6.14** Pier type foundation, proposed to be adopted by bidder, shall be designed and constructed as per IS: 456, IS: 491, and applicable

national/international standards/prudent utility practices so as to withstand all loads/reactions due to pole structures.

9.6.15 In case of Screw anchor type/Steel caisson foundations, design shall be as per applicable international standards and prudent utility practices. Detailed design calculations shall be submitted by the Contractor for approval of the DTL.

9.6.16 The construction drawings/working drawings along with design calculation of foundations shall be submitted by the Contractor for approval before execution.

9.7 Construction of pole foundations

9.7.1 Testing of Soil

The Contractor shall be required to undertake testing of soil for the pole locations in the manner specified under relevant Clauses of this Specification and shall submit his report about the subsoil water table, type of soil encountered, bearing capacity of soil, possibility of submergence and other soil properties required for the design of foundations. The Contractor shall also furnish soil resistivity values to DTL along the line alignment.

9.7.2 Excavation

9.7.2.1 Excavation work must not be started until the pole schedule and profile has been approved by DTL.

9.7.2.2 Except as specifically otherwise provided, all excavation for footing shall be made to the lines and grades of the foundation. The excavation wall shall be vertical and the pit dimensions shall be such as to allow a clearance of 150 mm on all sides from the foundation pad. All excavation shall be protected so as to maintain a clean sub-grade, until the footing is placed, using timbering/shuttering, shoring etc., if necessary. Any sand, mud, silt or other undesirable materials which may accumulate in the excavated pit shall be removed by the Contractor before placing concrete.

9.7.2.3 If any problem of dewatering persists at the construction site, detailed scheme of dewatering shall be prepared before starting of excavation work and IS: 9759 shall be followed as general guidance for dewatering.

9.7.2.4 The soil to be excavated for pole foundations shall be classified as under:

(a) Normal Dry Soil

Soil removable either manually, by means of an ordinary pick axe, spade and shovel or mechanically by excavators etc.

(b) Wet Soil

During the excavation, if wet soil or the subsoil water table is encountered within the range of foundation depth and/or where pumping or bailing out of water is required due to presence of surface water will be treated as wet soil.

(c) Dry Fissured Rock

Limestone, laterite, hard conglomerate or other soft or fissured rock in dry condition which can be quarried or split with crowbars, wedges, pickaxes etc. However, if required, light blasting may be resorted to for loosening the material but this will not in any way entitle the material to be classified as hardrock.

(d) Wet Fissured Rock

Above fissured rock, when encountered with subsoil water within the range of foundation depth or land where pumping or bailing out of water is required, shall be treated as wet fissured rock.

(e) Hard Rock

Any rock excavation other than specified under fissured rock above for which blasting drilling, chiseling are required.

9.7.2.5 Where soil is of composite nature, classification of foundation shall be according to the type of soil predominant in the footing.

9.7.2.6 No extra charge shall be admissible for the removal of the fallen earth in the pit, when once excavated. Shoring and timbering/shuttering as approved by authorized representative of DTL shall be provided by the Contractor when the soil condition is so bad that there is likelihood of accident due to the falling of earth.

9.7.2.7 Where rock is encountered, the holes for pole footings shall preferably be drilled, but where blasting is to be resorted to as an economy measure, it shall be done with the utmost care to minimize the use of concrete for filling the blasted area.

9.7.2.8 Unnecessarily large quantities of excavation/blasting resulting in placement of large volumes of concrete, payment of concrete should be avoided.

9.7.2.9 The Contractor shall supply requisite blasting materials and be responsible for the purpose of the storage and use of this material.

9.7.3 Setting of Anchor Bolts

(a) The anchor bolts shall be set correctly in accordance with approved method at the exact location and alignment shall be precisely at correct levels with the help of anchor bolt setting templates and leveling instrument. Anchor bolts shall be set in the presence of DTL's representative available at site and for which adequate advance

intimation shall be given to DTL by the Contractor.

- (b) Setting of anchor bolts at each location shall be approved by DTL's representative.

9.7.4 Anchor Bolt Setting Templates

Anchor bolt cage assembly templates shall be designed and arranged by the Contractor at no extra cost for all types of poles Pitch Circle Diameters (PCD). The anchor bolt assembly templates shall be galvanized in case it is forming part of foundation or shall be red oxide painted where it is removable. The Contractor shall deploy suitable number of templates to ensure timely completion of line. One set of anchor bolt cage assembly of each type shall be supplied without any extra cost to DTL after completion of work.

9.7.5 Mixing, Placing and Compacting of concrete

- (a) The concrete shall be mixed in a mechanical mixer. However, in case of difficult terrain, hand mixing may be permitted at the discretion of DTL. The water for mixing concrete shall be fresh, clean and free from oil, acids and alkalis. Salty or brackish water shall not be used.
- (b) Mixing shall be continued until there is uniform distribution of material and the mix is uniform in color and consistency, but in no case the mixing be done for less than two minutes. Normally mixing shall be done close to the foundation, but in case it is not possible the concrete may be mixed at the nearest convenient place. The concrete shall be transported from the place of mixing to the place of final deposit as rapidly as practicable by methods which shall prevent the segregation or loss of any ingredient. The concrete shall be placed and compacted before setting commences.
- (c) Form boxes shall be used for casting all types of foundations. The concrete shall be laid down in 150 mm layers and consolidated well, so that the cement cream works up to the top and no honey-combing is left in the concrete. The mechanical vibrator shall be employed for compacting the concrete. However, in case of difficult terrain, manual compaction may be permitted at the discretion of DTL. After concreting the chimney portion to the required height, the top surface should be finished smooth with a slight slope towards the outer edge to drain off any rain water falling on the coping.
- (d) In wet locations, the site must be kept complete dewatered, both during the placing of the concrete and for 24 hours thereafter. There should be no disturbance of concrete by water during this period.
- (e) After the form work has been removed if the concrete surface is found to be defective, the damage shall be repaired with rich cement and sand mortar to the satisfaction of DTL's representative before the foundation pits are back filled.

9.7.6 Back Filling and Removal of Anchor bolt Template

- (a) After opening of form work and removal of shoring and timbering, if any, backfilling shall be started, after repairs, if any, to the foundation concrete. Backfilling shall normally be done with the excavated soil, unless it consists of large boulders/stones, in which case the boulders shall be broken to a maximum size of 80 mm. At such locations where borrowed earth is required for backfilling, this shall be done by the Contractor at no extra cost.
- (b) The backfilling materials should be clean and free from organic or other foreign materials. The earth shall be deposited in maximum 200 mm layers, leveled, wetted and tempered properly before another layer is deposited. Care shall be taken that the backfilling is started from the foundation ends of the pits towards the outer ends. After the pits have been backfilled to all depth, the anchor bolt template may be removed.
- (c) The backfilling and grading shall be carried to an elevation of about 75 mm above the finished ground level to drain out water. After backfilling, 50 mm high earthen embankment (band) will be made along the sides of excavation pits and sufficient water shall be poured in the backfilling earth for at least 24 hours.

9.7.7 Curing

The concrete after setting for 24 hours shall be cured by keeping the concrete wet continuously for a period of 10 days after laying. The pit may be back filled with selected earth sprinkled with necessary amount of water and well consolidated in layers not exceeding 200 mm of consolidated thickness after a minimum period of 24 hours and thereafter both the backfilled earth and exposed chimney top shall be kept wet for the remainder of the prescribed time of 10 days. The uncovered concrete chimney above the backfilled earth shall be kept wet by providing empty cement bags dipped in water fully wrapped around the concrete chimney for curing and ensuring that the bags are kept wet by the frequent pouring of water on them.

9.7.8 Benching

When the line passes through hilly/undulated terrain, for a few pole locations it may be required to level the ground for casting of pole footings on same elevation. All the activities related to make the required area of ground in same elevation for casting of foundation, shall be termed as benching work. Benching work shall include cutting of excess earth and removing the same to a suitable point of disposal as required by DTL. Benching shall be resorted to only after getting specific approval from DTL. Volume of the earth to be cut shall be measured before cutting and got approved from DTL. This volume of earth shall be considered for the purpose of payment against the head of benching work.

9.7.9 Protection of pole footing

- 9.7.9.1 The work shall include all necessary stone revetments, concreting and earth filling above ground level and the clearance from stacking on the site of all surplus excavated soil, special measures for protection of foundation close to or in nallas, river bed hilly/undulated terrain etc. by providing suitable revetments or galvanized wire netting and meshing packed with boulders. The top seal cover of the stone revetments shall be done with M150 concrete (1:2:4 mix). The Contractor shall furnish recommendations for providing protection at these locations wherever required.
- 9.7.9.2 The quantity of excavated earth obtained from a particular location shall generally be utilized in backfilling work in protection of pole footing of same location, unless it is unsuitable for such purpose. In the latter case, the backfilling shall be done with borrowed earth of suitable quality irrespective of lead. The consolidation of earth shall, however, be done after backfilling free of cost.
- 9.7.9.3 The provisional quantities for protection work to foundations, if required, shall be as per scheme

10.0 Pole Erection, Stringing and Installation of Line

- 10.1 The erection, stringing and installation of line shall be carried out as per the relevant standards and procedures.
- 10.2 The details of the scope of erection work shall include the cost of labour, all tools & plants and all other incidental expenses in connection with erection and stringing work.
- 10.3 The Contractor shall be responsible for transportation of all the materials as per the scope of work to site, proper storage and preservation at his own cost till such time the erected line is taken over by DTL. The Contractor shall be responsible for transportation, proper storage, safe custody, loss or damage of all supplied items for incorporation in the lines and shall maintain & render proper account for all such materials at all times.
- 10.4 Contractor shall set up required number of stores along the line and the exact location of such stores shall be discussed and agreed to between the Contractor and DTL.
- 10.5 Anchor bolt nuts can be secured to prevent loosening during service, if desired by DTL. The nuts may be secured by mechanically damaging the bolt threads, using a mechanical locking system, using a jam nut (a third nut set above the top nut and tightened onto the top nut), or applying a tack weld between the anchor bolt nut and the base plate. Because of the risk of heat damage to high-strength bolt material, welds should not be applied directly to the anchor bolt.

11.0 Earthing

- 11.1** Suitable provision shall be made for fixing of pipe type and counter poise earthing on the pole structure. For counterpoise type earthing, the earthing will vary depending on soil resistivity. For soil resistivity less than 1500 ohms-meter, earthing shall be established by providing 4 lengths of 30 m counterpoise wire. Otherwise, for soil resistivity greater than 1500 ohms meter earthing shall be established by providing 4 length of 70 m counterpoise wire.
- 11.2** The footing resistance and impedance of each pole shall be measured by the Contractor in dry weather after pole erection but before the stringing of earth-wire and record of measurement shall be submitted to DTL. All the poles are to be earthed, however, in any case Pole Footing impedance shall not exceed 10 ohms. Pipe type or Counterpoise type earthing or multiple earthing or use of environmental friendly earth enhancement material shall be used for earthing of poles to achieve specified pole footing impedance. If it becomes difficult to achieve required pole footing resistance & impedance, line surge arresters, if required, shall be used on phase conductors, which will prevent back flashover. Pipe type earthing and counterpoise type earthing shall be provided in accordance with the stipulations made in IS: 3043 and IS: 5613 (Part-II/section-2). Additional earthing shall be provided on poles after every 7 to 8 km distance for direct earthing of shield wires.
- 11.3** The provisional quantities for pipe type earthing and counterpoise earthing shall be furnished in Bill of Quantities. The bidder shall include cost of fabrication, supply and installation of earthing material including supply of coke, salt, earth enhancement material etc.

12.0 Statuary regulation and Standards

- 12.1** The Contractor is required to follow local statutory provisions, stipulations of CEA Regulations & Electricity Act 2003 as amended from time to time and other local rules and regulations referred in these specifications.
- 12.2** The codes and/or standards referred to in specifications shall govern, in all cases wherever such references are made. In case of a conflict between such codes and/or standards and the specifications, latter shall govern. Such codes and/or standards, referred to shall mean the latest revisions and as amended from time to time.

13.0 Quality Assurance

- 13.1** To ensure that the supply 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 Site or at any other place of work, are in accordance with the specifications. The Contractor shall adopt suitable Quality Assurance Program to control such activities at all points necessary. Such program shall be outlined by the Contractor and shall be finally accepted by DTL after discussions before the award of Contract. A Quality Assurance Program of the Contractor shall generally cover but not limited to the following:

- (a) His organization structure for the management and implementation of the proposed quality assurance program.
 - (b) Documentation control system.
 - (c) Qualification data for 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, store inventory ledger, etc.
 - (e) System for shop manufacturing including process controls and fabrication and assembly controls.
 - (f) Control of non-conforming items and system for corrective action.
 - (g) Control of calibration and testing of measuring and testing equipment.
 - (h) Inspection and test procedure for manufacture.
 - (i) System for indication and appraisal of inspection status.
 - (j) System for quality audits.
 - (k) System for authorizing release of manufactured product to the DTL.
 - (l) System for maintenance of records.
 - (m) System for handling storage and delivery.
 - (n) A Quality Plan detailing out the specific quality control procedure adopted for controlling the quality characteristics relevant to each item of supply.
- 13.2** The Quality Plan shall be mutually discussed and approved by DTL after incorporating necessary corrections by the Contractor as may be required.
- 13.3** **Quality Assurance Documents:** The Contractor shall be required to submit all the Quality Assurance Documents as stipulated in the Quality Plan at the time of or prior to DTL's inspection of material.
- 13.4** DTL, through his duly authorized representatives, reserves the right to carry out Quality Audit and Quality Surveillance of the systems and procedures of the Contractor's/his sub-Contractor's Quality Management and Control Activities.
- 14.0** **Inspection and Tests**
- 14.1** The prototype of pole structures with body extension shall be tested as per relevant IS and specification. However, it shall not be mandatory to test prototype of tall river crossing pole structures and other special type pole structures designed for reliability level - 3 (500 year return period).
- 14.2** All standard tests, including quality control tests, in accordance with appropriate Indian/International standard, shall be carried out unless otherwise specified herein.
- 14.3** The Contractor shall keep DTL informed in advance about the time of

starting and of the progress of manufacture and fabrication of various pole parts at various stages so that arrangements can be made for inspection.

- 14.4** The acceptance of any part of items shall in no way relieve the Contractor of any part of his responsibility for meeting all the requirements of the Specification.
- 14.5** DTL or his representative shall have free access at all reasonable times to those parts of the Contractor's works which are concerned with the fabrication of DTL's material for satisfying himself that the fabrication is being done in accordance with the provisions of the specifications.
- 14.6** Unless specified otherwise, inspection shall be made at the place of manufacture prior to dispatch and shall be conducted so as not to interfere unnecessarily with the operation of the work.
- 14.7** Structural components and 100% of all welds shall be visually inspected to determine conformance to drawings, procedures, overall workmanship, weld contour, weld size and any other pertinent items.
- 14.8** Visual inspection shall be performed to detect pinhole crackings and other undesirable characteristics.
- 14.9** Structural components shall be inspected for dimensional compliance to determine conformance with detail drawings and established tolerances.
- 14.10** Should any member of the structure be found not to comply with the approved design, it shall be liable for rejection. No member once rejected shall be resubmitted for inspection, except in cases where DTL or his authorized representative considers that the defects can be rectified.
- 14.11** Defect which may appear during fabrication shall be rectified/made good according to the procedure proposed by the Contractor and approved by DTL.
- 14.12** All gauges and templates necessary to satisfy DTL shall be supplied by the Manufacturer.
- 14.13** The correct grade and quality of steel shall be used by the Contractor. To ascertain the quality of steel used, the inspector may at his discretion get the material tested at an approved laboratory.
- 14.14** DTL shall have the right to re-inspect at his expenses any material though previously inspected and approved by him at the Contractor's works, before and after the same are erected at Site.
- 14.15 Pole Load Tests**

I. Testing of Pole Structure

- (a) The Pole structure designed and supplied by Contractor shall be proto type tested by Contractor at NABL accredited pole testing

station in India only. The proto type pole structure after inspection by DTL shall be transported to the test bed by the Contractor. The Contractor shall also carryout erection of pole structure at the pole testing station and after successful completion of proto-type testing, shall dismantle and take back.

- (b) Testing of Pole structure shall generally conform to IS: 802 (Part-III). DTL shall depute its representative to witness the tests. The responsibility for design and successful proto type testing shall solely lie with the Contractor. At the time of proto-assembly and/or proto testing, if any modification is required to be carried out, the same shall be carried out by the Contractor. These modifications, if any, shall also be incorporated on the fabrication shop drawings and structural drawings.
- (c) A galvanized pole structure of each type complete with extension or critical poles (poles with maximum angle of deviation or with maximum extension or both) as decided by DTL based on quantities of supply and site requirement shall be subjected to design and non-destructive tests by applying test loads in a manner approved by DTL. The pole shall withstand these tests without showing any sign of failure or permanent distortion/deformation in any part and does not exceed the specified deflection limits.
- (d) The pole shall be tested for all the conditions considered for the design of pole. The Contractor shall submit to DTL, for approval, the detailed program and proposal for testing the poles showing the methods of carrying out the tests and manner of applying the loads. After DTL has approved the test procedures and programs, the Contractors will intimate DTL about carrying out the tests at least one week in advance of the scheduled date of tests during which DTL will arrange to depute his representative to be present at the time of carrying out the tests. The Contractor shall submit one set of shop drawings along with the bill of materials at the time of prototype pole testing for checking the pole and material. Further at the time of submitting test report, the Contractor has to submit the final tracings of shop drawings, Bill of materials and structural drawings of pole for DTL's reference and record.
- (e) **Premature Failure**
 - (i) In the event of failure at less than 95% of the specified design load, the failed component(s) may be replaced by other component(s). The modified structure shall be retested to resist 100% of specified design loads.
 - (ii) In the event of failure between 95% and less than 100% of the specified design loads, with the exception of the final load case, the support shall be modified and retested. If failure occurs in the final load case, DTL may opt not to retest the modified support.
 - (iii) In the event of failure at 100% of the specified design loads at less than 5 min. into the holding period, the client may accept the support without modification.

Note: 1) The steel used in damaged portion/section in the earlier test shall not be used again in the Pole structure.

2) In case of failure of any particular section/components during testing, that particular section shall be replaced and tests shall be continued for remaining tests/load cases. The load case that caused the failure should then be repeated.

- (f) In case of premature failure, DTL may decide to carry out the tensile test, bend test etc. as per relevant IS in any NABL accredited lab for compliance of the material with the specification for root cause analysis. The Contractor shall make suitable arrangement for the same without any extra cost to DTL.
- (g) No part of any pole shall be allowed to be used on the line unless it has been subjected to test.
- (h) The Contractor shall ensure that the specification of materials and workmanship of all poles actually supplied conform strictly to the poles which have successfully undergone the tests. In case any deviation is detected, the Contractor shall replace such defective poles free of cost to DTL.
- (i) Each type of pole to be tested shall be a full scale prototype/ galvanized pole and shall be erected vertically on rigid foundation on the base plate arrangement above ground level as provided in the design/drawing. The pole erected on the bed shall not be out of plumb by more than 1 in 360.
- (j) All the measuring instruments shall be calibrated in systematic/ approved manner with the help of standard weight/device. Calibration shall be done before commencing the test of each pole up to the maximum anticipated loads to be applied during testing.
- (k) The suspension pole is to be tested with an arrangement simulating the chosen insulators string.
- (l) The tension pole is to be tested with strain plate as per approved design/drawings.
- (m) The sequence of testing shall be as per relevant standard or as decided by DTL at the time of approving the rigging chart/test data sheet.
- (n) Prefix T shall be marked on all members of test pole in addition to the mark no. already provided.
- (o) DTL's liability is limited to witnessing testing of poles only once for each type of pole. Due to premature failure, if the testing of pole is to be repeated more than once for any type of pole, in such circumstances the Contractor has to bear all the expenses in respect of DTL's representative.

- (p) The destruction test shall not be carried out. The prototype shall be inspected after testing. Welds shall be inspected in accordance with the normal fabrication procedures. Visual inspection shall be conducted for any signs of structural damage.
- (q) The pole structure subjected to test shall be allowed to be used on the transmission line locations with lower deviation angle limits (for e.g. PC type pole (15 to 30 degree deviation) structure to be spotted for PB type pole location (2 to 15 degree deviation)) or for locations having span lower than the designed span, as decided by DTL.
- (r) Before utilization of tested pole in the transmission line the pole shall be de-stressed and all specified tests including examination of weld joints through Ultrasonic test shall be carried out. The pole should be structurally sound and within the fabrication tolerances.

II. Method of Load Application

- (a) Loads shall be applied according to the approved rigging arrangement through normal wire attachments, angles or bentplates.
- (b) The various types of loads, transverse, vertical and longitudinal shall be applied in such a way that there is no impact loading on the pole due to jerks from the winches.
- (c) All the loads shall be measured through a suitable arrangement of strain devices or by using weights. Positioning of the strain devices shall be such that the effect of pulley friction is eliminated. In case the pulley friction cannot be avoided, the same will be measured by means of standard weights and accounted for in the test loads.

III. Pole Testing Procedure

All the test procedures shall be approved prior to conducting the type tests as per IS: 802 part 3. The procedure for conducting the pole test shall be as follows:

(a) Bolt Slip test & Joint adjustment test

In a bolt slip & joint adjustment test the test loads shall be gradually applied up to the 50% of design loads under normal condition, kept constant for two (2) minutes at that loads and then released gradually.

For measurement of deflection the initial and final readings on the scales (in transverse & longitudinal directions) before application and after the release of loads respectively shall be taken with the help of theodolite. The difference between readings gives the values of the bolt slip & joint adjustments. The theodolite value after releasing the load to zero will be the initial/base reading for all the main loading tests to be conducted further.

(b) Normal Broken Wire Load Tests

All the loads, for a particular load-combination test, shall be applied gradually up to the full design loads in the following steps and shall also be released in the similar manner:

50 percent,
75 percent,
90 percent,
95 percent and
100 percent

(c) Observation Periods

Under normal and broken wire load tests, the monopole structure shall be kept under observation for sign of any failure for two minutes (excluding the time of adjustment of loads) for all intermediate steps of loading up to and including 95 percent of full design loads.

For normal, as well as broken wire tests, the monopole structure shall be kept under observation for five (5) minutes (excluding the time for adjustment of loads) after it is loaded up to 100 percent of full design loads for each load case.

While the loading operation are in progress, the monopole structure shall be constantly watched, and if it shows any tendency of failure anywhere, the loading shall be immediately stopped, released and then entire monopole structure shall be inspected. The reloading shall be started only after the corrective measures are taken.

Full design loads for five (5) minutes, with no visible local deformation after unloading (such as bowing, buckling etc.) and no breakage of elements or constituent parts. The structure shall be considered to be satisfactory, if it is able to support the specified loads with no structural failure of prototype members or parts and does not exceed the specified deflection limits. Unloading should be controlled to avoid possible damage or overload to the prototype.

Ovalization of holes and permanent deformation of bolts shall not be considered as failure.

(d) Recording

The deflection of the pole structure at the top cross arm level in transverse & longitudinal directions shall be recorded “before” and “off” load conditions as well as at each intermediate and final stage of normal load and broken wire load tests by means of a theodolite and graduated scale. The scale shall be of about one meter long with markings up to 5 mm accuracy. All deflections shall be referenced to common base readings taken before the first test loads are applied.

IV. Test Reports:

- a) The test reports shall include the information as specified in IS 802 Part-III. Any other information as specified by DTL shall also be included in the report.
- b) Certified steel producer test reports and physical test reports for the material being used in prototype pole shall be furnished as specified by DTL.

15.0 Packing

- 15.1** The steel pole structure and its parts shall be suitably packaged so as to avoid physical damages to pole and its galvanizing. Packing procedure shall be submitted by Contractor for approval of DTL.
- 15.2** All components of any pole shall be sent in single consignment so that complete pole can be erected without waiting for next consignment.
- 15.3** The procedure that will prevent damage, loss or deterioration to the structure during storage and shipment shall be provided by Contractor/manufacturer.
- 15.4** Cleat angles, gusset plates, brackets, fillet plate, hanger and similar loose pieces shall be tested and bolted together in multiples or securely wired through holes.
- 15.5** Bolts, Nuts, washers and other attachments shall be packaged in double gunny bags accurately tagged in accordance with the contents.
- 15.6** The packings shall be properly done to avoid losses/damages during transit. Each bundle or package shall be appropriately marked.

Note: Relevant Annexure-A to E attached with these specifications.

Survey, Route marking, Profile Plotting and Pole Spotting

1.0 Route Alignment

Route Alignment shall be done using Bhuvan/ Google imagery and Survey of India topographical maps (scale 1:50,000). In case the required Survey of India maps are available in digitized form, the same shall be procured and used by the Contractor.

1.1 Requirement of Transmission Line Routing

- (a) Routing of transmission lines shall be done in accordance with CEA (Technical Standards for Construction of Electrical Plants and Electric lines) Regulations and relevant IS codes.
- (b) The routing and realignment, if any required, of the transmission line shall be most economical from the point of view of construction and maintenance. The Contractor shall identify & examine alternative route alignments and suggest to DTL the optimal route alignment.
- (c) The line routing should avoid large habitations, densely populated areas, scheduled areas, forest/national park/wildlife infringement/GIB area/Animal/Bird sanctuary, infringement of endangered species habitat, vicinity to civil and defense Airports, major river/sea crossings & coal/ mineral mining areas, oil pipe line/underground pipe line/land slide prone areas, firing range, coastal regulation zones, inflammable pipe lines etc., to the extent possible. In case it is not possible to avoid the forests or areas having large trees completely, then keeping in view of the overall economy, the route should be aligned in such a way that cutting of trees is minimum.
- (d) The route should have minimum crossings of major river, railway lines, National/State highways, overhead EHV power line and communication lines.
- (e) The number of angle points shall be kept to minimum.
- (f) Angle points during survey should be selected such that shifting of the point within 100 m radius is possible at the time of construction of the line.
- (g) The distance between the terminal points specified shall be kept shortest possible, consistent with the terrain that is encountered.
- (h) Marshy and low lying areas, river beds and earth slip zones shall be avoided to minimize risk to the foundations.
- (i) The areas requiring special foundations and those prone to flooding

should be avoided.

- (j) It would be preferable to utilize level ground for the alignment.
- (k) Crossing of power lines shall be minimum. Alignment of a transmission line with respect to existing line shall be kept considering ROW and pole falling distance.
- (l) Crossing of communication line shall be minimized and it shall be preferably at right angle. Proximity and parallelism with telecom lines shall be eliminated to avoid danger of induction to them.
- (m) Areas subjected to flooding such as nalah shall be avoided.
- (n) All alignment should be easily accessible both in dry and rainy seasons to enable maintenance throughout the year.
- (o) Certain areas such as quarry sites, tea, tobacco & saffron fields, rich plantations, gardens & nurseries which may present DTL problems in acquisition of right of way and way leave clearance during construction and maintenance, should be avoided.

1.2 For examination of the alternatives & identification of the most appropriate route, besides making use of information/data/details available/extracted through Bhuvan/google imagery and Survey of India Topographical maps, the Contractor shall also carry out reconnaissance/preliminary survey as may be required for verification and collection of additional information/data/details.

1.3 The Contractor shall submit his preliminary observations & suggestions along with various information/data/details collected and topographical map data marked with the alternative routes etc. The final evaluation of the alternative routes shall be conducted by the Contractor in consultation with DTL's representatives and optimal route alignment shall be proposed by the Contractor. Site visit and field verification shall be conducted by the Contractor jointly with DTL's representative for the proposed route alignment.

1.4 Final route alignment drawing with latest topographical and other details/features including all rivers, railway lines, canals, roads etc. up to 8 kms on both sides of selected route alignment shall be submitted by the Contractor for DTL's approval along with report containing other information/details as mentioned above.

1.5 Changes in the route alignment, if any, during detail survey, shall be incorporated in the final route alignment drawings.

2.0 Detailed Survey

2.1 The detailed survey shall be carried out using Total Work stations etc. along the approved route alignment. As an alternative, the Contractor may also use ALTM (Airborne Laser Terrain Modeling) techniques of equal or better accuracy for the detailed survey.

- 2.2** Soil resistivity, along the route alignment shall be measured in dry weather by four electrode method keeping inter-electrode spacing of 50 m. For calculating soil resistivity, formula $2\pi ar$ (Where $a=50$ m and r = megger reading in ohms) shall be adopted. Measurement shall be made at every 2 to 3 km along the length of the route. In case soil characteristics changes within 2 to 3 km, values shall have to be measured at intermediate locations also. Megger reading and soil characteristics should also be indicated in the soil resistivity results.

3.0 Route Marking

- 3.1** The route of the transmission line shall be recorded using GPS/DGPS of positional accuracy less than 3m.
- 3.2** The co-ordinates of all the angle points as well as other important crossings, landmarks etc. shall be recorded using GPS for easy relocating.
- 3.3** At the starting point of the commencement of route survey a suitable peg/spike shall be driven firmly into the ground to indicate location of the survey instrument. The co-ordinates of the location of the survey instrument shall also be recorded. Further, the co-ordinates at prominent position at intervals of not more than 750 meter along the transmission line to be surveyed up to the next angle point shall also be recorded and wooden peg of 50mm x 50mm x 650mm size shall also be driven. Wire nails of 50mm length should be fixed on the top of these pegs to show the location of instrument. The pegs shall be driven firmly into the ground to project 100mm only above ground level. Wherever the line alignment crosses the EHV line, Railway line, P&T line or roads, the Contractor shall record co-ordinates on the points of crossing. Wherever line route alignment passes over permanent land marks such as rocks, boulders, culverts etc. suitable white paint marks with directional and utility markings shall be made and co-ordinates recorded. At angle positions stone/concrete pillars of 150 x 150 x 1000mm in size with name of utility marked on them shall be embedded into the ground for easy identification.

4.0 Profiling

- 4.1** The complete profiling along the route shall be carried out using modern surveying equipment viz. total stations. Reference levels at every 20 m along the route are to be recorded. RLs at other undulations along the route as well as in the route plan and other en-route details viz. crossings, building & structures, trees & other infrastructure etc. shall also be recorded. Areas along the route, which in the view of the Contractor, are not suitable for pole spotting, shall also be marked in profile. Any undulation keeping conductor location as reference may also be indicated as dotted line in profile.
- 4.2** The complete profiling details shall be digitized and the data shall be prepared & stored in the format compatible to computer-aided pole spotting software.
- 4.3** A printed/plotted output of the digitized profiling shall be submitted by the Contractor to DTL's site-in-charge for review before taking up computer-aided pole spotting.

5.0 Optimization of Pole Location/Pole Spotting

- 5.1** Optimization of pole locations including profiling shall be done by the Contractor using computer-aided pole spotting software –PLSCADD (or other software as specified by DTL) and shall furnish sample calculations and manual pole spotting drawings for some typical sections.
- 5.2** Necessary data in respect of conductor, earth-wire and insulator are to be collected from DTL. On the basis of these, the Contractor shall prepare the sag template drawing & pole spotting data and submit the same along with sag tension calculations for the approval of DTL. Sag template prepared based on the approved sag-template curve drawing shall only be used for pole spotting on the profiles. Approved templates, prepared on rigid transparent plastic sheet, shall be provided by the Contractor to DTL for the purpose of checking the pole spotting. The templates shall be on the same scale as that of the profile.
- 5.3 Pole Spotting:** While profiling & spotting the poles, the following shall be kept in mind:

I Span

The number of consecutive spans between the section points shall not exceed 15 spans or 5 km in plain terrain and 10 spans or 3 km in hilly terrain or in cyclone prone areas. A section point shall comprise of tension point with tension type poles (with deviation angle 0-15 deg./2-15 deg./0-30 deg./15-30 deg./30-60 deg.), as applicable.

II Extension

An individual span shall be as near to the normal design span as possible. In case an individual span becomes too short with normal supports on account of undulations in ground profile, one or both the supports of the span may be extended by inserting standard body extension. The provisions kept in the design of poles w.r.t. body extensions (as applicable) shall be intimated to the Contractor by DTL during execution stage.

III Loading

There shall not be any upward force on suspension poles under normal working conditions and the suspension poles shall support at least the minimum weight span as provided in the designs. In case uplift is unavoidable, it shall be examined if the same can be overcome by adding standard body extensions to the poles failing which tension poles designed for the purpose shall be deployed at such positions.

IV Road Crossing

At all important road crossings, the poles shall generally be fitted with normal tension insulator strings but the ground clearance at the roads under maximum temperature and in still air shall be such that

even with conductor broken in adjacent span, ground clearance of the conductor from the road surfaces shall not be less than specified minimum ground clearances. At all National/State highways, tension type poles (with deviation angle of 30-60 deg.) with tension insulator strings shall be used and crossing span will not be more than 250 meters, unless higher span is permitted by National Highways Authority.

V Railway Crossings

All the railway crossings en-route the transmission line shall be identified by the Contractor. At the time of detailed survey, the railway crossings shall be finalized based on the requirement of Regulation laid down by the Railway Authorities.

VI River Crossings

In case of major river crossing, river crossing poles shall be of suspension type along with anchor poles of tension type (with deviation angle of 30-60 deg.) on either side of the main river crossing. Alternately on the basis of economics and/or site/execution constraints, crossing of rivers using normal extended angle poles (+18/+25/+30M extensions) may also be considered. For navigable rivers, clearance required by navigation authority shall be provided. For non-navigable river, clearance shall be reckoned with respect to Highest Flood Level (HFL).

VII Power line Crossings

- (i) Where the line is to cross over another line, poles with suitable extensions may be used, depending upon the merit of the prevailing site condition.
- (ii) For crossing of power line of 400 kV or above voltage class, large angle poles of deviation angle of 30-60 degree & designed for dead end condition, with required body extension, shall be used on either sides of the power line.
- (iii) For crossing of power line of 110 kV, 132 kV, 220 kV and 230 kV voltage class, the tension poles with required body extension shall be used on either sides of the power line and the crossing of power lines of 66 kV class shall be done with any type of poles (suspension/tension) with required body extension.
- (iv) In case of crossing with tension poles proper guying shall be provided to facilitate stringing of the power line crossing sections separately on obtaining line shutdowns.
- (v) Clearance between lines crossing each other shall be kept in accordance with the CEA (Measures Relating to Safety and Electric Supply) Regulations.

VIII Telecommunication Line Crossings

The angle of crossing shall be as near to 90 degree possible. However, deviation to the extent of 30 degree may be permitted under exceptionally difficult situations.

When the angle of crossing has to be below 60 degree, the matter will be referred to the authority in charge of the Telecommunication System. On a request from the Contractor, the permission of the telecommunication authority may be obtained by DTL.

Also, in the crossing span, power line support will be as near the telecommunication line as possible, to obtain increased vertical clearance between the wires.

IX Oil Pipe-Line Crossings

Wherever transmission line crosses an oil/gas pipeline, the angle of crossing shall be as near to 90 degree as possible. Further, a minimum separation of 3m should be maintained between pipe line and transmission line footings & pipe/counterpoise earthing.

X Details En-route

All topographical details, permanent features, such as trees, building etc. within 33.5m (765kV D/C), 32m (765kV S/C Delta), 42.5m (765kV S/C Horizontal), 34.5m (± 800 kV HVDC), 26m (400kV S/C), 23m (400KV D/C), 26m (± 500 kV HVDC), 17.5m (220KV), 13.5m (132 KV) on either side of the center line alignment shall be detailed on the profile plan.

XI Clearance from Ground, Building, Trees etc.

Clearance from ground, buildings, trees and telephone lines shall be provided in conformity with the CEA (Measures relating to Safety and Electric Supply) Regulations 2010 or its successor.

6.0 Details of trees, forest areas, land owners etc.

- 6.1** To evaluate and tabulate the trees and bushes coming within 33.5m (765kV D/C), 32m (765kV S/C Delta), 42.5m (765kV S/C Horizontal), 34.5m (± 800 kV HVDC), 26m (400kV S/C), 23m (400KV D/C), 26m (± 500 kV HVDC), 17.5m (220KV), 13.5m (132 KV) on either side of the central line alignment, the trees will be numbered and marked with quality paint serially from angle point 1 onwards and the corresponding number will be painted on the stem of trees at a height of 1 meter from ground level. The tree outside the ROW but expected to infringe in the ROW of the line and may require lopping/trimming shall also be evaluated. The bushy and under growth encountered within this area should also be evaluated with its type, height, girth and area in square meters, clearly indicating the growth in the tree/bush statement. The trees list should contain the following:

- a) Girth (circumstances) measured at a height of 1 meter from ground

level.

b) Approximate height of the tree with an accuracy of +2 meters.

c) Name of the type of the species/tree.

6.2 The Contractor shall also intimate DTL his assessment about the likely amount of tree & crop compensation etc. required to be paid by DTL during execution stage. This assessment shall be done considering prevailing practices/guidelines, local regulations and other enquiries from local authorities.

6.3 The Contractor shall also collect data/details of ownership of land within the line corridor and pole base from the concerned revenue/local authorities and submit the same to DTL.

6.4 The Contractor shall also identify the forest/non forest areas involved duly authenticated by concerned authorities and shall provide following details:

(a) A statement of forest areas with survey/compartament Nos.(all type of forest RF/PF/Acquired forest/Revenue forest/Private forest/Forest as per dictionary meaning of forest etc.)

(b) A statement of non-forest areas with survey/compartament nos.

(c) Tree cutting details(Girth wise & specie wise)

(d) Marking of forest areas with category on topo sheets 1:250000 showing complete line route, boundaries of various forest divisions and their areas involved.

(e) Village forest maps of affected line and affected forest area and marking of the same.

(f) Forest division map showing line and affected forest area.

6.5 The Contractor shall finalize the forest clearance proposal on the prescribed format, as per requirements of the state/MOEF&CC, duly completed in all respects for submission by DTL to the Forest Department.

7.0 Preliminary Schedule

The profile sheets showing the locations of the poles together with preliminary schedules of quantities indicating pole types, wind & weight spans, angle of deviation, crossing & other details etc. shall be submitted by the Contractor for review & approval by DTL's site-in-charge.

8.0 Check Survey of Pole Locations

8.1 The check survey shall be conducted to locate pole locations on ground conforming to the approved profile and pole schedule.

- 8.2** The co-ordinates of all the pole locations shall also be recorded using GPS/DGPS of positional accuracy less than 3m for easy relocating. The position of all pole locations shall be marked in the final digitized route alignment drawing with relative distances from any permanent bench mark area.
- 8.3** The Contractor shall also collect required data at each pole location in respect of soil strata, ground water level, history of water table in adjacent areas/surface water, distance from permanent bench mark (these details to be furnished in a tabulated form) and classify the suitable type of foundation at each pole location based on the data collected at each location and detailed soil investigations carried out at selected locations etc.
- 8.4** Contouring at hilly/undulated locations: The levels up or down of each pit centre with respect to centre of pole location shall be recorded at intervals of 2m using total stations/GPS/digital theodolite and digitized contour plans shall be made. Based on the digitized elevation plans, the quantities of benching & protection work shall be optimized using suitable computer-aided techniques/software or manual method.
- 8.5** The changes desired by DTL in the preliminary pole schedule or as may be required based on detailed survey of pole locations & contouring shall be carried out by the Contractor and the final pole schedule shall be submitted for approval of DTL. The pole schedule shall show position of all type of poles, span length, type of foundation for each pole, benching & revetment requirement, deviation at all angles, crossings & other details etc.

9.0 Survey Methodology & Precision

- 9.1** All elevations shall be referenced to benchmarks established by the Survey of India. Survey operations shall begin and end at benchmarks approved by DTL.
- 9.2** During the leveling of the profile, check surveys will be effected at intervals not exceeding 50 km with benchmarks of known elevations. The difference in elevations as surveyed by the Contractor and as declared by Survey of India for these benchmarks shall not exceed the precision required for 3rd order surveys;

$$e \leq 24k$$

where k is the distance between benchmarks in km, and e is the difference between elevations in mm.

- 9.3** In the absence of suitable benchmarks, the leveling shall be done by two independent leveling parties working in opposite directions along the same line. The difference in elevations between the two surveys shall not exceed the precision required for 3rd order surveys as stated above.
- 9.4** All important objects and features along the transmission line centerline (railways, highways, roads, canals, rivers, transmission lines, distribution lines, telephone lines etc.) shall be surveyed and located with a positional accuracy of 1:2000 between points of known horizontal position.

10.0 Survey Report

- 10.1** Complete BOQ of the transmission lines as per format provided by DTL shall be furnished in the survey report.
- 10.2** Each angle point locations shall be shown with detailed sketches showing existing close by permanent land marks such as specific tree(s), cattle shed, homes, tube wells, temples, electric pole/tower, telephone pole, canal, roads, railway lines etc. The relative distance of land marks from the angle points and their bearings shall be indicated in the sketch. These details shall be included in the survey report.
- 10.3** Information regarding infrastructural facilities available along the final route alignment like access to roads, railway stations, construction material sources (like quarry points for stone, sand and availability of construction water), labour, existing transport facilities, fuel availability etc. shall be furnished in the survey report.
- 10.4** All observations which the Contractor thinks would be useful to the construction of the transmission lines mentioned under scope of work are to be reported. The Survey report shall include identification and explanation of route constraints.
- 10.5** Suggestions regarding the number of convenient zones (line segments/portions) in which the entire alignment can be divided keeping in view the convenience of construction/project implementation are to be given.
- 10.6** Suggestions regarding location for setting up stores during line construction in consultation with DTL's representative shall also be provided by the Contractor.
- 10.7** Working months available during various seasons along the final route alignment, with period, time of sowing & harvesting of different type of crops and the importance attached to the crops particularly in the context of way leave problems and compensation payable shall be stated by the Contractor.
- 10.8** Some portions of the line may require clearance from various authorities. The Contractor shall indicate the portion of the line so affected, the nature of clearance required and the name of concerned organizations such as local bodies, municipalities, P&T (name of circle), Inland navigation, Irrigation Department, Electricity Boards and Zonal railways, Divisional Forest Authorities, airport Authorities etc.
- 10.9** All the requisite data for processing the case for statutory clearances such as PTCC, Forest and Railway shall be provided along with the report.
- 10.10** The Contractor shall also collect & report details pertaining to pollution levels envisaged along the transmission line.
- 10.11** The soft copies of survey reports shall be furnished by the Contractor to the DTL.

Assembly and Installation of Pole Structures

The installation Contractor is ultimately responsible for the proper assembly and installation of pole structures. The Contractor shall provide storage and handling instructions to minimize damage to galvanized or painted surface. Care must be taken during installation to avoid structural damage which could weaken the members and prevent them from supporting the intended loads.

1. Identification of components:

Each major component should include an identification tag. The assembly and component drawings should show:

- (a) The location of each tag;
- (b) The identification number on each tag;
- (c) A list of all parts required for each structure or assembly.

2. Anchorage:

- (a) An evaluation of local soil conditions should be made by a foundation designer. The foundation size and reinforcement must be adequate to withstand the maximum reactions which might be applied by the pole base.
- (b) Concrete foundations should be installed well ahead of the installation of the poles. Standard concrete requires about 28 days to develop its full design strength.
- (c) In designing and installing the foundation, consideration should be given to the possible need for underground wiring and grounding.
- (d) Projection of the anchor bolts should allow for the thickness of the base plate, nuts (including the leveling nuts), and raking if required.
- (e) Orientation of the anchor bolts in relation to the direction of the transmission line must be checked carefully using data from the Manufacturer's drawings and DTL's plans and specifications. The anchor bolts must also be vertical. This is typically checked by leveling the top cage template.
- (f) Prior to installing the anchor bolt cage, the following assembly checks should be made:
 - (i) Verify the part number on the cage assembly with the part number listed on the erection drawing.
 - (ii) Inspect the cage assembly for shipping or handling damage. Verify the anchor bolt cage assembly and the anchor bolt circle roundness against the assembly drawing. A four way measurement of the anchor bolt assembly across the 45 degree orientation is recommended. This check will avoid an out-of-round anchor bolt cage not fitting the structure base plate. If the anchor bolt cage is found to be out-of-round, contact the Manufacturer.
- (g) Reinforcing steel for the foundation must not be welded to the anchor bolts.
- (h) Care must be taken not to disturb the position of the anchor bolts while pouring concrete.
- (i) After the concrete sets, the top cage template should be removed and the nuts should be retained for installation of the structure.
- (j) Leveling nuts should be adjusted before installing the pole. Typically,

they should be in a horizontal plane. However, they can be used to obtain a desired rake. The bottom of the base plate should be no more than 2 times the diameter of the anchor bolt above the top of the concrete foundation.

- (k) In the case of structures which utilize embedded base installation, typically the bottom (embedded) section of the pole is installed in the ground first. The specified embedment depth should be shown on the manufacturer's erection drawing.

3. Assembly:

(a) General

- (i) Assembly of pole sections at site shall in general be conducted using hydraulic jacking devices and/ or suitable chain pulley blocks to achieve proper jacking force.
- (ii) Where space near the foundation and lifting capabilities permit, it is preferable to assemble the complete structure on the ground and erect it as a unit. The sections of the pole should be aligned on the ground and supported, typically with wood blocks, in such a manner that they will readily fit together. Care should be taken to prevent dirt, stones, etc. from being trapped between the mating surfaces.
- (iii) Proper alignment of the pole sections is facilitated by the location of the identification tags. These are positioned on the pole sections so that aligning them on the same side for the entire pole length will assure proper orientation of all conductor attachment points, arms attachments, camber, etc.
- (iv) If the structure is assembled vertically, extra care may be needed to assure that all joints are properly assembled as indicated in the following paragraphs.
- (v) Any work left incomplete at the end of day should be guyed/ anchored properly to avoid any damage and a warning notice be displayed.

(b) Slipover Joints

- (i) To facilitate the assembly, mating surfaces may be lubricated. Care should be taken not to use a lubricant that will later leak from the joint and stain the pole. Soapy water can also be used successfully for this purpose.
- (ii) Each identification tag is positioned to indicate maximum splice. The mating section should never exceed this position. In addition, this tag can be used to determine if minimum splice has been achieved.
- (iii) A sound slip joint depends on the application of the necessary force to achieve a tight joint, although the method selected may depend upon the size of the pole sections, the type of pole design and the equipment available to the Contractor. It is recommended to use a hydraulic jacking device. Alternatively, two ratchet chain hoists or similar devices on opposite sides of the pole tube may be used provided adequate assembly forces can be achieved. Equal forces must be applied by the devices simultaneously. If the jacking nuts are used, forces must be applied no more than 1.5 inches from the surface of the pole and the forces must be distributed equally to all the nuts at each joint.

- (iv) A tight, sound slip joint is dependent on meeting all of the following:
- The force used in assembly is at least the minimum value specified on the manufacturer's drawings.
 - Any additional force applied to the joint does not result in additional movement of the joint.
 - The overlap length is not less than the minimum length specified and is not more than the maximum length specified on the manufacturer's drawings.
 - The joint shows no more than small gaps (which can be caused by slight mismatch in the shapes of the mating sections).
- (v) Forces should be applied in a slow steady pull and the assembly be facilitated by oscillating the advancing section with the supporting crane or by striking the pole in the area of the joint with a hammer using a cushioning block of wood.
- (vi) It should be ensured that galvanization on the external and internal surface of the pole does not get damaged.

(c) **Bolted Joints**

Any bolting instructions specifically provided on manufacturer's drawings will supersede these general guidelines.

- (i) **Multiple-bolt, moment connections (e.g. arm-to-pole connections, flange connections):** Threads may need to be lubricated in the field in order to achieve bolt tension in accordance with American Institute of Steel Construction (AISC) recommendations.
- (ii) **Single-bolt, pinned connections (e.g. swing brackets, cross-bracing, pinned cross arms):** The bolt head and the nut are snug against the outer plates and the locking device or nut is fully engaged. All plates do not need to be in contact.
- (iii) **Anchor Bolts:** After plumbing the structure, all nuts should first be uniformly snug-tightened against the base plate. Then, some provision should be made to prevent unauthorized loosening of the nuts. The two most common methods are:
- A slight amount of additional tightening of each top nut.
 - Peening of the threads.
- (iv) **All connection bolts with diameters of 1.75 inches or more** should be snug-tightened until the bolt head and the nut are snug against the outer plates and the locking device or nut is fully engaged. All plates do not need to be in contact.
- (v) **Cantilever Arms:** Before tightening the arm attachment bolts, the arm should be rotated toward the base of the structure to remove all play in the connection. While tightening the bolts, care should be taken to assure that the all arms remain in the same plane. Bolt tightening beyond the above recommended pretension is not required just to bring the connection plates into contact. A small gap

between the arm bracket and connection vangs is acceptable.

- (vi) **H-frame Structures:** Bolts in connections that are part of the frame assembly (i.e. not attachments of cantilever sections) should be left loose until all such bolts are installed. After all bolts are installed, the nuts should be tightened in the following sequence:

- Connections between main pole sections.
- Connections between cross-arms and poles.
- Connections between cross-braces and poles.
- Connections between cross-braces.

Care should be taken to maintain all alignments during this tightening operation.

- (vii) Every flange joints shall be provided with copper or any suitable material bye-pass strip to facilitate continuous path for leakage/short circuit current/Lightening discharge current to ground to ensure safety both to human and animals.

4. Corrosion protection and storage:

- (a) After assembly, any damage to the protective coating on the structure should be repaired.
- (b) An on-going maintenance program must include periodic inspection for normal deterioration of the protective coating and for any indication of corrosion. Rehabilitation of the protective coating must be done to preserve the structural integrity of each assembly.
- (c) Structures should not be stored longer than 6 months prior to use without a thoughtful storage maintenance and inspection program. The following recommendations should be considered for all stored sections:
- (i) All stored structures should be kept well ventilated, which includes not allowing vegetation to grow in and around sections. Sections should be blocked off the ground and separated if sections are stacked on top of each other to provide air flow and ventilation.
- (ii) Sections should be supported on wooden rafters while placing on the ground. Wooden blocks should be non-treated wood (wood treatments can be caustic to steel) and metal blocking should be coated (rusting of steel will stain the sections).
- (iii) Remove all packing and shipping materials to avoid finish deterioration through holding moisture against the surface.
- (iv) Provide proper inclination and orientation to allow free drainage of water, including any condensation inside the pole, so that it does not accumulate inside the pole or on outside surfaces.
- (v) Rotation of the poles should be performed as necessary to equalize any finish aging and to assess the continued effectiveness of blocking and allowing good air flow ventilation inside & around the sections.
- (vi) Space should be maintained between two sections to avoid white rust.

5. Erection

- (a) Prior to lifting the structure, any slipover joint below the crane attachment point should be securely lashed to prevent any possibility of separation during lifting.
- (b) The lifting crane must be attached:
 - (i) Above the center-of-gravity of the entire assembly including the weight of all equipment mounted on the structure before erection.
 - (ii) To the main pole member(s) or, if to the arms, the attachment(s) must be close to the pole(s).
 - (iii) As high as possible since higher attachment will result in more nearly vertical alignment of the assembly while suspended above the foundations.
- (c) H-frame structures may require a spreader bar to achieve two points of attachment to the structure and to assure that all lifting forces are applied vertically.
- (d) Care should be taken to operate the crane smoothly since movements inducing jolts will cause impact loads which could damage some portion of the assembly.
- (e) At least a few anchor bolt & nuts should be installed as quickly as possible after the base plate is in place. If the pole is eccentrically loaded, such as in the case of arms on only one side of the structure, the nuts on the side opposite the direction of eccentricity should be installed first.
- (f) The use of grout between the base plate and the concrete foundation is not recommended or structurally required. Galvanized structures require a method of drainage for any moisture that may enter the pole section and weathering steel structures should not have a surface that could hold moisture against the bottom of the base plate. If grouting under the base plate is used, it is critical that sufficient drainage is provided from the inside of the pole.

6. Protection from vibration:

Transmission structure components may be affected by vibrations induced aerodynamically or from other sources. Although rare, these vibrations can be severe enough to cause damage. This is believed to be more likely to happen when structures (or components such as arms) are installed without insulators and conductors which contribute damping to the system. It is considered good practice for installers to attach at least some equipment to each arm at the time of installation of the structure. The IEEE document, "Guide to the Assembly and Erection of Metal Transmission Structures", mentions the following methods:

- (a) Suspending weights or insulators from the arms;
- (b) Tying the arm tips together and to the structure.

Also, damping devices such as the Stockbridge type may be effective. In accordance with IS:1367/IS:12427 (latest revision) bolts and galvanized bolts shall not be reused. Touching up or re-tightening bolts that may have been loosened by the installation of adjacent bolts shall not be considered to be a reuse.

7. Installation:

Prior to installation, the fastener components shall be properly stored. For joints that are designated as snug-tightened joints, the bolts shall be installed in accordance with the section below.

Snug-tightened joints:

All bolt holes shall be aligned to permit insertion of the bolts without undue damage to the threads. Bolts shall be placed in all holes with washers positioned as required and nuts threaded to complete the assembly. Compacting the joint to the snug-tight condition shall progress systematically from the most rigid part of the joint. The snug-tightened condition is the tightness that is attained with a few impacts of an impact wrench or the full effort of an ironworker using an ordinary spud wrench to bring the nut and connection plate into firm contact.

8. Handling of material

- a) Suitable capacity of Hydra Cranes or overhead cranes should be used for lifting.
- b) Clean Nylon belts of appropriate capacity should be used for material handling.
- c) Sections should be lifted with two nylon belts fixed at the extreme ends from the center of gravity for easy lifting.
- d) Only one section should be lifted at time.
- e) Welded accessories should not come under direct load.

Minimum Safety Guidelines

The provision in Central Electricity Authority (Measures Related to Safety and Power Supply) Regulations, Central Electricity Authority (Safety Requirements for Construction, Operation and Maintenance of Power Plants and Power Lines) Regulations and relevant Indian Standards should be followed during erection and stringing along with the following safety guidelines.

1. Use of Personal Protective Equipment (PPEs):

- (a) No work at site should be without proper PPEs in place for all concerned.
- (b) All workers are to wear Safety Helmets, Safety Shoes, Hand Gloves & Safety Jackets all the time while executing the work. Contractor's Supervisors will also have to wear Safety Shoes and Safety Helmets while in the field. Goggles & Masks to be used while working in dusty or highly polluted areas.

2. Working at height:

- (a) Full body harness with double lanyard Safety Belts are to be used during working at heights above 1.5 m and secured with safety lifeline or any other rigid object/structure safely before starting the work. Also well-built ladders (properly secured at the base) can be used for working at height, where ladders can be used.
- (b) Efforts should be made to assemble the poles & accessories on the ground only so that working on height can be avoided later.
- (c) No work at height is to be carried out in case of inclement weather conditions such as rain, lightning, heavy winds, etc.
- (d) Ensure use of tool belts/backpack to properly secure hand tools at all times.
- (e) Ensure proper barricading of the drop zone to safeguard people at ground from any falling objects.

3. Proper demarcation & barricading:

- (a) Safety barricading to be done around the working area from day one to safe guard against trespassing. "Men at work" board must be put to indicate work under progress in the vicinity. Barricading to be kept in place till the work is over, even if it takes few days to complete.
- (b) No excavated pits/ loose soil areas should be kept open without barricading around the area.
- (c) Also all storage area of materials near the working area has to be demarcated & barricaded properly.

4. Use of cranes & clings:

- (a) Cranes with 20% factor of safety (i.e. cranes with a lifting capacity

- 20% higher than the weight to be lifted) are to be used.
- (b) The crane should be operated by a licensed operator only.
- (c) Operational fitness of the crane has to be checked before hiring the crane.
- (d) The lifting hooks must have a safety lock in place to avoid slipping of the clings.
- (e) The lifting capacity of the clings to be checked before starting of the work. The clings with 20% factor of safety in mechanical strength must be used for lifting.

5. Working near the existing power lines:

- (a) No work to be taken up without proper shutdown while working in the existing power line or while working in the proximity of any existing power line.
- (b) Work to be started only after the line (all the phases) is properly/securely earthed from both the ends and line clearance/work permit is issued by the concerned authority in writing.
- (c) All the earthing points to be personally verified by Site Engineer of Contractor.
- (d) No shutdown to be arranged over phone communication. Personal check is to be made for every shutdown and line clearance.
- (e) The work under shutdown should be executed under direct supervision of a qualified supervisor/engineer of the Contractor only.

6. Material handling & work process:

- (a) Poles and accessories to be stored in proper demarcated area and should be away from the routes/places of public use. Ensure adequate ingress & egress around the work area.
- (b) While lifting or shifting the Poles/sections nobody should stay boarded on it.
- (c) Proper/suggested tools & plants must be used for fixing & assembling to avoid accidents in the process. All the work must be supervised by experienced supervisor(s), who can guide the team in every activity.
- (d) While lifting heavy poles with multiple sections, proper support clings (along the length of the pole) are to be provided from the point of lifting cling to the bottom of the pole to avoid fall of sections due to malfunction of the slip joints.
- (e) Any person under the influence of alcohol neither should be allowed to enter the work location nor should help in the work from outside by any means.

7. Working at night (After sun set):

- (a) No work should be taken up once the day light is over.
- (b) However if there is need to execute the work at night, proper/sufficient lighting to be arranged to cover the working area and the work should be executed under direct supervision of responsible/qualified supervisor only and prior intimation to the DTL representative in writing. The

work group shouldn't be left alone to execute the work.

8. Emergency Response Plan:

- (a) First aid boxes to be kept handy at sites. The Contractor's supervisor(s) must have the knowledge of first aid treatment to meet the exigency.
- (b) Contact numbers for emergency help (e.g. Doctors, Hospitals, Ambulance services, Fire services, Police, etc.) available in the nearby areas to be kept displayed in the work site at all times.
- (c) All incidents including the near misses to be noted down by the Contractor's supervisor(s) and reported to the concern authority. However, all major incidents/accidents causing "Lost Time Injuries" & "Medically Treated Injuries" should be intimated immediately and in no case more than half an hour of occurrence.

9. Tool Box Meeting:

- (a) Tool Box Meetings to be conducted every day before starting of the work. Work Plan for the day along with hazards/risks involved in the activities and safe working practices for the same are to be discussed with the workers.
- (b) Record of the Tool Box Meeting to be generated and signature of all the workers/supervisor are to be taken on the TBM sheet. This activity will gradually enhance the safety awareness and will also help in operating in a planned manner.

**BIDDER'S/CONTRACTOR'S GUARANTEED
DATA SHEET**

BIDDER'S/ CONTRACTOR'S GUARANTEED DATA		Unit	Data offered for poles
(I)	General		
(i)	Nominal voltage	kV	
(ii)	Highest system voltage for equipment	kV	
(iii)	Frequency	Hz	
(iv)	Rated lightning impulse withstand voltage	kV peak	
(v)	Rated switching impulse withstand voltage (for 400 kV and above)	kV peak	
(vi)	Rated short duration power frequency withstand voltage	kVrms	
(vii)	System neutral (effectively earthed/unearthed)	-	
(viii)	System short-circuit level & duration	kA & sec	
(ix)	Short circuit current & duration for thermal stability check of the OPGW	kA & sec	
(x)	Minimum Specific creepage distance based on highest system phase to phase	mm/kV	
(xi)	Radio Interference Voltage	μV	
(II)	Main Design Parameters		
(i)	Maximum ambient air temperature	0C	
(ii)	Minimum ambient air temperature	0C	
(iii)	Maximum conductor operating temperature to be considered for design (for sag tension calculation)	0C	
(iv)	Every day temperature	0C	
(v)	Temperature with maximum wind	0C	
(vi)	Wind Zone and basic Design wind speed	m/s	
(vii)	Terrain Category		
(viii)	Reliability level		
(ix)	Wind span	m	
(x)	Weight span max	m	
(III)	Line Data		
(i)	Number of circuits	-	
(ii)	Number of conductors per phase	-	
(iii)	Number of OPGW	-	
(iv)	Number of earthwire	-	
(v)	Conductor Details	-	
	[Type of conductor, no. of sub-conductors per phase, Overall Diameter, stranding & wire diameter for Al/Al alloy & steel, weight per km, UTS, resistance per km, modulus of Elasticity, coefficient of linear expansion]		

(vi)	Earthwire & OPGW details [Overall Diameter, stranding & wire diameter, weight per km, UTS, resistance per km, modulus of Elasticity, coefficient of linear expansion]	-	
(IV)	Types of Poles (Specify data for all types of poles)		
(i)	Angle of deviation		
(ii)	Type of Insulator sets		
(iii)	Wind Span	m	
(iv)	Weight span	m	
(v)	Maximum span	m	
(vi)	Total weight of pole for Basic/normal height pole and extension poles	kg	
(V)	Corrosion protection measures		
(i)	Average weight (gm/m ²) and thickness (microns) of Zinc coating on Pole Structure & Parts		
(a)	Plates & Section below 5mm		
(b)	Plates & Section above 5mm		
(ii)	Galvanizing of bolts, nuts & washers	μm	
(VI)	Main Design Data		
(i)	Minimum partial factors		
(ii)	Partial factors for actions		
(iii)	Deadweight		
(iv)	Wind for normal conditions		
(v)	Conductor tension for normal conditions		
(vi)	Conductor tension for exceptional conditions		
(vii)	Erection/maintenance loads		
(viii)	Partial material factors(M)		
(ix)	Steel poles cross section areas		
(x)	Steel poles net section areas at bolt holes		
(xi)	Support bolts		
(xii)	Reinforcing steel for concrete foundations		
(xiii)	Foundation in-situ concrete structure		
(xiv)	Soil property		
(xv)	Conductors for maximum wind load		
(xvi)	Conductors for everyday conditions		
(xvii)	Insulators for normal conditions		
(xviii)	Insulators for exceptional conditions		

(xix)	Fittings for normal conditions		
(xx)	Fittings for exceptional conditions		
(VII)	Clearances		
(i)	Minimum vertical clearances (Minimum vertical clearances from the line conductors at maximum sag ground or for various crossings)		
(a)	Normal ground	m	
(b)	Ground in populated areas	m	
(c)	Roads and streets	m	

(d)	To residential or other buildings	m	
(ii)	Minimum Horizontal clearances		
(a)	Roadside (sidewalk of paved roads)	m	
(b)	Roadside of unpaved roads- depending on area	m	
(c)	Railway track axis	m	
(d)	Parallel running power lines	m	
(e)	Pipelines	m	
(iii)	Mid-span clearances		
(a)	Mid-span phase to phase clearance for horizontal phase arrangement	m	
(b)	Mid-span phase to phase clearance for quasi-vertical phase arrangement	m	
(c)	Mid-span phase to phase clearance for quasi-vertical wire phase arrangement	m	
(iv)	Minimum clearances between conductors/live fittings and pole steel structure		
(a)	Between conductors under still air condition	m	
(b)	Clearance between live parts and earthed Pole parts in still air	m	
(c)	Clearance under swung insulator string due to maximum wind on conductor	m	
(v)	Clearance condition for earthwire / OPGW		
(a)	EW/OPGW sag, compared to the conductor sag at every day temperature for the nominal span	-	
(b)	Shielding angle		
(VIII)	Foundations		
	Soil Data (for Bidding only) The foundations will be designed on the basis of the soil investigations performed by the Contractor. As soil investigations is not complete, the bid shall be based on the soil		

	characteristics given below		
(a)	Class 1 - Hard rock		
	Density	kN/m ³	
	Soil pressure	kN/m ³	
	Shear friction resistance	kN/m ³	
(b)	Class 2 - Soft rock		
	Density	kN/m ³	
	Soil pressure	kN/m ³	
	Angle of frustum		
(c)	Class 3 - Good Soil		
	Density	kN/m ³	
	Soil pressure	kN/m ³	
	Angle of frustum		
(d)	Class 4 - Poor Soil, no Water		

	Density	kN/m ³	
	Soil pressure	kN/m ³	
	Angle of frustum		
(e)	Class 5 - Poor Soil, with Water (submerged)		
	Density without groundwater	kN/m ³	
	Density with groundwater	kN/m ³	
	Soil pressure	kN/m ³	
	Angle of frustum		
(f)	Class 6 - Very Poor Soil, with Water(submerged)		
	Density	kN/m ³	
	Soil pressure	kN/m ³	
	Angle of frustum		
(g)	Backfill (good soil)		
	Density (compacted)	kN/m ³	
	Angle of frustum		
(IX)	Poles General information and data		
(a)	Material used for all Pole parts		
(b)	Bolts and nuts standard for poles		
(c)	Bolts and nuts qualities for poles		
(d)	Step bolt diameter (min.)	mm	
(e)	Permissible stresses of structural members,bolts and nuts correspond with	-	
(f)	Bolt connections secured with washers and spring washers		
(g)	All Pole steel parts hot dip galvanized	Yes/No	
(h)	Zinc coat for steel sections for bolts and nuts	μm	
(X)	Quality and tests correspond with		
	Welding qualification	-	
	Welding quality	-	
(XI)	Min. diameter and number of bolts		
	Bolt diameter	mm	
(XII)	Tolerances for poles	-	

RELEVANT INDIAN/ INTERNATIONAL STANDARDS

S. No.	Indian Standard	Title
1.	IS 209	Specification For Zinc
2.	IS 269	Ordinary Portland Cement, 33 Grade — Specification
3.	IS 278	Galvanized Steel Barbed Wire For Fencing - Specification
4.	IS 363	Hasps and Staples – Specification
5.	IS 383	Coarse and Fine Aggregate for Concrete— Specification
6.	IS 398 (all parts)	Aluminum Conductors For Overhead Transmission Purposes
7.	IS 432	Specification For Mild Steel and Medium Tensile Steel Bars and Hard-Drawn Steel wire For Concrete Reinforcement
8.	IS 731	Porcelain Insulators For Overhead Power Lines With A Nominal Voltage Greater Than 1000 V
9.	IS 800	Code of Practice For General Building Construction In Steel
10.	IS 802 (Part 1) Sec 1 Sec 2	Use of Structural Steel In Overhead Transmission Line Tower- Materials, Loads and Permissible Stress Section- 1: Materials and Loads Section-2 : Permissible Stresses.
11.	IS 802(Part 2)	Code of Practice For Use of Structural Steel In Over Head Transmission Line : Fabrication, Galvanizing, Inspection & Packing
12.	IS 802 (Part 3)	Code of Practice For Use of structural Steel In Overload Transmission Line: Testing
13.	ASCE 48-19	Design of Steel Transmission Pole Structure
14.	IEC 60826	Design Criteria of Overhead Transmission Lines
15.	IS 808	Dimensions For Hot Rolled Steel Beam, Column, Channel and Angle Sections.
16.	IS 875	Code of Practice For Design Loads (Other Than Earthquakes) For Buildings and Structures
17.	IS 1079	Hot Rolled Carbon Steel Sheet and Strip Specification
18.	IS 1080	Codes of Practice For Design and Construction of Shallow Foundations On Soils (Other Than Raft, Ring & Shell)

19.	IS 1340	Code of Practice For Chromate Conversion Coating On Zinc and Cadmium Coated Articles and Zinc Base Alloys
20.	IS 1363	Hexagon Head Bolts, Screws and Nuts (Size Range M5 To M36)
21.	IS 1367	Technical Supply Conditions For Threaded Steel Fasteners
22.	IS 1477	Code of Practice For Painting of Ferrous Metals In Buildings: Part-I: Pre-Treatment Part-II: Painting
23.	IS 1489	Portland - Pozzolana Cement Specification
24.	IS 1498	Classification and Identification of Soils For General Engineering Purposes
25.	IS 1521	Method of Tensile Testing of Steel Wire
26.	IS 1573	Electro-Plated Coatings of Zinc On Iron and Steel
27.	IS 1586	Metallic Materials - Rockwell Hardness Test: Part 2 Verification and Calibration of Testing Machines and Indenters
28.	IS 1892	Codes For Practice For Subsurface Investigation For Foundation
29.	IS 1904	Codes For Practice For Design and Construction of Foundation In Soil: General Requirements
30.	IS 2131	Method of Standard Penetration Test For Soils
31.	IS 2220	Codes For Practice For Thin Walled Tube Sampling of Soils
32.	IS 2720 (Part-1-39)	Method of Test For Soils (Relevant Parts)
33.	IS 2809	Glossary of Terms and Symbols Relating To Soil Engineering
34.	IS 2911- Part I-VI	Code of Practice For Design and Construction of Pile Foundations (Relevant Parts)
35.	IS 1778	Reels and Drums For Bare Conductors
36.	IS 1786	High Strength Deformed Steel Bars and Wires For Concrete reinforcement— Specification
37.	IS 1852	Rolling and Cutting Tolerances of Hot Rolled Steel Products
38.	IS 1893	Criteria For Earthquake Resistant Design of Structures
39.	IS 2016	Specification For Plain Washers
40.	IS 2062	Hot Rolled Medium and High Tensile Structural Steel
41.	IS 2071	High Voltage Test Techniques
42.	IS 2074	Ready Mixed Paint, Air Drying, Oxide. Zinc Chrome , Priming Specification
43.	IS 2121	Conductor and Earthwire Accessories
44.	IS 2486	Specification For Insulator Fittings For Overhead Power Lines With A Nominal Voltage Greater Than 1000 V

45.	IS 2502	Bending and Fixing of Bars For Construction Work
46.	IS 2551	Danger Notice Plates
47.	IS 2629	Recommended Practice For Hot Dip Galvanizing of Iron and Steel.
48.	IS 2633	Method of Testing Uniformity of Coating of Zinc Coated Articles
49.	ASTM A123	Standard Specification For Zinc (Hot-Dip Galvanized) Coatings On Iron and Steel Products
50.	IS 3025	Methods of Sampling and Testing (Physical and Chemical) For Water Used In Industry
51.	IS 3043	Code of Practice For Earthing
52.	IS 3063	Fastener- Single Coil Rectangular Section Spring Lock Washers For Bolts, Nuts Screws
53.	IS 3188	Characteristics of String Insulator Units
54.	IS 3757	High Strength Structural Bolts
55.	IS 3834-2	Quality Requirements For Fusion Welding of Metallic Materials — Part 2: Comprehensive Quality Requirements
56.	IS 4078	Code of Practice For Indexing and Storage of DrillCores
57.	IS 4091	Code of Practice For Design and Construction of Foundations For Transmission Line Poles and Poles
58.	IS 4434	Code of Practice For In-Situ Vane Shear Test For Soils
59.	IS 4453	Code of Practice For Sub-Surface Exploration By Pits, Trenches, Drifts and Shafts
60.	IS 4464	Code of Practice For Presentation of Drilling Information and Core Description In Foundation Investigation
61.	IS 4759	Hot Dip Zinc Coatings On Structural Steel and Other Allied Products
62.	IS 4826	Galvanized Coating On Round Steel Wires
63.	IS 4926	Ready-Mixed Concrete — Code of Practice
64.	IS 4968 (Part-II)	Method For Subsurface Sounding For Soils, Dynamic Method Using Cone and Bentonite Slurry
65.	IS 5313	Guide For Core Drilling Observations
66.	IS 5369	General Requirements For Plain Washers and Lock Washers
67.	IS 5525	Recommendations For Detailing of Reinforcement in Reinforced Concrete Works
68.	IS 5613 Part-1	Code of Practice For Design Installation and Maintenance of Overhead Power Lines: Lines Upto and Including 11kv Section-1: Design Section-2: Installation and Maintenance

69.	IS 5613 Part-2	Code of Practice For Design Installation and Maintenance of Overhead Power Lines: Lines Above 11kv and Upto & Including 220kv Section-1: Design Section 2: Installation and Maintenance
70.	IS 5613 Part-2	Code of Practice For Design Installation and Maintenance of Overhead Power Lines: 400kv Lines Section-1: Design Section 2: Installation and Maintenance
71.	IS 5624	Foundation Bolts - Specification
72.	IS 6610	Heavy Washers For Steel Structures
73.	IS 6623	High Strength Structural Nuts
74.	IS 6639	Hexagon Bolts For Steel Structure
75.	AWS 19.0-72	Welding of Zinc Coated Steel
76.	IS 6403	Code of Practice For Determination of Allowable Bearing Pressure on Shallow Foundation
77.	IS 6745	Methods of Determination of Weight of Zinc Coating of Zinc Coated Iron and Steel Articles
78.	IS 6926	Code of Practice For Diamond Core Drilling For Site Investigation For River Valley Projects
79.	IS 6935	Method of Determination of Water Level In A Bore Hole
80.	IS 7422	Symbols and Abbreviations For Use In Geological Maps, Sections and Subsurface Exploratory Logs (Relevant Parts)
81.	IS 8009 (Part-I)	Code of Practice For Calculation of Settlements of Foundations (Shallow Foundations Subjected To Symmetrical Vertical Loads)
82.	IS 8500	Specification For Weldable Structural Steel (Medium & High Strength Qualities)
83.	IS 8764	Method For Determination of Point Load Strength Index of Rocks
84.	IS 9143	Method For Determination of Unconfined Compressive Strength of Rock Materials

85.	IS 9179	Method of Preparation of Rock Specimen For Laboratory Testing
86.	IS 9259	Specification For Liquid Limit Apparatus
87.	IS 9640	Specification For Split Spoon Sampler
88.	IS 9759	Guidelines For Dewatering During Construction
89.	IS 10050	Method of Determination of Slake Durability Index of Rocks
90.	IS 11315 (Part-II)	Description of Discontinuities In Rock Mass- Core Recovery and Rock Quality
91.	IS/IEC 60815	Selection and Dimensioning of High-Voltage Insulators Intended For Use In Polluted Conditions
92.	IS 8112	Ordinary Portland Cement, 43 Grade — Specification
93.	IS 8263	Method of Radio Interference Tests On High Voltage Insulators

94.	IS 8269	Methods For Switching Impulse Test On HV Insulators
95.	IS 10162	Specification For Spacers Dampers For TwinHorizontal Bundle Conductors
96.	IS 10238	Fasteners- Threaded Steel Fasteners -Step Bolts For Steel Structures
97.	IS 12269	Ordinary Portland Cement, 53 Grade — Specification
98.	IS 13229	Zinc Galvanization - Specification
99.	IS 13620	Fusion Bonded Epoxy Coated Reinforcing Bars- Specification
100.	IS 14893	Non-Destructive Integrity Testing of Piles (NDT) — Guidelines
101.	SP 34	Handbook On Reinforcement and Detailing

SECTION-XXIV

HTLS CONDUCTOR AND ASSOCIATED H/W FITTINGS & ACCESSORIES

HTLS CONDUCTOR

AND

ASSOCIATED H/W FITTINGS
AND ACCESSORIES

TECHNICAL SPECIFICATIONS OF HTLS CONDUCTORS

1. **Description of High Temperature Low Sag (HTLS) Conductor and its Technical Requirements**

- 1.1 The HTLS Conductor except Gap Conductor shall be capable of providing the specified ampacity **as per Annexure -1** at a continuous operating conductor temperature higher than that of the maximum permissible temperature of the existing Conductor **and without exceeding the level of existing sag at worst loading condition in case of reconductoring.**

The physical and operating performance requirements of the transmission line after its up rating by means of re-conductoring with HTLS conductor are mentioned below. The bidder shall offer HTLS conductor complying with the specified requirements. The Bidder shall indicate particulars of the proposed conductor in the relevant GTP schedule along with calculations to establish compliance with the specified requirements.

1.2 **Current Carrying Capacity / Ampacity Requirements**

- 1.2.1 Each conductor/sub conductor in the HTLS conductor shall be suitable to carry minimum 50 Hz alternating current of **desired Amperes** per conductor, **as per scheme** under the ambient conditions & maximum conductor sag specified **in Annexure-1** while satisfying other specified technical requirements/ parameters.

Reference Ambient Temperature:	50° C
Minimum Temperature of Air:	0° C
Relative Humidity:	
Maximum:	100%
Minimum:	10%
Wind Velocity:	0.56 m/s
Solar absorption Coefficient:	0.8
Solar Radiation:	1045 watt/sq.m
Emissivity Constant:	0.45
Effective angle of incidence of sun's rays	90 degree

Maximum Conductor sag for [Ruling span as per Annexure - 1] span at steady state conductor temperature and nil wind corresponding to 50 Hz alternating current of **desired** Amperes per conductor under ambient conditions specified above = [Maximum conductor sag as per Annexure - 1] m

The calculations for Ampacity shall be based on latest edition of IEEE Standard 738. The bidder in his bid shall furnish calculations for the ampacity based on the above Standard for the proposed HTLS conductor.

The AC resistance and DC resistance for HT/ HTLS conductor shall be calculated as follows:

$R_{ac} = R_{dc} \times (1 + 0.00519 \times (mr)^n \times k1 + k2)$ where,

$mr = 0.3544938 / (R_{dc})^{1/2}$

if $mr < 2.8$, then $n = 4 - 0.0616 + 0.0896 \times mr - 0.0513 \times (mr)^2$

if $2.8 < mr < 5.0$, then $n = 4 + 0.5363 - 0.2949 \times mr + 0.0097 \times (mr)^2$

$k1 = \{\cos(90(d/D)^p)\}^{2.35}$ where,

$p = 0.7 + 0.11 \times mr - 0.04 \times mr^2 + 0.0094 \times mr^3$

$k2 = 0.15$ for single aluminium layer INVAR type HTLS conductor

$= 0.03$ for three aluminium layer INVAR type HTLS conductor

$= 0.003$ for two or four aluminium layer INVAR type HTLS conductor

$= 0$ for carbon fiber composite core type HTLS conductor

where,

D = conductor outer diameter in meters

d = conductor inner diameter in meters

R_{dc} = dc resistance of conductor at given temperature, ohms/ km

R_{ac} = ac resistance of conductor at given temperature, ohms/ km

The bidder in his bid shall furnish calculations for the ampacity based on the above for the proposed HT/ HTLS conductor.

- 1.2.2 The design of conductor shall be suitable for operation at a steady state conductor temperature experienced for a conductor AC current flow of **desired Amperes as per Annexure-1** under the above ambient conditions based on ampacity calculations mentioned above. The bidder shall also indicate the maximum permissible conductor temperature for continuous operation without any deterioration of its electrical, mechanical & metallurgical properties. The bidder shall also furnish the maximum permissible conductor temperature for short term operations including permissible duration of such short term operation. The UTS of conductor at ambient temperature and maximum continuous operating temperature shall be declared in the GTP. Further, UTS of conductor achieved at maximum continuous operating temperature (i.e. at the designed maximum steady state conductor temperature corresponding to desired ampacity) shall not be less than 80% of UTS at ambient temperature declared in the GTP.

1.3 Technical Particulars of HTLS Conductor

1.3.1 The HTLS conductor shall meet the technical particulars as detailed in Annexure-1 in line with requirement of scheme:

The bidder shall indicate the technical particulars and details of the construction of the conductor in the relevant schedule of GTP. The bidder shall also guarantee the DC resistance of conductor at 20 deg C and AC resistance at the calculated temperature corresponding to 50Hz alternating current flow of **desired amperes per conductor as per Annexure-1** at specified ambient conditions (maximum continuous operating temperature). The value of maximum DC resistance of the offered HTLS conductor shall **be as per Annexure-1**

The bidder shall submit the supporting calculations for the AC resistance indicating details & justifications of values of temperature coefficient of resistance & DC to AC resistance conversion factor(s) with due reference to construction / geometry of the conductor.

1.3.2 Evaluation of Ohmic Losses and Differential price loading:

Based on the conductor parameters guaranteed by the bidders, average ohmic losses for different conductors offered by the bidders shall be calculated as per the following:

Average Ohmic loss = Loss load factor x line length x No. of sub conductors x (continuous maximum operating current under normal conditions)² x AC resistance corresponding to the temperature at continuous operating current under normal conditions.

Note: value of continuous maximum operating current under normal condition shall be taken as the current carrying capacity of the conductor specified in **Annexure-1 as required in scheme.**

Differential price evaluation for the conductors offered by the bidders shall be carried out considering the average ohmic losses calculated as above and considering Rs.1,52,600/- per KW.

The load loss factor shall be taken as 0.3. The best parameter of loss (Lowest ohmic loss for conductor) corresponding to lowest AC resistance quoted among bidders by any technically responsive and qualified bidder shall be taken as basis and that quoted by the particular bidder shall be used to arrive at differential price to be applied for each bid.

1.4 Sag-Tension Requirements

1.4.1 The HTLS conductor shall meet the sag tension requirements with the required design span as per Annexure-1. Sag of the offered HTLS conductor at designed maximum temperature should not be more than that specified in Annexure-1. Further for reconductoring works, the sag of offered HTLS conductor at designed maximum temperature under NIL wind condition shall not exceed the corresponding sag of existing conductor for any of the spans of the Line (s) being reconducted.

Sag-Tension calculation for HTLS conductor can be carried out by using PLSCAD. Following values shall be considered for the purpose of sag-tension calculations:-

(i) Final values of modulus of elasticity of Aluminium/ Aluminium alloy/core, Coefficient of Linear Expansion of Aluminium/ Aluminium alloy/ core, Stress-Strain coefficients & Creep coefficients of aluminium/ Aluminium alloy/ core in the cable data (.wir file) used for calculation of sag in PLSCAD shall be based on either of the following:

- a) Existing '.wir' files for offered conductor as available on PLS website.
- b) A file derived from existing standard file for conductor of equivalent/ near equivalent stranding.
- c) A file derived from type test conducted on conductor of same stranding.

In each of the above cases, proper justification in the form of test reports/ calculations/ print out of '.wir' file as available on PLS website, etc. shall be required to be submitted during detailed engineering.

(ii) PLSCAD Sagging criteria/conditions shall be based on the sag tension limits specified in **Annexure-1** and shall be carried out in a manner that the above mentioned sag-tension limits are met in 'After Creep' as well as in 'After Load' condition.

However, for INVAR type HTLS conductor, following conventional methodology may also be adopted for sag-tension calculations.. Following values shall be considered for the purpose of sag tension calculation:

- i) Modulus of Elasticity of Thermal resistant Al alloy strands: 55 GPa to 61.8 GPa (one value from the above specified range to be selected conforming to the Al alloy strands in the offered conductor)
- ii) Modulus of Elasticity of INVAR core strands: 155 GPa
- iii) Coefficient of Linear Expansion of Thermal resistant Al. Alloy: $23 \times 10^{-6}/^{\circ}\text{C}$
- iv) Coefficient of Linear Expansion of INVAR core strands (max): $3.7 \times 10^{-6}/^{\circ}\text{C}$
- v) Initial temperature in manufacturing conductor- not less than 15°C. In case the bidder proposes the coefficient of linear expansion of INVAR core strands less than $3.7 \times 10^{-6}/^{\circ}\text{C}$, proper justification in the form of test reports, documents, etc. shall be submitted during detailed engineering.

1.4.2 After award of the contract, the Supplier shall submit Sag-Tension calculations corresponding to various conditions given above for all the existing spans as per detailed survey and spans ranging from 100 m to 1100 m in intervals of 50m.

- 1.4.3 The Contractor shall also furnish sag & tensions under no wind for various temperatures starting from 0oC to designed maximum temperature in steps of 5oC during detailed engineering.
- 1.4.4 Besides above, the Supplier shall also furnish details of creep characteristics in respect of HTLS conductor based on laboratory investigations/ experimentation (creep test as per IEEE1138 or IEC 61395) conducted on similar type of conductor and shall indicate creep strain values corresponding to 1 month, 6 months, 1 year, 10 years & 20 years creep at everyday tension and at maximum continuous operating temperature as well as room temperature..
- 1.5 Workmanship**
- 1.5.1 All the conductor strands shall be smooth, uniform and free from all imperfections, such as spills and splits, cracks, die marks, scratches, abrasions, rust etc.
- 1.5.2 The finished conductor shall be smooth, compact, uniform and free from all imperfections including kinks (protusion 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.
- 1.6 Joints in Wires**
- 1.6.1 Aluminium Alloy Wires**
- 1.6.1.1 During stranding, no Aluminium Alloy wire welds shall be made for the purpose of achieving the required conductor length.
- 1.6.1.2 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(s) 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 Alloy 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 Alloy wire of the completed conductor. A record of such joints for each individual length of the conductor shall be maintained by the Contractor for Employers review.

1.6.1.3 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.

1.6.2 Core Wires

There shall be no joint of any kind in the finished wire entering into the manufacture of the strand. There shall also be no joints or splices in any length of the completed stranded core. **However during production run, splicing of the galvanic protection barrier is allowed as per ASTM B987, provided diameter specifications are maintained**

1.7 Tolerances

Manufacturing tolerances on the dimensions to the extent of one percent (+/- 1%) shall be permitted for individual strands and the complete conductor. **In case of composite core conforming to ASTM B987, the tolerances shall be $\pm 0.05\text{mm}$ as per ASTM B987.**

1.8 Materials

The materials used for construction of the conductor shall be such that the conductor meets the specified technical and performance requirements.

1.8.1 Outer layer

1.8.1.1 The material of outer layer of HTLS conductor shall be of high temperature resistant aluminum alloy added with zirconium or any other suitable element(s) etc. to electrolytic aluminium having purity not less than 99.5% and a copper content not exceeding 0.04%. The strands shall be manufactured through appropriate manufacturing process to ensure consistent electrical mechanical and metallurgical properties under continuous high temperature operation. Bidder shall guarantee the chemical composition in the schedule GTP and also furnish description of the manufacturing process in the Bid.

1.8.1.2 In case of fully annealed type (0 tempered) aluminium/ alloy strands /round wire /trapezoidal/Z-shaped wire shall only be accepted.

1.8.2 Core

The core wire strand(s) shall be of galvanized steel wires/ aluminium clad steel wires / Zinc – 5% Aluminium – Misch metal alloy coated invar wire / galvanized invar wires/ aluminium clad invar wires/ composite materials etc. and shall have properties conforming to the technical performance requirements of the finished conductor. In case, the designed maximum temperature of the offered HTLS conductor exceeds 180 deg C, ordinary zinc coating/ galvanizing of the Steel/Invar core wires shall not be accepted and only aluminium clad or Misch metal coated wires shall be permitted. Bidder shall furnish properties and composition of the core wire strand(s) in the GTP.

The zinc used for galvanizing in case of steel /invar core shall be electrolytic High Grade Zinc of 99.95% purity. It shall conform to and satisfy all the requirements of IS: 209. The minimum mass of zinc coating shall be as per requirements of Class-1 coating as per IEC-888. Zinc-5% Aluminium –Mischmetal alloy coating, if used, shall conform to and satisfy all the requirements of ASTM B 803 / B 958. The aluminium cladding of invar/ steel wires shall be with aluminum having purity not less than 99.5 % and shall be thoroughly bonded to the core wire strand(s). The minimum thickness of aluminium cladding shall be 0.07mm to achieve a minimum conductivity of 14% of International Annealed Copper Standard (IACS).

Where composite material for core is offered, the material shall be either of High strength grade or extra high strength grade as per ASTM B987. The materials shall be of such proven quality that its properties are not adversely influenced by the normal operating conditions of a 220 kV transmission line in tropical environment conditions as experienced by the existing line. The bidder shall provide adequate details including specifications/test reports/operating experience details/performance certificates etc. in support of the suitability of the offered materials.

1.9 Conductor Length

- 1.9.1 The standard length of the conductor shall be indicated in the guaranteed technical particulars of offer. A tolerance of +/-5% on the standard length offered by the Bidder shall be permitted. Standard Length shall not be more than 2500 meters. All lengths outside this limit of tolerance shall be treated as random lengths.

- 1.9.2 Random lengths will be accepted provided no length is less than 70% of the standard length and the total quantity of such random lengths shall not be more than 10% of the total quantity ordered. At no point, the cumulative quantity supplied of such random lengths shall be more than 12.5% of the total cumulative quantity supplied including such random lengths. However, the last 20% of the quantity ordered shall be supplied only in standard lengths as specified.
- 1.9.3 Bidder shall also indicate the maximum single length, above the standard length, he can manufacture in the guaranteed technical particulars of offer. This is required for special stretches like river crossing etc. The Employer reserves the right to place orders for the above lengths on the same terms and conditions applicable for the standard lengths during the pendency of the Contract.

2.0 Tests and Standards

2.1 Type Tests

2.1.1 Type Tests on Stranded Conductor/ Stranded wire

The following tests shall be conducted once on sample/samples of conductor from each manufacturing facility:

(i) On complete Conductor

- a) DC resistance test on stranded conductor : As per Annexure-A
- b) UTS test on stranded conductor : As per Annexure-A
- c) Radio interference voltage test (dry) : As per Annexure-A
- d) Corona extinction voltage test (dry) : As per Annexure-A
- e) Stress- Strain test on stranded conductor and core at room temperature : IEC 1089
- f) Stress-strain test on stranded conductor and core at elevated temperature :As per Annexure-A
- g) High temperature endurance & creep test on stranded conductor : As per Annexure-A

- h) Sheaves Test : As per Annexure-A
- i) Axial Impact Test : As per Annexure-A
- j) Radial Crush Test : As per Annexure-A
- k) Torsional Ductility Test : As per Annexure-A
- l) Aeolian Vibration : As per Annexure-A
- m) Temperature Cycle Test : As per Annexure-A
- (ii) **On Conductor Strand/core**
 - a) Heat resistance test on Aluminium Alloy strands or core : As per Annexure-A
 - b) Bending test on core : As per Annexure-A
 - c) Compression test on core : As per Annexure-A
 - d) Coefficient of linear expansion on core/ core strands : As per Annexure-A
 - e) Strand Brittle fracture Test (for polymer composite core only) : As per Annexure-A
 - f) **Galvanic protection barrier layer thickness test (on polymer composite core) as per ASTM B987**

Type tests specified above shall not be required to be carried out if a valid test certificate is available for the offered design **with validity of the certificate in line with CEA guidelines**. The tests conducted earlier should have 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 the representative (s) of DTL or Utility. In the event of any discrepancy in the test report (i.e., any test report not applicable due to any design / material/manufacturing process change including substitution of components or due to non-compliance with the requirement stipulated in the

Technical Specification) the tests shall be conducted by the Contractor at no extra cost to the Employer/ Purchaser.

2.2 Acceptance Tests

- a) Visual and dimensional check on drum : As per Annexure-A
- b) Visual check for joints scratches etc. and length measurement of conductor by rewinding : As per Annexure-A
- c) Dimensional check on core strands/composite core and Aluminium Alloy strands : As per Annexure-A
- d) Check for lay-ratios of various layers : As per Annexure-A
- e) Galvanizing test on core strands **(If applicable)** : As per Annexure-A
- f) aluminum thickness on aluminium clad wires
- g) Torsion and Elongation tests on core strands/composite core : As per Annexure-A
- h) Breaking load test on core strands and Aluminium / Aluminium Alloy strands : As per Annexure-A
- i) Wrap test on core strands and Aluminium Alloy strands : As per IEC:888 & IEC:889
- j) Minimum conductivity test on thermal resistant Aluminium Alloy strands : As per IEC : 889 and IEC: 468

- k) Procedure qualification test on welded joint of Aluminium Alloy strands : As per Annexure-A
- l) Heat resistance test on Aluminium Alloy strands : As per Annexure-A
- m) Ageing test on filler (if applicable) : As per Annexure-A
- n) Minimum conductivity test on aluminium clad core strands : As per Annexure-A
- o) Glass transition temperature test (for polymer composites only) : As per Annexure-A
- p) Flexural Strength test (for polymer composites only) : As per Annexure-A
- q) Bending Test on composite core : As per Annexure-A
- r) Galvanic protection barrier layer thickness test (on polymer composite core) as per ASTM B987
- s) Coating test on zinc – 5% Al-Mischmetal alloy coating (if applicable) : As per ASTM B803 / B958
- t) Adherence of Coating Test on Zinc – 5% Al - Mischmetal alloy Coating (if applicable) : As per ASTM B803 / B958

Note: All the above tests except (k) shall be carried out on Aluminium / Aluminium Alloy and core strands after stranding only.

2.3 Routine Test

- a) Check to ensure that the joints are as per Specification
- b) Check that there are no cuts, fins etc., on the strands.

- c) Check that drums are as per Specification
- d) All acceptance tests as mentioned above to be carried out on 10% of drums.

2.4 Tests During Manufacture

- a) Chemical analysis of zinc used for galvanizing : As per Annexure-A
- b) Chemical analysis of Aluminium alloy used for making Aluminium Alloy strands : As per Annexure-A
- c) Chemical analysis of core strands (not on polymer composite core) : As per Annexure-A

2.5 Testing Expenses

- 2.5.1 No type test charges shall be payable to the supplier.
- 2.5.2 Bidder shall indicate the laboratories in which they propose to conduct the type tests. They shall ensure that adequate facilities are available in the laboratories and the tests can be completed in these laboratories within the time schedule guaranteed by them.
- 2.5.3 In case of failure in any type test the Supplier is either required to manufacture fresh sample lot and repeat the entire test successfully once or repeat that particular type test three times successfully on the sample selected from the already manufactured lot at his own expenses. In case a fresh lot is manufactured for testing then the lot already manufactured shall be rejected.
- 2.5.4 The entire cost of testing for the acceptance and routine tests and Tests during manufacture specified herein shall be treated as included in the quoted unit price of conductor, except for the expenses of the inspector/Employer's representative.
- 2.5.5 In case of failure in any type test, if repeat type tests are required to be conducted, then all the expenses for deputation of Inspector/Employer's representative shall be deducted from the contract price. Also if on receipt of the Supplier's notice of testing, the Employer's representative does not find material/ testing facilities to

be ready for testing the expenses incurred by the Employer for re-deputation shall be deducted from contract price.

- 2.5.6 The Supplier shall intimate the Employer about carrying out of the type tests alongwith detailed testing programme at least 3 weeks in advance (in case of testing in India) and at least 6 weeks in advance (in case of testing abroad) of the schedule date of testing during which the Employer will arrange to depute his representative to be present at the time of carrying out the tests.

2.6 Additional Tests

- 2.6.1 The Employer reserves the right of having at his own expenses any other test(s) of reasonable nature carried out at Supplier's premises, at site or in any other place in addition to the aforesaid type, acceptance and routine tests to satisfy himself that the materials comply with the Specifications.
- 2.6.2 The Employer also reserves the right to conduct all the tests mentioned in this specification at his own expense on the samples drawn from the site at Supplier's premises or at any other test centre. In case of evidence of non compliance, it shall be binding on the part of Supplier to prove the compliance of the items to the technical specifications by repeat tests, or correction of deficiencies, or replacement of defective items all without any extra cost to the Employer.

2.7 Sample Batch For Type Testing

- 2.7.1 The Supplier shall offer material for selection of samples for type testing only after getting Quality Assurance Plan approved from Employer's Quality Assurance Deptt. The sample shall be manufactured strictly in accordance with the Quality Assurance Plan approved by Employer.
- 2.7.2 The Supplier shall offer at least three drums for selection of sample required for conducting all the type test.
- 2.7.3 The Supplier is required to carry out all the acceptance tests successfully in presence of Employer's representative before sample selection.

2.8 Test Reports

- 2.8.1 Copies of type test reports shall be furnished in at least three copies along with one original. One copy will be returned duly certified by the Employer only after which the commercial production of the material shall start.
- 2.8.2 Record of routine test reports shall be maintained by the Supplier at his works for periodic inspection by the Employer's representative.
- 2.8.3 Test Certificates of tests during manufacture shall be maintained by the Supplier. These shall be produced for verification as and when desired by the Employer.

2.9 Inspection

- 2.9.1 The Employer's representative shall at all times be entitled to have access to the works and all places of manufacture, where conductor shall be manufactured and representative shall have full facilities for unrestricted inspection of the Supplier's works, raw materials and process of manufacture for conducting necessary tests as detailed herein.
- 2.9.2 The Supplier shall keep the Employer informed in advance of the time of starting and of the progress of manufacture of conductor in its various stages so that arrangements can be made for inspection.
- 2.9.3 No material shall be dispatched from its point of manufacture before it has been satisfactorily inspected and tested, unless the inspection is waived off by the Employer in writing. In the later case also the conductor shall be dispatched only after satisfactory testing for all tests specified herein have been completed.
- 2.9.4 The acceptance of any quantity of material shall in no way relieve the Supplier of any of his responsibilities for meeting all requirements of the Specification, and shall not prevent subsequent rejection if such material is later found to be defective.

2.10 Test Facilities

- 2.10.1 The following additional test facilities shall be available at the Supplier's works:
- a) Calibration of various testing and measuring equipment including tensile testing machine, resistance measurement facilities, burette, thermometer, barometer etc.

- b) Standard resistance for calibration of resistance bridges.
- c) Finished conductor shall be checked for length verification and surface finish on separate rewinding machine at reduced speed (variable from 8 to 16 meters per minute). The rewinding facilities shall have appropriate clutch system and free of vibrations, jerks etc. with traverse laying facilities.

2.11 Packing

- 2.11.1 The conductor shall be supplied in non-returnable, strong, wooden/painted steel/hybrid (painted steel cum wood) drums provided with lagging of adequate strength, constructed to protect the conductor against all damage and displacement during transit, storage and subsequent handling and stringing operations in the field. The Supplier shall select suitable drums for supply of conductor and shall be responsible for any loss or damage to conductor and/or drum during transportation handling and storage due to improper selection of drum or packing. The drums shall generally conform to IS:1778, except as otherwise specified hereinafter.
- 2.11.2 The drums shall be suitable for wheel mounting and for letting off the conductor under a minimum controlled tension of the order of 5 kN.
- 2.11.3 The Bidder should submit their proposed drum drawings along with the bid.
- 2.11.4 One standard length only shall be wound on each drum.
- 2.11.5 The conductor ends shall be properly sealed and secured on the side of one of the flanges to avoid loosening of the conductor layers during transit and handling.
- 2.11.6 All wooden components shall be manufactured out of seasoned soft wood free from defects that may materially weaken the component parts of the drums. Preservative treatment shall be applied to the entire drum with preservatives of a quality which is not harmful to the conductor.
- 2.11.7 The flanges shall be of two ply construction with each ply at right angles to the adjacent ply and nailed together. The nails shall be driven from the inside face flange, punched and then clenched on the outer face. The thickness of each ply shall not vary by more than 3mm from that indicated in the figure. There shall be

at least 3 nails per plank of ply with maximum nail spacing of 75mm. Where a slot is cut in the flange to receive the inner end of the conductor the entrance shall be in line with the periphery of the barrel.

- 2.11.8 The wooden battens used for making the barrel of the conductor shall be of segmental type. These shall be nailed to the barrel supports with at least two nails. The battens shall be closely butted and shall provide a round barrel with smooth external surface. The edges of the battens shall be rounded or chamfered to avoid damage to the conductor.
- 2.11.9 Barrel studs shall be used for the construction of drums. The flanges shall be holed and the barrel supports slotted to receive them. The barrel studs shall be threaded over a length on either end, sufficient to accommodate washers, spindle plates and nuts for fixing flanges at the required spacing.
- 2.11.10 Normally, the nuts on the studs shall stand protruded of the flanges. All the nails used on the inner surface of the flanges and the drum barrel shall be counter sunk. The ends of barrel shall generally be flushed with the top of the nuts.
- 2.11.11 The inner cheek of the flanges and drum barrel surface shall be painted with a bitumen based paint.
- 2.11.12 Before reeling, card board or double corrugated or thick galvanized water-proof bamboo paper shall be secured to the drum barrel and inside of flanges of the drum by means of a suitable commercial adhesive material. After reeling the conductor, the exposed surface of the outer layer of conductor shall be wrapped with water proof thick galvanized bamboo paper to preserve the conductor from dirt, grit and damage during transport and handling.
- 2.11.13 A minimum space of 75 mm for conductor shall be provided between the inner surface of the external protective tagging and outer layer of the conductor.
- 2.11.14 Each batten shall be securely nailed across grains as far as possible to the flange, edges with at least 2 nails per end. The length of the nails shall not be less than twice the thickness of the battens. The nails shall not protrude above the general surface and shall not have exposed sharp, edges or allow the battens to be released due to corrosion.

- 2.11.15 The nuts on the barrel studs shall be tack welded on the one side in order to fully secure them. On the second end, a spring washer shall be used.
- 2.11.16 A steel collar shall be used to secure all barrel studs. This collar shall be located between the washers and the steel drum and secured to the central steel plate by welding.
- 2.11.17 Outside the protective lagging, there shall be a minimum of two binders consisting of hoop iron/ galvanized steel wire. Each protective lagging shall have two recesses to accommodate the binders.
- 2.11.18 As an alternative to wooden drum, Bidder may also supply the conductors in returnable/ non-returnable painted steel drums. After preparation of steel surface according to IS:9954, synthetic enamel paint shall be applied after application of one coat of primer. Wooden/Steel drum will be treated at par for evaluation purpose and accordingly the Bidder should quote in the package.
- 2.11.19 In case of returnable steel drums for conductor, following clauses shall apply:
- (a) The ownership of the empty conductor drums shall lie with the conductor supplier who shall ultimately take back the empty conductor drum from the Project site(s) from the erection contractor's designated stores after the running out of conductor from the drum.
 - (b) The erection contractor shall intimate the Conductor supplier and Employer regarding empty steel drums at their designated stores.
 - (c) Necessary coordination for taking back the empty steel drums in this regard shall be done by the Conductor Supplier with the erection Contractor.
 - (d) The empty drum shall be taken back by the conductor supplier from the stores of erection contractor as & when these are available after usage of conductor. Conductor supplier shall be required to take back the empty steel drum within a period of one month from date of information by erection contractor regarding availability of the drums at erection contractor stores. However, 2% of the total drums shall not be returned to the conductor supplier as these may be used for storage of spare conductor by the Purchaser.

- (e) The steel drums may get damage and wear & tear due to transportation, normal handling & operation at site, which shall be rectified by the conductor supplier before re-use. However, 2% of the total drums shall not be returned on account of damages / wastage for which no compensation will be payable. The wastage beyond 2% shall be reimbursed by Erection Contractor. Thus, 4% of total drums shall not be returnable to the conductor supplier.

2.11.20 As an alternative to outer wooden lagging, in case of returnable/ non-returnable steel drums, solid polypropylene sheet (of min 5mm thickness) can be used for outer covering of conductor. In case of PP sheets are proposed to be used by the supplier, the conductor supplier shall supply two nos. additional binders per drum for re-wrapping PP sheet with each lot of conductor and 5 nos. crimping machines with the first lot of conductor for crimping the binders at site.

2.11.21 **Marking**

Each drum shall have the following information stenciled on it in indelible ink along with other essential data:

- (a) Contract/Award letter number.
- (b) Name and address of consignee.
- (c) Manufacturer's name and address.
- (d) Drum number
- (e) Size of conductor
- (f) Length of conductor in meters
- (g) Arrow marking for unwinding
- (h) Position of the conductor ends
- (i) Distance between outer-most Layer of conductor and the inner surface of lagging.
- (k) Barrel diameter at three locations & an arrow marking at the location of the measurement.

- (l) Number of turns in the outer most layer.
- (m) Gross weight of drum after putting lagging.
- (n) Tear weight of the drum without lagging.
- (o) Net weight of the conductor in the drum.
- (p) CIP/MICC No.

The above should be indicated in the packing list also.

2.12 Verification of Conductor Length

The Employer reserves the right to verify the length of conductor after unreeling at least ten (10) percent of the drums in a lot offered for inspection.

2.13 Standards

2.13.1 The conductor shall conform to the following Indian/International Standards, which shall mean latest revisions, with amendments/changes adopted and published, unless specifically stated otherwise in the Specification.

2.13.2 In the event of the supply of conductor conforming to standards other than specified, the Bidder shall confirm in his bid that these standards are equivalent to those specified. In case of award, salient features of comparison between the standards proposed by the Supplier and those specified in this document will be provided by the Supplier to establish their equivalence.

Sl. No.	Indian/International Standard	Title
1.	IS: 209-1992	Zinc Ingot – specification
2.	IS: 398-1982	Aluminium conductors for overhead transmission purposes- specification
3.	IS:398-1990 Part-II	Aluminum Conductor Galvanised Steel Reinforced
4.	IS:398- 1992 Part V	Aluminium conductor – Galvanized steel

		Reinforced for Extra High Voltage (400kV and above)
5	IS : 1778-1980	Specification for Reels and Drums for Bare Conductors
6	IS : 1521-1991	Method of Tensile Testing of Steel Wire
7	IS : 2629-1990	Recommended Practice for Hot Dip Galvanising of Iron and Steel
8.	IS : 2633-1992	Method of Testing Uniformity of Coating on Zinc Coated Articles
9.	IS : 4826-1992	Hot dipped Galvanised Coating on Round Steel Wires
10.	IS : 6745-1990	Methods of Determination of Weight of Zinc Coating of Zinc Coated Iron and Steel Articles
11.	IS : 8263-1990	Method of Radio Interference Tests on High Voltage Insulators
12.	IS : 9997-1988	Aluminium Alloy Redraw Rods for electrical purposes – specification
13.	IEC :888-987	Zinc Coated steel wires for stranded Conductors
14.	IEC:889-1987	Hard drawn Aluminium wire for overhead line conductors
15.	IS:398 (Part-IV)	Aluminium Alloy stranded conductor
16.	IEC:1232	Aluminium clad steel wires
17.	IEC: 468	Method of measurement of resistivity of metallic materials
18.	IEEE738	Standard for calculating the current temperature relationship of bare overhead

		conductors
19.	IEC62004	Thermal resistant aluminium alloy wire for overhead line conductor.
20.	ASTM B498	Standard specification for zinc coated steel core wire for use in overhead electrical conductors
21.	ASTM B606	Standard specification for high strength zinc coated steel core wire for aluminium and aluminium alloy conductors , steel reinforced.
22.	ASTM B502	Standard specification for aluminium clad steel core wire for use in overhead electrical aluminium conductors
23.	ASTM B388	Standard specification for thermostat metal sheet and strip
24.	ASTM B753	Standard specification for thermostat component alloys
25.	ASTM A856	Standard specification of zinc- 5% Aluminium Misch metal alloy coated carbon steel wire.
26.	ASTM A857	Steel sheet piling , cold formed , light gauge.
27.	ASTM B230	Aluminium 1350-H19 wire for electrical purposes.
28.	ASTM B398	Aluminium alloy 6201-T81 and 6201-T83 wire for electrical purposes.
29.	ASTM B609	Aluminium 1350 round wire, annealed and intermediate tempers for electrical purpose.
30.	SS 424 0813	Aluminium alloy wire for stranded conductors for overhead lines – Al-59 wire

31.	SS 424 0814	Aluminium alloy stranded conductors for overhead lines – Al-59 wire
32.	BS EN 50540	Conductor for overhead lines . (ACSS)
33.	ASTM B941	Heat resistant Al-zirconium alloy wire for electrical purposes
34.	ASTM B 957	Extra high strength and ultra high strength zinc coated steel core wire for overhead electrical conductors.
35.	ASTM B 802	Standard specification of zinc- 5% Aluminium Misch metal alloy coated steel core wire for aluminium conductors , steel reinforced.
36.	ASTM B 958	Extra high strength and ultra high strength class-A zinc 5% aluminium mischmetal alloy coated steel core wire for overhead electrical conductors.
37.	ASTM B 976	Fibre reinforced aluminium matrix composite (AMC) core wire for aluminium conductors , composite reinforced
38.	ASTM B 987-17	Carbon fiber thermoset polymer matrix composite core (CFC) for use in overhead electrical conductors.
39	ASTM- B117	Applicable for salt spray test.

Note: GTP of HTLS conductor is at Schedule-1, technical particulars as Annexure-1 and Test methods as Annexure-A

1. Tests on Conductor

1.1 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 5 m length between fixing arrangement suitably fixed by appropriate fittings on a tensile testing machine. 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 steady rate to minimum 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.

Note: The test is to be conducted at ambient temperature, between minimum and maximum ambient temperature of 0 deg C and 50 deg C respectively.

- b) UTS Test on Stranded Conductor at elevated temperature UTS Test on Stranded Conductor shall be conducted as per clause no. 1.1(a) specified above keeping conductor temperature at the designed maximum temperature.

1.2 Corona Extinction Voltage Test

The sample of the conductor of 5 m length shall be strung at a height not exceeding 7.01 m above ground. The sample assembly when subjected to power frequency voltage shall have a corona extinction voltage of not less than 154 kV (rms) line to ground under dry condition. There shall be no evidence of corona on any part of the samples. The test should be conducted without corona control rings. However, small corona control rings may be used to prevent corona in the end fittings. The voltage should be corrected for standard atmospheric conditions.

1.3 Radio Interference Voltage Test

Under the conditions as specified under (1.2) above, the conductor sample shall have radio interference voltage level below 1000 micro volts at one MHz when subjected to 50 Hz AC voltage of 154 kV line to ground under dry conditions. This test may carried out with corona control rings and arcing horns.

1.4 D.C. Resistance Test on Stranded Conductor

On a conductor 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 or using micro ohm meter of suitable accuracy 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 as per IS:398-(Part-IV)/(Part-V). The resistance corrected at 20deg C shall conform to the requirements of this Specification.

1.5 Stress-strain test at elevated temperature

Stress-strain test as per IEC-61089 shall be conducted keeping conductor temperature at designed maximum temperature (i.e. at the designed maximum steady state conductor temperature corresponding to desired ampacity) . UTS for this test shall be 80% of the UTS guaranteed in the GTP.

1.6 High Temperature endurance & creep test

Two conductor samples of length equal to at least $100 \times d + 2 \times a$ (where, d is the conductor diameter and a is the distance between the end fitting and the gauge length) shall be strung at tension equal to 25 % of conductor UTS. The distance, a, shall be at least 25 % of the gauge length or 2 m whichever is the smaller. The conductor samples shall be subjected to tests as indicated below:

- (i) On one of the conductor samples, the conductor temperature shall be maintained at 20 deg C for 1000 hours. The elongation/creep strain of the conductor during this period shall be measured and recorded at end of 1 hour, 10 hour, 100 hour and subsequently every 100 hour up to 1000 hours' time period.
- (ii) On other conductor sample, the conductor temperature shall be increased to designed maximum temperature in steps of 20 deg. C and thermal elongation of the conductor sample shall be measured & recorded at each step. The temperature shall be held at each step for sufficient duration for stabilization of temperature. Further, the temperature of the conductor shall be maintained at designed maximum temperature +10 Deg. C for 1000 hours. The elongation/creep strain of the conductor during this period shall be measured and recorded at end of 1 hour, 10 hour, 100 hour and subsequently every 100 hour up to 1000 hours time period. After completion of the above, the core of the conductor sample shall be subjected to UTS test as mentioned above at clause 1.1. The conductor core shall withstand a load equivalent to 95 % of UTS. In case of polymer composite core conductor, the flexural strength & glass transition temperature of the core shall also be evaluated and the same shall not be

degraded by more than 10 % over the initial value. The supplier shall plot the thermal elongation with temperature.

The supplier shall furnish details of creep characteristic in respect of the conductor based on laboratory test and other laboratory investigations/experimental conducted on similar type of conductor and shall indicate creep strain values corresponding to 1 month, 6 month, 1 year, 10 year & 20 year creep at everyday tension & designed maximum temperature as well as room temperature.

1.7 Sheaves Test

The conductor sample of minimum length of 35 meter shall be tensioned at 25 % of the UTS and shall be passed through pulleys having diameter of 32 times that of the conductor with angle of 20 deg. between the pulleys. The conductor shall be passed over the pulleys 36 times at a speed of 2 m/sec. After this test UTS test on the conductor shall be carried out as mentioned above at clause 1.1. In case of polymer composite core conductors, the core shall be inspected for any sign of damage or cracking through dye penetration test as per ASTM D5117.

1.8 Axial Impact Test

The conductor sample shall be suspended vertically and load applied by dropping a 650 Kg from an elevation of 4 meters above the sample. The impact velocity shall not be less than 8 m/sec. with an initial pre-tension of 200 kgs. The curve for load vs time shall be recorded and recorded load of failure for core shall not be less than UTS of core.

1.9 Radial Crush Test

A section of conductor is to be crushed between two six inch steel platens. Load shall be held at 350 Kgs for 1 minute and then released. All the strands shall be subsequently disassembled and tensile tested. All the strands shall exhibit full strength retention.

1.10 Torsional Ductility Test

The conductor sample of 10-15m shall be loaded to 20% of UTS and then rotated in increasing steps of +/- 180 degrees. The entire conductor shall withstand at least 16 such rotation and there shall not be any damage to Aluminium Alloy or core wires. In case of composite core conductors, after 4 rotations or after separation of aluminium strands, the aluminium wires shall be cut and removed from the conductor and the exposed core shall be twisted and shall withstand up to 16 rotations.

1.11 Aeolian Vibration Test

The conductor and supporting hardware shall be loaded to 25% of RTS (rated tensile strength). A dynamometer, load cell, calibrated beam or other device shall be used to measure the conductor tension. Some means should be provided to maintain constant tension to allow for temperature fluctuations during the testing. The overall span between system terminations shall be a minimum of 30 m. The span shall be supported at a height such that the static sag angle of the cable to horizontal is (1.5 ± 0.5) deg in the active span. Means shall be provided for measuring and monitoring the mid-loop (antinode) vibration amplitude at a free loop, not a support loop. An electronically controlled shaker shall be used to excite the conductor in the vertical plane. The shaker armature shall be securely fastened to the conductor so it is perpendicular to the conductor in the vertical plane. The shaker should be located in the span to allow for a minimum of six vibration loops between the suspension assembly and the shaker.

The test shall be carried out at one or more resonance frequencies (more than 10 Hz). The amplitude at the antinode point shall be one third of conductor diameter. The assembly shall be vibrated for not less than 10 million cycles without any failure. After the test, the conductor should not exhibit any damage (broken strands). The conductor shall be tested to demonstrate that it retains at least 95% RTS.

1.12 Temperature Cycle Test

The purpose of this test is verification of degradation characteristics of metallic and non-metallic material when subjected to thermal cycling. Temperature cycling can create large internal stresses due to thermal expansion mismatch between constituents.

Test Methods:-

- Mechanical tension, 20 % RBS (rated breaking strength), marks on the conductor at the edge of the conductor
- 100 cycles from room temperature up to **designed** maximum temperature. Hold at **Designed maximum temperature + 2.5 deg. C for 05 minutes.**
- **After the above mentioned 100 cycle** , Mechanical tension up to 70 % RBS at room temperature during 24 H and release to 20 % RBS.
- This cycling test shall be repeated 5 times.
- During the test, temperature of connectors, conductor and resistance are recorded according to ANSI C 119.
- A breaking load test is applied at the end of the test. Conductor strength has to be higher than 95 % UTS.
- In case of polymer composites, the flexural strength should not degrade by more than 10 % and the Glass Transition temperature shall not degrade by more than 10 % after thermal cycling. Flexural strength shall be obtained on the basis of test procedure indicated **at 1.32** below.

1.13 Heat Resistance test on Aluminium Alloy wire

Breaking load test as per clause 1.25 shall be carried out before and after heating the sample in uniform heat furnace at following temperature for one hour. The breaking strength of the wire after heating shall not be less than the 90% of the breaking strength before heating.

Maximum continuous operating temperature of the conductor	Test Temperature
Up to 150 deg. C	230 deg. C(+5/-3 deg C)
More than 150 & up to 210 deg. C	280 deg. C(+5/-3 deg C)
More than 210 & up to 230 deg. C	400 deg. C(+5/-3 deg C)

1.14 Bending test on aluminium clad core strand

A sample of aluminium clad invar strand measuring 30 cm in length shall be subject to bending with help of a vise. The vised length of wire should be 5 cm and radius of bend 4.8 mm. The bending should be first 90 degrees left and 90 degree right. After this operation the strand should cut at the bending point. There should be no separation of core and aluminium at the bending point after this operation.

1.15 Compression test on aluminium clad strand

A sample of aluminium clad core strand 10 mm in length is to be compressed by a plate with a load of 3600 kgs. The aluminium and core strand should not break.

1.16 Coefficient of linear expansion for core/core strands

The temperature and elongation on a sample shall be continuously measured and recorded at interval of approximately 15 degree C from 15 degree C to maximum continuous operating temperature corresponding to rated current **as per Annexure-1** by changing the temperature by suitable means. Coefficient of linear expansion shall be determined from the measured results.

1.17 Strand Brittle fracture test (for polymer composite core only)

The sample shall be tensioned with simultaneous application of 1N-HNO₃ acid directly in contact with naked polymer composite core. 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.

1.18 Visual and Dimensional Check on Drums

The drums shall be visually and dimensionally checked to ensure that they conform to the approved drawings.

1.19 Visual Check for Joints, Scratches etc.

Conductor drums shall be rewound in the presence of the Employer. The Employer shall visually check for scratches, joints etc. and that the conductor generally conform to the requirements of this Specification. Ten percent (10%) drums from each lot shall be rewound in the presence of the Employer's representative.

1.20 Dimensional Check on Core Strands and Aluminium Alloy Strands

The individual strands shall be dimensionally checked to ensure that they conform to the requirement of this Specification.

1.21 Check for Lay-ratios of Various Layers

The lay-ratios of various layers shall be checked to ensure that they conform to the guaranteed values furnished by the Contractor.

1.22 Galvanizing Test

The test procedure shall be as specified in IEC: 888. 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.

1.23 Aluminum thickness on aluminum clad wires

The thickness of aluminium of the specimen shall be determined by using suitable electrical indicating instruments operating on the permeameter principle, or direct measurement. Measurements shall be read to three decimal places, and number rounded to two decimal places is considered as measured thickness. For reference purposes, direct measurement shall be used to determine aluminium thickness on specimens taken from the end of the coils.

1.24 Torsion and Elongation Tests on Core Strands/ Composite core

The test procedures for Torsion and Elongation Tests on Core wires shall be as per clause No. 6.3.3 and 6.3.2 b) of IEC 61232 respectively. In torsion test, the number of complete twists before fracture shall not be less than the value specified in the GTP on a length equal to 100 times the standard diameter of the strand. 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 at fracture of the strand shall not be less than the value specified in the GTP for a gauge length of 250 mm. In case of composite core HTLS conductor, the following procedure shall be applicable:

(i) Elongation Test: The elongation of the composite core sample at shall be determined using extensometer. The load along the core shall be gradually increased. The elongation achieved on reaching the tensile strength of the core shall not be less than the value guaranteed in the GTP.

(ii) Torsion Test: The purpose of the test is to determine the resilience of the composite core to twisting and to show that after the composite core has experienced the prescribed twisting, it will not crack or have a loss in tensile strength due to the twisting. A sample length that is 170 times the diameter of the composite core being tested is mounted in the gripping fixtures. One grip shall then be fixed so that it does not twist and the other end shall be twisted a full 360 degrees and then fixed in this position for 2 minutes. Once the twist time is completed, the core is untwisted and inspected for any crazing or other damage. If no damage is observed, the composite core is then tensile tested to failure and the final load recorded. For the test to be accepted, the composite core must withstand at least 100% of its rated tensile strength. Two samples need to be completed in order to satisfy the testing requirement.

1.25 Breaking load test on Aluminium Alloy & Core strands and D.C Resistance test on Aluminium Alloy wire

The above tests shall be carried out as per IEC: 888/889 and the results shall meet the requirements of the specification.

1.26 Wrap test on Core strand (Applicable for steel/Al clad Steel core only)

The wrap test on steel strands shall be meeting the requirements of IEC: 888. In case of aluminium clad core wire, the same shall be wrapped around a mandrel of diameter of five times that of the strand to form a helix of eight turns. The strand shall be unwrapped. No breakage of strand shall occur.

1.27 Minimum conductivity test on thermal resistant aluminium alloy strands

Resistivity test as per IEC-468/IEC 889 shall be conducted to confirm minimum conductivity as per specification requirement.

1.28 Procedure Qualification test on welded Aluminium Alloy strands.

Two Aluminium Alloy wire 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 guaranteed breaking strength of individual strands.

1.29 Ageing Test on Filler (if applicable)

The test shall be done in accordance with Grease drop point test method. The specimen should be drop as a droplet when kept at a temperature 40 deg. C above designed maximum operating temperature of the conductor for 30 minutes. The temperature shall then be increase till one droplet drops and the temperature recorded.

1.30 Aluminium conductivity test on aluminium clad strand

Resistivity test as per IEC-468 shall be conducted to confirm minimum conductivity as per specification requirement.

1.31 Glass Transition Temperature Test (for polymer composite core only)

Test shall be conducted as per ASTM B987. The minimum glass transition temperature shall be either (i) the design maximum continuous operating temperature of the offered HTLS conductor + 35 deg C or (ii) minimum glass transition temperature as per ASTM B987 i.e.180 deg. C + 25 deg C ; Whichever is lower. In case, the design maximum continuous operating temperature of the offered HT/HTLS conductor is more than the minimum glass transition temperature as per ASTM B987 i.e. more than 180 deg. C then, the test shall be conducted as per ASTM B987 & the minimum glass transition temperature shall be the design maximum continuous operating temperature of the offered HTLS conductor + 25 deg C..

1.32 Flexural Strength Test (for polymer composite core only)

Test method shall be as per ASTM D7264, ASTM D4475 or ISO 14125. The flexural strength shall not be less than the value guaranteed in the GTP.

1.33 Chemical Analysis of Aluminium Alloy and Core

Samples taken from the Aluminium and core coils/strands shall be chemically/spectrographically analyzed. The same shall be in conformity to the particulars guaranteed by the bidder so as to meet the requirements stated in this Specification.

1.34 Chemical Analysis of Zinc

Samples taken from the zinc ingots shall be chemically/ spectrographically analyzed. The same shall be in conformity to the requirements stated in the Specification.

1.35 Bending test on polymer composite core (Type test):

Bending test on polymer composite core (CFC) before stranding shall be performed as per ASTM B987/B987M-17 on polymer composite core samples taken from composite core at conductor manufacturing unit before stranding of conductor. Alternatively Bending test on polymer composite core (CFC) before stranding may be performed at the core manufacturing unit on the samples taken from the same reel

being supplied to conductor manufacturer subject to proper traceability of the same at the conductor manufacturers works.

Bending test on polymer composite core (CFC) shall be performed as per ASTM B987/B987M-17 on polymer composite core samples taken from stranded conductor. For test after stranding the diameter of cylindrical mandrel shall be as following:

- 1) For high strength grade CFC – 60 times the diameter of CFC
- 2) For Extra high strength grade CFC – 70 times the diameter of CFC

1.36 Bending test on polymer composite core (Acceptance test):

Bending test on polymer composite core (CFC) shall be performed as per ASTM B987/B987M-17 on polymer composite core samples taken from stranded conductor. For test after stranding the diameter of cylindrical mandrel shall be as following:

- 1) For high strength grade CFC – 60 times the diameter of CFC
- 2) For Extra high strength grade CFC – 70 times the diameter of CFC

Technical Requirements of High Temperature Low Sag (HTLS) Conductor for 220kV lines

The offered HTLS conductor shall meet the following technical requirement:

S.NO.	Parameters	Requirements.
A)	Electrical Requirements	
1	Minimum Current carrying capacity/Ampacity At Maximum Design Continuous Operating Temperature (A)	1200
2	Maximum DC Resistance at 20 ⁰ C (Ohm/km)	≤0.06868
B)	Physical Dimension Requirements	
1	Overall diameter of complete conductor	
a)	Minimum (mm)	25
b)	Maximum (mm)	28.62
2)	Nominal mass of complete conductor (kg/km)	≤ 1621
3)	Direction of lay of outer layer	Right Hand
C)	Sag Tension Requirements for HTLS conductor for compatibility with lattice towers	
1)	Tension of HTLS at knee point temperature & no wind condition (kg)	No exceeding 40% of UTS of core @ of proposed HTLS conductor.
2)	Tension at every day condition (32°C, no wind)	≤ 25% of UTS of proposed conductor
3)	Tension at 32°C, full wind (kg/m ²)	≤ 70% of UTS of proposed conductor
4)	Tension at designed maximum temperature and no wind condition	Not exceeding 25% of UTS at designed maximum temperature ((i.e. at the designed maximum steady state conductor temperature corresponding to

		desired ampacity)
5)	Tension at designed maximum temperature and full wind	not exceeding 70% of UTS at designed maximum temperature (i.e. at the designed maximum steady state conductor temperature corresponding to desired ampacity) of proposed conductor

Sag Details of Narrow based Towers with span length of 225M

S.No.	Temperature & wind condition	Conductor (ACSR Zebra)	Ground wire (19/2.50MM, Grade-3, 1100N/mm2)
1	0 ⁰ C & still wind	2.814m	2.532m
2	32 ⁰ C & still wind	3.783m	3.117m
3	65 ⁰ C/ 50 ⁰ C & still wind	4.808m	3.469m
4	0 ⁰ C & 2/3 rd full wind	2.665m	2.425m
5	32 ⁰ C & full wind	3.229m	2.765m

Sag Details of broad based Towers with span length of 320M

S.No.	Temperature & wind condition	Conductor (ACSR Zebra)	Ground wire (19/2.50MM, Grade-3, 1100N/mm2)
1	5 ⁰ C & still wind	5.173m	4.656m
2	32 ⁰ C & still wind	6.245m	5.310m
3	67 ⁰ C & still wind	7.626m	5.757m
4	5 ⁰ C & 2/3 rd full wind	5.558m	5.010m
5	32 ⁰ C & full wind	6.898m	5.956m

Note :

1. In case more than one sag tension conditions are specified in the above table, Bidder shall offer only one design of HTLS conductor, which shall comply with all the above sag- tension requirements.
2. @ UTS of core of HTLS conductor shall be equal to the Breaking strength of individual core wires before stranding x No. of wires in the core of offered conductor.
3. The above sag details are indicative and the bidder shall submit complete sag tension details as per scheme requirement with respect to the line being reconductored with calculations with the bid for evaluation during detailed engineering.

Technical Specifications of Hardware fittings and accessories for HTLS conductors (For 400kV and 220kV overhead lines)

1. Technical Description of Hardware Fittings

1.1 General

This section details technical particulars of fittings viz. suspension clamps and compression type dead end clamps for the HTLS Conductor to be supplied by the bidder. Each fitting shall be supplied complete in all respects.

- 1.2 The fittings shall be suitable for attachment to suspension and tension insulator strings along with hardware fittings and shall include 2.5 % extra fasteners and Aluminium filler plugs. The supplier shall be responsible for satisfactory performance of complete conductor system along with fittings offered by them for continuous operation at the designed maximum temperature specified by them for the conductor.

1.3 Corona and RI Performance

Sharp edges and scratches on all the hardware fittings shall be avoided. All surfaces must be clean, smooth, without cuts and abrasions or projections. The Supplier shall be responsible for satisfactory corona and radio interference performance of the materials offered by him.

1.4 Maintenance

- 1.4.1 The hardware fittings offered shall be suitable for employment of hot line maintenance technique so that usual hot line operations can be carried out with ease, speed and safety. The technique adopted for hot line maintenance shall be generally bare hand method & hot stick method.

1.5 Split Pins

- 1.5.1 Split pins shall be used with bolts & nuts.

1.6 Suspension Assembly

- 1.6.1 The suspension assembly shall be suitable for the HTLS Conductor, the bidder intends to supply. The technical details of the conductor shall be as proposed by the bidder.
- 1.6.2 The suspension assembly shall include either free centre type suspension clamp along with standard preformed armour rods or armour grip suspension clamp.
- 1.6.3 The suspension clamp along with standard preformed armour rods set shall be designed to have maximum mobility in any direction and minimum moment of inertia so as to have minimum stress on the conductor in the case of oscillation of the same.

- 1.6.4 The suspension clamp suitable for various type of Conductor along with standard preformed armour rods/armour grip suspension clamp set shall have slip strength in conformity with relevant Indian/International Standards.
- 1.6.5 The suspension clamp shall be designed for continuous operation at the temperature specified by the bidder for conductor.
- 1.6.6 The suspension assembly shall be designed, manufactured and finished to give it a suitable shape, so as to avoid any possibility of hammering between suspension assembly and conductor due to vibration. The suspension assembly shall be smooth without any cuts, grooves, abrasions, projections, ridges or excrescence which might damage the conductor.
- 1.6.7 The suspension assembly/clamp shall be designed so that it shall minimize the static & dynamic stress developed in the conductor under various loading conditions as well as during wind induced conductor vibrations. It shall also withstand power arcs & have required level of Corona/RIV performance.
- 1.6.8 **Free Centre Type Suspension Clamp**
For the Free Centre Suspension Clamp seat shall be smoothly rounded and curved into a bell mouth at the ends. The lip edges shall have rounded bead. There shall be at least two U-bolts for tightening of clamp body and keeper pieces together.
- 1.6.9 **Standard Preformed Armour Rod Set**
- 1.6.9.1 The Preformed Armour Rods Set shall be used to minimize the stress developed in the sub-conductor due to different static and dynamic loads because of vibration due to wind, slipping of conductor from the suspension clamp as a result of unbalanced conductor tension in adjacent spans and broken wire condition. It shall also withstand power arcs, chafing and abrasion from suspension clamp and localized heating effect due to magnetic power losses from suspension clamps as well as resistance losses of the conductor.
- 1.6.9.2 The preformed armour rods set shall have right hand lay and the inside diameter of the helics shall be less than the outside diameter of the conductor to have gentle but permanent grip on the conductor. The surface of the armour rod when fitted on the conductor shall be smooth and free from projections, cuts and abrasions etc.
- 1.6.9.3 The pitch length of the rods shall be determined by the Bidder but shall be less than that of the outer layer of conductor and the same shall be accurately controlled to maintain uniformity and consistently reproducible characteristic wholly independent of the skill of linemen.
- 1.6.9.4 The length and diameter of each rod shall be furnished by the bidder in the GTP. The tolerance in length of the rods between the longest and shortest rod in complete set should be within the limits specified in relevant Indian/International Standards. The ends of armour rod shall be parrot billed.
- 1.6.9.5 The length and diameter of each rod shall be specified in the GTP. The tolerance in length of the rods in complete set should be within 13 mm between the longest and shortest rod. The ends of armour rod shall be parrot billed.

- 1.6.9.6 The number of armour rods in each set shall be suppliers design to suit HTLS conductor offered standards. Each rod shall be marked in the middle with paint for easy application on the line. The armour rod shall not lose their resilience even after five applications. The conductivity of each rod of the set shall not be less than 40% of the conductivity of the International Annealed Copper Standard (IACS).
- 1.6.10 **Armour Grip Suspension Clamp**
- 1.6.10.1 The armour grip suspension clamp shall comprise of retaining strap, support housing, elastomer inserts with aluminium reinforcements and AGS preformed rod set.
- 1.6.10.2 Elastomer insert shall be resistant to the effects of temperature up to designed maximum conductor temperature guaranteed by the bidder corresponding to peak current, Ozone, ultraviolet radiations and other atmospheric contaminants likely to be encountered in service. The physical properties of the elastomer shall be of approved standard. It shall be electrically shielded by a cage of AGS performed rod set. The elastomer insert shall be so designed that the curvature of the AGS rod shall follow the contour of the neoprene insert.
- 1.6.10.3 The supplier shall submit relevant type/performance test certificates as per applicable standard/product specifications for elastomer to confirm suitability of the offered elastomer for the specified application.
- 1.6.10.4 The AGS preformed rod set shall be as detailed in clause no.1.6.9.4 to 1.6.9.6 in general except of the following: The length of the AGS preformed rods shall be such that it shall ensure sufficient slipping strength as detailed under clause 1.6.4 and shall not introduce unfavourable stress on the conductor under all operating conditions. The length of the AGS preformed rods shall be indicated in the GTP.
- 1.7 **Envelope Type Suspension Clamp**
- 1.7.1 The seat of the envelope type suspension clamp shall be smoothly rounded & suitably curved at the ends. The lip edges shall have rounded bead. There shall be at least two U-bolts for tightening of clamp body and keeper pieces together. Hexagonal bolts and nuts with split-pins shall be used for attachment of the clamp.
- 1.8 **Dead end Assembly**
- 1.8.1 The dead end assembly shall be suitable for the offered HTLS Conductor.
- 1.8.2 The dead end assembly shall be of compression type with provision for compressing jumper terminal at one end. The angle of jumper terminal to be mounted should be 30° with respect to the vertical line. The area of bearing surface on all the connections shall be sufficient to ensure positive electrical and mechanical contact and avoid local heating due to I^2R losses. The resistance of the clamp when compressed on Conductor shall not be more than 75% of the resistance of equivalent length of Conductor.
- 1.8.3 Die compression areas shall be clearly marked on each dead-end assembly designed for continuous die compressions and shall bear the words 'COM

PRESS FIRST' suitably inscribed near the point on each assembly where the compression begins. If the dead end assembly is designed for intermittent die compressions it shall bear identification marks 'COMPRESSION ZONE' AND 'NON-COMPRESSION ZONE' distinctly with arrow marks showing the direction of compressions and knurling marks showing the end of the zones. Tapered aluminium filler plugs shall also be provided at the line of demarcation between compression & non-compression zone. The letters, number and other markings on the finished clamp shall be distinct and legible. The dimensions of dead end assembly before & after compression along with tolerances shall be guaranteed in the relevant schedules of the bid and shall be decided by the manufacturer so as to suit the conductor size & conform to electrical & mechanical requirement stipulated in the specification. These shall be guaranteed in the relevant schedules of bid.

- 1.8.4 The assembly shall not permit slipping of, damage to, or failure of the complete conductor or any part thereof at a load less than 95% of the ultimate tensile strength of the conductor.
- 1.8.5 Jumper bolting arrangement between jumper terminal/cone and terminal pad/plate of dead end assembly of tension hardware fittings shall be designed to suit the required current as per Annexure-1 in the TS of HTLS conductor and shall conform to the relevant Indian/International standards
- 1.8.6 For composite core HTLS conductor, dead end assembly shall inter- alia include collets, collect housing, inner sleeve etc., suitable for the offered design of HTLS conductor
- 1.9 **Fasteners: Bolts, Nuts and Washers**
 - 1.9.1 All bolts and nuts shall conform to IS 6639. All bolts and nuts shall be galvanized as per IS 1367 (Part-13)/IS 2629. All bolts and nuts shall have hexagonal heads, the heads being forged out of solid truly concentric, and square with the shank, which must be perfectly straight.
 - 1.9.2 Bolts up to M16 and having length up to 10 times the diameter of the bolt should be manufactured by cold forging and thread rolling process to obtain good and reliable mechanical properties and effective dimensional control. The shear strength of bolt for 5.6 grade should be 310 MPa minimum as per IS 12427. Bolts should be provided with washer face in accordance with IS 1363 (Part-1) to ensure proper bearing.
 - 1.9.3 Nuts should be double chamfered as per the requirement of IS 1363 Part-III 1984. It should be ensured by the manufacturer that nuts should not be over tapped beyond 0.4 mm oversize on effective diameter for size up to M16.
 - 1.9.4 Fully threaded bolts shall not be used. The length of the bolt shall be such that the threaded portion shall not extend into the place of contact of the component parts.
 - 1.9.5 All bolts shall be threaded to take the full depth of the nuts and threaded enough to permit the firm gripping of the component parts but no further. It shall be ensured that the threaded portion of the bolt protrudes not less than 3 mm and not more than 8 mm when fully tightened. All nuts shall fit and tight to the point where shank of the bolt connects to the head.

- 1.9.6 Flat washers and spring washers shall be provided wherever necessary and shall be of positive lock type. Spring washers shall be electro-galvanized. The thickness of washers shall conform to IS: 2016.
- 1.9.7 The Contractor shall furnish bolt schedules giving thickness of components connected, the nut and the washer and the length of shank and the threaded portion of bolts and size of holes and any other special details of this nature.
- 1.9.8 To obviate bending stress in bolt, it shall not connect aggregate thickness more than three time its diameter.
- 1.9.9 Bolts at the joints shall be so staggered that nuts may be tightened with spanners without fouling.
- 1.9.10 To ensure effective in-process Quality control it is essential that the manufacturer should have all the testing facilities for tests like weight of zinc coating, shear strength, other testing facilities etc, in-house. The manufacturer should also have proper Quality Assurance system which should be in line with the requirement of this specification and IS-14000 services Quality System standard.
- 1.9.11 Fasteners of grade higher than 8.8 are not to be used and minimum grade for bolt shall be 5.6.

1.10 **Materials**

The materials of the various components shall be as specified hereunder. The Bidder shall indicate the material proposed to be used for each and every component of hardware fittings stating clearly the class, grade or alloy designation of the material, manufacturing process & heat treatment details and the reference standards.

- 1.10.1 The details of materials for different component are listed as in Table No-1.

1.11 **Workmanship**

- 1.11.1 All the equipment shall be of the latest design and conform to the best modern practices adopted in the Extra High Voltage field. The Bidder shall offer only such equipment as guaranteed by him to be satisfactory and suitable for 400kV / 220 kV transmission lines and will give continued good performance. For employer's review of the offered design of clamps/ fittings, the supplier shall submit document/design details of similar type of clamps/ fittings used in past for similar type of HTLS conductor application.
- 1.11.2 High current, heat rise test shall be conducted by the supplier to determine the maximum temperature achieved in different components of fittings under simulated service condition corresponding to continuous operation of conductor at rated maximum temperature. The material of the components should be suitable for continued good performance corresponding to these maximum temperatures. The supplier shall submit relevant type/performance test certificates as per applicable standards/product specifications to confirm suitability of the offered material.

- 1.11.3 The design, manufacturing process and quality control of all the materials shall be such as to give the specified mechanical rating, highest mobility, elimination of sharp edges and corners to limit corona and radio-interference, best resistance to corrosion and a good finish.
- 1.11.4 All ferrous parts including fasteners shall be hot dip galvanized, after all machining has been completed. Nuts may, however, be tapped (threaded) after galvanizing and the threads oiled. Spring washers shall be electro galvanized. The bolt threads shall be undercut to take care of the increase in diameter due to galvanizing. Galvanizing shall be done in accordance with IS 2629 / IS 1367 (Part-13) and shall satisfy the tests mentioned in IS 2633. Fasteners shall withstand four dips while spring washers shall withstand three dips of one minute duration in the standard Preece test. Other galvanized materials shall have a minimum average coating of zinc equivalent to 600 gm/sq.m., shall be guaranteed to withstand at least six successive dips each lasting one (1) minute under the standard preece test for galvanizing.
- 1.11.5 Before ball fittings are galvanized, all die flashing on the shank and on the bearing surface of the ball shall be carefully removed without reducing the dimensions below the design requirements.
- 1.11.6 The zinc coating shall be perfectly adherent, of uniform thickness, smooth, reasonably bright, continuous and free from imperfections such as flux, ash rust, stains, bulky white deposits and blisters. The zinc used for galvanizing shall be grade Zn 99.95 as per IS:209.
- 1.11.7 Pin balls shall be checked with the applicable 'GO' gauges in at least two directions one of which shall be across the line of die flashing, and the other 90° to this line. "NO GO" gauges shall not pass in any direction.
- 1.11.8 Socket ends, before galvanizing, shall be of uniform contour. The bearing surface of socket ends shall be uniform about the entire circumference without depressions or high spots. The internal contours of socket ends shall be concentric with the axis of the fittings as per IS:2486/IEC : 120.
- The axis of the bearing surfaces of socket ends shall be coaxial with the axis of the fittings. There shall be no noticeable tilting of the bearing surfaces with the axis of the fittings.
- 1.11.9 In case of casting, the same shall be free from all internal defects like shrinkage, inclusion, blow holes, cracks etc. Pressure die casting shall not be used for casting of components with thickness more than 5 mm.
- 1.11.10 All current carrying parts shall be so designed and manufactured that contact resistance is reduced to minimum.
- 1.11.11 No equipment shall have sharp ends or edges, abrasions or projections and cause any damage to the conductor in any way during erection or during continuous operation which would produce high electrical and mechanical stresses in normal working. The design of adjacent metal parts and mating surfaces shall be such as to prevent corrosion of the contact surface and to maintain good electrical contact under service conditions.
- 1.11.12 All the holes shall be cylindrical, clean cut and perpendicular to the plane of the material. The periphery of the holes shall be free from burrs.

- 1.11.13 All fasteners shall have suitable corona free locking arrangement to guard against vibration loosening.
- 1.11.14 Welding of aluminium shall be by inert gas shielded tungsten arc or inert gas shielded metal arc process. Welds shall be clean, sound, smooth, uniform without overlaps, properly fused and completely sealed. There shall be no cracks, voids incomplete penetration, incomplete fusion, under-cutting or inclusions. Porosity shall be minimized so that mechanical properties of the aluminium alloys are not affected. All welds shall be properly finished as per good engineering practices.

1.12 **Bid Drawings**

- 1.12.1 The Bidder shall furnish full description and illustrations of materials offered.
- 1.12.2 Fully dimensioned drawings of the hardwares and their component parts shall be furnished in five (5) copies along with the bid. Weight, material and fabrication details of all the components should be included in the drawings.
- 1.12.3 All drawings shall be identified by a drawing number and contract number. All drawings shall be neatly arranged. All drafting & lettering shall be legible. The minimum size of lettering shall be 3 mm. All dimensions & dimensional tolerances shall be mentioned in mm.

The drawings shall include:

- (i) Dimensions and dimensional tolerance.
 - (ii) Material, fabrication details including any weld details & any specified finishes & coatings. Regarding material designation & reference of standards are to be indicated.
 - (iii) Catalogue No.
 - (iv) Marking
 - (v) Weight of assembly
 - (vi) Installation instructions
 - (vii) Design installation torque for the bolt or cap screw.
 - (viii) Withstand torque that may be applied to the bolt or cap screw without failure of component parts.
 - (ix) The compression die number with recommended compression pressure.
 - (x) Placement charts for spacer/ spacer damper and damper
 - (xi) All other relevant terminal details.
- 1.12.4 After placement of award, the Contractor shall submit fully dimensioned drawing including all the components in four (4) copies to the Owner for approval. After getting approval from the Owner and successful completion of all the type tests, the Contractor shall submit ten (10) more copies of the same drawings to the Owner for further distribution and field use at Owner's end.

TABLE-1 (Details of Materials)

Sl. No.	Name of item	Material treatment	Process of Standard	Reference	Remarks
1.	Security Clips	Stainless Steel/ Phosphor Bronze	-	AISI 302 or 304-L/ IS-1385	
2.	For Free Centre /Envelope type clamps				
(a)	Clamp Body, Keeper Piece	High Strength Al. Alloy 4600/ LM-6 or 6061/65032	Casted or forged & Heat treated	IS:617or ASTM-B429	
(b)	Cotter bolts/ Hangers, Shackles, Brackets	Mild Steel	Hot dip galvanized	As per IS-226 or IS-2062	
(c)	U Bolts	Stainless Steel or High Strength Al alloy 6061/ 65032	Forged & Heat treated	AISI 302 or 304-L ASTM-B429	
(d)	P. A. Rod	High Strength Al. Alloy 4600/ LM-6 or 6061/65032	Heat treatment during manufacturing	ASTM-B429	Min. tensile strength of 35kG / mm ²
3.	For AGS type clamp				
(a)	Supporting House	High Strength Corrosion resistant Al. Alloy 4600/ LM-6 or 6061/65032	Casted or forged & Heat treated	IS:617or ASTM-B429	
(b)	Al insert & Retaining strap	High Strength Al. Alloy 4600/ LM-6 or 6061/65032	Casted or forged & Heat treated	IS:617or ASTM-B429	High strength Al. Alloy 4600 / LM-6 or 6061/65032
(c)	Elastomer	Moulded on Al. reinforcement			

4.	For Dead End Assembly				
(a)	Outer Sleeve	EC grade Al of purity not less than 99.50%			
(b)	Steel Sleeve	Mild Steel	Hot Dip Galvanized	IS:226/ IS-2062	
5.	Ball & Socket Fittings,	Class-IV Steel	Drop forged & normalized Hot dip galvanized	As per IS: 2004	
6.	Yoke Plate	Mild Steel	Hot dip galvanized	As per IS-226 or IS-2062	
7.	Sag Adjustment plate	Mild Steel	Hot dip galvanized	As per IS-226 or IS-2062	
8(a)	Corona Control ring/ Grading ring	High Strength Al. Alloy tube (6061/ 6063/1100 type or 65032/ 63400 Type)	Heat treated Hot dip galvanized	ASTM-B429 or as per IS	Mechanical strength of welded joint shall not be less than 20kN.
8(b)	Supporting Brackets & Mounting Bolts	High Strength Al Alloy 7061/ 6063/ 65032/63400 Type) or Mild Steel	Heat treated Hot dip galvanized	ASTM-B429 or as per IS:226 or IS:2062	

Note: Alternate materials conforming to other national standards of other countries also may be offered provided the properties and compositions of these are close to the properties and compositions of material specified. Bidder should furnish the details of comparison of material offered vis-a- vis specified in the bid or else the bids are liable to be rejected.

2.0 **Accessories for the HTLS Conductor**

2.1 **General**

2.1.1 This portion details the technical particulars of the accessories for Conductor.

2.1.2 2.5% extra fasteners, filler plugs and retaining rods shall be provided.

2.1.3 The supplier shall be responsible for satisfactory performance of complete conductor system along with accessories offered by him for continuous operation at temperature specified for the HTLS Conductor.

2.2 **Mid Span Compression Joint**

2.2.1 Mid Span Compression Joint shall be used for joining two lengths of conductor. The joint shall have a resistivity less than 75% of the resistivity of equivalent

length of conductor. The joint shall not permit slipping off, damage to or failure of the complete conductor or any part thereof at a load less than 95% of the ultimate tensile strength of the conductor. It must be able to withstand the continuous design temperature of conductor.

- 2.2.2 The dimensions of mid span compression joint before & after compression along with tolerances shall be guaranteed in the relevant schedules of the bid and shall be decided by the manufacturer so as to suit the conductor size & conform to electrical & mechanical requirement stipulated in the specification. For composite core conductor, suitable sleeve, collets, collet housing shall be used for core jointing.

2.3 **Repair Sleeve**

Repair Sleeve of compression type shall be used to repair conductor with not more than two strands broken in the outer layer. The sleeve shall be manufactured from 99.5% pure aluminium / aluminium alloy and shall have a smooth surface. It shall be able to withstand the continuous maximum operating temperature of conductor. The repair sleeve shall comprise of two pieces with a provision of seat for sliding of the keeper piece. The edges of the seat as well as the keeper piece shall be so rounded that the conductor strands are not damaged during installation. The dimensions of Repair sleeve along with tolerances shall be guaranteed in the relevant schedules of the bid and shall be decided by the manufacturer so as to suit the conductor size & conform to electrical & mechanical requirement stipulated in the specification.

2.4 **Vibration Damper**

- 2.4.1 Vibration dampers of 4R-stockbridge type with four (4) different resonances spread within the specified aeolian frequency band width corresponding to wind speed of 1 m/s to 7 m/s are installed in the existing line at suspension and tension points on each conductor in each span to damp out aeolian vibration as well as sub- span oscillations,. One damper minimum on each side per sub-conductor for suspension points and two dampers minimum on each side per sub-conductor for tension points has been used for a ruling design span of (ruling span as per Annxure-1 in TS of HTLS conductor) meters.

- 2.4.2 The bidder shall offer damping system including Stockbridge type dampers for HTLS conductor for its protection from wind induced vibrations which could cause conductor fatigue /strand breakage near a hardware attachment, such as suspension clamps. Alternate damping systems with proven design offering equivalent or better performance also shall be accepted provided the manufacturer meets the qualifying requirements stipulated in the Specifications. Relevant technical documents including type test reports to establish the technical suitability of alternate systems shall be furnished by the Bidder along with the bid.

The damper shall be designed to have minimum 4 nos. of resonance frequencies to facilitate dissipation of vibration energy through inter-strand friction of the messenger cable and shall be effective in reducing vibration over a wide frequency range (depending upon conductor diameter) or wind velocity range specified above. The vibration damper shall meet the requirement of frequency or wind velocity range and also have mechanical impedance closely matched

with the offered HTLS conductor. The vibration dampers shall be installed at suitable positions to ensure damping effectiveness across the frequency range. The power dissipation of the vibration dampers shall exceed the wind power so that the vibration level on the conductor is reduced below its endurance limit. The bidder shall clearly indicate the method for evaluating performance of dampers including analytical and laboratory test methods. The bidder shall indicate the type tests to evaluate the performance of offered damping system.

- 2.4.3 The clamp of the vibration damper shall be made of high strength aluminium alloy of type LM-6. It shall be capable of supporting the damper and prevent damage or chafing of the conductor during erection or continued operation. The clamp shall have smooth and permanent grip to keep the damper in position on the conductor without damaging the strands or causing premature fatigue failure of the conductor under the clamp. The clamp groove shall be in uniform contact with the conductor over the entire clamping surface except for the rounded edges. The groove of the clamp body and clamp cap shall be smooth, free from projections, grit or other materials which could cause damage to the conductor when the clamp is installed. Clamping bolts shall be provided with self locking nuts and designed to prevent corrosion of threads or loosening in service.
- 2.4.4 The messenger cable shall be made of high strength galvanized steel/stain less steel with a minimum strength of 135 kg/sq mm. It shall be of preformed and postformed quality in order to prevent subsequent drop of weight and to maintain consistent flexural stiffness of the cable in service. The number of strands in the messenger cable shall be 19. The messenger cable other than stainless steel shall be hot dip galvanized in accordance with the recommendations of IS:4826 for heavily coated wires..
- 2.4.5 The damper mass shall be made of hot dip galvanized mild steel/cast iron or a permanent mould cast zinc alloy. All castings shall be free from defects such as cracks, shrinkage, inclusions and blowholes etc. The surface of the damper masses shall be smooth.
- 2.4.6 The damper clamp shall be casted over the messenger cable and offer sufficient and permanent grip on it. The messenger cable shall not slip out of the grip at a load less than the mass pull-off value of the damper. The damper masses made of material other-than zinc alloy shall be fixed to the messenger cable in a suitable manner in order to avoid excessive stress concentration on the messenger cables which shall cause premature fatigue failure of the same. The messenger cable ends shall be suitably and effectively sealed to prevent corrosion. The damper mass made of zinc alloy shall be casted over the messenger cable and have sufficient and permanent grip on the messenger cable under all service conditions.
- 2.4.7 The damper assembly shall be so designed that it shall not introduce radio interference beyond acceptable limits.
- 2.4.8 The vibration damper shall be capable of being installed and removed from energised line by means of hot line technique. In addition, the clamp shall be capable of being removed and reinstalled on the conductor at the designated torque without shearing or damaging of fasteners.

2.4.9 The contractor must indicate the clamp bolt tightening torque to ensure that the slip strength of the clamp is maintained between 2.5kN and 5 kN. The clamp when installed on the conductor shall not cause excessive stress concentration on the conductor leading to permanent deformation of the conductor strands and premature fatigue failure in operation.

2.4.10 The vibration analysis of the system, with and without damper and dynamic characteristics of the damper shall have to be submitted in line with latest CEA guidelines. The technical particulars for vibration analysis and damping design of the system are as follows:

Sl. No.	Description	Technical particulars
1.	Span length in meters	[ruling span as per Annexure – 1 of TS of HTLS conductor] 1100 meters 100 meters
i)	Ruling design span	
ii)	Maximum span	
iii)	Minimum span	
2.	Configuration	As required in scheme
3.	Tensile load in Conductor at temperature of 0 deg. C and still air	as per sag tension calculations
4.	Armour rods used	Standard preformed armour rods/AGS
5.	Maximum permissible dynamic strain i.e. endurance limit.	+/- 150 micro strains

2.4.11 The damper placement chart shall be submitted for spans ranging from 100m to 1100m. Placement charts should be duly supported with relevant technical documents and sample calculations.

2.4.12 The damper placement charts shall include the following

- (1) Location of the dampers for various combinations of spans and line tensions clearly indicating the number of dampers to be installed per conductor per span.
- (2) Placement distances clearly identifying the extremities between which the distances are to be measured.
- (3) Placement recommendation depending upon type of suspension clamps (viz Free centre type/Armour grip type etc.)
- (4) The influence of mid span compression joints, repair sleeves and armour rods (standard and AGS) in the placement of dampers.

2.5 Bundle Spacer (For 400kV twin HTLS conductor configuration)

- 2.5.1 Armour grip bundle spacers shall be used to maintain the spacing of 450 mm between the sub-conductors of each bundle under all normal working conditions.
- 2.5.2 Spacers offering equivalent or better performance shall also be accepted provided offer meets the qualifying requirements stipulated in the Specification.
- 2.5.3 The offer shall include placement charts recommending the number of spacers per phase per span and the sub span lengths to be maintained between the spacers while installing on the bundle conductors.
 - 2.5.3.1 The placement of spacers shall be in such a way that adjacent sub spans are sufficiently detuned and the critical wind velocity of each sub span shall be kept more than 30 km/hr. and to avoid clashing of sub conductors. The placement shall ensure bundle stability under all operating conditions.
 - 2.5.3.2 The placement chart shall be provided for spans ranging from 100 m to 1100m. The number of spacers recommended for a ruling design span of 400m [for 400kV] shall however be seven with no sub-span greater than 70m and no end sub-span longer than 40m.
 - 2.5.3.3 The Bidder may offer more number of spacers per ruling design span than the specified. However, in such case, suitable price compensation shall be considered for evaluation. For the purpose of price compensation, all the spans shall be assumed to be ruling design spans.
 - 2.5.3.4 The Bidder shall also furnish all the relevant technical documents in support of their placement charts along with the bid.
- 2.5.4 Jumpers at tension points shall also be fitted with spacers so as to limit the length of free conductor to 3.65m and to maintain the sub conductor spacing of 450 mm [for 400kV] for bundle conductors. Bidder shall quote for rigid spacer for jumper. It shall meet all the requirements of spacer used in line except for its vibration performance. Spacers requiring retaining rods shall not be quoted for jumpers.
- 2.5.5 The spacer offered by the Bidder shall satisfy the following requirements.
 - 2.5.5.1 Spacer shall restore normal spacing of the sub-conductors after displacement by wind, electromagnetic and the electrostatic forces under all operating conditions including the specified short circuit level without permanent deformation damage either to conductor or to the assembly itself. They shall have uniform grip on the conductor.
 - 2.5.5.2 For spacer requiring retaining rods, the retaining rods shall be designed for the specified conductor size. The preformed rods shall be made of high strength, special aluminum alloy of type 6061/65032 and shall have minimum tensile strength of 35 kg/sq.mm. The ends of retaining rods should be ball ended. The rods shall be heat-treated to achieve specified mechanical properties and give proper resilience and retain the same during service.
 - 2.5.5.3 Four numbers of rods shall be applied on each clamp to hold the clamp in

position. The minimum diameter of the rods shall be 7.87 ± 0.1 mm and the length of the rods shall not be less than 1100 mm.

- 2.5.5.4 Where elastomer surfaced clamp grooves are used, the elastomer shall be firmly fixed to the clamp. The insert should be forged from aluminum alloy of type 6061/65032. The insert shall be duly heat treated and aged to retain its consistent characteristics during service.
- 2.5.5.5 Any nut used shall be locked in an approved manner to prevent vibration loosening. The ends of bolts and nuts shall be properly rounded for specified corona performance or suitably shielded.
- 2.5.5.6 Clamp with cap shall be designed to prevent its cap from slipping out of position when being tightened.
- 2.5.5.7 The clamp grooves shall be in uniform contact with the conductor over the entire surface, except for rounded edges. The groove of the clamp body and clamp cap shall be smooth and free of projections, grit or other material which cause damage to the conductor when the clamp is installed.
- 2.5.5.8 For the spacer involving bolted clamps, the manufacturer must indicate the clamp bolt tightening torque to ensure that the slip strength of the clamp is maintained between 2.5 kN and 5 kN. The clamp when installed on the conductor shall not cause excessive stress concentration on the conductor leading to permanent deformation of the conductor strands and premature fatigue failure in operation.
- 2.5.5.9 Universal type bolted clamps, covering a range of conductor sizes, will not be permitted.
- 2.5.5.10 No rubbing, other than that of the conductor clamp hinges or clamp swing bolts, shall take place between any parts of the spacer. Joint incorporating a flexible medium shall be such that there is no relative slip between them.
- 2.5.5.11 The spacer shall be suitably designed to avoid distortion or damage to the conductor or to themselves during service.
- 2.5.5.12 Rigid spacers shall be acceptable only for jumpers.
- 2.5.5.13 The spacer shall not damage or chafe the conductor in any way which might affect its mechanical and fatigue strength or corona performance.
- 2.5.5.14 The clamping system shall be designed to compensate for any reduction in diameter of conductor due to creep.
- 2.5.5.15 The spacer assembly shall not have any projections, cuts, abrasions etc. or chattering parts which might cause corona or RIV.
- 2.5.5.16 The spacer tube shall be made of aluminum alloy of type 6061/65032. If fasteners of ferrous material are used, they shall conform to and be galvanized conforming to relevant Indian Standards.
- 2.5.5.17 Elastomer, if used, shall be resistant to the effects of temperature up to the designed maximum temperature specified for the conductor, ultraviolet radiation and other atmospheric contaminants likely to be encountered in service. It shall have good fatigue characteristics. The physical properties of the elastomer shall be of approved standard. The supplier shall submit relevant type/ performance test certificate as per applicable standard/ product

specification for elastomer to confirm suitability of the offered elastomer for the specified application.

- 2.5.5.18 The spacer assembly shall have electrical continuity. The electrical resistance between the sub-conductor across the assembly in case of spacer having elastomer clamp grooves shall be suitably selected by the manufacturers to ensure satisfactory electrical performance and to avoid deterioration of elastomer under all service conditions.
- 2.5.5.19 The spacer assembly shall have complete ease of installation and shall be capable of removal/reinstallation without any damage.
- 2.5.5.20 The spacer assembly shall be capable of being installed and removed from the energized line by means of hot line technique.

2.6 Spacer Damper (Alternative to Vibration Damper & Bundle Spacer for 400kV twin HTLS conductor configuration)

- 2.6.1 Suitable spacer dampers for HTLS conductor can be offered as an alternative to the combination of Vibration Damper and Bundle Spacer. The spacer damper covered by this specification shall be designed to maintain the bundle spacing of 450 mm under all normal operating conditions and to effectively control Aeolian vibrations as well as sub span oscillation and to restore conductor spacing after release of any external extraordinary load. The nominal sub conductor spacing shall be maintained within ± 5 mm.
- 2.6.2 The spacer damper shall restore the normal sub-conductor spacing due to displacement by wind, electromagnetic and electrostatic forces including the specified short circuit level without permanent deformation or damage either to bundle conductors or to spacer damper itself.
- 2.6.3 The design offered shall be presented as a system consisting of spacer dampers and their staggering scheme for spans ranging from 100 m to 1100m.
- 2.6.4 Under the operating conditions specified, the spacer damper system shall adequately control Aeolian vibrations throughout the life of the transmission line with wind velocity ranging from 0 to 30 km per hour in order to prevent damage to conductor at suspension clamps, dead end clamps and spacer damper clamps.
- 2.6.5 The spacer damper system shall also control the sub-span oscillations in order to prevent conductor damage due to chaffing and severe bending stresses at the spacer damper clamps as well as suspension and dead end clamps and to avoid wear to spacer damper components.
- 2.6.6 The spacer damper shall consist of a rigid central body called the frame linked to the conductor by two articulated arms terminated by suitable clamping system. The articulation shall be designed to provide elastic and damping forces under angular movement of the arms. The dynamic characteristics of the articulations shall be maintained for the whole life of the transmission line.
- 2.6.7 The clamping system shall be designed to provide firm but gentle and permanent grip while protecting the conductor against local static or dynamic stresses expected during normal operating conditions. The clamping system

shall be designed to compensate for any reduction of conductor diameter due to creep.

- 2.6.8 Bolted type clamps shall allow installation without removal of the bolts or the clamps from clamp body. Locking mechanism shall be suitable to prevent bolt loosening. Clamp locking devices with small loose components shall not be accepted. Nut cracker, hinged open or boltless type clamps are acceptable provided adequate grip can be maintained on the conductor.
- 2.6.9 Bolts and nuts shall be of mild steel, stainless steel, or high strength steel in accordance with the design of the spacer damper.
- 2.6.10 Where elastomer surfaced clamps are used, the elastomer elements shall be firmly fixed to the clamp. The insert should be forged from aluminum alloy of type 6061 or equivalent aluminum alloy having minimum tensile strength of 25 kg/mm². The insert shall be moulded on the insert surface. The insert shall be duly heat treated and aged to retain its consistent characteristics during service. The grain flow of the forged insert shall be in the direction of the maximum tension and compression loads experienced.
- 2.6.11 If clamps involving preformed rods are used, these rods shall be designed for specific conductor size. They shall be made of high strength aluminum alloy of type 6061 or equivalent aluminum alloy having a minimum tensile strength of 35 kg/mm³. The rods shall be ball ended. The rods shall be heat treated and aged to achieve specified mechanical properties and to retain the same during service. The length of the rods shall be such that the ends fall inside the imaginary square whose sides are vertical and horizontal outer tangents to the conductor sections.
- 2.6.12 The spacer damper body shall be cast/ forged from suitable high strength corrosion resistant aluminum alloy. The aluminum alloy shall be chosen in relation with the process used.
- 2.6.13 The rubber components involved in the design such as damping elements shall be made with rubber compound selected specifically for that particular application. The Contractor shall submit a complete list of physical and mechanical properties of the elastomer used. This list shall make reference to all applicable ASTM standards.
- 2.6.14 The rubber components used shall have good resistance to the effects of temperature up to the designed maximum temperature of the conductor and to ultraviolet radiation, ozone and other atmospheric contaminants. The rubber shall have good wear and fatigue resistance and shall be electrically semi-conductive.
- 2.6.15 The spacer damper involving ferrous material shall not have magnetic power loss more than 1 watt.
- 2.6.16 The spacer damper assembly shall have electrical continuity. The electrical

resistance between the sub-conductors across the assembly in case of spacer damper involving elastomer surfaced clamps shall be suitably selected by the manufacturer to ensure satisfactory electrical performance and avoid deterioration of elastomer under service conditions. The spacer damper assembly shall have complete ease of installation and shall be capable of removal/reinstallation without any damage.

- 2.6.17 The spacer damper assembly shall be capable of being installed and removed from the energized line by means of hot line techniques. The Bidder shall supply with the bid the complete description of the installation, removal and reinstallation procedure.
- 2.6.18 The Bidder shall recommend the staggering scheme for installation of spacer dampers on the line which shall ensure most satisfactory fatigue performance of the line as specified. The scheme shall indicate the number of spacer dampers per phase per span and the sub span lengths to be maintained between spacer dampers while installing on the bundle conductors.
- 2.6.19 The staggering scheme shall be provided for spans ranging from 100 m to 1100 m. The number of spacer dampers for a nominal ruling span of 400 m [for 400kV] shall not be less than six.
- 2.6.20 No sub span shall be greater than 70 m and no end sub span shall be longer than 40 m.
- 2.6.21 The staggering scheme shall be such that the spacer dampers be unequally distributed along the span to achieve sufficient detuning of adjacent sub spans for oscillations of sub span mode and to ensure bundle stability for wind speeds up to 60 km/hr.
- 2.6.22 The manufacturer / supplier shall supply free of cost 25 number fixed setting torque wrench (of torque as per spacer damper design) along with 1st batch of supply of spacer dampers for installation of spacer damper on the line by the tower contractors.
- 2.6.23 The Bidder shall furnish all the relevant technical documents in supports of the staggering scheme recommended for the spacer damper.

2.7 **Material and Workmanship**

- 2.7.1 All the equipment shall be of the latest proven design and conform to the best modern practice adopted in the extra high voltage field. The Bidder shall offer only such equipment as guaranteed by him to be satisfactory and suitable for 400kV/ 220 kV (as per scheme requirement) transmission line applications and will give continued good performance at all service conditions. For employer's review of the offered design of accessories, the supplier shall submit

document/design details of similar type of accessories used in past for similar type of HTLS conductor application

- 2.7.2 The design, manufacturing process and quality control of all the materials shall be such as to achieve requisite factor of safety for maximum working load, highest mobility, elimination of sharp edges and corners, best resistance to corrosion and a good finish.
- 2.7.3 High current, heat rise test shall be conducted by the supplier to determine the maximum temperature achieved in different components of fittings/accessories under simulated service condition corresponding to continuous operation of conductor at rated maximum temperature. The material of the components should be suitable for continued good performance corresponding to these maximum temperatures. The supplier shall submit relevant type/ performance test certificates as per applicable standards/product specifications to confirm suitability of the offered material.
- 2.7.4 All ferrous parts shall be hot dip galvanized, after all machining has been completed. Nuts may, however, be tapped (threaded) after galvanizing and the threads oiled. Spring washers shall be electro galvanized as per grade 4 of IS-1573. The bolt threads shall be undercut to take care of increase in diameter due to galvanizing. Galvanizing shall be done in accordance with IS: 2629/ IS-1367 (Part-13) and satisfy the tests mentioned in IS-2633. Fasteners shall withstand four dips while spring washers shall withstand three dips. Other galvanized materials shall have a minimum average coating of Zinc equivalent to 600 gm/sq.m and shall be guaranteed to withstand at least six dips each lasting one minute under the standard Preece test for galvanizing unless otherwise specified.
- 2.7.5 The zinc coating shall be perfectly adherent, of uniform thickness, smooth, reasonably bright, continuous and free from imperfections such as flux, ash, rust stains, bulky white deposits and blisters. The zinc used for galvanizing shall be of grade Zn 99.95 as per IS: 209.
- 2.7.6 In case of castings, the same shall be free from all internal defects like shrinkage, inclusion, blow holes, cracks etc.
- 2.7.7 All current carrying parts shall be so designed and manufactured that contact resistance is reduced to minimum and localized heating phenomenon is averted.
- 2.7.8 No equipment shall have sharp ends or edges, abrasions or projections and shall not cause any damage to the conductor in any way during erection or during continuous operation which would produce high electrical and mechanical stresses in normal working. The design of adjacent metal parts and mating surfaces shall be such as to prevent corrosion of the contact surface and to maintain good electrical contact under all service conditions.
- 2.7.9 Particular care shall be taken during manufacture and subsequent handling to ensure smooth surface free from abrasion or cuts.
- 2.7.10 The fasteners shall conform to the requirements of IS: 6639-1972. All fasteners and clamps shall have corona free locking arrangement to guard against vibration loosening.

2.8 **Compression Markings**

Die compression areas shall be clearly marked on each equipment designed for continuous die compressions and shall bear the words 'COMPRESS FIRST' 'suitably inscribed on each equipment where the compression begins. If the equipment is designed for intermittent die compressions, it shall bear the identification marks 'COMPRESSION ZONE' and 'NON-COMPRESSION ZONE' distinctly with arrow marks showing the direction of compression and knurling marks showing the end of the zones. The letters, number and other markings on finished equipment shall be distinct and legible.

2.9 **Bid Drawings**

2.9.1 The Bidder shall furnish detailed dimensioned drawings of the equipments and all component parts. Each drawing shall be identified by a drawing number and Contract number. All drawings shall be neatly arranged. All drafting and lettering shall be legible. The minimum size of lettering shall be 3 mm. All dimensions and dimensional tolerances shall be mentioned in mm.

2.9.2 The drawings shall include

- (i) Dimensions and dimensional tolerances
- (ii) Material fabrication details including any weld details and any specified finishes and coatings. Regarding material, designations and reference of standards are to be indicated.
- (iii) Catalogue No.
- (iv) Marking
- (v) Weight of assembly
- (vi) Installation instructions
- (vii) Design installation torque for the bolt or cap screw
- (viii) Withstand torque that may be applied to the bolt or cap screw without failure of component parts
- (ix) The compression die number with recommended compression pressure.
- (x) All other relevant technical details

2.9.3 The above drawings shall be submitted with all the details as stated above along with the bid document. After the placement of award, the Contractor shall again submit the drawings in four copies to the Owner for approval. After Owner's approval and successful completion of all type tests, 10 (ten) more sets of drawings shall be submitted to Owner for further distribution and field use at Owner's end.

3.0 **Tests and Standards**

3.1 **Type Tests**

3.1.1 **On Suspension Clamp**

- a) Magnetic power loss test : As per Annexure-A
- b) Clamp slip strength Vs torque test : As per Annexure-A
- c) Ozone Test on elastomer : As per Annexure-A

- | | | |
|----|--|-----------|
| d) | Vertical Damage load and failure load test | IEC-61284 |
|----|--|-----------|

3.1.2 On Dead end Tension Assembly

- | | | |
|----|--|---------------------------|
| a) | Electrical resistance test for dead end Assembly | : As per IS:2486-(Part-I) |
| b) | Heating cycle test for dead end Assembly | : As per Annexure-A |
| c) | Slip strength test for dead end assembly | : As per Annexure-A |
| d) | Ageing test on filler (if applicable) | : As per Annexure-A |

3.1.3 Mid Span Compression Joint for Conductor

- | | | |
|----|---|---------------------------|
| a) | Chemical analysis of materials | : As per Annexure-A |
| b) | Electrical resistance test | :As per IS:2121 (Part-II) |
| c) | Heating cycle test | : As per Annexure-A |
| d) | Slip strength test | : As per Annexure-A |
| e) | Corona extinction voltage test (dry) (for 400kV) | : As per Annexure-A |
| f) | Radio interference voltage test (dry) (for 400kV) | : As per Annexure-A |

3.1.4 Repair Sleeve for Conductor

- | | | |
|----|---|----------------------|
| a) | Chemical analysis of materials | : As per Annexure- A |
| b) | Corona extinction voltage test (dry) (for 400kV) | : As per Annexure- A |
| c) | Radio interference voltage test (dry) (for 400kV) | : As per Annexure- A |

3.1.5 Vibration Damper for Conductor

- | | | |
|----|---|----------------------|
| a) | Chemical analysis of materials | : As per Annexure- A |
| b) | Dynamic characteristics test* | : As per Annexure- A |
| c) | Vibration analysis | : As per Annexure- A |
| d) | Clamp slip test | : As per Annexure- A |
| e) | Fatigue tests | : As per Annexure- A |
| f) | Magnetic power loss test | : As per Annexure- A |
| g) | Corona extinction voltage test (dry) (for 400kV) | : As per Annexure- A |
| h) | Radio interference voltage test (dry) (for 400kV) | : As per Annexure- A |
| i) | Damper efficiency test | : As per IS:9708 |

* Applicable for 4 R Stockbridge dampers. For alternate type of vibration dampers (permitted as per clause 2.4.2), as an alternative to dynamic characteristic test, damper efficiency test as per IEEE-664 may be proposed/ carried out by the supplier.

3.1.6 **Bundle spacer for Line**

- | | | |
|----|---|----------------------|
| a) | Chemical analysis of materials | : As per Annexure- A |
| b) | Clamp slip test | : As per Annexure- A |
| c) | Vibration test | : As per Annexure- A |
| | (i) Vertical Vibration | : As per Annexure- A |
| | (ii) Longitudinal vibration | : As per Annexure- A |
| | (iii) sub span Oscillation | : As per Annexure- A |
| d) | Corona extinction voltage test (dry) (for 400kV) | : As per Annexure- A |
| e) | Radio interference voltage test (dry) (for 400kV) | : As per Annexure- A |
| f) | Ozone test on elastomer | : As per Annexure-A |
| g) | Magnetic power loss test (If applicable) | : As per Annexure-A |
| h) | Compressive and tension test | : As per Annexure-A |

3.1.7 **Rigid Spacer for Jumper**

- | | | |
|----|---|----------------------|
| a) | Chemical analysis of materials | : As per Annexure- A |
| b) | Clamp slip test | : As per Annexure- A |
| c) | Corona extinction voltage test (dry) (for 400kV) | : As per Annexure- A |
| d) | Radio interference voltage test (dry) (for 400kV) | : As per Annexure- A |
| e) | Tension Compression test | : As per Annexure-A |
| f) | Magnetic power loss test (If applicable) | : As per Annexure-A |

3.1.8 **Spacer Damper (Alternative to combination of Vibration Damper & Bundle spacer)**

- | | | |
|----|--------------------------------|----------------------|
| a) | Chemical analysis of materials | : As per Annexure- A |
| b) | Clamp slip test | : As per Annexure- A |
| c) | Vibration test | : As per Annexure- A |
| | (i) Vertical Vibration | : As per IS 10162 |
| | (ii) Longitudinal vibration | : As per IS 10162 |
| | (iii) sub span Oscillation | : As per IS 10162 |

- d) Dynamic characteristics test : As per Annexure- A
- e) Fatigue tests : As per Annexure- A
- f) Magnetic power loss test (If applicable) : As per Annexure- A
- g) Compressive and tension test : As per Annexure- A
- h) Corona extinction voltage test (dry) (for 400kV) : As per Annexure- A
- i) Radio interference voltage test (dry) (for 400kV) : As per Annexure- A
- j) Ozone test on elastomer : As per Annexure- A
- k) Log Decrement test : As per Annexure- A

Type tests specified above shall not be required to be carried out if a valid test certificate is available for the offered design with validity of the test certificate as per latest CEA guidelines. The tests conducted earlier should have 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 the representative (s) of DTL or Utility.

In the event of any discrepancy in the test report (i.e., any test report not applicable due to any design / material/manufacturing process change including substitution of components or due to non-compliance with the requirement stipulated in the Technical Specification) the tests shall be conducted by the Contractor at no extra cost to the Employer/ Purchaser.

3.2 Acceptance Tests

3.2.1 On Both Suspension Clamp and Tension Assembly

- a) Visual Examination : As per IS:2486-(Part-I)
- b) Verification of dimensions : As per IS:2486-(Part-I)
- c) Galvanizing/Electroplating test : As per IS:2486-(Part-I)
- d) Mechanical strength test of each component : As per Annexure- A
- e) Mechanical Strength test of welded joint : As per Annexure- A
- f) Chemical analysis, hardness tests, grain size, inclusion rating & magnetic particle inspection for forgings/castings : As per Annexure- A

3.2.2 On Suspension Clamp only

- a) Clamp Slip strength Vs Torque test for suspension clamp : As per Annexure- A
- b) Shore hardness test of elastomer cushion for AG suspension clamp : As per Annexure- A

- | | | |
|-------|--|---|
| c) | Bend test for armour rod set | : As per IS:2121(Part-I),
Clause 7.10 |
| d) | Resilience test for armour rod set | : As per IS:2121(Part-I),
Clause 7.11 |
| e) | Conductivity test for armour rods set | : As per IS:2121(Part-I),
Clause 7.5 |
|
 | | |
| 3.2.3 | On Tension Hardware Fittings only | |
| a) | Slip strength test for dead end assembly | : As per Annexure-A |
| b) | Ageing test on filler (if applicable) | : As per Annexure-B |
|
 | | |
| 3.2.4 | On Mid Span Compression Joint for Conductor | |
| a) | Visual examination and dimensional verification | : As per IS:2121
(Part-II), Clause 6.2, 6.3
& 6.7 |
| b) | Galvanizing test | : As per IS-2121(part-II) |
| c) | Hardness test | : As per Annexure-B |
| d) | Ageing test on filler (if applicable) | : As per Annexure-B |
|
 | | |
| 3.2.5 | Repair Sleeve for Conductor | |
| a) | Visual examination and dimensional verification | : As per IS:2121(Part-II)
Clause 6.2, 6.3 |
|
 | | |
| 3.2.6 | Vibration Damper for Conductor | |
| a) | Visual examination and dimensional verification | : As per IS:2121(Part-II)
Clause 6.2, 6.3 |
| b) | Galvanizing test | : As per IS-2121 (Part-II) |
| | (i) On damper masses | |
| | ii) On messenger cable | |
| c) | Verification of resonance frequencies | : As per Annexure-B |
| d) | Clamp slip test | : As per Annexure-B |
| e) | Clamp bolt torque test | : As per Annexure-B |
| f) | Strength of the messenger cable | : As per Annexure-B |
| g) | Mass pull off test | : As per Annexure-B |

h) Dynamic characteristics test* : As per Annexure-B

* Applicable for 4 R stockbridge dampers. For alternate type of vibration dampers (permitted as per clause 2.4.2), as an alternative to dynamic characteristic test, damper efficiency test as per IEEE-664 may be proposed/ carried out by the supplier.

3.2.7 **Bundle spacer for line/ Rigid spacer for jumper for conductor**

- a) Visual examination and dimensional verification
- b) Galvanizing test
- c) Movement test (except for spacer jumpers) : As per Annexure-B
- d) Clamp slip test : As per Annexure-B
- e) Clamp bolt torque test : As per Annexure-B
- f) Compression tension test : As per Annexure-B
- g) Assembly torque test : As per Annexure-B
- h) Hardness test for elastomer (If applicable) : As per Annexure-B

3.2.8 **Spacer Damper for conductor/ rigid spacer for jumper**

- a) Visual examination and dimensional verification
- b) Galvanizing test
- c) Movement test (except for spacer jumpers) : As per Annexure-B
- d) Clamp slip test : As per Annexure-B
- e) Clamp bolt torque test : As per Annexure-B
- f) Compression tension test : As per Annexure-B
- g) Assembly torque test : As per Annexure-B
- h) Hardness test for elastomer (If applicable) : As per Annexure-B

3.3 **Routine Tests**

3.3.1 **For Hardware Fittings**

- a) Visual examination : IS:2486-(Part-I)
- b) Proof Load Test : As per Annexure- A

3.3.2 **For conductor accessories**

- a) Visual examination and dimensional verification : As per IS:2121(Part-II) Clause 6.2, 6.3 & 6.7

3.4 **Tests During Manufacture on all components as applicable**

- a) Chemical analysis of Zinc used for galvanizing IS:2486-(Part-I)
- b) Chemical analysis mechanical metallographic test and magnetic particle inspection for malleable castings : As per Annexure- A
- c) Chemical analysis, hardness tests and magnetic particle inspection for forging : As per Annexure- A

3.5 **Testing Expenses**

- 3.5.1 Testing charges for the type test specified shall be indicated separately in the prescribed schedule.
- 3.5.2 Bidder shall indicate charges for all type tests covered under Clause No. 3.1.1 to 3.1.5 separately. The charges for each type test shall be separately indicated.
- 3.5.3 Bidder shall indicate the laboratories in which they propose to conduct the type tests. They shall ensure that adequate facilities for conducting the tests are available in the laboratory and the tests can be completed in these laboratories within the time schedule guaranteed by them in the appropriate schedule.
- 3.5.4 The entire cost of testing for acceptance and routine tests and tests during manufacture specified herein shall be treated as included in the quoted Ex-works/CIF Price.
- 3.5.5 In case of failure in any type test, repeat type tests are required to be conducted, then, all the expenses for deputation of Inspector/ Owner's representative shall be deducted from the contract price. Also if on receipt of the Contractor's notice of testing, the Owner's representative/Inspector does not find material & facilities to be ready for testing the expenses incurred by the Owner's for re-deputation shall be deducted from contract price.
- 3.5.6 The Contractor shall intimate the Owner about carrying out of the type tests along with detailed testing program at least 3 weeks in advance (in case of testing in India and at least 6 weeks advance in case of testing abroad) of the scheduled date of testing during which the Owner will arrange to depute his representative to be present at the time of carrying out the tests.

3.6 **Sample Batch For Type Testing**

- 3.6.1 The Contractor shall offer material for sample selection for type testing only after getting Quality Assurance Programme approved by the Owner. The Contractor shall offer at least three times the quantity of materials required for conducting all the type tests for sample selection. The sample for type testing will be manufactured strictly in accordance with the Quality Assurance Programme approved by the Owner.

3.6.2 Before sample selection for type testing the Contractor shall be required to conduct all the acceptance tests successfully in presence of Owner's representative.

3.7 **Schedule of Testing and Additional Tests**

3.7.1 The Bidder has to indicate the schedule of following activities in their bids

- (a) Submission of drawing for approval.
- (b) Submission of Quality Assurance programme for approval.
- (c) Offering of material for sample selection for type tests.
- (d) Type testing.

3.7.2 The Owner reserves the right of having at his own expense any other test(s) of reasonable nature carried out at Contractor's premises, at site, or in any other place in addition to the aforesaid type, acceptance and routine tests to satisfy himself that the material comply with the specifications.

3.7.3 The Owner also reserves the right to conduct all the tests mentioned in this specification at his own expense on the samples drawn from the site at Contractor's premises or at any other test centre. In case of evidence of non compliance, it shall be binding on the part of Contractor to prove the compliance of the items to the technical specifications by repeat tests, or correction of deficiencies, or replacement of defective items, all without any extra cost to the Owner.

3.8 **Co-ordination for testing**

The Contractors shall have to co-ordinate testing of their hardware fittings with insulators to be supplied by other Supplier to the *Owner* and shall have to also guarantee overall satisfactory performance of the hardware fittings with the insulators.

3.9 **Test Reports**

3.9.1 Copies of type test reports shall be furnished in at least four copies along with one original. One copy shall be returned duly certified by the Owner, only after which the commercial production of the concerned material shall start.

3.9.2 Copies of acceptance test report shall be furnished in at least four copies. One copy shall be returned, duly certified by the Owner, only after which the materials will be dispatched.

3.9.3 Record of routine test report shall be maintained by the Contractor at his works for periodic inspection by the Owner's representative.

3.9.4 Test certificates of tests during manufacture shall be maintained by the Contractor. These shall be produced for verification as and when desired by the Owner.

3.10 **Inspection**

3.10.1 The Owner's representative shall at all times be entitled to have access to the works and all places of manufacture, where the material and/or its component

parts shall be manufactured and the representatives shall have full facilities for unrestricted inspection of the Contractor's, sub-Contractor's works, raw materials manufacturer's of all the material and for conducting necessary tests as detailed herein.

3.10.2 The material for final inspection shall be offered by the Contractor only under packed condition as detailed in the Specification. The engineer shall select samples at random from the packed lot for carrying out acceptance tests.

3.10.3 The Contractor shall keep the Owner informed in advance of the time of starting and of the progress of manufacture of material in its various stages so that arrangements could be made for inspection.

3.10.4 Material shall not be dispatched from its point of manufacture before it has been satisfactorily inspected and tested unless the inspection is waived off by the Owner in writing. In the latter case also the material shall be dispatched only after all tests specified herein have been satisfactorily completed.

3.10.5 The acceptance of any quantity of material shall in no way relieve the Contractor of his responsibility for meeting all the requirements of the Specification, and shall not prevent subsequent rejection, if such materials are later found to be defective.

3.11 **Packing and Marking**

3.11.1 All material shall be packed in strong and weather resistant wooden cases/crates. The gross weight of the packing shall not normally exceed 200 Kg to avoid handling problems.

3.11.2 The packing shall be of sufficient strength to withstand rough handling during transit, storage at site and subsequent handling in the field.

3.11.3 Suitable cushioning, protective padding, dunnage or spacers shall be provided to prevent damage or deformation during transit and handling.

3.11.4 Bolts, nuts, washers, cotter pins, security clips and split pins etc. shall be packed duly installed and assembled with the respective parts and suitable measures shall be used to prevent their loss.

3.11.5 Each component part shall be legibly and indelibly marked with trade mark of the manufacturer and year of manufacture.

3.11.6 All the packing cases shall be marked legibly and correctly so as to ensure safe arrival at their destination and to avoid the possibility of goods being lost or wrongly dispatched on account of faulty packing and faulty or illegible markings. Each wooden case/crate shall have all the markings stencilled on it in indelible ink.

3.12 **Standards**

3.12.1 The Hardware fittings; conductor and earthwire accessories shall conform to the following Indian/International Standards which shall mean latest revisions, with amendments/changes adopted and published, unless specifically stated otherwise in the Specification.

3.12.2

In the event of the supply of hardware fittings; conductor and earthwire accessories conforming to standards other than specified, the Bidder shall confirm in his bid that these standards are equivalent to those specified. In case of award, salient features of comparison between the Standards proposed by the Contractor and those specified in this document will be provided by the Contractor to establish their equivalence.

Sl. No	Indian Standard	Title	International Standard
1.	IS: 209-1992	Specification for zinc	BS:3436-1986
2.	IS 1573	Electroplated Coating of Zinc on iron and Steel	
3.	IS : 2121 (Part-II)	Specification for Conductor and Earthwire Accessories for Overhead Power lines: Mid-span Joints and Repair Sleeves for Conductors	
4.	IS:2486 (Part-I)	Specification for Insulator Fittings for Overhead power Lines with Nominal Voltage greater than 1000 V: General Requirements and Tests	
5.	IS:2629	Recommended Practice for Hot Dip Galvanising of Iron and Steel	
6.	IS:2633	Method of Testing Uniformity of Coating on Zinc Coated Articles	
7.		Ozone test on Elastomer	ASTM- D1171
8.		Tests on insulators of Ceramic material or glass for overhead lines with a nominal voltage greater than 1000V	IEC:383-1993
9.	IS:4826	Galvanised Coating on Round Steel Wires	ASTM A472-729 BS:443-1969
10.	IS:6745	Methods of Determination of Weight of Zinc Coating of Zinc Coated Iron and Steel Articles	BS:433 ISO : 1460 (E)
11.	IS:8263	Method of Radio Interference Tests on High Voltage Insulators	IEC:437 NEMA:107 CISPR
12.	IS:6639	Hexagonal Bolts for Steel Structures	ISO/R-272
13.	IS:9708	Specification for Stock Bridge Vibration Dampers for Overhead Power Lines	

14.	IS:398	Aluminium conductor galvanized steel reinforced for extra high voltage	IEC:1089- 1 9 9 1 BS:215-1970
15.	IS 10162	Specifications for spacers dampers for twin horizontal bundle conductors	

1.0 Tests on Hardware Fittings**1.1 Magnetic Power Loss Test for Suspension Assembly**

Two hollow aluminium tubes of 32 mm diameter for the conductor shall be placed 450 mm (for 400kV) apart. An alternating current over the range of 1200 to 1800 amps shall be passed through each tube. The reading of the wattmeter with and without suspension assemblies along with line side yoke plate, clevis eye shall be recorded. Not less than three suspension assemblies shall be tested. The average power loss for suspension assembly shall be plotted for each value of current. The value of the loss corresponding to 1200/1600 amperes (as the case may be in line with scheme) shall be read off from the graph and the same shall be limited to the value guaranteed by the supplier.

1.2 Galvanising/Electroplating Test

The test shall be carried out as per Clause no. 5.9 of IS: 2486-(Part-1) except that both uniformity of zinc coating and standard preece test shall be carried out and the results obtained shall satisfy the requirements of this specification.

1.3 Mechanical Strength Test of Each Component

Each component shall be subjected to a load equal to 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. The component shall then again be loaded to 50% of UTS and the load shall be further increased at a steady rate till the specified UTS and held for one minute. No fracture should occur. The applied load shall then be increased until the failing load is reached and the value recorded.

1.4 Mechanical Strength Test of Welded Joint

The welded portion of the component shall be subjected to a Load of 2000 kgs for one minute. Thereafter, it shall be subjected to die-penetration/ ultrasonic test. There shall not be any crack at the welded portion.

1.5 Clamp Slip Strength Vs Torque Test for Suspension Clamp

The suspension assembly shall be vertically suspended by means of a flexible attachment. A suitable length of conductor shall be fixed in the clamp. The clamp slip strength at various tightening torques shall be obtained by gradually applying the load at one end of the conductor. The Clamp slip strength vs torque curve shall be drawn. The above procedure is applicable only for free centre type suspension clamp. For AG suspension clamp only clamp slip strength after assembly shall be found out. The clamp slip strength at the recommended tightening torque shall be as indicated in the GTP.

1.6 Heating Cycle Test

Heating cycle test shall be performed in accordance with IS 2486 (Part-I) with following modifications:-

- i) Temperature of conductor during each cycle: 40 deg. C above designed maximum operating temperature of the conductor, but not exceeding the emergency temperature of the conductor
- ii) Number of cycle: 100
- iii) Slip strength test shall also be carried out after heating cycle test.

1.7 **Slip strength test for dead end assembly**

The test shall be carried out as per IS:2486 (Part-I) except that the load shall be steadily increased to 95% of minimum ultimate tensile strength of conductor/earth wire and retained for one minute at this load.

1.8 **Ageing Test on Filler (if applicable)**

The test shall be done in accordance with Grease drop point test method. The specimen should be drop as a droplet when kept at a temperature 40 deg. C above designed maximum operating temperature of the conductor for 30 minutes. The temperature shall then be increase till one droplet drops and the temperature recorded.

1.9 **Shore Hardness Test for Elastomer Cushion for AG Suspension Assembly**

The shore hardness at various points on the surface of the elastomer cushion shall be measured by a shore hardness meter and the shore hardness number shall be between 65 to 80.

1.10 **Proof Load Test**

Each component shall be subjected to a load equal to 50% of the specified minimum ultimate tensile strength which shall be increased at a steady rate to 67% of the UTS specified. The load shall be held for one minute and then removed. After removal of the load the component shall not show any visual deformation.

1.11 **Tests for Forging Casting and Fabricated Hardware**

The chemical analysis, hardness test, grain size, inclusion rating and magnetic particle inspection for forging, castings and chemical analysis and proof load test for fabricated hardware shall 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 test will be as in the Quality Assurance programme.

1.12 **Ozone Test for Elastomer**

This test shall be performed in accordance with ASTM D-1171 by the Ozone chamber exposure method (method B). The test duration shall be 500 hours and the ozone concentration 50 PPHM. At the test completion, there shall be no visible crack under a 2 x magnification.

2.0 **Tests on Accessories for Conductor**

2.1 **Mid Span Compression Joint for Conductor**

(a) **Slip Strength Test**

The fitting compressed on conductor shall not be less than one metre in length. The test shall be carried out as per IS:2121 (Part-ii)-1981 clause 6.4 except that the load shall be steadily increased to 95% of minimum ultimate tensile strength of conductor/earthwire and retained for one minute at this load. There shall be no movement of the conductor/earthwire relative to the fittings and no failure of the fittings during this one minute period.

(b) **Heating Cycle Test**

Heating cycle test shall be performed in accordance with IS 2121 (Part-II- 1981) with following modifications:-

- i) Temperature of conductor during each cycle: 40 deg. C above designed maximum operating temperature of the conductor.
- ii) Number of cycle: 100
- iii) Slip strength test shall also be carried out after heating cycle test.

2.2

Vibration Damper for Conductor

(a) **Dynamic Characteristics, Test**

The damper shall be mounted with its clamp tightened with torque recommended by the manufacturer on shaker table capable of simulating sinusoidal vibrations for Aeolian vibration frequency band ranging from $0.18/d$ to $1.4/d$ where d is the conductor diameter in meters. The damper assembly shall be vibrated vertically with a + 1 mm amplitude from 5 to 15 Hz frequency and beyond 15 Hz at $\pm 0.5\text{mm}$ to determine following characteristics with the help of suitable recording instruments

- (i) Force Vs frequency
- (ii) Phase angle Vs frequency
- (iii) Power dissipation Vs frequency

The Force Vs frequency curve shall not show steep peaks at resonance frequencies and deep troughs between the resonance frequencies. The resonance frequencies shall be suitably spread within the aeolian vibration frequency-band between the lower and upper dangerous frequency, limits determined by the vibration analysis of conductor without dampers.

Acceptance criteria for vibration damper:

- (i) The above dynamic characteristics test on five damper shall be conducted.
- (ii) The mean reactance and phase angle Vs frequency curves shall be drawn with the criteria of best fit method.
- (iii) The above mean reactance response curve should lie within $0.191 f$ to $0.762 f$ Kgf/mm limits where f is frequency in Hz.

- (iv) The above mean phase angle response curve shall be between 25° to 130° within the frequency range of interest.
- (v) If the above curve lies within the envelope, the damper design shall be considered to have successfully met the requirement.
- (vi) Visual resonance frequencies of each mass of damper is to be recorded and to be compared with the guaranteed values.

(b) Vibration Analysis

The vibration analysis of the conductor shall be done with and without damper installed on the span. The vibration analysis shall be done on a digital computer using energy balance approach. The following parameters shall be taken into account for the purpose of analysis:

- (i) The analysis shall be done for single conductor without armour rods as per the parameters given in the Specification. The tension shall be taken from Sag & Tension calculation (0 deg. C & no wind condition and ruling span as per Annexure-I of TS of HTLS conductor) for a span ranging from 100 m to 1100.
- (ii) The self damping factor and flexural stiffness (EI) for conductor shall be calculated on the basis of experimental results. The details for experimental analysis with these data should be furnished.
- (iii) The power dissipation curve obtained from Dynamic Characteristics Test shall be used for analysis with damper.
- (iv) Examine the aeolian vibration level of the conductor with and without vibration damper installed at the recommended location or wind velocity ranging from 0 to 30 Km per hour, predicting amplitude, frequency and vibration energy input.
- (v) From vibration analysis of conductor without damper, anti-node vibration amplitude and dynamic strain levels at clamped span extremities as well as antinodes shall be examined and thus lower and upper dangerous frequency limits between which the Aeolian vibration levels exceed the specified limits shall be determined.
- (vi) From vibration analysis of conductor with damper/dampers installed at the recommended location, the dynamic strain level, at the clamped span extremities, damper attachment point and the antinodes on the conductor shall be determined. In addition to above damper clamp vibration amplitude and anti-node vibration amplitudes shall also be examined.

The dynamic strain levels at damper attachment points, clamped span extremities and antinodes shall not exceed the specified limits. The damper clamp vibration amplitude shall not be more than that of the specified fatigue limits.

(c) Clamp Slip and Fatigue Tests

(i) Test Set Up

The clamp slip and fatigue tests shall be conducted on a laboratory set up with a minimum effective span length of 30 m. The conductor shall be tensioned at tension corresponding to 0 deg & no wind condition and ruling span (ruling span as per annexure-1 of TS of HTLS conductor) m from sag –tension calculation and shall not be equipped with protective armour rods at any point. Constant tension shall be maintained within the span by means of lever arm arrangement. After the conductor has been tensioned, clamps shall be installed to support the conductor at both ends and thus influence of connecting hardware fittings are eliminated from the free span. The clamps shall not be used for holding the tension on the conductor. There shall be no loose parts, such as suspension clamps, U bolts on the test span supported between clamps mentioned above. The span shall be equipped with vibration inducing equipment suitable for producing steady standing vibration. The inducing equipment shall have facilities for stepless speed control as well as stepless amplitude arrangement. Equipment shall be available for measuring the frequency, cumulative number of cycles and amplitude of vibration at any point along the span.

(ii) Clamp Slip test

The vibration damper shall be installed on the test span. The damper clamp, after lightning with the manufacturer's specified tightening torque, when subjected to a longitudinal pull of 2.5 kN parallel to the axis of conductor for a minimum duration of one minute shall not slip i.e. the permanent displacement between conductor and clamp measured after removal of the load shall not exceed 1.0 mm. The load shall be further increased till the clamp starts slipping. The load at which the clamp slips shall not be more than 5 kN.

(iii) Fatigue Test

The vibration damper shall be installed on the test span with the manufacturer's specified tightening torque. It shall be ensured that the damper shall be kept minimum three loops away from the shaker to eliminate stray signals influencing damper movement.

The damper shall then be vibrated at the highest resonant frequency of each damper mass. For dampers involving resonant frequencies, tests shall be done at torsional modes also in addition to the highest resonant frequencies at vertical modes. The resonance frequency shall be identified as the frequency at which each damper mass vibrates with the maximum amplitude on itself. The amplitude of vibration of the damper clamp shall be maintained not less than $\pm 25/f$ mm, where f is the frequency in Hz.

The test shall be conducted for minimum ten million cycles at each resonant frequency mentioned above. During the test if resonance shift is observed the test frequency shall be tuned to the new resonant frequency.

The clamp slip test as mentioned hereinabove shall be repeated after fatigue test without re-torquing or adjusting the damper clamp, and the clamp shall withstand a minimum load equal to 80% of the slip strength for a minimum duration of one minute.

After the above tests, the damper shall be removed from conductor and subjected to dynamic characteristics test. There shall not be any major deterioration in the characteristic of the damper. The damper then shall be cut open and inspected. There shall not be any broken, loose, or damaged part. There shall not be significant deterioration or wear of the damper. The conductor under clamp shall also be free from any damage.

For the purpose of acceptance, the following criteria shall be applied.

- (1) There shall not be any frequency shift by more than ± 2 Hz for frequencies lower than 15 Hz and ± 3 Hz for frequencies higher than 15 Hz.
- (2) The force response curve shall generally lie within guaranteed % variation in reactance after fatigue test in comparison with that before fatigue test by the Contractor.
- (3) The power dissipation of the damper shall not be less than guaranteed % variation in power dissipation before fatigue test by the Contractor. However, it shall not be less than minimum power dissipation which shall be governed by lower limits of reactance and phase angle indicated in the envelope.

2.3 **Spacer / Spacer Damper**

(a) Vibration Tests

The test set up shall as per clause no.2.2 (c) (i) of Annexure-A. The spacer/ spacer damper assembly shall be clamped to conductor. During the vibration tests the axis of the clamp of sample shall be maintained parallel to its initial static position by applying a tension (tension from sag-tension calculations at minimum temperature and no wind condition and ruling span as per Annexure-1 of TS of HTLS conductor). The spacer/ spacer damper assembly shall be free to vibrate and shall not be re-torqued or adjusted between the tests.

All the vibration tests mentioned hereunder shall be conducted on the same sample on the same test span. The samples shall withstand the vibration tests without slipping on the conductor, loosening, damage or failure of component parts. After each vibration test, clamp slip test shall be carried out as per the procedure given in clause no. 2.3 (e) below:

(b) Longitudinal Vibration Tests

The stationary conductor and the vibrating conductor/equivalent diameter of aluminum alloy tube shall be restrained by fixed clamps. The displacement of the vibrating conductor shall be 25 mm minimum on either side. The longitudinal movement shall be parallel to the conductor at frequency not less than 2 Hz for minimum one million cycles.

(c) Vertical Vibration Tests

The spacer/spacer damper shall be installed in the middle of the test span and the frequency chosen so as to get an odd number of loops. The shaker shall be positioned at least two loops away from the test specimen to allow free movement of the conductor close to the test specimen. One conductor shall be connected to the shaker and vibrated to an amplitude such that

$$F^{1.8} Y_{\max} > 1000\text{mm/sec.}$$

Where Ymax being the anti node displacement (mm) and f is the test frequency (Hz). The test frequency shall be greater than 24 Hz and the total number of cycles shall be more than 10 million.

(d) Sub-span Oscillation Test

The test shall be conducted for oscillation in horizontal plane at frequency higher than 3 Hz for minimum one million cycles. The amplitude for oscillation shall be kept equivalent to amplitude of 150 mm for a full sub-span of 80m. Both the conductor shall be vibrated 180deg. Out of phase with the above minimum amplitude.

(e) Clamp Slip Test

The spacer assembly shall be installed on test span of twin conductor bundle string at a tension of tension at 0 deg. C & No wind. In case of spacer for jumper, the. clamp of sample shall be tightened with a specified tightening torque. One of the sample clamps, when subjected to a longitudinal pull parallel to the conductor axis for a minimum duration of one minute, shall not slip on the conductor i.e. the permanent displacement between the conductor and the clamp of the sample measured after removal of the load shall not exceed specified values. The minimum slip under longitudinal pull varies with clamp type according to the following table:

Clamp Type	Longitudinal Load (kN)	Maximum Slip (mm)
Metal-Metal bolted	6.5	1
Rubber loaded	2.5	2.5
Clamp using Preformed rods	2.5	12

(f) Compressive and tensile test

This test shall be conducted on 3 (three) nos samples The spacer assembly shall withstand ultimate compressive load of 14 kN and tensile load of 7.0 kN applied

between sub-conductor bundle and held for one minute without failure. Line distance between clamps shall be recorded during each of the compression and tension test. Measurement shall be recorded at (i) no load (ii) with load (iii) after release of load. The center line distance under load shall be within ± 100 mm of the nominal design spacing. After release of load it shall be possible to retain the clamps at their original position using only slight hand pressure. There shall be no deformation or damage to the spacer assembly which would impair its function of maintaining the normal spacing.

(g) Dynamic Characteristic Test (For spacer dampers only)

The purpose of this test is to obtain quantitative information regarding the dynamic characteristics of the spacer damper. The values obtained during this test will serve as references to evaluate the behavior of the same spacer damper under the fatigue test. The test will consist in the application of sinusoidal movement of the spacer-damper articulation and measuring the force (F), displacement (X) and phase angle (θ) between these two, from these values, the stiffness (K) and the damping factor (n) will be calculated.

$$K = (F/X) \cos(\theta); n = \tan(\theta)$$

The test frequency shall not be higher than 3 Hz. The test shall be performed at five different displacement amplitudes. The amplitudes shall be selected to reproduce 10, 20, 40, 60 and 90 percent of the maximum displacement permitted by the spacer-damper design. The test shall be performed on three samples.

(h) Fatigue Test (For spacer dampers only)

The purpose of this test is to evaluate the capacity of the spacer damper to sustain without damage the cyclic movements which can be induced by vibrations.

The spacer damper articulation shall be subjected to cyclic motions for a total of 10 million cycles. The test frequency shall be between 2 and 3 Hz. The amplitude of motion shall be established on the following basis:

- I. the load applied on the spacer damper clamp shall not be less than ± 300 N.
- II. the clamp displacement under the applied load shall not be less than 60% of the maximum displacement permitted by the design.
- III. if the 300 N load generates movement exceeding the maximum permitted displacement, the load can be reduced to limit the movement to 95% of the maximum displacement.
- IV. After the test, the sample shall be subjected to a second dynamic characteristic test. This test shall be performed at two amplitudes, 10% and 60% of the maximum displacement.
- V. The spacer damper shall show no signs of cracks or deterioration, loosening of bolts or abnormal wear.

The dynamic characteristics (k and n) shall not be less than 60% of the values measured before the fatigue test. The test shall be performed on three samples.

(i) Ozone Test

The test shall be performed in accordance with ASTM D-1171 by the ozone chamber exposure method (method B). The test duration shall be 500 hours and the ozone concentration 50 PPHM. At the test completion, there shall be no visible crack under a 2 x magnification.

(j) Log Decrement Test (For spacer dampers only)

The spacer damper assembly shall be mounted on test span of conductor bundle at a tension of 0 deg. C and no wind and ruling span of 400 m. The test span shall be instrumented to continuously monitor and record the horizontal motion of the sub-conductor in the sub-span between suspension point and the first sample. The log decrement test shall be made with an initial peak to peak amplitude of four to six times the conductor diameter in the middle of the sub-span being considered. The conductor shall be excited in a horizontal one loop per sub-span resonant mode with a slow and steady buildup of amplitude that minimizes harmonics and other distortions. After achieving a steady state motion, the conductor excitation shall be discontinued leaving the conductor undisturbed. The motion shall be recorded until it reduces to an amplitude of half of the conductor diameter. The logarithmic (log) decrement shall be the value for a minimum reduction of 80% in amplitude. The minimum acceptable log decrement average for five or more excitation shall be 0.04 based upon the following formula for decay:

$$\text{Loge} \frac{A_n}{A_{n+1}} = \frac{1}{n} \text{Loge} \frac{A_0}{A}$$

Where A0 is the initial amplitude and An is the amplitude 'n' cycles later.

2.4 Magnetic Power Loss test for spacer

The sample involving ferrous parts shall be tested in a manner to simulate service conditions for 50Hz pure sine-wave. The test should be carried out at various currents ranging from 1200 to 1800A per sub conductor (for 400kV) the magnetic power loss at various currents should be specified in tabulated graphical form. The difference between the power losses without and with sample at room temperature shall be limited to value guaranteed by the supplier for desired Amperes (At steady state conductor temperature). The losses shall be determined by averaging the observations obtained from at least 04 samples.

2.5 Corona Extinction Voltage Test (Dry) (For 400kV)

The sample when subjected to power frequency voltage shall have a corona extinction voltage of not less than 320 kV rms line to ground under dry condition. 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 IS: 731-1971.

2.6 Radio Interference Voltage Test (Dry)

Under the conditions as specified above, the sample shall have a radio interference voltage level below 1000 micro volts at one MHz when subjected to 50 Hz AC voltage of 320 kV rms line to ground under dry condition. The test procedure shall be in accordance with IS: 8263.

2.7 Chemical Analysis Test

Chemical analysis of the material used for manufacture of items shall be conducted to check the conformity of the same with Technical Specification and approved drawing.

3.0 Tests on All components (As applicable)

3.1 Chemical Analysis of Zinc used for Galvanizing

Samples taken from the zinc ingot shall be chemically analyzed as per IS-209-1979. The purity of zinc shall not be less than 99.95%.

3.2 Tests for Forgings

The chemical analysis hardness tests and magnetic particle inspection for forgings, 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 test will be as discussed and mutually agreed to by the Contractor and Owner in Quality Assurance Programme.

3.3 Tests on Castings

The chemical analysis, mechanical and metallographic tests and magnetic particle inspection for castings will be as per the internationally recognized procedures for these tests. The samplings will be based on heat number and heat treatment batch. The details regarding test will be as discussed and mutually agreed to by the Contractor and Owner in Quality Assurance Programme.

ANNEXURE-B

Acceptance Tests

1 **Mid Span Compression Joint for Conductor**

(a) **Hardness Test**

The Brinnel hardness at various points on the steel sleeve of conductor core and tension clamp shall be measured.

2. **Vibration Damper for Conductor**

(a) **Verification of Resonance Frequencies**

The damper shall be mounted on a shaker table and vibrate at damper clamp displacement of ± 0.5 mm to determine the resonance frequencies. The resonance shall be visually identified as the frequency at which damper mass vibrates with maximum displacement on itself. The resonance frequency thus identified shall be compared with the guaranteed value. A tolerance of ± 1 Hz at a frequency lower than 15 Hz and ± 2 Hz at a frequency higher than 15 Hz only shall be allowed.

(b) **Clamp Slip Test**

Same as Clause 2.2 (c) (ii) of Annexure-A.

(c) **Clamp Bolt Torque Test**

The clamp shall be attached to a section of the conductor/earthwire. A torque of 150 percent of the manufacturer's specified torque shall be applied to the bolt. There shall be no failure of component parts. The test set up is as described in Clause 2.2 (c) (i), Annexure-A.

(d) **Strength of the Messenger Cable**

The messenger cable shall be fixed in a suitable tensile testing machine and the tensile load shall be gradually applied until yield point is reached. Alternatively, each strand of messenger cable may be fixed in a suitable tensile testing machine and the tensile load shall be gradually applied until yield point is reached. In such a case, the 95% of yield strength of each wire shall be added to get the total strength of the cable. The load shall be not less than the value guaranteed by the Contractor.

(e) **Mass Pull off Test**

Each mass shall be pulled off in turn by fixing the mass in one jaw and the clamp in the other of a suitable tensile testing machine. The longitudinal pull shall be applied gradually until the mass begins to pull out of the messenger cable. The pull off loads shall not be less than the value guaranteed by the Contractor.

(f) **Dynamic Characteristics Test**

The test will be performed as acceptance test with the procedure mentioned for type test with sampling mentioned below:

Vibration Damper below	-	1 Sample for lot of 1000 Nos. &
	-	3 Samples for lot above 1 000 & up to 5000 nos.
	-	Additional 1 sample for every additional 1500 pieces above 5000.

The acceptance criteria will be as follows

- (i) The above dynamic characteristics curve for reactance & phase angle will be done for frequency range of 5 Hz to 40 Hz.
- (ii) If all the individual curve for dampers are within the envelope as already mentioned for type test for reactance & phase angle, the lot passes the test.
- (iii) If individual results do not fall within the envelope, averaging of characteristics shall be done.
- (iv) Force of each damper corresponding to particular frequency shall be taken & average force of three dampers at the frequency calculated.
- (v) Similar averaging shall be done for phase angle.
- (vi) Average force Vs frequency and average phase Vs frequency curves shall be plotted on graph paper. Curves of best fit shall be drawn for the entire frequency range.
- (vii) The above curves shall be within the envelope specified.

3. **Spacer/ Spacer damper**

(a) **Test set up**

The test set up for the test described hereunder shall be as per clause 2.3 (a) of Annexure-A

(b) **Movement Test**

The spacer assembly shall be capable of the following movements without damaging the conductor, assuming one conductor is fixed and the other moving:

- (i) Longitudinal movement parallel to the conductor: $\pm 50\text{mm}$.
- (ii) Vertical movement in a vertical direction at right angle to the conductor: $\pm 25\text{mm}$.
- (iii) Torsional movement / angular movement in a vertical plane parallel to the conductor: $\pm 5\text{ deg}$.

(c) **Compressive and Tensile test**

The spacer assembly shall withstand ultimate compressive load of 14kN and tensile load of 7.0 kN applied between sub-conductor bundle and held for one minute without failure. Line distance between clamps shall be recorded during each of the compression and tension test. Measurement shall be recorded at (i) no load (ii) with load (iii) after release of load. The center line distance under load shall be within $\pm 100\text{mm}$ of the nominal design spacing. After release of load it shall be possible to retain the clamps at their original position using only slight hand pressure. There shall be no deformation or damage to the spacer assembly which would impair its function of maintaining the normal spacing.

(d) **Clamp slip test**

Same as clause 2.3 (e) of Annexure-A.

(e) **Clamp Bolt Torque test**

The spacer assembly shall be attached to conductor. A torque of 150 per cent of the manufacturer's specified tightening torque shall be applied to the clamp bolts or cap screws. There shall be no failure of the component parts.

(f) **Assembly Torque Test**

The spacer assembly shall be installed on conductor. The same shall not rotate on either clamp on applying a torque of 0.04 kN in clockwise or anti-clockwise direction.

(g) **Hardness test for elastomer**

The shore hardness at different points on the elastomer surface of cushion grip clamp shall be measured by shore hardness meter. They shall lie between 65 to 80.

(h) **UTS of Retaining rods**

The UTS of the retaining rods shall be measured. The value shall not be less than 35kg/ sq. mm.

(i) **Ageing test on filler (If applicable)**

Same as clause 1.8 of Annexure-A.

GUARANTEED TECHNICAL PARTICULARS OF HTLS CONDUCTOR

(TO BE FILLED BY BIDDER)

Sl.	Description	Unit	Value guaranteed by the Bidder
1.	Name & address of Manufacturer		
2.	Construction of conductor/ Designation of conductor as per IEC:1089		
3.1	PARTICULARS OF RAW MATERIALS		
3.1	Outer Layers a) Applicable Standard(if any) b) Type of Aluminum alloy c) Minimum purity of aluminum d) Maximum Copper content e) Zirconium content i) Maximum ii) Minimum f) Other elements----- i) ----- ii) -----	 % % % % % %	
3.2	Inner Core a) Applicable Standard(if any) b) Material of core c) Chemical composition of core i) ----- ii) -----	 % %	
3.3	Zinc used for galvanization of inner core (if applicable) a) Minimum purity of zinc	%	
3.4	Chemical Composition of Misch Metal coating on core wires (if applicable) i) Zinc ii) Aluminium iii) Other elements-----	 % % %	
3.5	Aluminium used for Aluminium Cladding (if applicable) a) Minimum purity of aluminum b) Maximum Copper content c) Other elements-----	 % %	

	i) ----- ii).....	% %	
4.	STRANDS OF OUTER CONDUCTING PART (AFTER STRANDING)		
4.1	Number of outer layers	Nos.	
4.2	Number of strands a) 1 st Layer from core b) 2 nd Layer from core c) 3 rd Layer from core	Nos. Nos. Nos.	
4.2	Diameter of strands a) Nominal b) Maximum c) Minimum	mm mm mm	
4.3	Minimum Breaking load of strand a) Before stranding b) After stranding	kN kN	
4.4	Resistance of 1m length of strand at 20 deg. C	Ohm	
4.5	Final Modulus of elasticity	Kg/sq. mm	
4.6	Final Coefficient of linear expansion	Per ⁰ C	
5	INNER CORE STRANDS/ INNER CORE (AFTER STRANDING)		
5.1	Number of layers in inner core (excluding central wire)		
5.2	Number of strands a) 1 st Layer from centre (excluding central wire) b) 2 nd Layer from centre c) 3 rd Layer from centre	Nos. Nos. Nos.	
5.3	Diameter a) Nominal b) Maximum c) Minimum	mm mm mm	
5.3	Minimum Breaking load of strand/Core a) Before stranding b) After stranding	kN kN	

5.4	Resistance of 1m length of strand at 20 deg. C	Ohm	
5.5	Final Modulus of elasticity	Kg/sq. mm	
5.6	Final coefficient of linear expansion	Per ⁰ C	
5.7	Aluminum cladding of INVAR core (if applicable)		
	a) Thickness of cladding		
	i) Maximum	mm	
	ii) Minimum	mm	
	b) Minimum no. of twists in a gauge length equal to 100 times diameter of wire which the strands can withstand in the torsion test		
	a) Before stranding	Nos.	
	b) After stranding	Nos.	
	c) Minimum elongation of strand for a gauge length of 250 mm	%	
	d) Resistance of 1m length of strand at 20 deg. C	Ohm	
5.8	Galvanizing/ Misch Metal coating (if applicable)		
	a) Minimum mass of zinc coating per sqm. of uncoated wire surface.	gm	
	b) Minimum mass of Misch metal coating per sqm. of uncoated wire surface (if applicable).	Nos.	
	c) Min. no. of twists which a single strand shall withstand during torsion test for a length equal to 100times dia of wire after stranding.	Nos.	
	d) Minimum elongation of strand for a gauge length of 250 mm	%	
6	FILLER (if applicable)		
6.1	Type & Designation of Filler		
6.2	Chemical composition of Filler		
6.3	Mass of Filler	Kg/km	
7	COMPLETE HTLS CONDUCTOR		
7.1	Cross section drawing of the offered conductor enclosed	Yes/No	

7.2	Diameter of conductor a) Nominal b) Maximum	mm mm		
	c) Minimum	mm		
7.3	UTS (minimum) of Conductor	kN		
7.4	Lay ratio of conductor a) 1 st layer from centre (excluding central wire) b) 2 nd Layer c) 3 rd Layer d) 4 th Layer		Max.	Min.
7.5	DC resistance of conductor at 20°C	Ohm/km		
7.6	Final Modulus of elasticity			
	a) Upto transition temperature	Kg/sq mm		
	b) Above transition temperature	Kg/sm m		
7.7	Coefficient of linear expansion			
	a) Upto transition temperature	Per deg C		
	b) Above transition temperature	Per deg C		
7.8	Calculation for transition temperature Enclosed	Yes/No		
7.9	Transition temperature (corresponding to ---m ruling span and tension at ruling condition as per 7.19)	Deg C		
7.10	Minimum Corona Extinction Voltage (line to ground) under Dry condition .	kV(rms)		
7.11	RIV at 1MHz and 156 kV (rms)under dry conditions .	Micro- volts		
7.12	Maximum permissible conductor temperature for continuous operation	Deg C		
7.13	Maximum permissible conductor temperature for short term operation	Deg C		
7.14	Permissible duration of above short term operation	Minutes		
7.15	Steady state conductor temperature at specified conductor current of 1200 A and under Ambient conditions detailed in Clause 1.2.1			

	of the Technical Specification for HTLS conductor		
7.16	AC resistance at maximum continuous operating temperature corresponding to specified maximum operating current(1200 A under ambient condition enclosed as per Technical Specification for HTLS conductor)	Ohm/km	
7.17	AC resistance at continuous operating temperature corresponding to specified operating current of 1200 A (under ambient condition enclosed as per Clause 1.2.1 of the Technical Specification for HTLS conductor)	Ohm/km	
7.18	Details of Creep characteristic for HTLS conductor enclosed (as per Clause 1.4.5 of the Technical Specification for HTLS conductor)	Yes/No	
7.19	Sag Tension Calculation		
7.19.1	Sag Tension Calculation enclosed (clause 1.4.1 of Section-IV of the Technical Specification for HTLS conductor)	Yes/No	
7.19.2	Tension at 32 deg. C & no wind	Kg	
7.19.3	Sag & tension at maximum continuous operating temperature (corresponding to current of 1200 A and Ambient conditions detailed in Technical Specification for HTLS conductor)	Meters & Kgs	
i)	Tension for following conditions:		
a.	32 deg. C & full wind condition	kg	
b.	32 deg. C & Nil wind condition	kg	
c.	Minimum tempt. & Nil wind condition	kg	
d.	Minimum tempt. & 36% of full wind Condition		
e.	32 deg. C & 75% of full wind condition		

7.19.4	Tension at transition temperature	kg	
7.20	Direction of lay for outside layer		
7.21	Linear mass of the Conductor a) Standard b) Minimum c) Maximum	Kg/km Kg/km Kg/km	
7.22	Standard length of conductor	M	
7.23	Maximum length of conductor that can be offered as single length	M	
7.24	Tolerance on standard length of conductor	%	
7.25	Drum is as per specification	Yes/No	
7.26	No. of cold pressure butt welding equipment available at works	Nos.	

**GUARANTEED TECHNICAL PARTICULARS OF SUSPENSION HARDWARE FITTINGS
(To be filled by the Bidder)**

Sl. No.	Description	Unit	Value guaranteed by the Bidder
1.	Name & address of Manufacturer		
2.	Address of Manufacturer		
3.	Drawing enclosed	Yes/No	
4.	Maximum magnetic power loss of suspension clamp at conductor / sub- conductor current of amperes (at steady state conductor temperature)	Watt	
5.	Slipping strength of suspension assembly (clamp torque Vs slip curve shall be enclosed)	kN	
6.	Particulars of standard/AGS Standard / AGS preformed armour rod set for suspension assembly		
	a) No. of rods per set	No.	
	b) Direction of lay		
	c) Overall length after fitting on conductor	mm	
	d) Actual length of each rod along its helix	mm	
	e) Diameter of each rod	mm	
	f) Tolerance in		
	i) Diameter of each rod	±mm	
	ii) Length of each rod	±mm	
	iii) Difference of length between the longest and shortest rod in a set	±mm	
	g) Type of Aluminium alloy used for manufacture of PA rod set		
	h) UTS of each rod	Kg/mm ²	

7.	Particulars of Elastomer (For AGS Clamp only)		
	a) Supplier of elastomer		
	b) Type of elastomer		
	c) Shore hardness of elastomer		
	d) Temperature range for which elastomer is designed		
	e) Moulded on insert		
8.	UTS of suspension clamp		
9.	Purity of Zinc used for galvanizing	%	
11.	Minimum corona extinction voltage under dry condition [for 400kV lines]	kV (rms)	
12.	Radio interference voltage at 1 Mhz for phase to earth voltage of 320 kV (dry condition) [for 400kV lines]	μV	
13.	Maximum permissible continuous operating temperature of		
	i) Clamp body	Deg. C	
	ii) Standard/AGS preformed rods	Deg. C	

**GUARANTEED TECHNICAL PARTICULARS OF TENSION HARDWARE FITTINGS
(To be filled by the Bidder)**

Sl. No.	Description	Unit	Value guaranteed by the Bidder
1.	Name of Manufacturer		
2.	Address of Manufacturer		
3.	Drawing enclosed	Yes/ No	
4.	Purity of aluminum used for aluminum sleeve	%	
5.	Material for steel sleeve		
	(i) Type of material with chemical		

	composition			
	(ii) Range of Hardness of material (Brinell Hardness)	BHN	Fromto	
	(iii) Weight of zinc coating	gm/m ²		
			<u>Aluminium</u> <u>/ Alloy</u>	<u>Steel</u>
6.	Outside diameter of sleeve before compression	mm		
7.	Inside diameter of sleeve before compression	mm		
8.	Length of sleeve before compression			
9.	Dimensions of sleeve after compression			
	(a) Corner to Corner			
	(b) Surface to Surface			
10.	Length of sleeve after compression			
11.	Weight of sleeve			
	(a) Aluminium/ aluminum Alloy	kg		

	(b) Steel	kg		
	(c) Total	kg		
12.	Electrical resistance of dead end assembly as a percentage of equivalent length of Conductor	%		
13.	Slip strength of dead end assembly	kN		
14.	UTS of dead end assembly	kN		
15.	Purity of Zinc used for galvanizing	%		
16.	Design calculation of yoke plates and sag adjustment plate enclosed.	Yes / No		
17.	Minimum corona extinction voltage under dry condition [for 400kV lines]	kV (rms)		

18.	Radio interference voltage at 1 Mhz for phase to earth voltage of 320 kV (dry condition) [for 400kV lines]	μV	
19.	Maximum permissible continuous operating temperature of dead end assembly	Deg . C	

GUARANTEED TECHNICAL PARTICULARS OF MID SPAN COMPRESSION JOINT FOR HT/HTLS CONDUCTOR (To be filled by the Bidder)

Sl. No.	Description	Unit	Value guaranteed by the Bidder	
1.	Name of Manufacturer			
2.	Address of Manufacturer			
3.	Drawing enclosed		Yes/No	
4.	Suitable for conductor size	mm		
5.	Purity of aluminium used for aluminium sleeve	%		
6.	Material for steel sleeve			
	(i) Type of material with chemical composition			
	(ii) Range of Hardness of material (Brinell Hardness)	BHN	Fromto	
	(iii) Weight of zinc coating	gm/m^2		
			<u>Aluminium / alloy</u>	<u>Steel</u>
7.	Outside diameter of sleeve before compression	mm		
8.	Inside diameter of sleeve before compression	mm		
9.	Length of sleeve before compression			
10.	Dimensions of sleeve after compression			
	<u>(a) Corner to Corner</u>			
	<u>(b) Surface to Surface</u>			
11.	Length of sleeve after compression			

12.	Weight of sleeve		
	(a) Aluminium	kg	
	(b) Steel	kg	
	(c) Total	kg	
13.	Slip strength	kN	
14.	Resistance of the compressed unit expressed, as percentage of the resistivity of equivalent length of bare conductor.	%	
15.	Minimum Corona extinction voltage under dry condition [for 400kV lines]	kV (rms)	
16.	Radio interference voltage at 1 MHz for phase to earth voltage of 320 kV under dry condition[for 400kV lines]	μV	
17.	Maximum permissible continuous operating temperature of mid span compression joint	Deg. C	

GUARANTEED TECHNICAL PARTICULARS OF REPAIR SLEEVE FOR HT/HTLS CONDUCTOR (To be filled by the Bidder)

Sl. No.	Description	Unit	Value guaranteed by the Bidder
1.	Name of Manufacturer		
2.	Address of Manufacturer		
3.	Drawing enclosed	Yes/No	
4.	Suitable for conductor size	mm	
5.	Purity of Aluminium / Al Alloy type	%	
6.	Dimension of sleeve before compression		
	i) Inside diameter of sleeve	mm	
	ii) Outside dimensions of sleeve	mm	
	iii) Length of sleeve	mm	
7.	Dimension of sleeve after compression		

	i) Corner to Corner	mm	
	ii) Surface to Surface	mm	
	iii) Length of sleeve	mm	
8.	Weight of sleeve	Kg	
9.	Minimum Corona extinction voltage under dry condition [for 400kV lines]	kV (rms)	
10.	Radio interference voltage at 1 MHz for phase to earth voltage of 320 kV dry condition) [for 400kV lines]	μV	
11.	Maximum permissible continuous operating temperature of Repair Sleeve	Deg. C	

NOTE: Tolerances, wherever applicable, shall also be specified.

GUARANTEED TECHNICAL PARTICULARS OF VIBRATION DAMPER FOR HT/HTLS CONDUCTOR (IF APPLICABLE) (To be filled by the Bidder)

Sl. No.	Description	Unit	Value guaranteed by the Bidder	
1.	Name of Manufacturer			
2.	Address of Manufacturer			
3	Drawing enclosed			
	(a) Design Drawing	YES / NO		
	(b) Placement Chart	YES / NO		
4.	Suitable for conductor size	mm		
5.	Total weight of one damper	kg		
			<u>Right</u>	<u>Left</u>
6.	Diameter of each damper mass	mm		
7.	Length of each damper mass	mm		

8.	Weight of each damper mass	kg		
9.	Material of damper masses			
10.	Material of clamp			
11.	Material of the stranded messenger cable			
12.	Number of strands in stranded messenger cable			
13.	Lay ratio of stranded messenger cable			
14.	Minimum ultimate tensile strength of stranded messenger cable	Kg/m m ²		

15.	Slip strength of stranded messenger cable (mass pull off)	kN		
			<u>Right</u>	<u>Left</u>
16.	Resonance frequencies			
	(a) First frequency	Hz		
	(b) Second frequency	Hz		
17.	Designed clamping torque	Kg-m		
18.	Slipping strength of damper clamp			
	(a) Before fatigue test	kN		
	(b) After fatigue test	kN		
19.	Magnetic power loss per vibration damper watts for ---Amps, 50 Hz Alternating Current [average continuous operating current]	watts		
20.	Minimum corona Extinction voltage kV (rms) under dry condition [for 400kV lines]	kV		
21.	Radio Interference Voltage at 1 MHz for phase to earth voltage of 320 kV (rms) Microvolts under dry condition [for 400kV lines]	μV		
22.	Maximum permissible continuous operating temperature of Vibration Damper	Deg. C		

23.	Percentage variation in reactance after fatigue test in comparison with that before fatigue test	%	
24.	Percentage variation in power dissipation after fatigue test in comparison with that before fatigue test	%	

NOTE: Tolerances, wherever applicable, shall also be specified.

GUARANTEED TECHNICAL PARTICULARS OF BUNDLE SPACER FOR HT/HTLS CONDUCTOR (IF APPLICABLE) (To be filled by the Bidder)

Sl. No.	Description	Unit	Value guaranteed by the Bidder	
1.	Name of Manufacturer			
2.	Address of Manufacturer			
3.	Drawing enclosed			
	(a) Design Drawing		YES / NO	
	(b) Placement Chart		YES / NO	
4	Suitable for conductor size	mm		
5.	Material / Manufacturing process of component parts			
			<u>Material</u>	<u>Manufaturing Process</u>
	(a) Insert			
	(b) Main body			
	(c) Retaining rods (if any)			
6.	Retaining rods (if used)			
	(a) Type of alloy used			
	(b) Number of retaining rods used for each spacer	no.		
	(c) Diameter	mm		

	(d) Length	mm	
	(e) Weight	kg	
7.	Elastomer		

	(a) Contractor		
	(b) Type		
	(c) Moulded on insert		
	(d) Shore hardness		
	(e) Thickness on insert	mm	
	(f) Temp. range for which designed	°C	
8.	Minimum ultimate tensile strength of spacer		
	(a) Compressive load	kN	
	(b) Tensile load	kN	
9.	Weight of Spacer	kg	
10.	Designed clamping torque(if applicable)	kg. m	
			<u>Before Vibration</u> <u>After Vibration</u>
11.	Slipping strength of spacer clamp	kN	
12.	Magnetic power loss per spacer for ---- A, 50 Hz Alternating Current (at steady state conductor temperature)	Watt s	
			Maximum Minimum
13.	Electrical resistance of elastomer cushioned spacer	oh m	
14.	Minimum corona Extinction voltage kV (rms) under dry condition [for 400kV lines]	kV	
15.	Radio Interference Voltage at 1 MHz for phase to earth voltage of 320 kV (rms) Microvolts under dry condition [for 400kV lines]	μV	
16.	Maximum permissible continuous operating temperature of Bundle spacer	Deg. C	

NOTE: Tolerances, wherever applicable, shall also be specified.

**GUARANTEED TECHNICAL PARTICULARS OF RIGID SPACER FOR JUMPER
FOR HTLS CONDUCTOR**

(To be filled by the Bidder)

Sl. No.	Description	Unit	Value guaranteed by the Bidder
1.	Name of Manufacturer		
2.	Address of Manufacturer		
3.	Drawing enclosed		
	(a) Design Drawing	YES / NO	
	(b) Placement Chart	YES / NO	
4	Suitable for conductor size	mm	
5.	Material of component parts		
	(a) Clamp		
	(b) Main body		
6.	Manufacturing process for		
	(a) Clamp		
	(b) Main body		
	(e) Weight	kg	
7.	Elastomer		
	(a) Contractor		
	(b) Type		
	(c) Moulded on insert		
	(d) Shore hardness		
	(e) Thickness on insert	mm	
	(f) Temp. range for which designed	°C	
8.	Minimum ultimate tensile strength of spacer		
	(a) Compressive load	kN	

	(b) Tensile load	kN		
9.	Weight of Spacer	kg		
10.	Designed clamping torque(if applicable)	kg.m		
11.	Slipping strength of spacer clamp	kN		
12.	Magnetic power loss per spacer for Watts --- Amps, 50 Hz Alternating Current (at steady state conductor temperature)	watt		
			<u>Maximum</u>	<u>Minimum</u>
12.	Electrical resistance of elastomer cushioned spacer	ohm	
13.	Minimum corona Extinction voltage kV (rms) under dry condition [for 400kV lines]	kV (rms)		
14.	Radio Interference Voltage at 1 MHz for phase to earth voltage of 320 kV (rms) Microvolts under dry condition [for 400kV lines]	μV		
15.	Maximum permissible continuous operating temperature of rigid spacer	Deg. C		

NOTE: Tolerances, wherever applicable, shall also be specified.

**GUARANTEED TECHNICAL PARTICULARS OF SPACER DAMPER FOR HTLS
CONDUCTOR (IF APPLICABLE)**

(To be filled by the Bidder)

Sl. No.	Description	Unit	Value guaranteed by the Bidder
1.	Name of Manufacturer		
2.	Address of Manufacturer		
3.	Drawing enclosed		
	(a) Design Drawing	YES / NO	
	(b) Placement Chart	YES / NO	

4	Suitable for conductor size	mm	
5.	Material of component parts		
	(a) Clamp		
	(b) Main body		
6.	Type of Clamps		
7.	Type of Damping element		
8.	Manufacturing process for		
	(a) Clamp		
	(b) Main body		
	(e) Weight	kg	
9.	Elastomer		
	(a) Contractor		
	(b) Type		
	(c) Moulded on insert		

	(d) Shore hardness		
	(e) Thickness on insert	mm	
	(f) Temp. range for which designed	°C	
10.	Minimum ultimate tensile strength of spacer		
	(a) Compressive load	kN	
	(b) Tensile load	kN	
11.	Weight of Spacer	kg	
12.	Designed clamping torque(if applicable)	kg. m	
13.	Slipping strength of spacer clamp	kN	
14.	Magnetic power loss per spacer for Watts 1574 Amps, 50 Hz Alternating Current	watt	
			<u>Maxi</u> <u>mum</u>
			<u>Minim</u> <u>um</u>
15.	Electrical resistance of elastomer cushioned spacer	ohm	

16.	Minimum corona Extinction voltage kV (rms) under dry condition [for 400kV lines]	kV (rms)	
17.	Radio Interference Voltage at 1 MHz for phase to earth voltage of 320 kV (rms) Microvolts under dry condition [for 400kV lines]	μV	
18.	Maximum permissible continuous operating temperature of spacer damper	Deg. C	

NOTE: Tolerances, wherever applicable, shall also be specified.

SECTION-XXV

220kV POLYMER INSULATOR

TECHNICAL SPECIFICATIONS

SECTION-I

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TECHNICAL SPECIFICATIONS

SECTION-I

1.0 General Information

- 1.1 The material covered in this specification shall be used in the pollution stretches of existing 220 kV Transmission Lines of Delhi Transco Limited.

2.0 Scope

- 2.1 The material to be supplied on final destination at site basis as covered in this volume shall be designed, manufactured and tested as per the requirements specified.

Final Destination shall mean the stores established by the Owner/Contractor of the Owner along the Transmission Lines.

- 2.2 The materials covered here under this specification shall be supplied complete in all respects, including all components, fittings and accessories which are necessary or are usual for their efficient performance and satisfactory maintenance under the various operating and atmospheric conditions. Such parts shall be deemed to be within the scope of the Contract, whether specifically included or not in the Specification or in the Contract Schedules. The Supplier shall not be eligible for any extra charges for such fittings, etc.

The details of the materials required for the Insulator package under this Specification are mentioned in the bidding documents.

3.0 Weights and Measures

All weights and measures shall be in System International (S.I.) units. All fasteners shall be of Metric size only.

4.0 General Technical Conditions

- 4.1 The following provisions shall supplement all the detailed technical specifications and requirements brought out in the accompanying Technical Specifications. The Bidder's proposal shall be based on the use of equipment and materials complying fully with the requirements, specified herein.

The Bidder shall furnish clause-by-clause commentary (with detailed technical data as required) on the Technical Specifications demonstrating the goods substantial responsiveness to the specifications or deviations and exceptions to the provisions of the Technical Specification.

4.2 Equipment Performance Guarantee

- 4.2.1 The performance requirements of the items are detailed separately in this Specification. These guarantees shall supplement the general performance guarantee

provisions covered under General Terms and Conditions of Contract in clause entitled 'Guarantee'.

- 4.2.2 Liquidated damages for not meeting specified Technical performance shall be assessed and recovered from the Supplier. Such liquidated damages shall be without any limitation whatsoever and shall be in addition to damages, if any payable under any other clause of Conditions of Contract.

4.3 Engineering Data

- 4.3.1 The furnishing of engineering data by the Supplier shall be in accordance with the appropriate Schedule appended to this document. The review of these data by the Owner will cover only general conformance of the data to the specifications and drawings. This review by the Owner 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 Owner shall not be considered by the Supplier, as limiting any of his responsibilities and liabilities for mistakes and deviations from the requirements, specified under these Specifications and documents.
- 4.3.2 All engineering data submitted by the Supplier after final process including review and approval by the Owner 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 Owner in writing.

4.4 Drawings

- 4.4.1 All drawings submitted by the Supplier including those submitted at the time of bid shall be in sufficient detail to indicate the type, size, arrangement, dimensions, material description, Bill of Materials, weight of each component, break-up for packing and shipment, fixing arrangement required, the dimensions required for installation and any other information specifically requested in the Specifications.
- 4.4.2 Each drawing submitted by the Supplier shall be clearly marked with the name of the Owner, the unit designation, the Specification title, title Specification number and title name of the Project. All titles, noting, markings and in writings on the drawing shall be in English. All the dimensions should be to the scale and in metric units.
- 4.4.3 The drawings submitted by the Supplier shall be reviewed by the Owner as far as practicable within four (4) weeks and shall be modified by the Supplier if any modifications and/or corrections are required by the Owner in compliance with Specifications. The Supplier shall incorporate such modifications and or corrections and submit the final drawings for approval. Any delays arising out of failure by the Supplier to rectify the drawings in good time shall not alter the Contract completion date.
- The drawings submitted for approval to the Owner shall be in quadruplicate. One print of such drawings shall be returned to the Supplier by the Owner marked approved/approved with corrections". The Supplier shall there upon furnish the Owner additional print as stipulated in Technical Specification along with one reproducible in original of the drawings after incorporating all corrections.

- 4.4.4 Further work by the Supplier shall be strictly in accordance with these drawings and no deviation shall be permitted without the written approval of the Owner, if so required.
- 4.4.5 All manufacturing and fabrication work in connection with the equipment/ material prior to the approval of the drawings shall be at the Supplier's risk. The Supplier 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 Owner. Approval of Supplier's drawing or work by the Owner shall not relieve the Supplier of any of his responsibilities and liabilities under the Contract.

4.5 Manufacturing Schedule

The Supplier shall submit to the Owner his manufacturing, testing and delivery schedules of various items within thirty (30) days from the date of the Letter of Award in accordance with the delivery requirements stipulated. Schedules shall also include the materials and items purchased from outside Suppliers, if any.

4.6 Reference Standards

- 4.6.1 The Codes and/or Standards referred to in Specifications shall govern, in all cases wherever such references are made. In case of a conflict between such Codes and/or Standards and the specifications, latter shall govern. Such Codes and/or Standards, referred to shall mean the latest revisions, amendments/ changes adopted and published by the relevant agencies.
- 4.6.2 Other Internationally acceptable Standards which ensure equivalent or better performance than those specified shall also be accepted.

4.7 Design Improvements

- 4.7.1 The Owner or the Supplier may propose changes in the Specification of the equipment or quality thereof and if the parties agree upon any such changes, the Specification shall be modified accordingly.
- 4.7.2 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 Supplier proceeds with the change. Following such agreement, the provision thereof, shall be deemed to have been amended accordingly.

4.8 Quality Assurance

- 4.8.1 To ensure that the equipment under the scope of this Contract whether manufactured within the Supplier's Works or at his Sub-Supplier's premises is in accordance with the specifications, the Supplier shall adopt suitable Quality Assurance Programme to control such activities at all points necessary. Such programme shall be outlined by the Supplier and shall be finally accepted by the Owner after discussions before the

award of Contract. A Quality Assurance Programme of the Supplier shall generally cover but not limited to the following:

- (a) His organisation structure for the management and implementation of the proposed Quality Assurance Programme.
- (b) Documentation control system.
- (c) Qualification data for key personnel;
- (d) The procedure for purchases of materials, Parts/components and selection of sub-Supplier's services including vendor analysis, source inspection, incoming raw material inspection, verification of material purchases etc.
- (e) System for shop manufacturing including process controls.
- (f) Control of non-conforming items and system for corrective action.
- (g) Control of calibration and testing of measuring and testing equipments.
- (h) Inspection and test procedure for manufacture.
- (i) System for indication and appraisal of inspection status.
- (j) System for quality audits.
- (k) System for authorising release of manufactured product to the Owner.
- (l) System for maintenance of records.
- (m) System for handling, storage and delivery and
- (n) A Quality Plan detailing out the specific quality control procedure adopted for controlling the quality characteristics of the product.

The Quality Plan shall be mutually discussed and approved by the Owner after incorporating necessary corrections by the Supplier as may be required.

4.8.2 Quality Assurance Documents

The Supplier shall be required to submit all the Quality Assurance Documents as stipulated in the Quality Plan at the time of Owner's inspection of equipment/material.

- 4.8.3 The Owner or his duly authorised representatives reserves the right to carry out Quality Audit and quality surveillance of the systems and procedures of the Supplier's/his vendor's Quality Management and Control Activities.

4.9 Owner's Supervision

- 4.9.1 To eliminate delays and avoid disputes and litigation it is agreed between the parties to the Contract that all matters and questions shall be resolved in accordance with the provisions of this document.
- 4.9.2 The manufacturing of the product shall be carried out in accordance with the specifications. The scope of the duties of the Owner, pursuant to the contract, will include but not be limited to the following:

- (a) Interpretation of all the terms and conditions of these Documents and Specifications.
- (b) Review and interpretation of all the Supplier's drawings, engineering data etc.
- (c) Witness or authorize his representative to witness tests at the manufacturer's works or at site, or at any place where work is performed under the Contract.
- (d) Inspect, accept or reject any equipments, material and work under the Contract, in accordance with the Specifications.
- (e) Issue certificate of acceptance and/or progressive payment and final payment certificate.
- (f) Review and suggest modification and improvement in completion schedules from time to time, and
- (g) Supervise the Quality Assurance Programme implementation at all stages of the works.

4.10 Inspection, Testing & Inspection Certificate

- 4.10.1 The Owner, his duly authorised representative and/or outside inspection agency acting on behalf of the Owner shall have at all reasonable times access to the Supplier's premises and works and shall have the power at all reasonable times to inspect and examine the materials and workmanship of the product during its manufacture and if part of the product is being manufacture or assembled at other premises or works, the Supplier shall obtain from the Owner and / or his duly authorised representative permission to inspect as if the equipment / materials were manufactured or assembled on the Supplier's own premises or works.
- 4.10.2 The Supplier shall give the Owner Inspector fifteen (15) days written notice of any material being ready for testing. Such tests shall be to the Supplier's account except for the expenses of the Inspector. The Owner/inspector, unless witnessing of the tests is waived, will attend such tests within fifteen (15) days of the date of which the equipment is notified as being ready for test/inspection or on a mutually agreed date, failing which the Supplier 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 duly certified copies of tests in triplicate.
- 4.10.3 The Owner/Inspector shall, within fifteen (15) days from the date of inspection as defined herein give notice in writing to the Supplier, of any objection to any drawings and all or any equipment and workmanship, which in his opinion is not in accordance with the Contract. The Supplier shall give due consideration to such objections and shall make the modifications that may be necessary to meet the said objections.
- 4.10.4 When the factory tests have been completed at the Supplier's or Sub-Supplier's works, the Owner inspector shall issue a certificate to this effect within fifteen (15) days after completion of tests but if the tests are not witnessed by the Owner/inspector, the

certificate shall be issued within fifteen (15) days of receipt of the Supplier's Test Certificate by the Owner/ Inspector. The completion of these tests or the issue of the certificate shall not bind the Owner to accept the equipment should it, on further tests after erection, be found not to comply with the Contract.

- 4.10.5 In all cases where the Contract provides for test whether at the premises or works of, the Supplier or of any Sub-Supplier, the Supplier except where otherwise specified shall provide free of charge such item as labour, materials, electricity, fuel, water, stores, apparatus and instruments as may be reasonably demanded by the Owner 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 Owner/Inspector or to his authorised representative to accomplish testing.
- 4.10.6 The inspection by Owner and issue of Inspection Certificate thereon shall in no way limit the liabilities and responsibilities of the Supplier in respect of the agreed Quality Assurance Programme forming a part of the Contract.

5.0 Technical Description

- 5.1 The technical description of Composite Long Rod Insulator shall be as specified in Section- II of this Technical Specifications.

6.0 Tests and Standards

6.1 Tests

The following type, acceptance and routine tests and tests during manufacture shall be carried-out on the material. For the purpose of this clause:

- 6.1.1 Type Tests shall mean those tests which are to be carried out to prove the process of manufacture and general conformity of the material to this Specification. These tests shall be carried out on samples prior to commencement of commercial production against the order. The Bidder shall indicate his schedule for carrying out these tests.
- 6.1.2 Acceptance Tests shall mean those tests which are to be carried out on samples taken from each lot offered for pre-dispatch inspection, for the purposes of acceptance of that lot.
- 6.1.3 Routine Tests shall mean those tests, which are to be carried out on the material to check requirements which are likely to vary during production.
- 6.1.4 Tests during Manufacture shall mean those tests, which are to be carried out during the process of manufacture and end inspection by the Supplier to ensure the desired quality of the end product to be supplied by him.
- 6.1.5 The norms and procedure of sampling for these tests will be as per the Quality Assurance Programme to be mutually agreed to by the Supplier and the Owner.
- 6.1.6 The standards and norms to which these tests will be carried out are listed against them. Where a particular test is a specific requirement of this Specification, the norms

and procedure of the test shall be as specified in Annexure-A or as mutually agreed to between the Supplier and the Owner in the Quality Assurance Programme.

- 6.1.7 For all type and acceptance tests, the acceptance values shall be the values specified in this Specification or guaranteed by the Bidder, as applicable.

7.0 Guaranteed Technical Particulars

- 7.1 The Guaranteed Technical Particulars of the various items shall be furnished by the Bidders in one original and four (4) copies in the prescribed schedules of the specifications. The Bidder shall also furnish any other schedule informations as in their opinion is needed to give full description and details to judge the item(s) offered by them
- 7.2 The data furnished in Guaranteed Technical Particulars should be the minimum or maximum value (as per the requirement of the specification) required. A Bidder may guarantee a value more stringent than the specification requirement. However, for testing purpose or from performance point of view, the material shall be considered performed successfully if it achieves the minimum or maximum value required as per the technical specification. No preference what so ever shall be given to the bidder offering better/more stringent values than those required as per specification.

8.0 Technical Information

8.1 Electrical System Data

a. Nominal Voltage	KV	220
b. Maximum system voltage	KV	245
c. BIL (Impulse)	KV(peak)	1050
d. Power frequency withstand voltage (Wet)	KV(rms)	460
e. Minimum Corona extinction voltage at 50 Hz AC system under dry condition	KV(rms)	154 (Min) Phase to earth
f. Radio interference voltage at one MHz for phase to earth voltage (dry condition.)	Micro volts	1000 (max)

8.2 Details of Line Materials

8.2.1 Conductor and Earthwire for 220kV Transmission Line

S No	Description	Unit	Conductor	Earthwire
1	Name/Type		ACSR ZEBRA	19/2.64 mm Galvanised steel wire stranded of grade 3
2	Size	mm	54/3.18 Aluminium 7/3.18 Steel	19/2.64 steel
3	Conductor per phase		1	N.A.
4	Spacing between conductor of same phase (sub conductor spacing)	mm	-	N.A.
5	Configuration		Vertical single	Single running on top of the tower
6	Overall diameter	mm	28.62	12.50
7	Unit mass	Kg/KM	1623	-

8	Ruling Design Span	Meter	320 (Broad Base)/225 (narrow Base)	320 (Broad Base)/225 (narrow Base)
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8.2.2 Detail of Insulator String with Composite Long Rod Insulators for Pollution Stretches

SL. No.	Particulars	Single 'T' suspension String	Double tension String	Single tension String	Single Suspension Pilot String	Double Suspension	Double Suspension for JCT
1	Size of Composite insulator (Core Dia x Nominal length) mm	20-24 x 2175	24 x 2720	24 x 2720	20-24 x 2175	20-24 x 2175	24x2175
2	E&M strength of each insulator unit in the string in KN	90/120	2x160	160	90/120	2x90/120	2x160
3	No. of Long rod insulators per string	1 x 1	2x1	1 x 1	1 x 1	2x1	2x1
4	Minimum creepage distance of each composite long rod in mm	7595	7595	7595	7595	7595	7595

9.0 Service Condition.

Equipment/material to be supplied against this specification shall be suitable for satisfactory continuous operation under conditions as specified below:

Maximum ambient temperature (Degree Celcius)	: 50
Minimum ambient temperature (Degree Celsius)	: 0
Relative humidity (% range)	: 10-100
Maximum annual rainfall & snowfall (Cm)	as per published Meteorological/ Climatological data
Wind zone	: 5
Basic wind velocity (m/sec.)	: 50 m/sec.
Maximum altitude above mean sea level (Metres)	Upto 1000m
Isoceraunic level (days/years)	50

Moderately hot and humid tropical, climate, conducive to rust and fungus growth.

TECHNICAL SPECIFICATIONS

SECTION-II

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TECHNICAL SPECIFICATIONS

SECTION-II

1.0 Technical Description of Composite Long Rod Insulators

1.1 Details of Composite Long Rod Insulators

- 1.1.1 The insulators of the strings shall consist of composite long rod insulators for a three phase, 50 Hz, effectively earthed 220kV transmission system in a very heavy polluted atmosphere. Couplings shall be ball and socket type.
- 1.1.2 Bidder shall quote such composite insulators which have proven use under saline environmental and operational condition. The Bidder shall furnish evidence in the form of certification from the power utilities that the similar type of product supplied to them had been performing satisfactory. The Bidder shall also submit certified test report for an accelerated ageing test of 5000 hours such as that described in Appendix-C of IEC-61109 or 62217.
- 1.1.3 Insulators shall have sheds of the "open aerodynamic profile with good self-cleaning properties. Insulator shed profile, spacing projection etc. shall be strictly in accordance with the recommendation of IEC-60815.
- 1.1.4 The size of long rod insulator, minimum creepage distance, the number to be used in different type of strings, their electromechanical strength and mechanical strength of insulator string along with hardware fittings shall be as follows:

S. No.	Type of String	*Size of composite Insulator (Core dia x Nominal length)(mm)	Minimum Creepage Distance (mm)	No. of individual Units per string	Electro-Mechanical Strength of Insulator Unit (KN)	Mechanical Strength of Insulator String along with Hardware fittings (KN)
1	2	3	4	5	6	7
1	Single Suspension 'pilot'	20-24 x 2175	7595	1 x 1	90/120	90/120
2	Single 'I' suspension	20-24 x 2175	7595	1 x 1	90/120	90/120
3	Single tension String	24 x 2720	7595	1 x 1	160	160
4	Double tension String	24 x 2720	7595	2 x 1	160	2x 160
5	Double Suspension	20-24x2175	7595	2 x 1	90/120	2 x 90/120
6	Double Suspension for JCT	24x2175	7595	2 x 1	160	2x 160

Note: **The core dia of composite insulators mentioned at column No.3 is for indicative purpose. The bidder shall offer composite long rod insulators of suitable core dia to meet specified E&M and torsion strength requirements. For offered core dia, less than indicated in table above, the bidder shall submit documentary evidence of past supplies & satisfactory operation of the same for minimum period of three years. However, the overall string length shall be within the limits specified in the drawing.*

1.2 Ball and Socket Designation

The dimensions of the Ball and Socket shall be of 16 mm designation for 90KN insulators and 20mm designation for 120 KN & 160 KN Insulators in accordance with the standard dimensions stated in IEC:60120 / IS:2486 (part-II)

1.3 Dimensional Tolerance of Composite Insulators

The tolerances on all dimensions e.g. diameter, length and creepage distance shall be allowed as follows:

$\pm (0.04d + 1.5)$ mm when $d \leq 300$ mm.

$\pm (0.025d + 6)$ mm when $d > 300$ mm.

Where, d being the dimensions in millimeters for diameter, length or creepage distance as the case may be.

However, no negative tolerance shall be applicable to creepage distance.

1.4 Interchangeability

The composite long rod insulators inclusive of the ball & socket connection shall be standard design suitable for use with the hardware fittings of any make conforming to relevant IEC standards.

1.5 Corona and RI Performance

All surfaces shall be clean, smooth, without cuts, abrasions or projections. No part shall be subjected to excessive localized pressure. The insulator and metal parts shall be so designed and manufactured that it shall avoid local corona formation and no generate any radio interference beyond specified limit under the operating conditions.

1.6 Maintenance

1.6.1 The long rod insulators offered shall be suitable for employment of hot line maintenance technique so that usual hot line operation can be carried out with ease speed and safety.

1.6.2 All insulators shall be designed to facilitate cleaning and insulators shall have the minimum practical number of sheds and grooves. All grooves shall be so proportioned that any dust deposit can be removed without difficulty either by wiping with a cloth or by remote washing under live line condition.

1.7 Materials

1.7.1 Core

It shall be a glass-fiber reinforced (FRP rod) epoxy resin rod of high strength. The rod shall be resistant to hydrolysis. Glass fibers and resin shall be optimized. The rod shall be electrical grade corrosion resistant (ECR), boron free glass and shall exhibit both high electrical integrity and high resistance to acid corrosion.

1.7.2 Housing & Weather sheds

The FRP rod shall be covered by a sheath of a silicone rubber compound of a thickness of minimum 3mm for 220 kV AC. 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 technique to be followed with detailed procedure and sampling shall be furnished by the Supplier and finalized during finalization of MQP.

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 molding process) and free from imperfections. The vulcanization for extrusion process shall be at high temperature and for injection molding shall be at high temperature & high pressure. Any seams / burrs protruding axially along the insulator, resulting from the injection molding 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.

1.7.3 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.

1.7.4 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 radio and 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. Grading rings shall be capable of installation and removal with hot line tools without disassembling any other part of the insulator assembly. They shall have simple locking mechanism to ensure they are installed at the correct position.

The design & supply of grading rings shall be in the scope of the composite insulator supplier.

1.8 Workmanship

- 1.8.1 All the materials shall be of latest design and conform to the best modern practices adopted in the extra high voltage field. Bidders shall offer only such insulators as are guaranteed by him to be satisfactory and suitable for 220kV transmission lines and will give continued good service.
- 1.8.2 The design, manufacturing process and material control at various stages shall be such as to give maximum working load, highest mobility, best resistance to corrosion, good finish and elimination of sharp edges and corners to limit corona and radio interference.
- 1.8.3 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.
- 1.8.4 The core shall be sound and free of cracks and voids that may adversely affect the insulators.
- 1.8.5 Weathersheds/ Housing shall be uniform in quality. They shall be clean, sound, smooth and free from gross defects and excessive flashing at parting lines.
- 1.8.6 End fittings shall be free from cracks, seams, shrinks, air holes and rough edges. End fittings should be effectively, sealed to prevent moisture ingress, effectiveness of sealing system must be supported by test documents. All surfaces of the metal parts shall be perfectly smooth with the projecting points or irregularities which may cause corona. All load bearing surfaces shall be smooth and uniform so as to distribute the loading stresses uniformly.
- 1.8.7 All ferrous parts shall be hot dip galvanized to give a minimum average coating of zinc equivalent to 600 gm/sq.m. and shall be in accordance with the requirement of ISO: 1461 (E) and shall satisfy the tests mentioned in ISO: 1460 (E). The zinc used for galvanizing shall be of purity of 99.95%. 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 galvanized metal parts shall be guaranteed to withstand at least six successive dips each lasting for one (1) minute duration under the standard preece test. The galvanizing shall be carried out only after any machining.

2.0 Equipment Marking

- 2.1 Each composite long rod unit shall be legibly and indelibly marked with the trade mark of the manufacturer, name of Delhi Transco Limited and month & year of manufacture. The guaranteed combined mechanical and electrical strength shall be indicated in kilo Newton followed by the word 'kN' to facilitate easy identification and to ensure proper use.
- 2.2 One 10 mm thick ring or 20 mm thick spot of suitable quality of paint shall be marked on the cap/end fitting of each composite long rod of particular strength for easy identification of the type of insulator. The paint shall not have any deteriorating effect on the insulator performance. Following codes shall be used as identification mark:

For	90 kN long rod unit	: Orange
For	120 kN long rod unit	: Yellow
For	160 kN long rod unit for nominal length of 2720 mm	: Green
For	160 kN long rod unit for nominal length of 2175 mm	: Blue

3.0 Bid Drawings

- 3.1 The Bidder shall furnish full description and illustration of the material offered.
- 3.2 The Bidder shall furnish along with the bid the outline drawing of each insulator unit including a cross sectional view of the long rod insulator unit. The drawing shall include but not limited to the following information:
- (a) Major Dimensions with manufacturing tolerances
 - (b) Minimum Creepage distance with positive tolerance
 - (c) Protected creepage distance
 - (d) Unit mechanical and electrical characteristics
 - (e) Size and weight of ball and socket parts
 - (f) Weight of composite long rod units
 - (g) Materials
- 3.3 After placement of award, the Supplier shall submit full dimensioned insulator drawings containing all the details as given in Clause No. 3.2 above, in four (4) copies to Owner for approval. After getting approval from Owner, the Supplier shall submit 10 more copies of the same drawing along with a soft copy to the Owner for further distribution and field use at Owner's end.

- 3.4 After placement of award the Supplier shall also submit fully dimensioned insulator crate drawing for different type of insulators.

4.0 Tests and Standards

4.1 Type Tests

The required type tests on composite long rod units, components, materials and complete strings are stipulated hereunder.

The specified type tests under the following clause shall not be required to be carried out if a valid test certificate is available for a similar design. The tests certificate shall be considered valid if:

- i. Tests conducted earlier is either conducted in accredited laboratory (accredited based on ISO/IEC vide 25/17025 or EN 45001 by the National accreditation body of the country where laboratory is located) or witnessed by the representative(s) of DTL or utility and
- ii. Tests have been conducted not prior to 5 (five) years from the date of bid opening.

In case the test have been conducted earlier than the above stipulated period or in the event of any discrepancy in the test report (i.e., any test not applicable due to any design/manufacturing change including substitution of components or due to non-compliance with the requirement stipulated in the Technical Specifications), the tests shall be conducted by the Supplier at no extra cost to the Purchaser.

4.1.1 On the complete composite Long Rod Insulator String with Hardware Fittings

	Tests	Ref
a)	Power frequency voltage withstand test with corona control rings/grading ring and arcing horns under wet condition	As per IEC:60383
b)	Impulse voltage withstand test under dry condition	As per IEC:60383
c)	Corona and RIV test under dry condition	As per Annex-A
f)	Mechanical Strength test	As per Annex-A
g)	Vibration test	As per Annex-A
h)	Salt-fog pollution withstand test	As per Annex-A

Note: Above test should have to be conducted on single suspension and single tension.

4.1.2 On Composite Insulator Units

(a)	Tests on interfaces and connections of metal fittings	IEC: 61109-2008
(b)	Assembled core load time test	IEC: 61109-2008
(c)	Damage limit proof test and test of tightness of interface between end fittings and insulator housing.	IEC: 61109-2008
(d)	High Pressure washing test	Annexure-A
(e)	Brittle fracture resistance test	Annexure-A
(f)	Dye penetration test	IEC: 61109-2008
(g)	Water diffusion test	IEC: 61109-2008
(h)	Tracking and erosion test	IEC: 61109-2008
(i)	Hardness test	IEC: 61109-2008
(j)	Accelerated weathering test	IEC: 61109-2008
(k)	Flammability test	IEC: 61109-2008
(l)	Silicone content test	Annexure-A
(m)	Recovery of Hydrophobicity test	Annexure-A
(n)	Torsion test	Annexure-A

Hardness test, Accelerated weathering test and Flammability test specified under clause no. 4.1.2 above shall be conducted on housing/weather shed of either 90 KN or 120 KN or 160 KN composite long rod for the same type of material.

4.2 Acceptance Tests:

4.2.1 For Composite Long Rod Insulators

a)	Verification of dimensions	IEC : 61109-2008
b)	Galvanising test	IEC : 60383
c)	Verification of end fittings	IEC: 61109 -2008
d)	Recovery of Hydrophobicity	Annexure-A
e)	Verification of tightness of interface between end fittings and insulator housing and of specified mechanical load	IEC : 61109-2008
f)	Tests on interfaces and connections of metal fittings	IEC: 61109-2008
g)	Silicone content test	Annexure-A

h)	Brittle Fracture Resistance Test	Annexure-A
i)	Dye Penetration Test	IEC :61109-2008
j)	Water Diffusion Test	IEC : 61109-2008

The test 4.2.1 (f) to (j) shall be carried out as acceptance test on any one lot.

In the event of failure of the sample to satisfy the acceptance test(s) specified in 4.2 above, the retest procedure shall be as per IEC 61109.

4.3 Routine Tests

4.3.1 For Composite Long Rod Insulator Units

- | | |
|----------------------------|-----------------|
| a) Mechanical routine test | IEC: 61109-2008 |
| b) Visual Inspection | IEC: 61109-2008 |

4.4 Tests During Manufacture

On all components as applicable

a)	Chemical analysis of zinc used for galvanising	As per Annexure-A
b)	Chemical analysis, mechanical, metallographic test and magnetic particle inspection for malleable castings.	As per Annexure-A
c)	Chemical analysis hardness tests and magnetic particle inspection for forgings	As per Annexure-A
d)	Tracking and erosion test on insulating material	IEC 60587

4.5 Testing Expenses

As mentioned under clause 4.1 above, no type test charges shall be payable to the supplier.

4.5.1 For Type Tests which involves the tests on the complete insulator string with hardware fitting, standard hardware fittings similar to existing insulator strings shall be arranged and used by the insulator supplier at his own cost.

4.5.2 In case of failure in any type test the supplier is either required to modify the design of the material & successfully carryout all the type tests as has been detailed out in Clause 4.1 of this specifications or to repeat that particular type test at least three times successfully at his own expenses.

- 4.5.3 Bidder shall indicate the laboratories in which they propose to conduct the type tests. They shall ensure that adequate facilities are available in the laboratory and the tests can be completed in these laboratories within the time schedule guaranteed by them in the appropriate schedule.
- 4.5.4 The entire cost of testing for acceptance and routine tests and tests during manufacture specified herein shall be treated as included in the quoted Ex-works/CIF Price.
- 4.5.5 In case of failure in any type test, if repeat type tests are required to be conducted, then all the expenses for deputation of Inspector/ Owner's representative shall be deducted from the contract price. Also if on receipt of the Supplier's notice of testing, the Owner's representative does not find the material or test setup / equipments to be ready for testing, the expenses incurred by the Owner for re-deputation shall be deducted from contract price.
- 4.5.6 The Supplier shall intimate the Owner about carrying out of the type tests alongwith detailed testing programme at least 3 weeks in advance (in case of testing in India) and at least 6 weeks advance (in case of testing abroad) of the scheduled date of testing during which the Owner will arrange to depute his representative to be present at the time of carrying out the tests.

4.6 Sample Batch for Type Testing

- 4.6.1 The bidder shall offer material for sample selection for type testing only after getting Quality Assurance Programme approved by the Owner. The bidder shall offer at least three times the quantity of materials required for conducting all the type tests for sample selection. The sample for type testing will be manufactured strictly in accordance with the Quality Assurance Programme approved by the Owner.
- 4.6.2 Before sample selection for type testing, the bidder shall be required to conduct all the acceptance tests successfully in presence of Owner's representative.

4.7 Schedule of Testing

- 4.7.1 The Bidder has to indicate the schedule of following activities in their bids:
- a) Submission of drawing for approval.
 - b) Submission of Quality Assurance Programme for approval.
 - c) Offering of material for sample selection for type tests.
 - d) Type testing.

4.8 Additional Tests:

- 4.8.1 The Owner reserves the right of having at his own expenses any other test(s) of reasonable nature carried out at Supplier's premises, at site, or in any other place in addition to the aforesaid type, acceptance and routine tests to satisfy himself that the material comply with the Specifications.

- 4.8.2 The Owner also reserves the right to conduct all the tests mentioned in this specification at his own expense on the samples drawn from the site at Supplier's premises or at any other test centre. In case of evidence of non compliance, it shall be binding on the part of the Supplier to prove the compliance of the items to the technical specifications by repeat tests or correction of deficiencies or replacement of defective items, all without any extra cost to the Owner.

4.9 Guarantee

The Supplier of insulators shall guarantee overall satisfactory performance of the insulators.

4.10 Test Reports

- 4.10.1 Copies of type test reports shall be furnished in at least six (6) copies along with one original. One copy shall be returned duly certified by the Owner only after which the commercial production of the concerned material shall start.
- 4.10.2 Copies of acceptance test reports shall be furnished in at least six (6) copies. One copy shall be returned duly certified by the Owner, only after which the material shall be dispatched.
- 4.10.3 Record of routine test reports shall be maintained by the Supplier at his works for periodic inspection by the Owner's representative.
- 4.10.4 Test certificates of test during manufacture shall be maintained by the Supplier. These shall be produced for verification as and when desired by the Owner.

4.11 Inspection

- 4.11.1 The Owner's representative shall at all times be entitled to have access to the works and all places of manufacture, where insulator, and its component parts shall be manufactured and the representatives shall have full facilities for unrestricted inspection of the Supplier's and sub-Supplier's works, raw materials, manufacture of the material and for conducting necessary test as detailed herein.
- 4.11.2 The material for final inspection shall be offered by the Supplier only under packed condition as detailed in clause No 4.12 of the specification. The Owner shall select samples at random from the packed lot for carrying out acceptance tests. The lot should be homogeneous and should contain insulators manufactured in 3-4 consecutive weeks.
- 4.11.3 The Supplier shall keep the Owner informed in advance of the time of starting and the progress of manufacture of material in their various stages so that arrangements could be made for inspection.
- 4.11.4 No material shall be dispatched from its point of manufacture before it has been satisfactorily inspected and tested unless the inspection is waived off by the Owner in writing. In the latter case also the material shall be dispatched only after satisfactory testing for all tests specified herein have been completed.

- 4.11.5 The acceptance of any quantity of material shall in no way relieve the Supplier of his responsibility for meeting all the requirements of the specification and shall not prevent subsequent rejection, if such materials are later found to be defective.

4.12 Packing and Marking

- 4.12.1 All insulators shall be packed in suitable PVC/ plastic tubes/any other suitable packing. The packing shall provide protection against rodent. The Supplier shall furnish detailed design of the packing. For marine transportation, crates shall be palletted.
- 4.12.2 The packing shall be of sufficient strength to withstand rough handling during transit, storage at site and subsequent handling in the field.
- 4.12.3 Suitable cushioning, protective padding, or dunnage or spacers shall be provided to prevent damage or deformation during transit and handling.
- 4.12.4 All packing cases shall be marked legibly and correctly so as to ensure safe arrival at their destination and to avoid the possibility of goods being lost or wrongly dispatched on account of faulty packing and faulty or illegible markings. Each case/crate shall have all the markings stenciled on it in indelible ink.
- 4.12.5 The Supplier shall guarantee the adequacy of the packing and shall be responsible for any loss or damage during transportation, handling, storage and installation due to improper packing.

4.13 Standards

The insulator strings and its components shall conform to the following Indian/ International Standards which shall mean latest revision, with amendments/ changes adopted and published, unless specifically stated otherwise in the Specification.

- 4.13.1 In the event of supply of insulators conforming to standards other than specified, the Bidder shall confirm in his bid that these standards are equivalent or better to those specified. In case of award, salient features of comparison between the standards proposed by the Bidder and those specified in this document will be provided by the Supplier to establish equivalence.

Sl No.	Indian Standard	Title	International Standard
1.	IS:209-1992	Specification for zinc	BS:3436
2.	IS:406-1991	Method of Chemical Analysis of Slab Zinc	BS:3436
3.	IS:731-1991	Porcelain insulators for overhead Power lines with a nominal voltage greater than 1000 V	BS:137- (I&II) IEC:60383
4.	IS:2071 Part (1) - 1993	Methods of High Voltage Testing	IEC:60060-1

	(Part(II)- 1991 Part(III)- 1991		
5.	IS:2486 Part- 1-1993 Part- II-1989 Part-III-1991	Specification for Insulator fittings for Overhead Power Lines with a nominal voltage greater than 1000V General Requirements and Tests Dimensional Requirements Locking Devices	BS:3288 IEC:60120 IEC:60372
6.	IS:2629-1990	Recommended Practice for Hot, Dip Galvanisation for iron and steel	ISO-1461 (E)
7.	IS:2633-1992	Testing of Uniformity of Coating of zinc coated articles	
8.	IS:6745-1990	Determination of Weight of Zinc Coating on Zinc coated iron and steel articles	BS:433-1969 ISO:1460-1973
9.	IS:8263-1990	Methods of RI Test of HV insulators	IEC:60437 NEMA Publication No.07/ 1964/ CISPR
10.	IS:8269-1990	Methods for Switching Impulse test on HV Insulators	IEC:60506
11.		Thermal Mechanical Performance test and mechanical performance test on string insulator units	IEC: 60575
12.		Salt Fog Pollution Voltage Withstand Test	IEC:60507
13.		Insulators for overhead lines – Composite suspension and tension insulators for a.c. systems with a nominal voltage greater than 1000 V – definitions, test methods and acceptance criteria	IEC: 61109
14.		Selection and dimensioning of high voltage insulators intended for use in polluted conditions: Polymer Insulators for AC systems	IEC:60815-3
15.		Tests on insulators of Ceramic material or glass or glass for overhead lines with a nominal voltage greater than 1000V	IEC:60383
16.		Composite string insulator units for overhead lines with a nominal voltage above 1000V : Standard strength classes and end fittings	IEC 61466-1

17.		Composite string insulator units for overhead lines with a nominal voltage above 1000V : Dimensional and electrical characteristics	IEC 61466-2
18.		Electrical Insulating materials used under severe ambient conditions –Test methods for evaluating resistance to tracking and erosion	IEC 60587
19.		Polymeric insulators for indoor and outdoor use with nominal voltage greater than 1000V- General definitions, tests, methods and acceptance criteria.	IEC 62217

The standards mentioned above are available from:

Reference Abbreviation	Name and Address
BS	British Standards, British Standards Institution 101, Pentonville Road, N - 19-ND, UK
IEC/CISPR	International Electro technical Commission, Bureau Central de la Commission, electro Technique international, 1 Rue de verembe, Geneva, SWITZERLAND
BIS/IS	Beureau Of Indian Standards. ManakBhavan, 9, Bahadur Shah ZafarMarg, New Delhi - 110001.INDIA
ISO	International Organisation for Standardization. Danish Board of Standardization Danish Standardizing Sraat, Aurehoegvej-12 DK-2900, Heeleprup, DENMARK
NEMA	National Electric Manufacture Association, 155, East 44th Street. New York, NY 10017U.S.A.
ASTM	American Society for Testing and Materials, 1916 Race St. Philadelphia, PA19103 USA

1.0 Tests on Complete Strings with Hardware Fittings

1.1 Corona Extinction Voltage Test (Dry)

The sample assembly when subjected to power frequency voltage shall have a corona extinction voltage of not less than 154 kV (rms) line to ground under dry condition for 220 kV lines. 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.

1.2 RIV Test (Dry)

Under the conditions as specified under (1.1) above, the insulator string along with complete hardware fittings shall have a radio interference voltage level below 1000 micro volts at one MHz when subjected to 50 Hz AC voltage line to ground under dry condition. The test procedure shall be in accordance with IS: 8263/ IEC: 60437.

1.3 Mechanical Strength Test

The complete insulator string along with its hardware fitting excluding arcing horn, corona control ring, grading ring and suspension assembly/dead end assembly 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 disassemble 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.

1.4 Vibration Test

The suspension string shall be tested in suspension mode, and tension string in tension mode itself in laboratory span of minimum 30 metres. In the case of suspension string a load equal to 600 kg shall be applied along the axis of the suspension string by means of turn buckle. The insulator string along with hardware fittings and the each sub-conductors (each tensioned at 35 KN) shall be secured with clamps. The system shall be suitable to maintain constant tension on each sub-conductors throughout the duration of the test. Vibration dampers shall not be used on the test span. All the sub-conductors shall be vertically vibrated simultaneously at one of the resonance frequencies of the insulators string (more than 10 Hz) by means of vibration inducing equipment. The peak to peak displacement in mm of vibration at the anti node point, nearest to the string, shall be measured and the same shall not be less than $1000/f^{1.8}$ where f is the frequency of vibration in cycles/sec. The insulator string shall be vibrated for not less than 10 million cycles without any failure. After the test the insulators shall be examined for looseness of pins and cap or any crack. The hardware shall be examined for looseness, fatigue failure and mechanical strength test. There shall be no deterioration of properties of hardware components and insulators after the

vibration test. The insulators shall be subjected to the Mechanical performance test followed by mechanical strength test as per relevant standards.

1.5 Salt-fog pollution withstand test

This test shall be carried out in accordance with IEC: 60507. The salinity level for porcelain long rod insulators & composite long rod insulators shall be 160 Kg/m³ NaCl.

2.0 Composite Long rod Insulator Units

2.1 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.

2.2 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.

2.3 Silicone content test

Minimum content of silicone as guaranteed by supplier shall be verified through FT-IR spectroscopy & TGA analysis or any other suitable method mutually agreed between Owner & Supplier in Quality Assurance Programme.

2.4 High Pressure washing test

The washing of a complete insulator of each E&M rating is to be carried out at 3800kPa with nozzles of 6mm diameter at a distance of 3m from nozzles to the insulator, The washing shall be carried out for 10 minutes. There shall be no damage to the sheath or metal fitting to housing interface. The verification shall be 1 minute wet power frequency withstand test.

2.5 Torsion Test

Three complete insulators of each E&M 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.

3. Tests on All components (As applicable)

3.1 Chemical Analysis of Zinc used for Galvanizing

Samples taken from the zinc ingot shall be chemically analyzed as per IS: 209-1979. The purity of zinc shall not be less than 99.95%.

3.2 Tests for Forgings

The chemical analysis hardness tests and magnetic particle inspection for forgings, will be as per the internationally recognised procedures for these tests. The sampling will be based on heat number and heat treatment batch. The details regarding test will be as discussed and mutually agreed to by the Supplier and Owner in Quality Assurance Programme.

3.3 Tests on Castings

The chemical analysis, mechanical and metallographic tests and magnetic, particle inspection for castings will be as per the internationally recognised procedures for these tests. The samplings will be based on heat number and heat treatment batch. The details regarding test will be as discussed and mutually agreed to by the Supplier and Owner in Quality Assurance Programme.

COMPOSITE LONG ROD INSULATOR PACKAGE FOR 220 kV TRANSMISSION LINES

(Guaranteed Technical Particulars for Composite Long Rod Insulators)

Bidder's Name & Address

Guaranteed Technical Particulars of AC Composite Long Rod Insulators:

S.No.	Description	Unit	90 KN	120 KN	160 KN
1.	Name & Address of manufacturer				
2.	Weight of single unit	Kg.			
3.	Size and Designation of Ball & Socket assembly	mm			
4.	Core diameter	mm			
5.	Tolerance on Core Diameter	±mm			
6.	Nominal length (Insulation Spacing)	Mm			
7.	Tolerance on Nominal length	±mm			
8.	Dry Arcing distance	mm			
9.	Number of sheds .	Nos.			
10.	Sheds profile (type)				
11.	Shed spacing	mm			
12.	Sheds profile (Regular/Alternating)				
13.	Shed diameter	mm			
14.	Tolerance on shed diameter	±mm			
15.	Minimum Creepage distance	mm			
16.	Tolerance on Creepage distance	mm			
17.	Guaranteed mechanical strength	KN			
18.	Routine mechanical load	KN			
19.	Material a) FRP Rod b) Weather Sheds with % contents of silicon c) Housing d) End Fittings e) Grading Rings				
20.	Minimum thickness of sheath covering over the core	mm			
21.	Power frequency withstand voltage of single unit a) Dry b) Wet	KV(rms) KV(rms)			
22.	Power Frequency flashover voltage of single unit a) Dry b) Wet	KV(rms) KV(rms)			
23.	Impulse withstand voltage of single unit (Dry) a) Positive b) Negative	kV(Peak) kV(Peak)			
24.	Impulse flashover voltage of single unit (Dry) a) Positive	kV(Peak)			

	b) Negative	kV(Peak)			
25	Purity of zinc used for galvanizing end fittings	%			
26	Number of dips which the end fittings can withstand in standard Preece test	Nos.			
27	Certified test report of accelerated ageing test of 5000 hours (enclosed) (Appendix-C of IEC-61109)	Yes/ No			
28	Drawing enclosed	Yes/ No			

COMPOSITE LONG ROD INSULATOR PACKAGE FOR 220 kV TRANSMISSION LINES

(Guaranteed Technical Particulars for Insulator Strings with Composite Long Rod Insulators along with Hardware Fittings)

Bidder's Name & Address

Guaranteed Technical Particulars for Insulator Strings with Composite Long Rod Insulators along with Hardware Fittings

S No.	Description	Unit	Single 'I' Suspension String	Single Suspension Pilot String	Double 'I' Suspension String	Single Tension String	Double Tension String
1	Power Frequency withstand voltage of string with arcing horns, corona control rings/ grading rings under wet condition '	Kv rms					
2	Switching Surge withstand voltage (Wet) a) Positive b) Negative	kV (Peak) kV (Peak)					
3	Impulse withstand voltage (dry) a) Positive b) Negative	kV (Peak) kV (Peak)					
4	Impulse flashover voltage (dry) c) Positive d) Negative	kV (Peak) kV (Peak)					
5	Minimum Corona extinction voltage under dry condition	Kv					
6	RIV at 1 MHZ when the string is energized at 154 kV(rms) under dry condition	Microvolt					
7	Power Frequency withstand Voltage at salinity level of 160 Kg/m ³ NACL	KV					

S No.	Description	Unit	Single 'V' Suspension String	Single 'T' Suspension String	Single Suspension Pilot String	Double Tension String
8	Mechanical strength of complete insulator string along with hardware fittings	KN				
9	Dimensioned drawings of insulator strings enclosed.	Yes/ No				

DELHI TRANSCO LTD

(A Government of NCT of Delhi Undertaking)



Bidding Documents

For

Design, Engineering, Supply, Erection, Testing & Commissioning of 220/66kV GIS Substation at Bharthal, including complete civil works & automation, along with LILO of 220kV D/C Bamnauli-DIAL Overhead Transmission Line at Bharthal, on a Turnkey Basis.



Volume – III

Bid Form, Attachments, GTP & Price Schedules

Tender No: T26P630001

VOLUME-III

Bid Form, Attachments, GTP & Price Schedules

SECTION 1: BID FORM

SECTION 2: ATTACHMENTS

SECTION 3: GUARANTEED TECHNICAL PARTICULARS

SECTION 4: PRICE SCHEDULE

SECTION-I

BID FORM

SECTION: I

BID FORMS

Bid Proposal Ref. No......

Date:

Name of Package:

Design, Engineering, Supply, Erection, Testing & Commissioning of 220/66kV GIS Substation at Bharthal, including complete civil works & automation, along with LILO of 220kV D/C Bamnauli-DIAL Overhead Transmission Line at Bharthal, on a Turnkey Basis.

To,

**Delhi Transco Limited
Shakti Sadan, Kotla Road
New Delhi – 110002**

Ladies and Gentlemen,

1.0 Having examined the Bidding Documents, including Amendment Nos. _____(*Insert Numbers*) dated the receipt of which is hereby acknowledged, we _____, offer to design, test, deliver, install and commission (including carrying out Performance & Guarantee Test) the Facilities under the above-named package in full Conformity with the said Bidding Documents for the sum of:

(_____)

(Amount in Words)

(_____)

(Amount in Figures)

or such other sums as may be determined in accordance with the terms and conditions of the Bidding Documents.

“Note: Being a Two Part tender, bidders are required to submit the Bid Forms in Part –I as well as in Part-II. However, the prices shall be quoted only in the Bid Form to be submitted with Price Bid Part -II.

2.0 ATTACHMENTS TO THE BID FORM

In line with the requirement of the Bidding Documents, we enclose herewith the following Attachments to the Bid Form:

(a)	Attachment 1	:	Bid Security in the form of* for a sum of (amount in words and figures) initially valid for a period of two hundred Forty (240) days from the date set for opening of bids. *Please fill in the alternative chosen in line with 23.3 Section-ITB, Vol.-I, of the Bidding Documents.
(b)	Attachment 2	:	A power of attorney duly authorized by a Notary Public indicating that the person(s) signing the bid have the authority to sign the bid and thus that the bid is binding upon us during the full period of its validity in accordance with the ITB Clause 24.
(c)	Attachment 3	:	The documentary evidence that we are eligible to bid in accordance with Clause 10.3 (c) & (d) of ITB are qualified to perform the contract if our bid is accepted. The qualification data has been furnished as per your format enclosed with the bidding documents.
(d)	Attachment 4	:	The details of all major items of services or supply which we propose subcontractor in case of award, giving details of the name and nationality of the proposed subcontractor/ sub-vendor for each item.
(e)	Attachment 5	:	The variation and deviations from the requirements of the Conditions of Contract as per ITB and other commercial conditions, in your format enclosed with the Bidding Documents, including, inter alia, the cost of withdrawal of the variations and deviations indicated therein.
(f)	Attachment 6	:	The variation and deviations from the requirements of the Important Conditions of Contract as per ITB, in your format enclosed with the Bidding Documents, including, inter alia, the cost of withdrawal of the variations and deviations indicated therein.

(g)	Attachment 7	:	The variation and deviations from the requirements of the Technical Deviation clauses mentioned in Volume-II, in your format enclosed with the Bidding Documents, including, inter alia, the cost of withdrawal of the variations and deviations indicated therein.
(h)	Attachment 8	:	Additional information submitted by the bidder, in your format enclosed with the Bidding Documents, including, inter alia, indicated therein, if any.
(i)	Attachment 9	:	Bought-out & Sub-contracted item listed with bidding documents.
(j)	Attachment 10	:	Work Completion Schedule.
(k)	Attachment 11	:	List of special tools & tackles listed with bidding documents.
(l)	Attachment 12	:	Information regarding ex-employees of DTL in our firm.
(m)	Attachment 13	:	Deleted
(n)	Attachment 14	:	Price Adjustment Data
(o)	Attachment 15	:	Guarantee Declaration (If applicable)
(p)	Attachment 16	:	Integrity Pact, in a separate envelope duly signed on each page by the person signing the bid.
(q)	Attachment 17	:	Deleted
(r)	Attachment 18	:	Checklist (Bidder shall submit the information regarding documents submitted by them in the offer as per the checklist provided in Attachment-18 of Sec: Attachments, Vol-III of bidding document. It shall be sole responsibility of bidder to provide the information based on the documents submitted by them).
(s)	Attachment 19	:	Affidavit of Self certification regarding Minimum Local Content in line with PPP-MII order and MoP Order, as applicable (submission of Hard Copy in 'Original'), to be submitted on a non-judicial stamp paper of Rs. 100/-.
(t)	Attachment 20	:	Certificate from statutory auditor or cost auditor of the company giving the percentage of Local Content, in line with PPP-MII order and MoP Order, as applicable (submission of Hard Copy in 'Original') to be submitted on the letter head of the auditor/ cost accountant.
(u)	Attachment 21	:	Undertaking for not indulging in Corrupt & Fraudulent practice

(v)	Attachment 22	:	Certification by the Bidder as per DoE Order no-F.No.7/10/2021-PPD(1) dated 23/02/2023 in line with ITB Clause 1.2.2 (In case of a Joint Venture bid, the declaration shall be given by all partners of the Joint Venture)
(w)	Attachment 23	:	Details of complete type test report of all the equipment as per QR and in accordance with latest IEC / NIT in the prescribed format

3.0 **Price Schedules**

- 3.1 Schedule 1 : Price break-up Plant and Equipment (including Mandatory Spares) to be supplied
- Schedule 2 : Break-up of Local Transportation, Insurance and other Incidental Services
- Schedule 3 : Price Breakup of Installation Charges
- Schedule 4 : Grand summary of the quoted bid price.
- 3.2 We are aware that the Price Schedules do not generally give a full description of the Work to be performed under each item and we shall be deemed to have read the Technical Specifications and other sections of the Bidding Documents and Drawings to ascertain the full scope of Work included in each item while filling-in the rates and prices. We agree that the entered rates and prices shall be deemed to include for the full scope as aforesaid, including overheads and profit.
- 3.3 We declare that as specified in the clause 11.2 CC of the Bidding Documents prices quoted by us in the Price Schedules shall be Fixed and Firm during the execution of Contract.
- 3.4 We understand that in the price schedules, where there are errors between the total of the amounts given under the column for the price Breakdown and the amount given under the Total Price, the former shall prevail and the latter will be corrected accordingly. We further understand that where there are discrepancies between amounts stated in figures and amounts stated in words, the amount stated in words shall prevail. Similarly, any discrepancy in the total bid price and that of the summation of Schedule price (price indicated in a Schedule indicating the total of that schedule), the total bid price shall be corrected to reflect the actual summation of the Schedule prices.
- 3.5 We declare that items left blank in the Schedules will be deemed to have been included in other items. The TOTAL for each Schedule and the TOTAL of Grand Summary shall be deemed to be the total price for executing the Facilities and sections thereof in complete accordance with the Contract, whether or not each individual item has been priced.
- 4.0 We confirm that except as otherwise specifically provided our Bid Prices include all taxes, duties, levies and charges as may be assessed on us, our Sub Contractor/Sub-Vendor or their employees by all municipal, state or national government authorities in connection with the Facilities, in and outside of India.

- 4.1 Deleted
- 4.2 We further understand that notwithstanding 4.0 above, in case of award on us, you shall also bear and pay/reimburse to us, Taxes, Duties and Levies as per GST rules in respect of transaction between you and us, imposed on the Plant & Equipment including Mandatory Spare Parts specified in Price Schedule to be incorporated into the Facilities; by the Indian Laws.
- 4.3 Deleted.
- 4.4 We confirm that we shall also get registered with the concerned Tax Authorities as per GST rules, in all the states where the project is located.
- 4.5 Deleted.
- 4.6 We confirm that TDS under the applicable laws shall be deducted by the Employer from the payments made to us and Employer shall issue TDS certificates in lieu of deductions so made.

5.0 CONSTRUCTION OF THE CONTRACT

- 5.1 We declare that we are making this offer on the basis of divisible Supply-cum-Erection Contract on a single source responsibility basis. The supply portion of the Contract will relate to the Supply of equipment and materials on the ex-works basis and the Erection portion will relate to transportation, storage, insurance, erection, testing and commissioning etc. of equipment/ materials as specified in the bidding documents. However, we have no objection in case Owner decides to split the above mentioned package into two separate Contracts-one Contract for Supply of all equipment on ex-works basis and second Contract for all services such as transportation & insurance, handling at site, storage, insurance, installation, testing and commissioning etc of equipment/materials as specified in the bidding documents.

We hereby declare that the award of two separate Contracts, will not, in any way, dilute our responsibility for successful completion of work and fulfillment of all obligations as per Bidding Documents and that both the Contracts will have a cross-fall breach clause i.e. a breach in one Contract will automatically be considered as a breach of the other Contract which will confer on the Owner the right to terminate the other Contract at our risk and cost and/or recover damages under any or both the Contracts.

6.0 PERFORMANCE GUARANTEE

We declare that the ratings and performance figures of the equipment to be furnished and erected by us are guaranteed. The Guaranteed particulars of different equipment are enclosed in Technical Data Sheets.

7.0 QUALIFICATION DATA

We confirm having submitted the Qualification Data in two Copies, as required by you in your Conditions of Contract in a separate envelope along with this Bid. Further we have filled in the information for qualification requirements in Attachment-3. In case you require any further information in this regard, we agree to furnish the same.

8.0 DEVIATIONS

8.1 We declare that the contract shall be executed strictly in accordance with the specifications and documents except for the variations and deviations, all of which have been detailed out exhaustively in the following Attachments, irrespective of whatsoever has been stated to the contrary elsewhere in our proposal.

- (a) Commercial Deviations Attachment : Attachment-5
- (b) Cost of withdrawal of deviation on : Attachment-6
Important/critical conditions Attachment
- (c) Technical Deviations Attachment : Attachment-7

8.2 We confirm having noted Clause 11.2 of Section-ITB, Conditions of Contract, Volume-I, as per which Bid containing deviations from following provision relating to following critical clauses will be treated as non-responsive, as stated therein.:

- (a) Governing Laws : Clause 5, CC
- (b) Settlement of Disputes : Clause 6, CC
- (c) Taxes and Duties, : Clause 14, CC
- (d) Appendix 2 to the Form of : Clause No. 15 ITB
Contract Agreement (Price Adjustment)
- (e) Bid Security : Clause 23.0, Section ITB Volume-I,
conditions of contract
- (f) Contract Performance Guarantee : Clause 43.0, Section ITB, Volume-I,
Conditions of Contract
- (g) Liquidated Damages & : Clause 28 & 28.5 CC
(Functional Guarantee)
- (h) Defect Liability : Clause No. 27 CC
- (i) Price Basis and Payment : Clause No.12 CC and Clause 14 Section
ITB
- (j) Completion Time : Section F&P Appendix-4
- (k) Patent Indemnity : Clause No.29, CC

8.2.1 We confirm that we have not taken any deviations / exceptions to above clauses.

8.3 Further, we agree that additional conditions, deviations, if any, found in the proposal documents other than those stated in attached Deviation Attachments (i.e., Attachment 5, 6 & 7), save that pertaining to any rebates offered, shall not be given effect to.

9.0 ADDITIONAL INFORMATION

We have included with this proposal additional information as listed in Attachment-8, We further confirm that such additional information do not imply any additional deviation beyond those

covered in Attachment- 5, 6 & 7 and in case of any contradiction between these additional information and other provisions of Bid, the latter will prevail.

10.0 GUARANTEE DECLARATION

We guarantee that the equipment offered shall meet the rating and performance requirements stipulated in the specifications.

11.0 BOUGHT-OUT AND SUB-CONTRACTED ITEMS

We are furnishing herewith at Attachment-9, the detail of all major items of supply amounting to more than 10% of our bid price, which we propose subcontract giving detail of the name of sub-contractor / sub-vendor and quantity for each item.

12.0 WORK SCHEDULE

If this proposal is accepted by you, we agree to complete the entire scope of work as per the bidding documents, in accordance with schedule indicated in the proposal. We fully understand that the work completion schedule stipulated in this proposal is the essence of the Contract, if awarded. The completion schedule of the various major key phases of the work is indicated in Attachment-10.

13.0 SPECIAL TOOLS AND TACKLES

We have given a list of Special Tools and Tackles in Attachment-11 and prices thereof are included in his lumpsum bid price. We further agree that any items of special tools and tackles, though not included in the aforesaid list, but required for effective erection, testing and commissioning & operation of the equipment for subject Package shall also be furnished by us at no extra cost to you.

14.0 CONTRACT PERFORMANCE GUARANTEE

The successful Bidder shall be required to furnish to DTL a Contract Performance Guarantee (CPG) for the value of ten percent (10%) of total Contract Price as per conditions stipulated in Clause 43.0, Section-ITB and Clause 13.0, Section-CC, Conditions of Contract, Volume-I of the Bidding Documents, which shall be extended from time to time beyond the actual date of successful completion of warranty/ defect liability period, as may be required under the Contract. The Bid Security/ guarantee shall be kept valid by the successful Bidder till the CPG is accepted by DTL

15.0 INFORMATION REGARDING EX-EMPLOYEES OF DTL

We have furnished the details of Ex-employees of DTL, who had retired/resigned at the level of General Manager and above from DTL and subsequently have been employed by us, in Attachment-12.

16.0 CHECK LIST

We have included a checklist duly filled in Attachment-18

17.0 Deleted

18.0 We undertake, if our bid is accepted, to commence the work on Facilities immediately upon your Notification of Award to us, and to achieve Completion within the time stated in the Bidding Documents.

We agree to abide by this bid for a period of 180 days from the date fixed for opening of bids as stipulated in the Bidding Documents, and it shall remain binding upon us and may be accepted by you at any time before the expiration of that period.

19.0 We, hereby, declare that only the persons or firms interested in this proposal as principals are named herein and that no company, persons or firms other than mentioned herein have any interest in this proposal or in the Contract to be entered into, if we are awarded the Contract, and this proposal is made without any connection with any other persons, firm or party likewise submitting a proposal and that this proposal is in all respect for and in good faith, without collusion or fraud.

Dated this day of 20.....

Thanking you, we remain

Yours faithfully

.....

(Signature of the authorized signatory[@])

(Printed Name).....

(Designation)

(Common Seal)

Date:.....

Place.....

Business Address:

Name and Address of Principal Officer

([@] Written Power of Attorney of all signatories of bid to commit the bidder must be enclosed with the bid.)

SECTION-II

ATTACHMENTS

Tender No. T26P630001

Design, Engineering, Supply, Erection, Testing & Commissioning of 220/66kV GIS Substation at Bharthal, including complete civil works & automation, along with LILO of 220kV D/C Bamnauli-DIAL Overhead Transmission Line at Bharthal, on a Turnkey Basis.

Bidder's Name & Address:

To,
Delhi Transco Limited,
Shakti Sadan Kotla Road,
New Delhi- 110002 (India),
Email: dgmms105@gmail.com

(Bid Security Form)

Please Refer Volume I (Conditions of Contract), Section: Forms & Procedures

ATTACHMENT - 2

Tender No. T26P630001

Design, Engineering, Supply, Erection, Testing & Commissioning of 220/66kV GIS Substation at Bharthal, including complete civil works & automation, along with LILO of 220kV D/C Bamnauli-DIAL Overhead Transmission Line at Bharthal, on a Turnkey Basis.

Bidder's Name & Address:

To,
Delhi Transco Limited,
Shakti Sadan Kotla Road,
New Delhi- 110002 (India),
Email: dgmms105@gmail.com

(Power of Attorney)

Please Refer Volume I (Conditions of Contract), Section: Forms & Procedures.

or

Bidders may use their own performa for furnishing the required information with bid.

Tender No. T26P630001

Design, Engineering, Supply, Erection, Testing & Commissioning of 220/66kV GIS Substation at Bharthal, including complete civil works & automation, along with LILO of 220kV D/C Bamnauli-DIAL Overhead Transmission Line at Bharthal, on a Turnkey Basis.

Bidder's Name & Address:

To,
Delhi Transco Limited,
Shakti Sadan Kotla Road,
New Delhi- 110002 (India),
Email: dgmms105@gmail.com

(QUALIFYING REQUIREMENT (QR) DATA)

In support of the Qualification Requirements (QR) for bidders, stipulated in Annexure-A, BDS Section-III, Volume-I of the Bidding Documents, we furnish herewith our QR data/details along with other information, as follows herewith. However, in case of any discrepancy the QR as given in Volume-I, Section-III, BDS, Annexure-A shall prevail.

I. We have submitted bid as Individual Firm* through route-1/ route-2/ route-3/ route-4* of QR as given in Volume-I, Section-III, BDS, Annexure-A.

II. We have submitted bid as Joint Venture* of following firms:

Lead Partner:

Other Partners:

:

[*Strike off whoever is not applicable]

We are furnishing the following details/document in support of Qualifying Requirement for the subject package:

A. Attached copies of original documents defining:

- a) The constitution or legal status;
- b) The principal place of business;
- c) The place of incorporation (for bidders who are corporations); or the place of registration and the nationality of the Owners (for applicants who are partnerships or individually-owned firms).
- d) Joint Venture Agreement.

B. Attached original & copies of the following documents:

- a) Written power of attorney of the signatory of the Bid to commit the bidder.

GENERAL INFORMATION

- a. Bidder is required to provide general information as per the following format.

Where the Bidder proposes to use named subcontractor(s) for critical components of the works or for work contents in excess of ten (10) percent of the bid price, the following information should also be supplied for the subcontractor(s).

Sl. No.	Particulars	For Individual Firm	In case of Joint venture		
			For Lead Partner	For Other Partner-1	For Other Partner - 2
1.	Name of Firm				
2.	Head Office / Registered Office Address				
3.	Telephone				
4.	Fax				
5.	Contact Person				
6.	Place of Incorporation/ Registration				
7.	Year of Incorporation/ Registration				
8.	Nationality of Owner(i)				
9	Nationality of Owner(ii)				
10	Nationality of Owner(iii)				

- b. The qualification and experience of key personnel, proposed for carrying out the work;

Name of Person	Professional	Experience	Designation
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	Qualification		

- c. **Litigation History:** Information regarding any current litigation in which the bidder is involved, the parties concerned and disputed amount; As per ITB, the information is to be completed for individual bidder and each Partner of a Joint venture

S. No.	Name of Parties concerned	Cause of litigation and matter in dispute	Disputed amount

1.0 DETAILS/DATA IN SUPPORT OF THE QUALIFYING REQUIREMENTS:

Using the following formats, each Bidder (individual firms or partners of a joint venture) is requested to list the experience as per the Qualifying Requirement, on the basis of which the Bidder wishes to qualify. The information is to be summarized using following format for each experience of the Bidder or of each Partner of a Joint Venture.

(The bidder shall attach documentary evidence in support of the Qualifying Requirement stipulated in the **Volume-I, Section-III, BDS, Annexure-A**, such as proof of work executed by them along with Performance/utility certificates for completed contracts and copies of award letters etc. for ongoing contracts in support of experience as listed in the following proforma for each Contract)

Format-A		
Format for the Bidder/ Lead Partner/ Partners of JV in case of Joint Venture in support of meeting the requirement of Clause 1.1 (A), Annexure-A, BDS, Section-III, Volume-I of the Bidding Documents		
S. No	Description	Details
1.	Bidder's Name	
2.	Single Firm/Lead Partner/Other Partners of a JV	
3.	Name of Contract Undertaken	
4.	Contract Reference No. & Date of Award	

Format-A		
Format for the Bidder/ Lead Partner/ Partners of JV in case of Joint Venture in support of meeting the requirement of Clause 1.1 (A), Annexure-A, BDS, Section-III, Volume-I of the Bidding Documents		
S. No	Description	Details
5.	<p>Name and Address of the Employer/Utility for whom the Contract was executed by the firm/Partner of a JV:</p> <p>Email:</p> <p>Telephone:</p> <p>Fax:</p>	
6.	<p>Voltage Level of GIS Substation or Switchyard commissioned under the Contract</p> <p>(Indicate 220kV or above Voltage class)</p>	
	<p>a) No. of Circuit Breaker equipped bays under the contract</p> <p><i>(Indicate nos. of GIS Circuit Breaker equipped bays of 220kV or above voltage level)</i></p>	
	<p>b) Name of the substation or switchyard</p>	
	<p>c) No. of years, the above Substation/switchyard/bays has been in Satisfactory operation as on originally scheduled date of bid opening.</p>	
	<p>d) Date of commissioning of the above substation/switchyard/bays.</p>	
	<p>e) Scope of work involved under the Contract:</p> <p><i>(Strike off whichever is Not Applicable)</i></p>	<p>i.Design</p> <p>ii.Manufactured</p> <p>iii.Type Tested (IEC or Equivalent Standard)</p> <p>iv.Supplied</p> <p>v.Erected</p>

Format-A		
Format for the Bidder/ Lead Partner/ Partners of JV in case of Joint Venture in support of meeting the requirement of Clause 1.1 (A), Annexure-A, BDS, Section-III, Volume-I of the Bidding Documents		
S. No	Description	Details
		vi. Commissioned vii. Supervised Erection and Commissioning
	f) Has the Contract under reference been executed as a Prime Contractor?	
7.	Details of documents submitted along with the bid in support of the above stated experience.	

Format-B		
Format for the Indian Entity/ Lead Partner/ Partners of JV in support of meeting the requirement of Clause 1.2 & 1.3 of Annexure-A, BDS, Section-III, Volume-I of the Bidding Documents		
S. No	Description	Details
1.	Name of the Indian Entity not meeting the requirement stipulated in clause 1.1(A) of Annexure-A, BDS, Section-III, Volume-I, but has established manufacturing and testing facilities in India for 220kV or above voltage level Gas Insulated Switchgear (GIS):	
2.	Name of Contract Undertaken	
3.	Contract Reference No. & Date of Award	
4.	Name and Address of the Employer/Utility for whom the Contract was executed by the bidder: Email: Telephone: Fax:	
5.	Voltage Level of GIS Circuit Breaker Bay	

Format-B		
Format for the Indian Entity/ Lead Partner/ Partners of JV in support of meeting the requirement of Clause 1.2 & 1.3 of Annexure-A, BDS, Section-III, Volume-I of the Bidding Documents		
S. No	Description	Details
	Manufactured under the Contract <i>(Indicate 220kV or above Voltage class)</i>	
	a) No. of GIS Circuit Breaker equipped bays manufactured. <i>(Indicate nos. of GIS Circuit Breaker equipped bays of 220kV or above voltage level)</i>	
	b) Whether the above Circuit Breaker Bays have been supplied as on originally scheduled date of bid opening.	
	c) Whether the above Circuit Breaker Bays have been Type Tested as per IEC as on originally scheduled date of bid opening.	
	d) Whether 220kV or above voltage level GIS Circuit breaker bays, as mentioned above, has been manufactured based on technological support of the Collaborator/parent/principal/sister concern under the Contract.	
	e) If yes, indicate the name of the Collaborator(s) /parent/principal/sister concern.	
6.	Whether consent letter from the collaborator or parent or principal or sister concern company etc. stating that erection, testing and commissioning of GIS circuit breaker bays shall be carried out under their supervision has been enclosed with bid (As per format Annexure-D3)? (In line with Route 2/3 of Annexure-A, BDS, Section-III, Volume-I of the Bidding Documents).	

Format-B		
Format for the Indian Entity/ Lead Partner/ Partners of JV in support of meeting the requirement of Clause 1.2 & 1.3 of Annexure-A, BDS, Section-III, Volume-I of the Bidding Documents		
S. No	Description	Details
7.	Details of documents submitted along with the bid in support of the above stated experience.	

Format-C		
Format for Collaborator/parent/principal/subsidiary/sister concern in support of meeting the requirement of Clause 1.2 & 1.3 of Annexure-A, BDS, Section-III, Volume-I of the Bidding Documents		
S. No	Description	Details
1.	Name _____ of _____ the Collaborator/parent/principal/subsidiary/sister concern, if applicable	
2.	Name of Contract Undertaken	
3.	Contract Reference No. & Date of Award	
4.	Name and Address of the Employer/Utility for whom the Contract was executed by the firm/Partner of a JV: Email: Telephone: Fax:	
5.	Voltage Level of GIS Substation or Switchyard commissioned under the Contract: (Indicate 220kV or above Voltage class)	
	a) No. of Circuit Breaker equipped bays under the contract <i>(Indicate nos. of GIS Circuit Breaker equipped bays of 220kV or above voltage level)</i>	
	b) Name of the substation or switchyard	
	c) No. of years, the above Substation or switchyard or Bays has been in Satisfactory	

Format-C		
Format for Collaborator/parent/principal/subsidiary/sister concern in support of meeting the requirement of Clause 1.2 & 1.3 of Annexure-A, BDS, Section-III, Volume-I of the Bidding Documents		
S. No	Description	Details
	operation as on originally scheduled date of bid opening.	
	d) Date of commissioning of the above substation or switchyard or bays.	
	e) Scope of work involved under the Contract as per IEC: <i>(Strike off whichever is Not Applicable)</i>	i. Design ii. Manufactured iii. Type Tested (IEC) iv. Supplied v. Erected vi. Commissioned vii. Supervised Erection and Commissioning
6.	Whether a legally enforceable undertaking (jointly with the collaborator(s) or parent or Principal or subsidiary/ sister concern company) to guarantee quality, timely supply, performance and warranty obligations as specified for the equipment(s) has been enclosed with bid? (In line with Route 2/3 of Annexure-A, BDS, Section-III, Volume-I of the Bidding Documents).	
7.	Whether confirmation letter from the collaborator(s) or GIS manufacturer or GIS collaborator or parent or principal or subsidiary or JVC or group or sister concern company etc regarding performance guarantee has been enclosed with bid? (In line with Route 2/3 of Annexure-A, BDS, Section-III, Volume-I of the Bidding Documents).	
8.	Whether valid collaboration agreement for technology transfer / license to design, manufacture, test and supply 220kV or above voltage level GIS equipment in India has been	

Format-C		
Format for Collaborator/parent/principal/subsidiary/sister concern in support of meeting the requirement of Clause 1.2 & 1.3 of Annexure-A, BDS, Section-III, Volume-I of the Bidding Documents		
S. No	Description	Details
	enclosed with bid? (In line with Route 2/3 of Annexure-A, BDS, Section-III, Volume-I of the Bidding Documents).	
9.	Details of documents submitted along with the bid in support of the above stated experience.	

Format-D		
Format for the Bidder/ Lead Partner/ Partners of JV in support of meeting the requirement of Clause 1.4 of Annexure-A, BDS, Section-III, Volume-I of the Bidding Documents)		
S. No	Description	Details
1.	Bidder's Name	
2.	Name of Contract Undertaken	
3.	Contract Reference No. & Date of Award	
4.	Name and Address of the Employer/Utility for whom the Contract was executed by the firm/Partner of a JV: Email: Telephone: Fax:	
5.	Voltage Level of GIS Substation or Switchyard/ bays commissioned under the Contract: (Indicate 220kV or above Voltage class)	
	a) No. of Circuit Breaker equipped bays under the contract <i>(Indicate nos. of GIS Circuit Breaker equipped bays of 220kV or above voltage level)</i>	

Format-D		
Format for the Bidder/ Lead Partner/ Partners of JV in support of meeting the requirement of Clause 1.4 of Annexure-A, BDS, Section-III, Volume-I of the Bidding Documents)		
S. No	Description	Details
	b) Name of the substation or switchyard	
	c) No. of years, the above Substation or switchyard or bays has been in Satisfactory operation as on originally scheduled date of bid opening.	
	d) Date of commissioning of the above Substation or switchyard or bays.	
	e) Scope of work involved under the Contract as per IEC: <i>(Strike off whichever is Not Applicable)</i>	i.Erected ii.Commissioned 220kV or above voltage class GIS Bays.
6.	Whether consent letter (as per format Annexure-D2) from the proposed GIS Manufacturer has been enclosed with the bid?	
7.	Whether the legally enforceable undertaking (jointly with GIS manufacturer) to guarantee quality, timely supply, performance and warranty obligations as specified for the equipment(s) has been enclosed with the bid?	
8.	Whether confirmation letter from the GIS manufacturer or GIS Collaborator or parent or subsidiary or JVC or group or sister concern company etc. or EPC bidder regarding performance guarantee has been enclosed with bid? (In line with Route-4 of Annexure-A, BDS, Section-III, Volume-I of the Bidding Documents).	
9.	Details of documents submitted along with the bid in support of the above stated experience.	

Format-E		
Format for the Bidder/ Lead Partner/ Partners of JV in case of Joint Venture in support of meeting the requirement of Clause 3.0, Annexure-A, BDS, Section-III, Volume-I of the Bidding Documents		
S. No	Description	Details
1.	Bidder's Name	
2.	Single Firm/Lead Partner/Other Partners of a JV	
3.	Name of Contract Undertaken	
4.	Contract Reference No. & Date of Award	
5.	Name and Address of the Employer/Utility for whom the Contract was executed by the firm/Partner of a JV: Email: Telephone: Fax:	
6.	Voltage Level of GIS Substation or Switchyard commissioned under the Contract (Indicate 220kV or above Voltage class)	
	a) No. of Circuit Breaker equipped bays under the contract <i>(Indicate nos. of GIS Circuit Breaker equipped bays of 220kV or above voltage level)</i>	
	b) Name of the substation or switchyard	
	c) No. of years, the above Substation / switchyard/ bays has been in Satisfactory operation as on originally scheduled date of bid opening.	
	d) Scope of work involved under the Contract: <i>(Strike off whichever is Not Applicable)</i>	i.Design ii.Manufactured iii.Type Tested (IEC or Equivalent Standard)

Format-E		
Format for the Bidder/ Lead Partner/ Partners of JV in case of Joint Venture in support of meeting the requirement of Clause 3.0, Annexure-A, BDS, Section-III, Volume-I of the Bidding Documents		
S. No	Description	Details
		iv. Supplied v. Erected vi. Commissioned vii. Supervised Erection and Commissioning
	e) Has the Contract under reference been executed as a Prime Contractor?	
7.	Whether a confirmation letter from the GIS manufacturer/ GIS Collaborator/ Parent/ Subsidiary/ JVC/ Group company etc. regarding performance guarantee (in addition to CPG) has been enclosed with bid? (In line with Annexure-A, BDS, Section-III, Volume-I of the Bidding Documents).	
8.	Details of documents submitted along with the bid in support of the above stated experience.	

Format-F		
Format for Proposed Erector as Subcontractor for the Manufacturer of GIS (Route 1, 2 & 3) of Annexure-A, BDS, Section-III, Volume-I of the Bidding Documents		
S. No	Description	Details
1.	Name of the Proposed Erector	
2.	Name of Contract Undertaken	
3.	Contract Reference No. & Date of Award	
4.	Name and Address of the Employer/Utility for whom the Contract was executed by the firm/Partner of a JV: Email:	

Format-F		
Format for Proposed Erector as Subcontractor for the Manufacturer of GIS (Route 1, 2 & 3) of Annexure-A, BDS, Section-III, Volume-I of the Bidding Documents		
S. No	Description	Details
	Telephone: Fax:	
5.	Voltage Level of GIS Substation or Switchyard commissioned under the Contract: (Indicate 220kV or above Voltage class)	
	a) No. of Circuit Breaker equipped bays under the contract <i>(Indicate nos. of GIS Circuit Breaker equipped bays of 220kV or above voltage level)</i>	
	b) Name of the substation or switchyard	
	c) No. of years, the above Substation or switchyard or bays has been in Satisfactory operation as on originally scheduled date of bid opening.	
	d) Scope of work involved under the Contract as per IEC: <i>(Strike off whichever is Not Applicable)</i>	i. Erected ii. Tested iii. Commissioned including Civil works
6.	Whether consent letter (as per format Annexure-D1) from the proposed Erector has been enclosed with the bid.	
7.	Details of documents submitted along with the bid in support of the above stated experience.	

Format-G
<p>Format for the Bidder for indicating its technical experience of Manufacturer(s)@ for offered Power Transformer</p> <p>@ Please provide details of all the manufacturers from whom 220kV class Power Transformer is proposed to be offered.</p>

Details of manufacturer from whom 220kV class Power Transformer (s) is being offered:		
a)	Name of the Manufacturer	
b)	No. of years for which the manufacturer has been manufacturing 220kV class Power Transformers	
c)	Documentary evidence enclosed herewith in support of being manufacturer of 220kV class Power Transformers for no. of years as stated above.	
d)	Name of Contract Undertaken	
e)	Contract Reference / Order No. & Date of Award	
f)	Details of manufacturer@ from whom 220kV class Power Transformer (s) is being offered: Name and Address of the manufacturer Fax No. E-mail ID Telephone No.
g)	Name of the customer	
h)	Rating of Transformer supplied under the Contract (Indicate Only 220kV or above class)	
i)	Quantity	
j)	Date of supply	
k)	Scope of work executed under the above contract for 220 kV or higher voltage class Transformer by the proposed transformer Manufacturer: (Tick only whichever is/are applicable)	<ul style="list-style-type: none"> • Design • Manufacture • Type test • Supply • Erection • Commission
l)	Date of Commissioning of above Transformer	
m)	Period of satisfactory operation as on the original scheduled date of bid opening	
n)	Details of documents furnished in the Bid, in support of the aforesaid data/details/information	

Format-H		
Format for Proposed Transformer Erector as Subcontractor in support of meeting the requirement of Clause 1.2 & 1.3 of Annexure-A, BDS, Section-III, Volume-I of the Bidding Documents		
S. No	Description	Details
1.	Name of the Proposed Erector	

Format-H		
Format for Proposed Transformer Erector as Subcontractor in support of meeting the requirement of Clause 1.2 & 1.3 of Annexure-A, BDS, Section-III, Volume-I of the Bidding Documents		
S. No	Description	Details
2.	Name of Contract Undertaken	
3.	Contract Reference No. & Date of Award	
4.	Name and Address of the Employer/Utility for whom the Contract was executed by the firm/Partner of a JV: Email: Telephone: Fax:	
5.	Voltage Level of Transformer supplied under the Contract (Indicate Only 220kV or above class)	
6.	Scope of work executed under the above contract by the firm/Partner of a JV:	<ul style="list-style-type: none"> • Erected • commissioned of 220 kV or above class Transformer
7.	Date of Commissioning of above Transformer	
8.	No. of years the above Transformer is in satisfactory operation as on the original scheduled date of bid opening.	
9.	Whether consent letter (as per format Annexure-D4) from the proposed transformer Erector has been enclosed with the bid?	
10.	Details of documents submitted along with the bid in support of the above stated experience.	

2.0 FINANCIAL POSITION:

The bidder should have adequate financial capability to meet the minimum criteria as per **Financial Position stipulated in the Volume-I, Section-III, BDS, Annexure-A:**

Format-I			
Data in support of meeting the Financial Position as per Clause 2.0 (a), Annexure-A, BDS, Section-III, Volume-I of the Bidding Documents.			
Name of the Bidder:			
S. No.	Financial Year	Net worth (in Lakhs) (INR)	Details of documentary evidence submitted in support of Qualification Data

Format-J			
Data in support of meeting the Financial Position as per Clause 2.0 (b), Annexure-A, BDS, Section-III, Volume-I of the Bidding Documents.			
Name of the Bidder:			
S. No.	Financial Year	Turnover (in Lakhs) (INR)	Details of documentary evidence submitted in support of Qualification Data

Average Annual Turnover for last Three Years is:

Format-K	
Data in support of meeting the Financial Position as per Clause 2.0 (c), Annexure-A, BDS, Section-III, Volume-I of the Bidding Documents.	
Name of the Bidder:	
Description	LA (in Lakhs) (INR)
Details of evidence of having Liquid Assets (LA)	
OR	
Details of evidence of access to or availability of credit facilities	

3.0 FINANCIAL & CAPACITY REQUIREMENTS: REFER CLAUSE 4.0 OF ANNEXURE-A, BDS, SECTION-III, VOLUME-I OF THE BIDDING DOCUMENTS:

(A) Details of Banker:

Name of Banker	
Address of Banker	
Telephone No.	
Contact Name and Title	
Fax No.	
E-mail ID	

(B) Certificate of Fund Based and Non-Fund Based Limits sanctioned to the bidder and extent of utilization as on date issued by the banker:

S. No.	Name of Bank	Date of Issue of Certificate

(C) The monthly cash flow projection for execution of the contract having regard to implementation schedule along with proposed means to meet funding gap in each month, if any, is given below:-

S. No	Month	Anticipated Cash Flow	Source	Funding Gap	Proposed means to meet the funding gap
1)					
2)					
3)					
4)					
5)					
6)					
7)					
8)					
9)					
10)					
11)					
12)					
.					
Till completion period of the project.					

- (D) Annual Report, summarized actual Assets and Liabilities in Indian Rupees or equivalent (at the rates of exchange current at the end of each year to be indicated) for the last five years and, based upon known commitments, summarized projected assets and liabilities in Indian Rupees equivalent for the next three years.

Financial Information in Indian Rupees	Details for last five years preceding to the date of Bid Opening				
	1 st Year	2 nd Year	3 rd Year	4 th Year	5 th Year
1. Total Assets					
2. Current Assets					
3. Total Liabilities					
4. Current Liabilities					
5. Profit before Taxes					
6. Profit after Taxes					

(* Indicate the rate of exchange used in calculating the equivalent Indian Rupees amount)

- (E) Audited Balance Sheet and Income Statements for the last five years (for the individual bidder or each partner of a Joint venture/consortium), as stated below are attached:

Years preceding to the bid opening	Audited Balance Sheet and Income Statements enclosed	
1 st Year	Yes	No
2 nd Year	Yes	No
3 rd Year	Yes	No
4 th Year	Yes	No
5 th Year	Yes	No

Date :

Place :

Signature

(Printed Name)

(Designation)

(Common Seal)

ATTACHMENT - 4

Tender No. T26P630001

Design, Engineering, Supply, Erection, Testing & Commissioning of 220/66kV GIS Substation at Bharthal, including complete civil works & automation, along with LILO of 220kV D/C Bamnauli-DIAL Overhead Transmission Line at Bharthal, on a Turnkey Basis.

Bidder's Name & Address:

To,
Delhi Transco Limited,
Shakti Sadan Kotla Road,
New Delhi- 110002 (India),
Email: dgmms105@gmail.com

LIST OF APPROVED SUBCONTRACTORS

Prior to award of Contract, the following details shall be completed indicating those sub-contractors proposed by the Bidder by Attachment to its bid that are approved by the Employer for engagement by the Contractor during the performance of the contract.

The following Subcontractors are approved for carrying out the item of the facilities indicated. Where more than one Subcontractor is listed, the Contractor is free to choose between them, but it must notify the Employer of its choice in good time prior to appointing any selected Subcontractor. No Subcontractors shall be placed with any such Subcontractors for additional items until the Subcontractors have been approved in writing by the Employer and their names have been added to this list of Approved Subcontractors.

Item of Facilities	Approved Subcontractors	Nationality

ATTACHMENT - 5

Tender No. T26P630001

Design, Engineering, Supply, Erection, Testing & Commissioning of 220/66kV GIS Substation at Bharthal, including complete civil works & automation, along with LILO of 220kV D/C Bamnauli-DIAL Overhead Transmission Line at Bharthal, on a Turnkey Basis.

Bidder's Name & Address:

To,
Delhi Transco Limited,
Shakti Sadan Kotla Road,
New Delhi- 110002 (India),
Email: dgmms105@gmail.com

(Commercial Deviations)

Dear Sirs,

The following are the Commercial Deviations and variations from and exceptions to the specifications and documents for the subject package. These deviations and variations are exhaustive. Except for these deviations, the entire work shall be performed as per your specifications and documents.

S.No.	Volume/Clause No.	Ref./Page No.	Details of Deviation	Reason/ Justification of Deviation	Withdrawal Price in Rupees

Date :

Place :

(Signature)

(Printed Name)

(Designation)

(Common Seal)

Note : Continuation sheets of like size and format may be used as per Bidder's requirements and annexed to this Schedule.

ATTACHMENT - 6

Tender No. T26P630001

Design, Engineering, Supply, Erection, Testing & Commissioning of 220/66kV GIS Substation at Bharthal, including complete civil works & automation, along with LILO of 220kV D/C Bamnauli-DIAL Overhead Transmission Line at Bharthal, on a Turnkey Basis.

Bidder's Name & Address:

To,
Delhi Transco Limited,
Shakti Sadan Kotla Road,
New Delhi- 110002 (India),
Email: dgmms105@gmail.com

(DEVIATIONS ON IMPORTANT CONDITIONS)

Dear Sirs,

Sub.: Deviation on Important Conditions along with their withdrawal price.

The following are the Deviations/variations/exceptions to the provisions of important conditions stipulated in Clause 11.2 of ITB, Conditions of Contract, Volume-I. We undertake to execute the contract in line with the provisions of bidding documents in respect of above said clauses in case DTL agree to pay us the withdrawal price indicated below against each such deviations/variations/exceptions.

Volume of bidding document	Section	Clause No.	Page No.	Statement of deviations/ variations/ exceptions	Withdrawal Price in Rupees

Date : (Signature)

Place : (Printed Name)

(Designation)

(Common Seal)

Note : Continuation sheets of like size and format may be used as per Bidder's requirements and annexed to this Schedule.

Tender No. T26P630001

Design, Engineering, Supply, Erection, Testing & Commissioning of 220/66kV GIS Substation at Bharthal, including complete civil works & automation, along with LILO of 220kV D/C Bamnauli-DIAL Overhead Transmission Line at Bharthal, on a Turnkey Basis.

Bidder's Name & Address:

To,
Delhi Transco Limited,
Shakti Sadan Kotla Road,
New Delhi- 110002 (India),
Email: dgmms105@gmail.com

Technical Deviations.

Dear Sir,

The following are the Technical Deviations and variations from and exceptions to the specifications and documents for the subject package. These deviations and variations are exhaustive. Except for these deviations, the entire work shall be performed as per your specifications and documents.

S.No.	Volume/Clause No.	Ref./Page No.	Details of Deviation	Reason/Justification of Deviation	Withdrawal Price in Rupees

Date :

(Signature)

Place :

(Printed Name)

(Designation)

(Common Seal)

Note:

- Continuation sheets of like size and format may be used as per Bidder's requirements and annexed to this Schedule.
- The deviations and variations, if any, shall be brought out separately for each of the equipment.

Tender No. T26P630001

Design, Engineering, Supply, Erection, Testing & Commissioning of 220/66kV GIS Substation at Bharthal, including complete civil works & automation, along with LILO of 220kV D/C Bamnauli-DIAL Overhead Transmission Line at Bharthal, on a Turnkey Basis.

 Bidder's Name & Address:

To,
 Delhi Transco Limited,
 Shakti Sadan Kotla Road,
 New Delhi- 110002 (India),
 Email: dgmms105@gmail.com

(Additional Information)

We have enclosed with our proposal the following additional information for the subject package.

Sl. No.	Brief description of Information	Ref. & Page No.

Date : (Signature)

Place : (Printed Name)

(Designation)

(Common Seal)

Note: Continuation sheets of like size and format may be used as per Bidder's requirements and annexed to this Schedule.

Tender No. T26P630001

Design, Engineering, Supply, Erection, Testing & Commissioning of 220/66kV GIS Substation at Bharthal, including complete civil works & automation, along with LILO of 220kV D/C Bamnauli-DIAL Overhead Transmission Line at Bharthal, on a Turnkey Basis.

Bidder's Name & Address:

To,
Delhi Transco Limited,
Shakti Sadan Kotla Road,
New Delhi- 110002 (India),
Email: dgmms105@gmail.com

(BOUGHT-OUT & SUB-CONTRACTED ITEMS)

We hereby furnish the details of the items/sub-assemblies; we propose to buy for the purpose of subject package.

Sl. No.	Item Description	Quantity Proposed be bought/Sub-contracted	Source of Supply

Date : (Signature)

Place : (Printed Name)

(Designation)

(Common Seal)

Note: Continuation sheets of like size and format may be used as per Bidder's requirements and annexed to this Schedule.

Tender No. T26P630001

Design, Engineering, Supply, Erection, Testing & Commissioning of 220/66kV GIS Substation at Bharthal, including complete civil works & automation, along with LILO of 220kV D/C Bamnauli-DIAL Overhead Transmission Line at Bharthal, on a Turnkey Basis.

Bidder's Name & Address:

To,
Delhi Transco Limited,
Shakti Sadan Kotla Road,
New Delhi- 110002 (India),
Email: dgmms105@gmail.com

(WORK COMPLETION SCHEDULE)

We hereby declare that the following Work Completion Schedule shall be followed by us for the subject package.

Sl. No.	Description of Work	Period in Months (from the date of Award of Contract)
1.	Completion of detailed engineering a) Commencement b) Completion	
2.	Procurement of equipment & raw materials	
3.	Tests a) Commencement b) Completion	
4.	Manufacturing a) Commencement b) Completion	
5.	Shipments a) Commencement b) Completion	
6.	Establishment of site office	
7.	Receipt at final destination at site a) Commencement b) Completion	
8.	Erection a) Commencement b) Completion	
9.	Testing & Commissioning a) Commencement b) Completion	

Date :

(Signature)

Place :

(Printed Name)

(Designation)

(Common Seal)

Note: Continuation sheets of like size and format may be used as per Bidder's requirements and annexed to this Schedule.

Tender No. T26P630001

Design, Engineering, Supply, Erection, Testing & Commissioning of 220/66kV GIS Substation at Bharthal, including complete civil works & automation, along with LILO of 220kV D/C Bamnauli-DIAL Overhead Transmission Line at Bharthal, on a Turnkey Basis.

Bidder's Name & Address:

To,
Delhi Transco Limited,
Shakti Sadan Kotla Road,
New Delhi- 110002 (India),
Email: dgmms105@gmail.com

(LIST OF SPECIAL TOOLS & TACKLES)

We hereby furnish below the list of special tools & tackles for erection and commissioning of equipment for the subject package. The prices for these tools & tackles are already included in the lumpsum bid price.

Sl. No.	For Equipment	Item Description	Unit	Quantity

Date : (Signature)

Place : (Printed Name)

(Designation)

(Common Seal)

Note: Continuation sheets of like size and format may be used as per Bidder's requirements and annexed to this Schedule.

Tender No. T26P630001

Design, Engineering, Supply, Erection, Testing & Commissioning of 220/66kV GIS Substation at Bharthal, including complete civil works & automation, along with LILO of 220kV D/C Bamnauli-DIAL Overhead Transmission Line at Bharthal, on a Turnkey Basis.

Bidder's Name & Address:

To,
Delhi Transco Limited,
Shakti Sadan Kotla Road,
New Delhi- 110002 (India),
Email: dgmms105@gmail.com

(INFORMATION REGARDING EX-EMPLOYEES OF "DTL")

We hereby furnish the details of Ex-Employees of DTL who had retired/resigned at the level of General Manager and above from DTL and subsequently have been employed by us.

Sl. No.	Name of Person with designation in DTL	Date of Retirement/ resignation from DTL	Date of joining and designation in our Organisation

Date : (Signature)

Place : (Printed Name)

(Designation)

(Common Seal)

Note: Continuation sheets of like size and format may be used as per Bidder's requirements and annexed to this Schedule.

Tender No. T26P630001

Design, Engineering, Supply, Erection, Testing & Commissioning of 220/66kV GIS Substation at Bharthal, including complete civil works & automation, along with LILO of 220kV D/C Bamnauli-DIAL Overhead Transmission Line at Bharthal, on a Turnkey Basis.

Bidder's Name & Address:

To,
Delhi Transco Limited,
Shakti Sadan Kotla Road,
New Delhi- 110002 (India),
Email: dgmms105@gmail.com

(PRICE ADJUSTMENT DATA)

Refer BDS

Tender No. T26P630001

Design, Engineering, Supply, Erection, Testing & Commissioning of 220/66kV GIS Substation at Bharthal, including complete civil works & automation, along with LILO of 220kV D/C Bamnauli-DIAL Overhead Transmission Line at Bharthal, on a Turnkey Basis.

Bidder's Name & Address:

To,
Delhi Transco Limited,
Shakti Sadan Kotla Road,
New Delhi- 110002 (India),
Email: dgmms105@gmail.com

(GUARANTEE DECLARATION)

Dear Sirs,

We declare that the ratings and performance figures of Power Transformer, LT Transformer, and HTLS conductor furnished by us for subject tender covered under this specification are guaranteed. We further declare that in the event of any deficiencies in meeting the guarantees in respect of the characteristics mentioned below as established after conducting the factory test, you may at your discretion, reject or accept the equipment after assessing the liquidated damages as specified in the relevant clauses of Bid document.

Power Transformer:

Equipment	Guaranteed Losses at rated output (kW) per unit			
	Max. No Load Loss at rated voltage and frequency	Max. Load Loss at rated current and at 75°C for HV and IV windings at principal tap position	Max. I ² R Loss at rated current and at 75°C for HV and IV windings at principal tap position	Max. Auxiliary Loss at rated voltage and frequency
220/66/11kV, 160MVA Power Transformer				

LT Transformer:

Equipment	Guaranteed Losses at rated output (kW) per unit			
	No Load Loss at rated voltage and frequency	Load Loss at rated current and at 75°C	Total Loss rated parameter at 75 °C	
			50% load condition	100% load condition
1000KVA, 11/0.433kV, Auxiliary LT Transformer (170kVp BIL)				

HTLS conductor:

We declare that the equipment offered shall meet the rating and performance requirements stipulated in the Technical Specification for various equipment or as indicated in Data requirements. Further, the parameters of the HTLS conductor, based on which the average ohmic losses shall be evaluated, shall be in accordance with clause no. 1.3.2 of the Technical Specifications of the HTLS Conductor (Volume-II, Section XXIV).

Further, the guaranteed AC resistance & Guaranteed Average Ohmic Loss of the HTLS conductor, based on which differential price evaluation shall be evaluated, in accordance with clause no. 1.3.2 of the Technical Specifications of the HTLS Conductor, are given herein below:

S.No.	Guaranteed AC Resistance corresponding to temperature at 1200A under normal condition = R_{ac} (in Ohm/ KM)	Guaranteed Average Ohmic Loss (In KW) = $432 \times R_{ac}$

Date:.....

(Signature).....

Place:.....

(Printed Name).....

(Designation).....

(Common Seal).....

Tender No. T26P630001

Design, Engineering, Supply, Erection, Testing & Commissioning of 220/66kV GIS Substation at Bharthal, including complete civil works & automation, along with LILO of 220kV D/C Bamnauli-DIAL Overhead Transmission Line at Bharthal, on a Turnkey Basis.

Bidder's Name & Address:

To,
Delhi Transco Limited,
Shakti Sadan Kotla Road,
New Delhi- 110002 (India),
Email: dgmms105@gmail.com

INTEGRITY PACT

INTEGRITY PACT

Between

Delhi Transco Limited

having its Registered Office at Shakti Sadan, Kotla Road, New Delhi -110 002

hereinafter referred to as

"DTL"

and

(Insert the name of the Sole Bidder/Lead Partner of Joint Venture)

having its Registered Office at _____
(Insert full Address)

and

(Insert the name of the Partner(s) of Joint Venture/agent, as applicable)

having its Registered Office at _____
(Insert full Address)

(Signature) _____ (Signature) _____

(For & On behalf of DTL)

(For & On behalf of Bidder/Partner(s) of
Joint Venture/Contractor)

(Office Seal)

(Office Seal)

hereinafter referred to as

“The Bidder/Contractor”

Preamble

DTL intends to award, under laid-down organisation procedures, contract(s) for _____ Package
(Insert the name of the package)

and Specification Number _____ DTL values full compliance with all relevant
(Insert Specification Number of the Package)
laws and regulations, and the principles of economical use of resources, and of fairness and
transparency in its relations with its Bidders/Contractors.

In order to achieve these goals, DTL and the above named Bidder/Contractor enter into this
agreement called ‘**Integrity Pact**’ which will form a part of the bid.

It is hereby agreed by and between the parties as under :-

Section I – Commitments of DTL

- (1) DTL commits itself to take all measures necessary to prevent corruption and to observe the following principles:
 - (a) No employee of DTL, personally or through family members or relative(s), will in connection with the tender, or the execution of the contract, demand, take a promise for or accept, for him/herself or third person, any material or other benefit which he/she is not legally entitled to.
 - (b) DTL will, during the tender process treat all Bidder(s) with equity and fairness. DTL 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 for the execution of contract.
 - (c) DTL will exclude from evaluation of Bids its such employee(s) who has any personnel interest in the Companies/Agencies participating in the Bidding/Tendering process.

The action stipulated in this Integrity Pact is without prejudice to any other Legal action that may follow in accordance with the provisions of the relevant law in force relating to any civil or criminal proceedings.

(Signature) _____ (Signature) _____

(For & On behalf of DTL)

(For & On behalf of Bidder/Partner(s) of
Joint Venture/Contractor)

(Office Seal)

(Office Seal)

- (2) If Managing Director obtains information on the conduct of any employee of DTL which is a criminal offence under the relevant Anti-Corruption Laws of India or illegal under the Indian Contract Act or Indian Laws, or if there be a substantive suspicion in this regard, he will inform its Chief Vigilance Officer and in addition can initiate disciplinary actions under its Rules.

Section II – Commitments of the Bidder/Contractor

- (1) The Bidder/Contractor commits himself to take all measures necessary to prevent corruption. He commits himself to observe the following principles during his participation in the tender process and during the contract execution.
- (a) The Bidder/Contractor will not, directly or through any other person or firm, offer, promise or give to DTL, or to any of DTL's employees involved in the tender process or the execution of the contract or to any third person any material or other benefit which he/she is not legally entitled to, in order to obtain in exchange an advantage during the tender process or the execution of the contract.
- (b) The Bidder/Contractor will not enter into any illegal agreement or understanding, whether formal or informal with other Bidders/Contractors. This applies in particular to prices, specifications, certifications, subsidiary contracts, submission or non-submission of bids or actions to restrict competitiveness or to introduce cartelization in the bidding process.
- (c) The Bidder/Contractor will not commit any criminal offence under the relevant Anti-Corruption Laws of India, further, the Bidder/Contractor will not use for illegitimate purposes or for purposes of restrictive competition or personal gain, or pass on to others, any information provided by DTL as part of the business relationship, regarding plans, technical proposals and business details, including information of any type contained or transmitted electronically.
- (d) The Bidder/Contractor of foreign origin shall disclose the name and address of the Agents/representatives in India, if any, involved directly or indirectly in the Bidding. Similarly, the Bidder/Contractor of Indian Nationality shall furnish the name and address of the foreign principals, if any, involved directly or indirectly in the bidding.
- (e) The Bidder/Contractor will, when presenting his bid, disclose any and all payments he has made, or committed to or intends to make to agents, brokers or any other intermediaries in connection with the award of the contract and/or with the execution of the contract.

(Signature)_____ (Signature) _____

(For & On behalf of DTL)

(For & On behalf of Bidder/Partner(s) of
Joint Venture/Contractor)

(Office Seal)

(Office Seal)

- (f) The Bidder/Contractor will not misrepresent facts or furnish false/forged documents/information in order to influence the bidding process or the execution of the contract to the detriment of DTL.
- (2) The Bidder/Contractor will not instigate third persons to commit offences outlined above or be an accessory to such offences.

Section III – Disqualification from tender process and exclusion from future contracts

- (1) If the bidder, before contract award, has committed a serious transgression through a violation of Section II or in any other form such as to put his reliability or credibility as Bidder into question, DTL may disqualify the Bidder from the tender process or terminate the contract, if already signed, for such reason.
- (2) If the Bidder/Contractor has committed a serious transgression through a violation of Section II such as to put his reliability or credibility into question, DTL may after following due procedures also exclude the Bidder/Contractor from future contract award processes. The imposition and duration of the exclusion will be determined by the severity of the transgression. The severity will be determined by the circumstances of the case, in particular the number of transgressions, the position of the transgressors within the company hierarchy of the Bidder/Contractor and the amount of the damage. The exclusion will be imposed for a minimum of 12 months and maximum of 3 years and it has to be decided by the Competent authority.
- (3) If the Bidder/Contractor can prove that he has restored/Recouped the damage caused by him and has installed a suitable corruption prevention system, DTL may revoke the exclusion prematurely with the approval of Competent Authority.

Section IV – Liability for violation of Integrity Pact

- (1) If DTL has disqualified the Bidder from the tender process prior to the award under Section III, DTL may forfeit the Bank Guarantee under the Bid.
- (2) If DTL has terminated the contract under Section III, DTL may forfeit the Contract Performance Guarantee of this contract besides resorting to other remedies under the contract.

Section V – Previous Transgression

- (1) The Bidder shall declare in his Bid that no previous transgressions occurred in the last 3 years with any other Public Sector Undertaking or Government Department that could justify his exclusion from the tender process.
- (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.

(Signature)_____ (Signature) _____

(For & On behalf of DTL)

(For & On behalf of Bidder/Partner(s) of
Joint Venture/Contractor)

(Office Seal)

(Office Seal)

Section VI – Equal treatment to all Bidders/Contractors

- (1) DTL will enter into agreements with identical conditions as this one with all Bidders.
- (2) DTL will disqualify from the tender process any bidder who does not sign this Pact or violate its provisions.

Section VII – Punitive Action against violating Bidders/Contractors

If DTL obtains knowledge of conduct of a Bidder or a Contractor or his subcontractor or of an employee or a representative or an associate of a Bidder or Contractor or his Subcontractor which constitutes corruption, or if DTL has substantive suspicion in this regard, DTL will inform the Chief Vigilance Officer (CVO).

(*)Section VIII – Independent External Monitor/Monitors

- (1) DTL has appointed a panel of Independent External Monitors (IEMs) for this Pact with the approval of Central Vigilance Commission (CVC), Government of India, out of which one of the IEMs has been indicated in the NIT.
- (2) The IEM is to review independently and objectively, whether and to what extent the parties comply with the obligations under this agreement. He has right of access to all project documentation. The IEM may examine any complaint received by him and submit a report to Managing Director, DTL at the earliest. He may also submit a report directly to the CVO and the CVC, in case of suspicion of serious irregularities attracting the provisions of the PC Act. However, for ensuring the desired transparency and objectivity in dealing with the complaints arising out of any tendering process, the matter shall be referred to the full panel of IEMs, who would examine the records, conduct the investigations and submit report to Managing Director, DTL, giving joint findings.
- (3) The IEM is not subject to instructions by the representatives of the parties and performs his functions neutrally and independently. He reports to the Managing Director, DTL.
- (4) The Bidder(s)/Contractor(s) accepts that the IEM has the right to access without restriction to all documentation of DTL related to this contract including that provided by the Contractor/Bidder. The Bidder/Contractor will also grant the IEM, upon his request and demonstration of a valid interest, unrestricted and unconditional access to his documentation. The same is applicable to Subcontractors. The IEM is under contractual obligation to treat the information and documents of the Bidder(s)/Contractor(s)/Sub-Contractor(s) with confidentiality.

(Signature)_____ (Signature) _____

(For & On behalf of DTL)

(For & On behalf of Bidder/Partner(s) of
Joint Venture/Contractor)

(Office Seal)

(Office Seal)

- (5) DTL will provide to the IEM information as sought by him which could have an impact on the contractual relations between DTL and the Bidder/Contractor related to this contract.
- (6) As soon as the IEM notices, or believes to notice, a violation of this agreement, he will so inform the Managing director, DTL and request the Managing Director, DTL to discontinue or take corrective action, or to take other relevant action. The IEM can in this regard submit non-binding recommendations. Beyond this, the IEM has no right to demand from the parties that they act in a specific manner, refrain from action or tolerate action. However, the IEM shall give an opportunity to DTL and the Bidder/Contractor, as deemed fit, to present its case before making its recommendations to DTL.
- (7) The IEM will submit a written report to the Managing Director, DTL within 8 to 10 weeks from the date of reference or intimation to him by DTL and should the occasion arise, submit proposals for correcting problematic situations.
- (8) If the IEM has reported to the Managing Director, DTL a substantiated suspicion of an offence under relevant Anti-Corruption Laws of India, and the Managing Director, DTL has not, within the reasonable time taken visible action to proceed against such offence or reported it to the CVO, the Monitor may also transmit this information directly to the CVC, Government of India.
- (9) The word '**IEM**' would include both singular and plural.

(*) This Section shall be applicable for only those packages wherein the IEMs have been identified in Section – I: Invitation for Bids and/or Clause 9 in Section –III : Conditions of Contract, Volume-I of the bidding documents.

Section IX – Pact Duration

This Pact begins when both parties have legally signed it. It expires for the Contractor after the closure of the contract and for all other Bidder's six month after the contract has been awarded.

Section X – Other Provisions

- (1) This agreement is subject to Indian Law. Place of performance and jurisdiction is the establishment of DTL. The Arbitration clause provided in the main tender document/contract shall not be applicable for any issue/dispute arising under Integrity Pact.
- (2) Changes and supplements as well as termination notices need to be made in writing.

(Signature)_____ (Signature) _____

(For & On behalf of DTL)

(For & On behalf of Bidder/Partner(s) of
Joint Venture/Contractor)

(Office Seal)

(Office Seal)

- (3) If the Contractor is a partnership firm or a consortium or Joint Venture, this agreement must be signed by all partners, consortium members and Joint Venture partners.
 - (4) Nothing in this agreement shall affect the right of the parties available under the General conditions of Contract (CC/GCC) and Special Conditions of Contract (SCC).
 - (5) Views expressed or suggestions/submissions made by the parties and the recommendations of the CVO/IEM# in respect of the violation of this agreement, shall not be relied on or introduced as evidence in the arbitral or judicial proceedings (arising out of the arbitral proceedings) by the parties in connection with the disputes/differences arising out of the subject contract.
- # CVO shall be applicable for packages wherein IEM are not identified in Section IFB/BDS of Condition of Contract, Volume-I. IEM shall be applicable for packages wherein IEM are identified in Section IFB/BDS of Condition of Contract. Volume-I
- (6) Should one or several provisions of this agreement turn out to be invalid, the remainder of this agreement remains valid. In this case, the parties will strive to come to an agreement to their original intentions.

(Signature)_____ (Signature) _____

(For & On behalf of DTL)

(For & On behalf of Bidder/Partner(s) of
Joint Venture/Contractor)

(Office Seal)

(Office Seal)

Name : _____

Name : _____

Designation: _____

Designation: _____

Witness 1 : _____

Witness 1 : _____

(Name &Address)_____

(Name & Address)_____

Witness 2 : _____

Witness 2 : _____

(Name &Address)_____

(Name & Address)_____

(Signature)_____ (Signature) _____

(For & On behalf of DTL)

(For & On behalf of Bidder/Partner(s) of
Joint Venture/Contractor)

(Office Seal)

(Office Seal)

Tender No. T26P630001

Design, Engineering, Supply, Erection, Testing & Commissioning of 220/66kV GIS Substation at Bharthal, including complete civil works & automation, along with LILO of 220kV D/C Bamnauli-DIAL Overhead Transmission Line at Bharthal, on a Turnkey Basis.

Bidder's Name & Address:

To,
Delhi Transco Limited,
Shakti Sadan Kotla Road,
New Delhi- 110002 (India),
Email:dgmms105@gmail.com

(CHECK LIST)

We have enclosed with our proposal the following additional information for the subject package.

	Particulars	
Bid Validity	Whether Bid is valid is as stipulated in ITB from the date of bid opening.	Yes/No
Bid Security amount	Whether Bid security amount and form is enclosed as per ITB.	Yes/No
Bid Security Validity	Whether bid security is valid for a period as stipulated in ITB.	Yes/No
Bid Signatory	Power of Attorney of Signatory of Bid as per Section ITB	Yes/No
	Technical Specification	
1.	Is the material offered according to the specifications required by the purchaser, if not, please state the deviation from the same and deviation statement thereof	Yes/No
2	Have you submitted copies of Type Test Certificates in physical form in respect of material offered?	Yes/No
3	Have you submitted dimension drawings leaflets, descriptive and illustrative catalogues in physical form (if necessary)?	Yes/No
4	Whether product conforms to relevant ISS and our technical particulars?	Yes/No
5	Have you submitted in physical form (i)the copy of NIT duly signed & stamped on each page, (ii) copies of past supplies and (iii) performance certificates?	Yes/No
6	Whether testing facilities as per IS for conducting various tests are available with you?	Yes/No

	Terms and Condition	
1.	Do you agree to all clauses of General Conditions of our tender documents?	Yes/No
2	If you do not agree to any/all the clauses, please state clearly the clause which you do not agree and state the modification in respect of clauses of which you do not agree.	Yes/No
3	Do you agree to furnish security deposit if order is placed with you?	Yes/No
4	Whether agreeable to DTL's liquidate damages clause for late completion of work?	Yes/No
5	Are you agreeable to inspection clause?	Yes/No
6	Any further particulars not otherwise covered in the tender specifications submitted physically?	Yes/No
7	Quantity offered against each item be quoted. Are you prepared to accept order for bigger quantity as per NIT?	Yes/No
Part-I	Techno-commercial Bid	
a)	Whether undertaking for corrupt & fraudulent practice signed and submitted.	Yes/No
b)	Whether Bid form duly completed, signed and submitted.	Yes/No
c)	Whether following Attachments submitted:	Yes/No
d)	Attachment 1: "Bid security".	Yes/No
e)	Attachment 2: "Power of Attorney".	Yes/No
f)	Attachment 3: "Qualifying Requirement Data".	Yes/No
g)	Attachment 4: "List of approved Subcontractors".	Yes/No
h)	Attachment 5: "Commercial Deviations".	Yes/No
i)	Attachment 6: "Deviations on important Conditions".	Yes/No
j)	Attachment 7: "Technical Deviations".	Yes/No
k)	Attachment 8: "Additional Information".	Yes/No
l)	Attachment 9: "Bought Out and Sub-contracted items"	Yes/No
m)	Attachment 10: "Work completion schedule".	Yes/No
n)	Attachment 11: "List of Special Tools and Tackles".	Yes/No
o)	Attachment 12: "Information regarding ex-employees of Employer in Bidder's firm".	Yes/No
p)	Attachment 14: "Price Adjustment Data."	Yes/No
q)	Attachment 15: "Guarantee Declaration".	Yes/No
r)	Attachment 16: "Integrity Pact".	Yes/No
s)	Attachment 18: "Check list".	Yes/No
t)	Attachment 19: Affidavit of Self certification regarding Minimum Local Content in line with PPP-MII order and MoP Order, as applicable (submission of Hard Copy in 'Original'), to be submitted on a non-judicial stamp paper of Rs. 100/-.	Yes/No
u)	Attachment 20: Certificate from statutory auditor or cost auditor of the company giving the percentage of Local Content, in line with PPP-MII order and MoP Order, as applicable (submission of	Yes/No

	Hard Copy in 'Original') to be submitted on the letter head of the auditor/ cost accountant.	
v)	Attachment 21: Undertaking for not indulging in Corrupt & Fraudulent practice	Yes/No
w)	Attachment 22: Certification by the Bidder as per DoE Order no-F.No.7/10/2021-PPD (1) dt 23.02.2023 in line with ITB Clause 1.2.2 (In case of a Joint Venture bid, the declaration shall be given by all partners of the Joint Venture)	Yes/No
x)	Attachment no 23: Details of complete type test report of all the equipment as per QR and in accordance with latest IEC / NIT in the prescribed format	Yes/No
Part-II	Price Bid	
a)	Whether Price Bid submitted.	Yes/No
b)	Whether Bid form duly completed, signed and submitted.	Yes/No
c)	Whether following Price Schedules submitted:	Yes/No
d)	Schedule 1: "Price break-up Plant and Equipment (including Mandatory Spares) to be supplied."	Yes/No
e)	Schedule 2: "Break-up of Local Transportation, Insurance and other Incidental Services."	Yes/No
f)	Schedule 3: "Price Breakup of Installation Charges."	Yes/No
g)	Schedule 4: "Grand summary of the quoted bid price."	Yes/No
Tender Document/NIT	Whether Tender document along with all amendments duly signed & stamped on each page submitted.	Yes/No

Date : (Signature)

Place : (Printed Name)

(Designation)

(Common Seal)

Note: (i) Continuation sheets of like size and format may be used as per Bidder's requirements and annexed to this Attachment.

(ii) Replies against each item should be complete without any ambiguity. Terms such as refer covering letter etc. shall not be acceptable unless the replies/ information are specific and complete

Tender No. T26P630001

Design, Engineering, Supply, Erection, Testing & Commissioning of 220/66kV GIS Substation at Bharthal, including complete civil works & automation, along with LILO of 220kV D/C Bamnauli-DIAL Overhead Transmission Line at Bharthal, on a Turnkey Basis.

Format for Affidavit of Self certification regarding Local Content in line with PPP-MII order dated 15/06/2017, its revision dated **16/09/2020** & their latest amendments thereof **and MoP Order dated 16/11/2021** & their latest amendments thereof, as applicable, to be provided on a non-judicial stamp paper of Rs. 100/-.

Date:

I _____ S/o, _____ D/o, _____ W/o, _____ Resident of _____ hereby solemnly affirm and declare as under:

That I will agree to abide by the terms and conditions of the Public Procurement (Preference to Make in India) Order, 2017 of Government of India issued vide Notification No:P-45021/2/2017 -BE-II dated 15/06/2017, its revision dated **16/09/2020** & their latest amendments thereof, (hereinafter **PPP-MII order**), and 'Public Procurement (Preference to Make in India) to provide for Purchase Preference (linked with local content)' order **dated 16/11/2021** & their latest amendments thereof, issued by Ministry of Power (hereinafter **MoP order**) and **any subsequent modifications/ Amendments, if any and**

That the information furnished hereinafter is correct to the best of my knowledge and belief and I undertake to produce relevant records before the procuring entity/DTL or any other Government authority for the purpose of assessing the local content of goods/services/works supplied by me for **Turnkey Package (Insert the name of Package and Tender no.)**.

That the local content for all inputs which constitute the said goods/services/works has been verified by me and I am responsible for the correctness of the claims made therein.

That the 'Local Content 'as defined in the PPP-MII order and MoP order in the goods/services/works supplied by me for Turnkey Package (Insert the name of Package and Tender no.) is percent (%).

That the goods/services/works supplied by me for **Turnkey Package (Insert the name of Package and Tender no.)** meet the 'Local Content 'requirement as defined in the PPP-MII order **and MoP order for 'Class –I local supplier'.**

That the value addition for the purpose of meeting the 'Local Content 'has been made by me at *(Enter the details of the location(s) at which value addition is made).*

That in the event of the local content of the goods/services/works mentioned herein is found to be incorrect and not meeting the prescribed Local Content criteria, based on the assessment of procuring agency (ies)/DTL/Government Authorities for the purpose of assessing the local content, action shall be taken against me in line with the PPP-MII order, **MoP order** and provisions of the Integrity pact/ Bidding Documents.

I agree to maintain the following information in the Company's record for a period of 8 years and shall make this available for verification to any statutory authority.

- i Name and details of the Local Supplier
(Registered Office, Manufacturing unit location, nature of legal entity)
- ii. Date on which this certificate is issued
- iii. Goods/services/works for which the certificate is produced
- iv. Procuring entity to whom the certificate is furnished
- v. Percentage of local content claimed and whether it meets the Local Content prescribed for **‘Class –I local supplier’**
- vi. Name and contact details of the unit of the Local Supplier (s)
- vii. Sale Price of the product
- viii Ex-Factory Price of the product
- ix. Freight, insurance and handling
- x. Total Bill of Material
- xi List and total cost value of input used to manufacture the Goods/to provide services/in construction of works
- xii. List and total cost of input which are domestically sourced. Value addition certificates from suppliers, if the input is not in-house to be attached
- xiii. List and cost of inputs which are imported, directly or indirectly

For and on behalf of..... (Name of firm/entity)

Authorized signatory (To be duly authorized by the Board of Directors)

<Insert Name, Designation and Contact No.>

Tender No. T26P630001

Design, Engineering, Supply, Erection, Testing & Commissioning of 220/66kV GIS Substation at Bharthal, including complete civil works & automation, along with LILO of 220kV D/C Bamnauli-DIAL Overhead Transmission Line at Bharthal, on a Turnkey Basis.

Certificate from statutory auditor or cost auditor of the company giving the percentage of Local Content, in line with **PPP-MII order** dated 15/06/2017, its revision dated **16/09/2020** & their latest amendments thereof, **and MoP order** dated **16/11/2021** & their latest amendments thereof, as applicable *[to be submitted on the letter head of the issuer.]*

Dear Sir,

We have read and understood the provisions of “Public Procurement (Preference to Make in India) Order, 2017” dated 15/06/2017, its revision dated **16/09/2020** & their latest amendments thereof [hereinafter, “PPP-MII Order”] issued by Department for promotion of Industry and Internal Trade (DPIIT), Ministry of Commerce and Industry, Government of India, and ‘Public Procurement (Preference to Make in India) to provide for Purchase Preference (linked with local content)’ order dated **16/11/2021** & their latest amendments thereof issued by Ministry of Power [hereinafter, “MoP order”] and **any subsequent modifications/ Amendments, if any.**

In line with the provisions of the PPP-MII Order **and MoP Order**, M/s. *[Enter the name of the Bidder]* [hereinafter, “**Class-I Local Supplier**”] have submitted an Affidavit of self-certification to M/s. Delhi Transco Limited [hereinafter, DTL] regarding Local Content in Goods/Services/Works to be supplied by the “**Class-I Local Supplier**” for **Turnkey Package (Insert the name of Package and Tender No.)**, wherein they have agreed to abide by the terms and conditions of the PPP-MII Order **and MoP Order**.

Further, in line with the PPP-MII Order, the statutory auditor or cost auditor of the company shall provide a certificate giving the percentage of Local Content in the Goods/Service/Works to be supplied by the “**Class-I Local Supplier**” for **Turnkey Package (Insert the name of Package and Tender No.)**.

Accordingly, we, the Statutory Auditor(s) / Cost auditor of the “**Class-I Local Supplier**”, certify that the Local Content as defined under the PPP-MII **and MoP Order**, in the Goods/Service/Works to be supplied by the “**Class-I Local Supplier**” for **Turnkey Package (Insert the name of Package and Tender No.)** isPercentage *[specify the percentage of Local content]*.

For and on behalf of,
 <<Statutory Auditor's/Cost auditor's attestation>>
 Firm Reg No. Membership No.

Date:

Note: This is a guiding format. In case the bidder submits the certificate in a format different from the above, the same may be considered provided it meets the intent and purpose, as may be ascertained by DTL.

Tender No. T26P630001

Design, Engineering, Supply, Erection, Testing & Commissioning of 220/66kV GIS Substation at Bharthal, including complete civil works & automation, along with LILO of 220kV D/C Bamnauli-DIAL Overhead Transmission Line at Bharthal, on a Turnkey Basis.

Bidder's Name & Address:

To,
Delhi Transco Limited,
Shakti Sadan Kotla Road,
New Delhi- 110002 (India),
Email:dgmms105@gmail.com

**UNDERTAKING FOR NOT INDULGING IN CORRUPT &
FRAUDULENT PRACTICE**

We declare that all the documents submitted or would be submitted by us in this tender are/would be genuine, and in case any discrepancy is found in the declaration/documents submitted by us at any stage, action can be taken against us as deemed fit by DTL.

We further declare that in the submission of this tender no agent, middleman or any intermediary has been, or will be engaged to provide any services, or any other item of work related to the award and performance of this contract. We further confirm and declare that no agency commission or any payment which may be construed as an agency commission has been, or will be, paid and that the tender price does not include any such amount.

We acknowledge the right of the employer, if he finds to the contrary, to declare, our tender to be non-compliant and if the contract has been awarded to declare the contract null and void.

STAMP & SIGNATURE OF AUTHORISED SIGNATORY

Tender No. T26P630001

Design, Engineering, Supply, Erection, Testing & Commissioning of 220/66kV GIS Substation at Bharthal, including complete civil works & automation, along with LILO of 220kV D/C Bamnauli-DIAL Overhead Transmission Line at Bharthal, on a Turnkey Basis.

Certification by the Bidder as per order no. F.No.7/10/2021-PPD(1) dated **23/02/2023** issued by Public Procurement Division, Department of Expenditure, Ministry of Finance, Government of India (DoE Order) in line with ITB Clause 1.2.2

(In case of a Joint Venture bid, the declaration shall be given by all partners of the Joint Venture)

Dear Sir,

We have read and understood the provisions of Order no.F.No.7/10/2021-PPD(1)(Order Public Procurement no.4) dated **23/02/2023** regarding “Restriction under Rule 144(xi) of General Financial Rules” issued by Public Procurement Division, Department of Expenditure, Ministry of Finance, Government of India [hereinafter collectively “**DoE Order**”] and **any subsequent modifications/ Amendments, if any.**

Particularly, we, the Bidder, have read the clause regarding restrictions on procurement from a ‘Bidder of a country which shares a land border with India’ and on sub-contracting to contractors from such countries.

We certify that we, the bidder is not from such a country or, if from such a country, has been registered with the Competent Authority and will not subcontract any work to a subcontractor/sub vendor from such countries unless such subcontractor/sub vendor fulfils all requirement in this regard and is eligible to be considered. [*Where applicable, evidence of **valid registration by the Competent Authority shall be attached.***]

We also undertake to comply the above said DoE order dt. 23.02.2023 and **any subsequent modifications/ Amendments, if any.**

We further declare that any misrepresentation or submission of false/forged document/information in this regard this would be ground for immediate termination and further legal action in accordance with law.

Date :

Place :

(Signature)

(Printed Name)

(Designation)

(Common Seal)

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Bidder's Name & Address:

To,
Delhi Transco Limited,
Shakti Sadan Kotla Road,
New Delhi- 110002 (India),
Email: dgmms105@gmail.com

Bidder has to submit details of complete type test report of all the equipment as per QR and in accordance with latest IEC / NIT in the below format

S. No.	Equipment	IEC Clause Ref.	Type of test	Type Test Description/
				a) Manufacturer b) Model no. test conducted on c) Report No.: d) Lab. Name: e) Date of Test: f) Date of Issue: g) IEC: h) Ref Page

Date :

Place :

(Signature)

(Printed Name)

(Designation)

(Common Seal)

SECTION-III

GUARANTEED TECHNICAL PARTICULARS

S.NO.	NAME OF EQUIPMENT
1.	GIS
2.	LIGHTENING ARRESTOR
3.	POWER TRANSFORMER
4.	DISTRIBUTION TRANSFORMERS
5.	DG SET

Guaranteed Technical Particular - GIS

A. Complete GIS Module

- | | |
|---|-------------------|
| 1. Nominal voltage of system | kV |
| 2. Rated voltage of system | kV |
| 3. Rated voltage for equipment (U_r) | kV |
| 4. Rated insulation levels phase-to-earth and between phases | |
| Rated short-duration power-frequency withstand voltage (U_d) | kV |
| 5. Rated switching impulse withstand voltage (U_s) | |
| Phase-to-earth | kV |
| Between phases | kV |
| 6. Rated lightning impulse withstand voltage (U_p) | |
| 7. Rated frequency (f_t) | Hz |
| 8. Rated normal current (I_r) | A |
| 9. Rated short-time withstand current (I_k) | kA |
| 10. Rated peak withstand current (I_p) | kA |
| 11. Rated duration of short-circuit (t_k) | s |
| 12. Rated supply voltage of closing and opening devices and of auxiliary and control circuits (U_a) | V |
| 13. Rated supply frequency of closing and opening devices and of auxiliary circuits | Hz DC or 50 or 60 |
| 14. Neutral earthing Solidly or not solidly | |
| 15. Number of phases | |
| 16. Single- or three-phase design | |
| 17. Maximum SF6 leakage rate | % / year |
| 18. Rated filling pressure p_r | |
| Circuit-breaker | |
| Other compartments | |
| 19. Alarm pressure p_a | |
| Circuit-breaker | |
| Other compartments | |
| 20. Minimum functional pressure p_m | |
| Circuit-breaker | |
| Other compartments | |
| 21. Design pressure of enclosures | |

	Circuit-breaker	
	Other compartments	
22. Type test pressure of enclosures		
	Circuit-breaker	
	Other compartments	
23. Routine test pressure of enclosures		
	Circuit-breaker	
	Other compartments	
24. Operating pressure of pressure relief device		
	Circuit-breaker	
	Other compartments	
25. Internal fault		
	Short-circuit current	kA
26. Quantity of SF6 gas of complete GIS at filling pressure		kg
27. Quantity of SF6 gas of the largest compartment at filling pressure		kg
28. Maximum permissible gas dew point		°C
29. Number of gas compartments		
30. Length of longest section for transportation		m
31. Weight of the heaviest piece of equipment to be handled during installation on-site		kg

B. Bus ducts

1. Inductance	H/m
2. Capacitance	pF/m
3. Resistance of enclosure at <i>f</i> r	Ω/m
4. Resistance of conductor at <i>f</i> r	Ω/m
5. Surge impedance	Ω

C. Bushing (Outdoor-immersed bushing)

1. Type of internal insulation	
2. Type of external insulation	
3. Nominal specific creepage distance	mm/kV
4. Shed profile	Normal or alternating
5. Rated short-duration, power-frequency	kV
6. withstand voltage (<i>U</i> d)	

- | | |
|--|----|
| 7. Rated switching impulse withstand voltage (U_s) | kV |
| 8. Rated lightning impulse withstand voltage (U_p) | kV |
| 9. Cantilever test load | N |
| 10. Cantilever operation load | N |
| 11. Type of line termination | |

GUARANTED TECHNICAL PARTICULARS LIGHTENING ARRESTOR

1. Name of the Manufacturer :
2. Type
3. Model
4. No. of he Units
5. Rated Voltage of Arrestor : KV (rms)
6. Nominal Discharge Current : Amps.
7. Minimum Power frequency
discharge voltage : KV (rms)
8. Dry & wet power frequency withstand
voltage of arrester insulation : KV (rms)
9. Max. continuous operating voltage : KV (rms)
10. Protective level of the arrester :
11. Ratio of system voltage with stand level
to protection level of surge arrestor :
12. Max. residual voltage for discharge current
of (8/20 micro second wave) :KV (Peak)
 - (i) 5000 Amps.
 - (ii) 10000 Amps.
 - (iii) 20000 mps
13. High current impulse with stand
4/10 micro second peak value :KV
14. Leakage current through Arrestor at COV:
 - (i) Capacitive
 - (ii) Resistive
 - (iii) Total
15. Long Duration current test
 - (i) Current peak :
 - (ii) Virtual duration :
16. Creep age distance (suitable
for heavily polluted atmosphere) :
17. Pressure relief class :
18. Long duration discharge class :
19. Type & specification of the surge counters :
20. Type & range of mili ampere meter :
21. Mounting flanges dimensional details :
22. Earthing arrangement provided
for earthing side of arrestor :
23. Clearance required from grounded
equipment at various heights of arresters unit: mm
24. Min. recommended spacing between
arresters center to center :
25. Height of complete unit from

base to the line side : mm

26. Weight of complete unit :

Guaranteed and other technical Particulars of Power Transformer

(To be filled by the manufacturer)

A. GENERAL

S. No	DESCRIPTION	Unit	Specified by Buyer	Offered by manufacturer
1.	General Information i) Supplier ii) Name of Manufacturer iii) Place of Manufacture (Country & City) iv) Type of transformer (Core/Shell)			
2.	Applications i) Indoor/Outdoor ii) 2wdg/3wdg/Auto iii) GT/Step-down/ICT/Station Start-up/ Auxiliary/ Rail Trackside Supply			
3.	Corrosion Level at Site i) Light ii) Medium iii) Heavy iv) Very Heavy			
4.	Site altitude above mean sea level	m		
5.	Seismic zone and ground acceleration at site (both in horizontal & vertical direction)			
6.	Maximum and minimum ambient temperature at site			
7.	Applicable Standards i) IEC: 60076 ii) IS : 2026 iii) Any other, please specify			
8.	Rated Capacity / Full load rating (HV/IV/LV)	MVA		
9.	3-Phase/Bank of Three Single Phase (A,B,C)			
10.	Rated No Load Voltages (HV/IV/LV)	kV		
11.	Currents at normal tap (HV/IV/LV)	Amp		
12.	Rated Frequency	Hz		
13.	Connections and phase displacement symbols (Vector Group)			
14.	Weight Schedules (Minimum with no negative tolerance)			
	i) Active part (Core + coil)	Kg		

	ii) Insulating Oil (excluding mass of extra oil)	Kg		
	iii) Tank and Fittings	Kg		
	iii) Total weight	Kg		
	iv) Transportation Weight	Kg		
	v) Overall dimensions L x B x H	Mm		
	vi) Size of heaviest package L x B x H	Mm		
	vii) Weight of heaviest package	Kg		
	viii) Weight of 5% extra oil	Kg		
	ix) Weight of core	Kg		
	x) Weight of copper (HV/IV/LV/ Regulating)	Kg		
	xi) Insulating Oil volume (excluding 5% extraoil)	Ltrs		
	xii) Quantity of oil in OLTC	Ltrs		
15.	Transport limitation			
16.	LV Winding i) Stabilizing tertiary (Yes/No) ii) Loaded (Yes/No)			
17.	Tappings i)Type (OLTC/OCTC) and make of tap changer ii)Position of Tapping on the winding iii)Variation on i v)Range of variation v)No. of Steps vi) Whether control suitable for : <ul style="list-style-type: none"> Remote/local operation Auto/manual operation vi)Parallel Operation Requirements 	%		
18.	Impedance and Losses			
	i) Guaranteed No load loss at rated voltage and frequency	kW		
	Tolerance (to be considered for loss evaluation)	%		
	ii) Guaranteed I ² R Loss at rated current & frequency (at 75°C) at principal tap	kW		
	Tolerance (to be considered for loss evaluation)	%		
	iii) Eddy current and stray loss at rated current & frequency (at 75°C) at principal tap	kW		
	iv) Load Loss(I ² R+Eddy and Stray) at rated current & frequency (at 75°C) at principal tap	kW		

	v) Guaranteed Auxiliary loss at rated voltage and frequency	kW		
	Tolerance (to be considered for loss evaluation)	%		
	vi) Calculated Fan Loss	kW		
	vii) Calculated Pump Loss	kW		
	viii) Air core reactance of HV winding	%		
	ix) Guaranteed Impedance (at Highest MVA base)	%		
	(a) HV-IV (at Principal tap)			
	(b) HV-LV(at Principal tap)			
	(c) IV-LV(at Principal tap)			
	Tolerance			
	x) Impedance at extreme tap-ings at Highest MVA base [for HV-IV for 3 winding transformer (or) HV-LV for two winding transformer] a) Max. Voltage tap b) Min. Voltage tap	%		
	Tolerance	%		
	xi) Zero sequence impedance at principal tap (for 3-phase transformers)			
19.	Capacitance to earth for HV/IV/LV	pF		
20.	Regulation at full load at 75 °C winding temperature at: a) upf b) 0.8 pf			
21.	Guaranteed maximum Magnetizing Current at rated Voltage	%		
22.	Efficiency : At 100% load upf 0.8 lead 0.8 lag At 75% load upf 0.8 Lead 0.8 lag At 50% load upf 0.8 lead 0.8 lag	%		
23.	Load at Maximum efficiency	%		

24.	Any limitations in carrying out the required test? If Yes, State limitations			
25.	Fault level of system (in kA) and its duration (in sec)	kA (sec)		
26.	Calculated short Circuit current (in kA) withstand capability for 2 seconds (3 seconds for generator transformers) without exceeding temperature limit (i.e. Thermal ability to withstand SC current)	kA		
27.	Test current (in kA) and duration (in ms) for short Circuit current test (i.e. Dynamic ability to withstand SC)	kA & msec		
28.	Over fluxing withstand time (due to combined voltage & frequency fluctuations): 110% 125% 140% 150% 170%	msec		
29.	Free space required above the tank top for removal of core			
30.	Maximum Partial discharge level at $1.58 U_r/\sqrt{3}$	pC		

B. MAGNETIC SYSTEM

Sl. No.	Description	Unit	Specified by Buyer	Offered by manufacturer
1.	Core Type: i) 3 Phase 3 Limb (3 wound limbs) ii) 3 Phase 5 Limb (3 wound limbs) iii) 1 Phase 2 Limb (2 wound limbs) iv) 1 Phase 3 Limb (1 wound limb) v) 1 Phase 4 Limb (2 wound limbs) vi) 1 Phase 5 Limb (3 wound Limbs)			

2.	Type of Core Joint: i) Mitred ii) Step Lap			
3.	CRGO : i) Make & Country of Origin ii) Thickness, mm iii) Max. Specific loss at 1.7 T, 50Hz, in Watts/kg iv) Grade of core as per BIS v) Insulation between core lamination vi) BIS certified (Yes/No)			
4.	Minimum Gross & Net Area of: i) Core ii) Limb iii) Yoke iv) Unwound limb (May be verified during manufacturing stage – at the discretion of buyer)	cm ²		
5.	Stacking Factor	%		
6.	Voltage per turn	V		
7.	Apparent Core Density for Weight Calculation			
8.	Minimum Net Weight of Silicon Steel Lamination CRGO (may be verified during manufacturing stage by calculation)	kg		
9.	Maximum Flux density at 90%, 100% and 110% voltage and frequency (may be verified during manufacturing stage by calculation)	T		
10.	W/kg at working flux density			
11.	Building Factor Considered			
12.	Calculated No Load Loss at rated voltage and Frequency (Net Weight x W/kg x Building factor)	kW		
13.	Magnetizing inrush current	Amp		
14.	No load current at normal ratio and frequency for : 85% of rated voltage 100% of rated voltage 105% of rated voltage	Amp		
15.	Core Isolation test	kV		
16.	Core bolt in limb / yoke	Yes/No		

17.	Core bolt insulation withstand voltage for one minute	kV		
18.	Maximum temperature rise of any part of core or its support structure in contact with oil	°C		

C. CONDUCTING SYSTEM

Sl. No.	Description	Unit	Offered by manufacturer			
			HV	IV	LV	Regulating
1.	Type of Winding Helical/Disc/Layer/inter wound					
2.	Type of Conductor PICC/CTC/CTCE/CTCEN/BP CC					
3.	Minimum Yield Strength of Conductor for 0.2% elongation	N/mm ²				
4.	Maximum Current density at CMR and conductor area at any tap: i) HV ii) IV iii) LV	A/mm ² & sq. mm				
5.	Maximum current density under short circuit: i) HV ii) IV iii) LV	A/mm ²				
6.	Bare Weight of copper without paper insulation and lead (Minimum)	Kg				
7.	Per Phase Maximum resistance of winding at rated tap at 75 °C	ohm				
8.	Number of Turns/Phase					
9.	Insulating material used for HV/IV/LV winding					
10.	Insulating material used between : i) HV and IV winding ii) IV and LV winding iii) LV winding and core iv) Regulating winding and ad-					

	jacent winding/core					
11.	Details of special arrangement provided to					
12.	Dielectric Shielding used: i) Interleaved winding ii) Wound in Shield iii) Others					
13.	Magnetic Shielding used: i) Yoke Shunt on core clamp ii) Magnetic shunt on tank iii) Electromagnetic (Copper/Aluminum) shield on tank iv) Others					
14.	Noise level when energized at normal voltage and frequency without load	dB				

D.COOLING SYSTEM

Sl. No.	Description	Unit	Specified by Buyer	Offered by manufacturer
1.	Type of Cooling [ONAN (or) ONAN/ONAF (or) ONAN / ONAF / OFAF (or) ONAN / ONAF/ ODAF (or) ONAN / ONAF1 / ONAF2 etc.]			
2.	Percentage Rating Corresponding to Cooling Stages (HV/IV/LV)			
3.	No. of Cooler banks (2x50% / 2x100% / 1x100% etc.)			
4.	Temperature gradient between windings and oil			
5.	Time in minutes for which the transformer can run at full load without exceeding maximum permissible	min		

	temperature at temperature when supply to fans and / or pumps is cut off			
6.	<p>Guaranteed Maximum Temperature rise at 1000 mts. altitude and at actual altitude at site at ambient temperature at cooling specified at sl. No. 1:</p> <p>i) Top Oil by thermometer ii) Average Winding by resistance iii) Winding hot spot</p>	°C		
7.	<p>Type of Cooler:</p> <p>i) Radiator Bank ii) Oil to Air Heat Exchanger (Unit Cooler) iii) Oil to Water Cooler (Single Tube) iv) Oil to Water Cooler (Double Tube) v) Tank Mounted vi) Header Mounted vii) Separately Mounted viii) Degree of Protection of terminal box</p>			
8.	<p>Cooling Fans:</p> <p>i) Type ii) Size iii) Rating (kW) iv) Supply voltage v) Quantity (Running + Standby) per cooler bank vi) Whether fans are suitable for continuous operation at 85% of their rated voltage calculated time constant:</p> <ul style="list-style-type: none"> • natural cooling • forced air cooling <p>vii) Degree of Protection of terminal box</p>			

9.	Oil Pumps: i) Type ii) Size iii) Rating (lpm and kW) iv) Supply voltage v) Quantity (Running + Standby) per cooler bank vi) Efficiency of motor at full load vii) Temperature rise of motor at full load viii) BHP of driven equipment			
10.	Coolers (Oil to Air): i) Quantity (Running + Standby) ii) Type and Rating			
11.	Coolers (Oil to Water): i) Quantity (Running + Standby) ii) Type and Rating iii) Oil flow rate (lpm) iv) Water flow rate (lpm) v) Nominal Cooling rate (kW) vi) Material of tube			
12.	Radiators: i) Width of elements (mm) ii) Thickness (mm) iii) Length (mm) iv) Numbers			
13.	Cooler loss at rated output, normal ratio, rated voltage, rated frequency at ambient temperature of 50°C	kW		

E. DIELECTRIC SYSTEM

Sl. No.	Description	Unit	Offered by manufacturer
1.	Geometric Arrangement of winding with respect to core e.g: Core-LV-IV-HV-Reg Coarse-Reg Fine		

2.	Regulating Winding: i) Body Tap ii) Separate						
3.	HV Line Exit point in winding: i) Top ii) Center						
4.	Varistors used across Windings If yes, Details	Yes/No					
5.	Insulation Levels of windings		HV	IV	LV	HV-N	IV-N
	i) Lightning Impulse withstand voltage (1.2/50μs)	kV _p					
	ii) Chopped wave Lightning Impulse withstand voltage	kV _p					
	iii) Switching Impulse with- stand voltage (250/2500μs)	kV _p					
	iv) Power frequency withstand voltage	kV _{rms}					
	(one minute / 5 minutes)						
6.	Tan delta of windings at ambi- ent temperature	%					

F. ACCESSORIES

Sl. No.	Description	Unit	Offered by manufacturer	Specified by Buyer
1.	Tap Changers			
	i) Control a-Manual b- Automatic c-Remote d- Local			
	ii) Voltage Class and Current Rating of Tap Changers			
	iii) Make and Model			
	iv) Make and Type of Auto- matic Voltage Regulator (AVR)			
	v) Tie-in resistor require- ment (to limit the recovery volt-			

	age to a safe value) and its value					
	vi) OLTC control and monitoring to be carried out through Substation Automation System	Y/N				
	vii) Power Supply for control motor (No. of Phases/Voltage/Frequency)					
	viii) Rated Voltage for control circuit (No. of Phases/Voltage/Frequency)	V				
2.	Tank					
	i) Tank Cover: Conventional/Bell/Bottom Plate					
	ii) Material of plate for tank					
	iii) Plate thickness : side, bottom, cover	mm				
	iv) Rail Gauge	mm				
	v) Minimum Clearance height from rail for lifting Active Part	mm				
	vi) Wheels : Numbers/Plane/Flanged/Uni-Directional/Bi-Directional/Locking Details					
	vii) Vacuum withstand Capability (a) Tank (b) Radiators/Conservator/Accessories	mm of Hg				
	viii) High Pressure withstand Capability (a) Tank (b) Radiators/Conservator/Accessories	mm of Hg				
	ix) Radiator fins/ conservator plate thickness	mm				
	x) Tank Hot spot temperature	°C				
3.	Bushings:		HV	IV	LV	HV-N LV-N

	i) Termination Type a-Outdoor b-Cable Box (oil/Air/SF ₆) c-Plug in Type				
	ii) Type of Bushing: OIP/RIP/RIS/oil communicating				
	iii) Bushing housing - Porcelain / polymer				
	iv) Rated Voltage Class	kV			
	v) Rated Current	A			
	vi) Lightning Impulse withstand voltage (1.2/50μs)	kV _p			
	vii) Switching Impulse withstand voltage (250/2500μs)	kV _p			
	viii) One minute Power frequency withstand voltage (dry & wet)	kV _{rms}			
	ix) Minimum Creepage Distance	mm			
	x) Quantity of oil in bushing and specification of oil used				
	xi) Make and Model				
	xii) Tan delta of bushings	%			
	xiii) Max Partial discharge level at Um	pC			
	xiv) Terminal Pad details				
	xv) Weight of assembled bushings	kg			
	xvi) Whether terminal connector for all bushings included in the scope of supply				
4.	Minimum clearances between bushings (for HV, IV and LV) (a) Phase to phase (b) Phase to ground				
5.	Indicator / Relay				
	i) Winding temperature thermometer/ indicator: Range Accuracy				
	ii) Oil temperature thermometer/ indicator: Range Accuracy				
	iii) Temperature sensors by fiber optic (if provided)				

	iv) Oil actuated/gas operated relay			
	v) Oil level Indicators: Main Conservator OLTC Conservator			
	vi) Oil Sight Window: Main Tank Main Conservator OLTC Conservator			
6.	Conservator: i) Total volume ii) Volume between highest and lowest visible oil levels			
7.	Conservator Bag (air cell) i) Material of air cell ii) Continuous temperature withstand capacity of air cell			
8.	Air cell rupture relay provided	Yes / No		
9.	Pressure Relief Device: i) Number of PRDs provided ii) Location on the tank iii) Operating pressure of relief device			
10.	Sudden Pressure Relay / Rapid Pressure rise relay provided; if yes, i) Location on the tank ii) Operating pressure	Y/N		
11.	Dehydrating Breathers(Type & No. of breathers) (a) For main Conservator tank (b) For OLTC conservator			
12.	Flow sensitive Conservator Isolation Valve Provided	Y/N		
13.	Tap Changer protective device			
14.	Type and material of gaskets used at gasketed joints			

15.	Bushing CTs: (HV side and IV/LV side) i) Voltage class ii) No. of cores iii) Ratio iv) Accuracy class v) Burden vi) Accuracy limit factor vii) Maximum resistance of secondary winding viii) Knee point voltage ix) Current rating of secondaries	kV VA Ω V A		
16.	Neutral CTs: i) Voltage class ii) No. of cores iii) Ratio iv) Accuracy class v) Burden vi) Accuracy limit factor vii) Maximum resistance of secondary winding viii) Knee point voltage ix) Current rating of secondaries	kV VA Ω V A		
17.	Transformer Oil i) IS 335 / IEC60296 / as per specification ii) Inhibited/ un-inhibited iii) Mineral / Natural Ester / Synthetic Ester iv) Spare oil as percentage of first filling v) Manufacturer vi) Quantity of oil (before filling and before commissioning) vii) Moisture content (mg/L or ppm) viii) Tan delta (Dielectric Dissipation Factor) at 90°C ix) Resistivity (Ω -cm)			

	x) Breakdown Voltage (before and after treatment) (kV) xi) Interfacial tension at 20 °C (N/m) xii) Pour point (°C) xii) Flash point(°C) xiii) Acidity (mg KOH/gm) xiv) Inhibitors (for inhibited oil) (%) xv) Oxidation Stability			
18.	Press Board: i) Make ii) type			
19.	Conductor Insulating Paper i) Kraft paper ii) Thermally upgraded Kraft paper iii) Nomex			
20.	Provision for fire protection system (as per spec), if yes, provide details	Y/N		
21.	Insulation of core bolts, washers, end plates etc.			
22.	Weights and Dimensions: i) Weights: a. Core b. Windings c. Tank d. Fittings e. Oil f. Total weights of complete transformers with oil and fittings ii) Dimensions; a. Overall Height above track b. Overall length			
	c. Overall breadth iii) Minimum bay width required for installation of the transformer iv) Weight of the heaviest package of the transformer arranged for transportation			

23.	Lifting Jacks i) Number of jacks included ii) Type and Make iii) Capacity iv) Pitch v) Lift vi) Height in close position			
24.	Rail Track gauges i) 2 Rails or 3 rails or 4 rails ii) Distance between adjacent rails on shorter axis iii) Distance between adjacent rails on longer axis			

GUARANTEED AND OTHER PARTICULARS FOR DISTRIBUTION TRANSFORMERS

(To be furnished by the Manufacturer)

Sl. No. Description

1. Make
2. Name of Manufacturer
3. Place of Manufacture
4. Voltage Ratio
5. Rating in kVA
6. Short circuit level (In kA):
7. Core Material used and Grade:
 - a) Flux density
 - b) Over fluxing without saturation
(Curve to be furnished by the Manufacturer in support of his claim)
8. Maximum temperature rise of:
 - a) Windings by resistance method
 - b) Oil by thermometer
9. Magnetizing (no-load) current at:
 - a) 90% Voltage
 - b) 100% voltage
 - c) 110% Voltage
10. Energy Efficiency level as per IS-1180:
11. Core loss in watts:
 - a) Normal voltage
 - b) Maximum voltage
12. Resistance of windings at 20 C
(with 5% tolerance):
 - a. HV Winding (ohms)
 - b. LV Winding (ohms)
13. Full load losses (watts) at 75 deg C
14. Total Losses at 100% load at 75 deg C
15. Total Losses at 50% load at 75 deg C
16. Current density used for : (Ampere/sq mm)
 - a) HV Winding
 - b) LV Winding
17. Clearances : (mm)
 - a) Core and LV
 - b) LV and HV
 - c) HV phase to phase
 - d) End insulation clearance to earth
 - e) Any point of winding to tank
18. Efficiency at 75 deg C:

a) Unity P.F. and

b) 0.8 P.F.

1) 125% load

2) 100% load

3) 75% load

4) 50% load

5) 25% load

19. Regulation at:

a) Unity P.F.

b) 0.8 P.F. at 75 deg C

20. % Impedance at 75 deg C

21. Power frequency withstand voltage test:

i) HV winding (kV) for 1 minute

ii) LV winding (kV) for 1 minute

22. Over potential Test (Double Voltage and Double frequency for 1 minute)

23. Impulse test

24. Mass of : (kg)

a) Core lamination (minimum)

b) Winding (minimum)

c) Tank and fittings

d) Oil

e) Oil quantity (minimum) (litre)

f) Total weight

25. Oil Data:

1. Quantity for first filling (minimum) (litre)

2. Grade of oil used

3. Maker's Name

4. BDV at the time of filling (kV)

26. Transformer:

1) Overall length x breadth x height (mm x mm x mm)

2) Tank length x breadth x height

3) Thickness of plates for

a) Side plate (min)

b) Top and bottom plate (min)

4) Conservator Dimensions

25. Radiation:

1. Heat dissipation by tank walls excluding top and bottom

2. Heat dissipation by cooling tube

3. Diameter and thickness of cooling tube

4. Whether calculation sheet for selecting cooling Area to ensure that the transformer is capable of giving continuous rated output without Exceeding temperature rise is enclosed.
26. Inter layer insulation provided in design for:
 - 1) Top and bottom layer
 2. In between all layer
 - 3) Details of end insulation
 - 4) Whether wedges are provided at 50% turns of the HV coil
27. Insulation materials provided
 - a) For Conductors
 - 1) HV
 - 2) LV
 - b) For Core
28. Material and size of the wire used
 1. HV Dia (mm) (SWF)
 2. LV a) strip size
 - b) No. of Conductors in parallel
 - c) Total area of cross section (sq mm)
29. Whether the name plate gives all particulars as required in Tender
30. Particulars of bushings HV/LV
 - 1) Maker's name
 - 2) Type IS-3347/IS-2099/S7421
 - 3) Rating as per IS
 - 4) Dry power frequency voltage withstands test (As applicable)
 - 5) Wet power frequency voltage withstand test (As applicable)

GURANTEED TECHNICAL PARTICULARS FOR GEN SET

1.0 General

- 1.1 Contract's Name & Address
- 1.2 Manufacturer's, type and address

- a. Engine.
- b. Alternator
- c. Exciter
- d. Battery

2.0 Engine

- 2.1 Rating
- 2.2 Revolutions per min.
- 2.3 Number and arrangement of cylinder.
- 2.4 No. of strokes.
- 2.5 Method of starting.
- 2.6 Time required for starting
- 2.7 Auxiliary Power consumption
- 2.8 Type of Governor
- 2.9 Sensitivity of Governor
- 2.10 Guaranteed limits of Governing
 - a. Permanent variation
 - b. Full Load thrown off
 - c. Full load put on.
- 2.11 Total speed variation
- 2.12 Specification of fuel oil.
- 2.13 Specification of Lube oil
- 2.14 Guaranteed fuel consumption
 - a) At full load
 - b) At 3/4 load
 - c) At 1/2 load

d) At 1/4 load

- 2.15 Lub.oil consumption
- 2.16 Mechanical efficiency
- 2.17 Thermal efficiency
- 2.18 Method of aspiration
- 2.19 Method of cooling of engine and lub. oil.
- 2.20 Amount of water required for cooling system.
- 2.21 Total weight.
- 2.22 Space requirement including clearances
- 2.23 Maker's name, type and technical literature for the following:
 - a. Air filter & silencer.
 - b. Thermometer.
 - c. Pressure Gauges.
 - d. Level indicator
 - e. Tachometer.
 - f. Fuel oil pump
- 2.24 Mechanical auxiliaries loads connected on Radiator fans Main shaft with wiring.
- 2.25 Rated engine power and the ambient conditions at which rated power is defined.
- 2.26 Direction of rotation.

3.0 Storage Tank. (Outside)

- a. Type and shade.
- b. Capacity
- c. Number Specifies.
- d. Material of construction
- e. Overall dimensions
- f. Plate thickness
- g. Installation paint.

4.0 Alternator

- 4.1 Rated K.W capacity.
- 4.2 Rated KVA capacity.
- 4.3 Rated Terminal Voltage.

- 4.4 Rated Power Factor
- 4.5 Rated Stator Current
- 4.6 Rated Speed.
- 4.7 Rated Frequency
- 4.8 No. of phases/ Terminals brought outside
- 4.9 Excitation current and voltage at rated 3 Amp DC power output and power factor
- 4.10 Efficiencies at 0.8 power factor at
 - a. 100% load.
 - b. 75% load.
 - c. 50% load.
 - d. 25% load.
- 4.11 Inherent regulation (%)
- 4.12 Impedance
 - a) X_a dir axis synchronous
 - b) X'_d dir axis transient
 - c) X^n dir axis sub transient
 - d) X_q quad axis reactance
 - e) X^n_q quad axis sub transient
- 4.13 Type of exciter used; capacity & rating of exciter
- 4.14 Class of Insulation.
- 4.15 Permissible Temp. Rise of.
 - a. Armature winding.
 - b. Field winding.
 - c. Bearing
- 4.16 Short circuit ratio
- 4.17 Rotor air gap
- 4.18 Overload capacity
- 4.19 Insulation level test voltage
- 4.20 Total weight & dimensions.
- 4.21 Applicable standard.
- 4.22 Automotive voltage regulator type, technical specifications and characteristics curves.

4.23 Electrical auxiliaries load connected to generator terminals with rating.

5.0 Engine Alternator Set

5.1 Starting time.

5.2 Interval between starting impulse

5.3 No. of starting impulse.

5.4 Time for picking up the load.

5.5 Voltage variation

5.6 Frequency variation

5.7 Duration of continuous full load operation.

5.8 Noise level.

6.0 Battery.

6.1 Type

6.2 Name of manufacturer and address

6.3 No. of Cells

6.4 Capacity in AH

6.5 Capacity current of

a) Full charged battery.

b) Fully discharged battery.

6.6 Average life in years.

6.7 Applicable standard.

6.8 Weight of the battery.

SECTION-IV

PRICE SCHEDULES

Tender No. T26P630001

Price Schedule-1

Design, Engineering, Supply, Erection, Testing & Commissioning of 220/66kV GIS Substation at Bharthal, including complete civil works & automation, along with LILO of 220kV D/C Bamnauli-DIAL Overhead Transmission Line at Bharthal, on a Turnkey Basis.

(Schedule of rates and prices)

Bidder's Name and Address :

Plant and Equipment (including Mandatory Spares Parts) to be supplied.

S.No.	Item Description	HSN Code	Whether HSN is confirmed. If not, indicate applicable HSN code	Unit	Qty	Currency (INR)	Ex-Works Price		Mode of Transaction Direct/ Bought Out	Taxes & Duties		
							Unit Price	Total Price		GST		
										Rate	Whether rate of GST is confirmed. If not, indicate applicable rate of GST	Amount
1	2	3	4	5	6	7	8	9=6x8	10	11	12	13
I	Main Material & equipments											
A	245kV GIS Equipment											
1	245kV, SF6, GIS 160 MVA Transformer Bay Module: 245kV, 1600 A, SF6 gas insulated 160 MVA transformer bay module each comprising of SF6 gas insulated circuit breaker, current transformer, bus-bar disconnectors with common grounding switch, line disconnector, safety grounding switches, local control cubicle, SF6 gas monitoring system for complete bay, gas insulated terminal connection for connecting transformer with GIS through SF6/air bushings/ SF6 duct etc. to complete transformer bay module.	85359030		Set	4					18%		
2	245kV, SF6, GIS 50 MVAR Reactor Bay Module: 245kV, 1600 A, SF6 gas insulated Reactor bay module each comprising of SF6 gas insulated circuit breaker, current transformer, bus-bar disconnectors with common grounding switch, line disconnector, safety grounding switches, local control cubicle, SF6 gas monitoring system for complete bay, gas insulated terminal connection for connecting Reactor with GIS through XLPE cable to complete reactor bay module.	85359030		Set	1					18%		
3	245kV, SF6, GIS Feeder Bay Module: 245kV, 1600A, SF6 gas insulated feeder bay module each comprising of SF6 gas insulated circuit breaker, current transformer, two bus-bar disconnectors with common grounding switch, line disconnector, high speed fault making grounding switch, PT with disconnector, surge arrester, local control cubicle, SF6 gas monitoring system for complete bay, gas insulated terminal connection for connecting feeder with GIS through SF6/Air bushings or indoor cable terminal, SF6 duct etc., to complete feeder bay module.	85359030		Set	6					18%		
4	245kV, SF6, GIS Busbar Module: 245kV, 3 single phase (isolated) units, SF6 gas insulated, metal enclosed 2500A bus bars each enclosed in bus enclosures running along the length of the switchgear to interconnect each of circuit breaker bay module. Each bus bar set shall be complete with voltage transformer, disconnector and safety grounding switch, SF6 gas monitoring system for complete bay etc.	85359030		Set	2					18%		
5	245kV, SF6, GIS Bus Coupler Bay Module: 245kV, 2500A, SF6 gas insulated bus coupler bay module comprising of SF6 gas insulated circuit breaker, current transformer, disconnectors with safety grounding switches, local control cubicle, SF6 gas monitoring system etc. for complete bay.	85359030		Set	2					18%		
6	245kV, SF6, Bus Sectionaliser Bay Module: 245kV, 2500A, SF6 gas insulated bus sectionaliser bay module comprising of SF6 gas insulated circuit breaker, current Transformer, two disconnectors with safety grounding switches, SF6 Gas monitoring system for complete bay etc.	85359030		Set	2					18%		
7	245kV, 1600A, SF6/Air Bushing for Connecting GIS to AIS alongwith support structure	85359030		No.	21					18%		
8	245kV, 1600A, 1 Phase SF6 GIS Bus duct alongwith support structure	85359030		Lot	1					18%		

Tender No. T26P630001

Price Schedule-1

Design, Engineering, Supply, Erection, Testing & Commissioning of 220/66kV GIS Substation at Bharthal, including complete civil works & automation, along with LILO of 220kV D/C Bamnauli-DIAL Overhead Transmission Line at Bharthal, on a Turnkey Basis.

(Schedule of rates and prices)

Bidder's Name and Address :

Plant and Equipment (including Mandatory Spares Parts) to be supplied.

S.No.	Item Description	HSN Code	Whether HSN is confirmed. If not, indicate applicable HSN code	Unit	Qty	Currency (INR)	Ex-Works Price		Mode of Transaction Direct/ Bought Out	Taxes & Duties		
							Unit Price	Total Price		GST		
										Rate	Whether rate of GST is confirmed. If not, indicate applicable rate of GST	Amount
1	2	3	4	5	6	7	8	9=6x8	10	11	12	13
	Sub-Total (A)											
B	66kV GIS Equipment											
1	72.5kV, SF6, GIS Feeder Bay Module: 72.5kV, 2000A, SF6 gas insulated feeder bay module each comprising of SF6 gas insulated circuit breaker, current transformer, two bus-bar disconnectors with one earthing switch, line disconnector with one normal & one high speed fault make grounding switch, surge arrestors, SF6 gas monitoring system for complete bay, PT with disconnector switch, gas insulated terminal connection for connecting 66kV feeder bays will be through XLPE cable with suitable run and size cable termination enclosure and accessories with GIS, local control cubicle etc., to complete feeder bay module.	85359030		Set	18					18%		
2	72.5kV, SF6, GIS Incomer/Transformer Bay Module: 72.5kV, 2500A, SF6 gas insulated transformer bay module each comprising of SF6 gas insulated circuit breaker, current transformer, Two nos. of bus-bar disconnectors with common grounding switch, line disconnector with one normal & one high speed fault make grounding switch, surge arrestors, SF6 gas monitoring system for complete bay, gas insulated terminal connection for connecting transformer (XLPE cable/SF6) through XLPE cable suitable run and size with cable end box and accessories with GIS, local control cubicle etc., to complete transformer bay module.	85359030		Set	4					18%		
3	72.5kV, SF6, GIS Bus Coupler Bay Module: 72.5kV, 2500A, SF6 gas insulated bus coupler bay module comprising of SF6 gas insulated circuit breaker, current transformer, two nos. of disconnectors with earthing switches, SF6 gas monitoring system for complete bay, local control cubicle etc.	85359030		Set	2					18%		
4	Bus Sectionaliser Bay: 72.5kV, 2500A, SF6 gas insulated bus Sectionaliser bay module comprising of SF6 gas insulated circuit breaker, current transformer, two nos. of disconnectors with earthing switches, SF6 gas monitoring system for complete bay, local control cubicle etc.	85359030		Set	2					18%		
5	72.5kV, SF6, GIS Busbar Bay Module: 72.5kV, 3000A, 3-phase or single-phase encapsulated unit, SF6 gas insulated, metal enclosed bus bars each enclosed in bus enclosures running along the length of the switchgear to interconnect each of circuit breaker bay module. Each bus bar set shall be complete with voltage transformer, disconnectors with safety grounding switch, local control cubicle, SF6 gas monitoring system etc.	85359030		Set	2					18%		
	Sub-Total (B)											
C	Transformer and Associated Equipment											
1	220/66/11kV, 160 MVA Power Transformer with bushings and all accessories and first filling of oil with 10% spare quantity oil.	85042320		No.	3					18%		

Design, Engineering, Supply, Erection, Testing & Commissioning of 220/66kV GIS Substation at Bharthal, including complete civil works & automation, along with LILO of 220kV D/C Bamnauli-DIAL Overhead Transmission Line at Bharthal, on a Turnkey Basis.

(Schedule of rates and prices)

Bidder's Name and Address :

Plant and Equipment (including Mandatory Spares Parts) to be supplied.

S.No.	Item Description	HSN Code	Whether HSN is confirmed. If not, indicate applicable HSN code	Unit	Qty	Currency (INR)	Ex-Works Price		Mode of Transaction Direct/ Bought Out	Taxes & Duties		
							Unit Price	Total Price		GST		
										Rate	Whether rate of GST is confirmed. If not, indicate applicable rate of GST	Amount
1	2	3	4	5	6	7	8	9=6x8	10	11	12	13
2	NIPES For 160 MVA Power Transformers	85311020		No.	3					18%		
3	Oil Storage Tank as per specification	73090010		No.	1					18%		
4	17.5kV Neutral CT of ratio 800-400/1A for 220kV Neutral of Transformer.	85042320		No.	3					18%		
5	17.5kV Neutral CT of ratio 2000-1000/1A for 66kV Neutral of Transformer.	85042320		No.	3					18%		
6	1000 KVA, 11/0.433kV, 170kVp BIL at 11kV side, three phase, transformer including bushing accessories and first filling of oil	85042100		No.	2					18%		
	Sub-Total (C)											
D	Material for Termination of Transformers/Feeders											
1	216kV, 10kA, Single Phase LA with surge/discharge counter, milli ampere meter and terminal connector etc	85354010		No.	21					18%		
2	60kV, 10kA Single Phase LAs with discharge counter, milli ampere meter and terminal connectors etc	85354010		No.	63					18%		
3	66kV Bus Post Insulator with Corona Ring etc.	85354010		No.	126					18%		
4	Steel for support structure for double support gantry, 220/66kV O/D surge arrester, 66kV BPI, 66kV H pole, tertiary support structure, etc.	73089090		Lot	1					18%		
5	ACSR Zebra conductor along with fittings and 4" IPS Al. tube	76042910		Lot	1					18%		
6	66kV XLPE Power Cable with termination kit (Double Run, single core, 1200 Sq.mm, Copper) for connecting 3 no. 160 MVA Transformer to 66kV GIS	85446090		Lot	1					18%		
7	66kV XLPE Power Cable with termination kit (Single run, single core, 1200 Sq.mm, Copper) for connecting 66kV GIS Outgoing feeder bays to H-pole arrangement.	85446090		Lot	1					18%		
8	Petty items required for completion of job	85369090		LS	1					18%		
	Sub-Total (D)											
E	Sub-Station Automation System and Relays & Protection Panels											
1	220kV Control & Relay and Panels with complete automation with local SCADA system											
(a)	220kV Feeder Bays	85372000		No.	6					18%		
(b)	220kV Transformer Bays	85372000		No.	4					18%		
(c)	220kV Reactor Bays	85372000		No.	1					18%		
(d)	220kV Bus Coupler Bays	85372000		No.	2					18%		
(e)	220kV Bus Section Bays	85372000		No.	2					18%		
(f)	220kV Bus Bar Protection	85372000		No.	2					18%		
(g)	Time Synchronization equipment and Other common equipments pertaining to Relay & Protection System	85372000		Lot	1					18%		

Tender No. T26P630001

Price Schedule-1

Design, Engineering, Supply, Erection, Testing & Commissioning of 220/66kV GIS Substation at Bharthal, including complete civil works & automation, along with LILO of 220kV D/C Bamnauli-DIAL Overhead Transmission Line at Bharthal, on a Turnkey Basis.

(Schedule of rates and prices)

Bidder's Name and Address :

Plant and Equipment (including Mandatory Spares Parts) to be supplied.

S.No.	Item Description	HSN Code	Whether HSN is confirmed. If not, indicate applicable HSN code	Unit	Qty	Currency (INR)	Ex-Works Price		Mode of Transaction Direct/ Bought Out	Taxes & Duties		
							Unit Price	Total Price		GST		
										Rate	Whether rate of GST is confirmed. If not, indicate applicable rate of GST	Amount
1	2	3	4	5	6	7	8	9=6x8	10	11	12	13
2	66kV Control & Relay and Panels with complete automation with local SCADA system											
(a)	66kV Feeder Bays	85372000		No.	18					18%		
(b)	66kV Transformer Incomer Bays	85372000		No.	4					18%		
(c)	66kV Bus Coupler Bays	85372000		No.	2					18%		
(d)	66kV Bus Section Bays	85372000		No.	2					18%		
(d)	Other common equipments pertaining to Relay & Protection System	85372000		Lot	1					18%		
3	Automation & SCADA											
(a)	Substation automation equipment, Optic Fibre and other interface/ converter equipment	85176290		Set	1					18%		
(b)	SCADA Equipments	85176290		Set	1					18%		
(c)	FOTE Equipments along with teleprotection card (for remote end substation also)	85176290		Set	4					18%		
(d)	Testing & Maintenance equipment											
(i)	Optical Time Domain Reflected Meter	85176290		No.	1					18%		
(ii)	Fibre Splicing Machine	85176290		No.	1					18%		
(iii)	Test Plug for testing & Isolation of Relay for testing	85176290		No.	1					18%		
(iv)	Manufacture's Specific Maintenance tool	85176290		No.	1					18%		
(e)	Remote HMI alongwith monitor for DTL control room	85176290		Set	1					18%		
(f)	Inverter of suitable capacity for station HMI and peripheral devices i. e. printer etc.	85176290		Set	1					18%		
4	Air Conditioning system (VRV/VRF) 220kV Relay & Protection Panels Room	84151010		Lot	1					18%		
5	Air Conditioning system (VRV/VRF) 66kV Relay & Protection Panels Room	84151010		Lot	1					18%		
6	Air Conditioning system (VRV/VRF) for Control Room Building	84151010		Lot	1					18%		
7	Air Conditioning system (VRV/VRF) for Battery Room	84151010		Lot	1					18%		
8	Air Conditioning system (VRV/VRF) for office space, Lab, conference hall etc.	84151010		Lot	1					18%		
9	Ventilation system for 220kV GIS Hall	84151010		Lot	1					18%		
10	Ventilation system for 66kV GIS Hall	84151010		Lot	1					18%		
	Sub-Total (E)											
F	LT Switchgear & other items											
1	LT Switchgear											
(a)	415V Main Switchboard	85371000		Set	1					18%		
(b)	415V ACDB	85371000		Set	1					18%		
(c)	415V MLDB	85371000		Set	1					18%		
(d)	415V Emergency LDB	85371000		Set	1					18%		
(e)	415V Air-conditioning & Ventilation DB	85371000		Set	1					18%		
(f)	220V DCDB	85371000		Set	2					18%		
2	Batteries and Battery Chargers											
(a)	220V, 600 AH Battery	85072000		Set	2					18%		

Design, Engineering, Supply, Erection, Testing & Commissioning of 220/66kV GIS Substation at Bharthal, including complete civil works & automation, along with LILO of 220kV D/C Bamnauli-DIAL Overhead Transmission Line at Bharthal, on a Turnkey Basis.

(Schedule of rates and prices)

Bidder's Name and Address :

Plant and Equipment (including Mandatory Spares Parts) to be supplied.

S.No.	Item Description	HSN Code	Whether HSN is confirmed. If not, indicate applicable HSN code	Unit	Qty	Currency (INR)	Ex-Works Price		Mode of Transaction Direct/ Bought Out	Taxes & Duties		
							Unit Price	Total Price		GST		
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1	2	3	4	5	6	7	8	9=6x8	10	11	12	13
(b)	220V, 600 AH, Battery Charger System	85044030		Set	2					18%		
3	Generator Set along with control panel (250kVA, 440V)	85021310		Set	1					18%		
4	Fire Protection for 220kV GIS building, Control Room Building, etc. (Portable type fire extinguishers system)	85318000		Lot	1					18%		
5	Fire Protection for 66kV GIS buidling, Store, etc. (Portable type fire extinguishers system)	85318000		Lot	1					18%		
6	Heat/Smoke Fire Detection system	85318000		Lot	1					18%		
7	Illumination system for Control Room, 220kV GIS Building, control room building, etc. Illumination with LED base/Metal Halide Lamp	85395000		LS	1					18%		
8	Illumination system for Control Room, 66kV GIS Building, control room building, store, etc. Illumination with LED base/Metal Halide Lamp	85395000		LS	1					18%		
9	Switchyard/Street light system (High Mast Lighting System)	85393220		LS	1					18%		
10	1.1kV Grade PVC insulated Al. conductor armoured power cables and copper conductor armoured control cables alongwith lugs, Glands and straight joints											
(a)	Power cables (XLPE)	85446020		LS	1					18%		
(b)	Power cables (PVC)	85446020		LS	1					18%		
(c)	Control Cable (PVC)	85446020		LS	1					18%		
11	40 mm MS rod for Main Earthmat 220kV GIS system	73089090		LS	1					18%		
12	40 mm MS rod for Main Earthmat 66kV GIS system	73089090		LS	1					18%		
13	Lightning Mast/ GS Shield Wire	73121090		LS	1					18%		
14	EOT Crane for 220kV GIS room with complete accessories	84261100		No.	1					18%		
15	EOT Crane for 66kV GIS room with complete accessories	84261100		No.	1					18%		
16	EOT Crane for store room	84261100		No.	1					18%		
17	Tertiary Loading equipments for one 160 MVA Transformer											
i.	33kV, O/D type isolator with earth switch MOM type	85353090		No.	1					18%		
ii.	33kV, O/D type CT, ratio 400-200-100/1-1-1A	85043100		No.	3					18%		
iii.	33kV, O/D type 630A, SF6 Circuit Breaker	85352112		No.	1					18%		
iv.	Control & Relay Protection Scheme	85371000		No.	1					18%		
v.	11kV, O/D type Potential Transformer of ratio (11kV/√3)/(110V/√3)-(110V/√3)	85043100		No.	3					18%		
vi.	11kV Surge Arrester	85354010		No.	3					18%		
vii.	33kV XLPE Power Cable with termination kit (2 Run x 3C x 400 Sq.mm, Copper)	85446090		Lot	1					18%		
18	11kV equipments for loading 1000 KVA Auxilary Transformer											
i.	11kV switchgear, 3 Panel Board (1 incomer, 1 outgoing and 1 bus-coupler) alongwith associated control & relay system, 11kV cables etc.	85372000		LS	1					18%		
	Sub-Total (F)											
G	CCTV System with remote Operations											

Design, Engineering, Supply, Erection, Testing & Commissioning of 220/66kV GIS Substation at Bharthal, including complete civil works & automation, along with LILO of 220kV D/C Bamnauli-DIAL Overhead Transmission Line at Bharthal, on a Turnkey Basis.

(Schedule of rates and prices)

Bidder's Name and Address :

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							Unit Price	Total Price		GST		
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1	2	3	4	5	6	7	8	9=6x8	10	11	12	13
1	Supply of compact type day and night network PTZ camera with outdoor housing - as per specifications	85258010		Nos.	8					18%		
2	Supply of compact type day and night network fixed camera with outdoor housing - as per specifications	85258010		Nos.	8					18%		
3	Network Video Management Software for 32 cameras as per specifications	85299090		No.	1					18%		
4	NVMS client License Pack for 2 users as per specifications	85299090		No.	1					18%		
5	Video management workstation Server with Storage hardware with suitable capacity for continuous recording for 30 Days Minimum as per specifications	85299090		No.	1					18%		
6	Video analytic software for fixed type cameras (2 camera per site)	85299090		Nos.	3					18%		
7	The contractor is responsible for supplying and laying of armoured Fibre Optics cables through HDPE Conduit by digging and laying through cable trench as per the site requirements including the supply of converters and other accessories (suitable for outdoor application) required to complete the connectivity in all respect as per the direction of Engineer-in-Charge.	85299090		LS	1					18%		
8	Auxiliary structure with all required poles/mast & related mount with all accessories. Pole/Mast (G.I.) : Length - 9 mtrs and should be ISI make Mounting : to be grounded in concrete structure should be self-supporting in the ground.	85299090		Lot	1					18%		
9	32" LCD monitor Diagonal Industrial Grade Panel for 24x7 applications as per specification.	85299090		Nos.	2					18%		
10	24" Client PC TFT LCD monitor as per specification	85312000		Nos.	2					18%		
11	16 port Network Switch with fibre optic connectivity along with all related accessories - as per specifications.	85299090		No.	1					18%		
12	Heavy duty with weather proof Power supply units for outdoor cameras	85229000		Nos.	16					18%		
13	2 KVA On line UPS system for Power distribution with 60 Minutes power back up with all related accessories at all locations - as per specifications	85229000		No.	1					18%		
14	Supply & laying of 3Core X 1.5 sq mm armoured Power cable - as per specifications	85229000		LS	1					18%		
15	Supply and laying of Twisted pair shielded un-armored cable (CAT-6) - as per specification (from Terminal box to camera etc.)	85229000		LS	1					18%		
16	Supply and laying of 25 mm GI conduits with all necessary accessories - ISI mark	85229000		LS	1					18%		
17	Control console wooden table cabinet along with computer chair to accommodate Video Management Work station, Network switch, UPS of Reputed make	85229000		No.	1					18%		
	Sub-Total (G)											
H	LILO arrangement of 220kV D/C Bamnauli-Dial Overhead line.											
1	Design of D/C MONOPOLE											
(a)	Double Circuit Tension DPD Dead End type (60-90deg.) BXA Height 28 meter	73089090		No.	1					18%		
2	Supply of D/C MONOPOLE											
(a)	Double Circuit Tension DPD Dead End type (60-90deg.) BXA Height 28 meter	73089090		No.	1					18%		

Tender No. T26P630001

Price Schedule-1

Design, Engineering, Supply, Erection, Testing & Commissioning of 220/66kV GIS Substation at Bharthal, including complete civil works & automation, along with LILO of 220kV D/C Bamnauli-DIAL Overhead Transmission Line at Bharthal, on a Turnkey Basis.

(Schedule of rates and prices)

Bidder's Name and Address :

Plant and Equipment (including Mandatory Spares Parts) to be supplied.

S.No.	Item Description	HSN Code	Whether HSN is confirmed. If not, indicate applicable HSN code	Unit	Qty	Currency (INR)	Ex-Works Price		Mode of Transaction Direct/ Bought Out	Taxes & Duties		
							Unit Price	Total Price		GST		
										Rate	Whether rate of GST is confirmed. If not, indicate applicable rate of GST	Amount
1	2	3	4	5	6	7	8	9=6x8	10	11	12	13
3	Supply of high temperature low sag (HTLS) Conductor as per specification	76042920		KM	1					18%		
4	Supply of OPGW with accessories	76042920		KM	0.2					18%		
5	Single I suspension hard ware fittings along with clamps	73082011		Set	6					18%		
6	Single "I" Suspension Pilot Hardware fittings along with clamps	73082011		Set	12					18%		
7	Single Tension Hardware fittings suitable for HTLS conductor along with clamps	73082011		Set	30					18%		
8	Long Rod Polymer Insulator											
(a)	160 KN	85469090		No.	30					18%		
(b)	90 KN	85469090		No.	12					18%		
9	Vibration Dampers for HTLS Conductor	73082011		No.	12					18%		
10	Supply of Tower Accessories											
(a)	Pipe Type Earthing of Towers	73082011		Set	2					18%		
(b)	Number Plate (1 set = 2 no.)	73082011		Set	1					18%		
(c)	Phase Plate (Set of two, One set contains IR, IY, IB)	73082011		Set	1					18%		
(d)	Danger Plate (1 set = 2 no.)	73082011		Set	1					18%		
(e)	Circuit Plate (1 set = 2 nos. circuit I & II)	73082011		Set	1					18%		
(f)	Anticlimbing Device including cost of Barbed Wire, MS Angle etc.	73082011		No.	1					18%		
11	Petty items to complete the job	73082011		LS	1					18%		
	Sub-Total (H)											
	SUB-TOTAL - I: MAIN EQUIPMENTS [(A) to (H)]											
II	Testing/ Maintenance Equipments and Mandatory Spares											
	Testing & Maintenance Equipments for GIS											
1	SF6 Gas filling and evacuating plant	85437019		Set	1					18%		
2	SF6 Gas Analyser	85352119		Set	1					18%		
3	SF6 gas leak detector	90271000		Set	1					18%		
4	Gas masks	90200000		Nos.	10					12%		
5	Partial Discharge Monitoring System	85437019		Set	1					18%		
6	Contact resistance meter	85437019		Set	1					18%		
7	Digital Insulation test kit,10 kV	85437019		Set	1					18%		
8	Oil Breakdown Voltage test kit, 100 kV	85437019		Set	1					18%		
9	Clamp on meter suitable for measuring the secondary current of CT in mA and load current upto 300 A	85437019		Set	1					18%		
10	Transformer winding resistance meter	85437019		Set	1					18%		
11	Digital Earth resistance meter complete with all accessories	85437019		Set	1					18%		

Tender No. T26P630001

Price Schedule-1

Design, Engineering, Supply, Erection, Testing & Commissioning of 220/66kV GIS Substation at Bharthal, including complete civil works & automation, along with LILO of 220kV D/C Bamnauli-DIAL Overhead Transmission Line at Bharthal, on a Turnkey Basis.

(Schedule of rates and prices)

Bidder's Name and Address :

Plant and Equipment (including Mandatory Spares Parts) to be supplied.

S.No.	Item Description	HSN Code	Whether HSN is confirmed. If not, indicate applicable HSN code	Unit	Qty	Currency (INR)	Ex-Works Price		Mode of Transaction Direct/ Bought Out	Taxes & Duties		
							Unit Price	Total Price		GST		
										Rate	Whether rate of GST is confirmed. If not, indicate applicable rate of GST	Amount
1	2	3	4	5	6	7	8	9=6x8	10	11	12	13
12	Thermoscanning camera for substation	85437019		Set	1					18%		
	SUB-TOTAL - II : TESTING EQUIPMENTS											
III	MANDATORY SPARES											
1	Spares for 220kV GIS											
i	220kV GIS	85389000		LS	1					18%		
ii	245kV CB	85389000		LS	1					18%		
iii	245kV CT (single phase current transformers of each rating)	85043100		LS	1					18%		
iv	245kV VT (Single phase VT complete with all Gaskets and mounting hardware.)	85043100		LS	1					18%		
v	245kV Isolators & ES	85389000		LS	1					18%		
vi	220kV Surge Arrester	85354010		LS	1					18%		
2	Spares for 66kV GIS											
i	66kV GIS	85389000		LS	1					18%		
ii	66kV Circuit Breaker	85389000		LS	1					18%		
iii	66kV Isolator & ES	85389000		LS	1					18%		
iv	66kV CT	85043100		LS	1					18%		
v	66kV Voltage Transformer	85043100		LS	1					18%		
vi	66kV Surge Arrester	85354010		LS	1					18%		
3	Spare for DG Set	85021310		LS	1					18%		
4	Spare for Battery	85072000		LS	1					18%		
5	Spare for Battery Charger	85072000		LS	1					18%		
6	Spare for Relay & Protection Panels	85364900		LS	1					18%		
7	Spare for Sub station Automation	85389000		LS	1					18%		
8	Spare for Illumination System	85393220		LS	1					18%		
9	Spare for Fire Fighting system	85311020		LS	1					18%		
10	Spare for LT switchgear	85371000		LS	1					18%		
11	Spares for 220/66/11kV, 160 MVA Transformer											
a	HV bushing of Transformer with complete metal parts and gaskets	85049010		No.	3					18%		
b	MV bushing of Transformer with complete metal parts and gaskets	85049010		No.	3					18%		
c	LV bushing of Transformer with complete metal parts and gaskets	85049010		No.	3					18%		
d	Set of gaskets	85049010		Set	3					18%		
e	PRV	85049010		No.	3					18%		
f	SPR	85049010		No.	3					18%		

Tender No. T26P630001

Price Schedule-1

Design, Engineering, Supply, Erection, Testing & Commissioning of 220/66kV GIS Substation at Bharthal, including complete civil works & automation, along with LILO of 220kV D/C Bamnauli-DIAL Overhead Transmission Line at Bharthal, on a Turnkey Basis.

(Schedule of rates and prices)

Bidder's Name and Address :

Plant and Equipment (including Mandatory Spares Parts) to be supplied.

S.No.	Item Description	HSN Code	Whether HSN is confirmed. If not, indicate applicable HSN code	Unit	Qty	Currency (INR)	Ex-Works Price		Mode of Transaction Direct/ Bought Out	Taxes & Duties		
										GST		
							Unit Price	Total Price		Rate	Whether rate of GST is confirmed. If not, indicate applicable rate of GST	Amount
1	2	3	4	5	6	7	8	9=6x8	10	11	12	13
g	WTI	85049010		No.	3					18%		
h	OTI	85049010		No.	3					18%		
i	Buchholz Relay with complete contacts	85049010		No.	3					18%		
j	CT for WTI	85049010		No.	3					18%		
k	Set of Oil Circulating pump assembly complete with Motor OFAF	85049010		Set	3					18%		
	SUB-TOTAL - III : MANDATORY SPARES											
	GRAND TOTAL [I+II+III]											

Note : Bidder is required to quote prices in this Schedule for all the individual items/sub-items.

HSN/SAC Code shall be filled/confirmed by Bidder.

Currency shall be only in INDIAN Rupee in accordance with clause 14.2 Section-ITB Volume I of the bidding documents.

Please refer NIT/Tender Document for list of Mandatory Spares.

In case any additional equipment is required, the same shall be supplied without any additional payment and the offer should be complete and comprehensive.

Date :

Place :

Signature : _____

Printed Name _____

Designation _____

Common Seal

Design, Engineering, Supply, Erection, Testing & Commissioning of 220/66kV GIS Substation at Bharthal, including complete civil works & automation, along with LILO of 220kV D/C Bamnauli-DIAL Overhead Transmission Line at Bharthal, on a Turnkey Basis.

(Schedule of rates and prices)

Bidder's Name and Address :

Local Transportation, Insurance, and other Incidental Services.

S.No.	Item Description	Unit	Qty	Transport, Insurance and other Incidental Services						
				SAC Code	Whether SAC code is confirmed, Yes/No. If not, indicate applicable SAC code.	Unit Charges (INR)	Total Charges (INR)	Taxes & Duties		
								GST		
								Rate	Whether rate of GST is confirmed. If not, indicate applicable rate of GST.	Amount
1	2	3	4	5	6	7	8=4*7	9	10	11=8*(9or10)
I	Main Material & equipments									
A	245kV GIS Equipment									
1	245kV, SF6, GIS 160 MVA Transformer Bay Module: 245kV, 1600 A, SF6 gas insulated 160 MVA transformer bay module each comprising of SF6 gas insulated circuit breaker, current transformer, bus-bar disconnectors with common grounding switch, line disconnector, safety grounding switches, local control cubicle, SF6 gas monitoring system for complete bay, gas insulated terminal connection for connecting transformer with GIS through SF6/air bushings/ SF6 duct etc. to complete transformer bay module.	Set	4	996519				18%		
2	245kV, SF6, GIS 50 MVAR Reactor Bay Module: 245kV, 1600 A, SF6 gas insulated Reactor bay module each comprising of SF6 gas insulated circuit breaker, current transformer, bus-bar disconnectors with common grounding switch, line disconnector, safety grounding switches, local control cubicle, SF6 gas monitoring system for complete bay, gas insulated terminal connection for connecting Reactor with GIS through XLPE cable to complete reactor bay module.	Set	1	996519				18%		
3	245kV, SF6, GIS Feeder Bay Module: 245kV, 1600A, SF6 gas insulated feeder bay module each comprising of SF6 gas insulated circuit breaker, current transformer, two bus-bar disconnectors with common grounding switch, line disconnector, high speed fault making grounding switch, PT with disconnector, surge arrestor, local control cubicle, SF6 gas monitoring system for complete bay, gas insulated terminal connection for connecting feeder with GIS through SF6/Air bushings or indoor cable terminal, SF6 duct etc., to complete feeder bay module.	Set	6	996519				18%		
4	245kV, SF6, GIS Busbar Module: 245kV, 3 single phase (isolated) units, SF6 gas insulated, metal enclosed 2500A bus bars each enclosed in bus enclosures running along the length of the switchgear to interconnect each of circuit breaker bay module. Each bus bar set shall be complete with voltage transformer, disconnector and safety grounding switch, SF6 gas monitoring system for complete bay etc.	Set	2	996519				18%		
5	245kV, SF6, GIS Bus Coupler Bay Module: 245kV, 2500A, SF6 gas insulated bus coupler bay module comprising of SF6 gas insulated circuit breaker, current transformer, disconnectors with safety grounding switches, local control cubicle, SF6 gas monitoring system etc. for complete bay.	Set	2	996519				18%		
6	245kV, SF6, Bus Sectionalizer Bay Module: 245kV, 2500A, SF6 gas insulated bus sectionaliser bay module comprising of SF6 gas insulated circuit breaker, current Transformer, two disconnectors with safety grounding switches, SF6 Gas monitoring system for complete bay etc.	Set	2	996519				18%		
7	245kV, 1600A, SF6/Air Bushing for Connecting GIS to AIS alongwith support structure	No.	21	996519				18%		
8	245kV, 1600A, 1 Phase SF6 GIS Bus duct alongwith support structure	Lot	1	996519				18%		

Design, Engineering, Supply, Erection, Testing & Commissioning of 220/66kV GIS Substation at Bharthal, including complete civil works & automation, along with LILO of 220kV D/C Bamnauli-DIAL Overhead Transmission Line at Bharthal, on a Turnkey Basis.

(Schedule of rates and prices)

Bidder's Name and Address :

Local Transportation, Insurance, and other Incidental Services.

S.No.	Item Description	Unit	Qty	Transport, Insurance and other Incidental Services						
				SAC Code	Whether SAC code is confirmed, Yes/No. If not, indicate applicable SAC code.	Unit Charges (INR)	Total Charges (INR)	Taxes & Duties		
								GST		
								Rate	Whether rate of GST is confirmed. If not, indicate applicable rate of GST.	Amount
	Sub-Total (A)									
B	66kV GIS Equipment									
1	72.5kV, SF6, GIS Feeder Bay Module: 72.5kV, 2000A, SF6 gas insulated feeder bay module each comprising of SF6 gas insulated circuit breaker, current transformer, two bus-bar disconnectors with one earthing switch, line disconnector with one normal & one high speed fault make grounding switch, surge arrestors, SF6 gas monitoring system for complete bay, PT with disconnector switch, gas insulated terminal connection for connecting 66kV feeder bays will be through XLPE cable with suitable run and size cable termination enclosure and accessories with GIS, local control cubicle etc., to complete feeder bay module.	Set	18	996519				18%		
2	72.5kV, SF6, GIS Incomer/Transformer Bay Module: 72.5kV, 2500A, SF6 gas insulated transformer bay module each comprising of SF6 gas insulated circuit breaker, current transformer, Two nos. of bus-bar disconnectors with common grounding switch, line disconnector with one normal & one high speed fault make grounding switch, surge arrestors, SF6 gas monitoring system for complete bay, gas insulated terminal connection for connecting transformer (XLPE cable/SF6) through XLPE cable suitable run and size with cable end box and accessories with GIS, local control cubicle etc., to complete transformer bay module.	Set	4	996519				18%		
3	72.5kV, SF6, GIS Bus Coupler Bay Module: 72.5kV, 2500A, SF6 gas insulated bus coupler bay module comprising of SF6 gas insulated circuit breaker, current transformer, two nos. of disconnectors with earthing switches, SF6 gas monitoring system for complete bay, local control cubicle etc.	Set	2	996519				18%		
4	Bus Sectionalizer Bay: 72.5kV, 2500A, SF6 gas insulated bus Sectionalizer bay module comprising of SF6 gas insulated circuit breaker, current transformer, two nos. of disconnectors with earthing switches, SF6 gas monitoring system for complete bay, local control cubicle etc.	Set	2	996519				18%		
5	72.5kV, SF6, GIS Busbar Bay Module: 72.5kV, 3000A, 3-phase or single-phase encapsulated unit, SF6 gas insulated, metal enclosed bus bars each enclosed in bus enclosures running along the length of the switchgear to interconnect each of circuit breaker bay module. Each bus bar set shall be complete with voltage transformer, disconnectors with safety grounding switch, local control cubicle, SF6 gas monitoring system etc.	Set	2	996519				18%		
	Sub-Total (B)									

Design, Engineering, Supply, Erection, Testing & Commissioning of 220/66kV GIS Substation at Bharthal, including complete civil works & automation, along with LILO of 220kV D/C Bamnauli-DIAL Overhead Transmission Line at Bharthal, on a Turnkey Basis.

(Schedule of rates and prices)

Bidder's Name and Address :

Local Transportation, Insurance, and other Incidental Services.

S.No.	Item Description	Unit	Qty	Transport, Insurance and other Incidental Services						
				SAC Code	Whether SAC code is confirmed, Yes/No. If not, indicate applicable SAC code.	Unit Charges (INR)	Total Charges (INR)	Taxes & Duties		
								GST		
								Rate	Whether rate of GST is confirmed. If not, indicate applicable rate of GST.	Amount
C	Transformer and Associated Equipment									
1	220/66/11kV, 160 MVA Power Transformer with bushings and all accessories and first filling of oil with 10% spare quantity oil.	No.	3	996519				18%		
2	NIFPES For 160 MVA Power Transformers	No.	3	996519				18%		
3	Oil Storage Tank as per specification	No.	1	996519				18%		
4	17.5kV Neutral CT of ratio 800-400/1A for 220kV Neutral of Transformer.	No.	3	996519				18%		
5	17.5kV Neutral CT of ratio 2000-1000/1A for 66kV Neutral of Transformer.	No.	3	996519				18%		
6	1000 KVA, 11/0.433kV, 170kVp BIL at 11kV side, three phase, transformer including bushing accessories and first filling of oil	No.	2	996519				18%		
	Sub-Total (C)									
D	Material for Termination of Transformers/Feeders									
1	216kV, 10kA, Single Phase LA with surge/discharge counter, milli ampere meter and terminal connector etc	No.	21	996519				18%		
2	60kV, 10kA Single Phase LAs with discharge counter, milli ampere meter and terminal connectors etc	No.	63	996519				18%		
3	66kV Bus Post Insulator with Corona Ring etc.	No.	126	996519				18%		
4	Steel for support structure for double support gantry, 220/66kV O/D surge arrester, 66kV BPI, 66kV H pole, tertiary support structure, etc.	Lot	1	996519				18%		
5	ACSR Zebra conductor along with fittings and 4" IPS Al. tube	Lot	1	996519				18%		
6	66kV XLPE Power Cable with termination kit (Double Run, single core, 1200 Sq.mm, Copper) for connecting 3 no. 160 MVA Transformer to 66kV GIS	Lot	1	996519				18%		
7	66kV XLPE Power Cable with termination kit (Single run, single core, 1200 Sq.mm, Copper) for connecting 66kV GIS Outgoing feeder bays to H-pole arrangement.	Lot	1	996519				18%		
8	Petty items required for completion of job	LS	1	996519				18%		
	Sub-Total (D)									
E	Sub-Station Automation System and Relays & Protection Panels									

Design, Engineering, Supply, Erection, Testing & Commissioning of 220/66kV GIS Substation at Bharthal, including complete civil works & automation, along with LILO of 220kV D/C Bamnauli-DIAL Overhead Transmission Line at Bharthal, on a Turnkey Basis.

(Schedule of rates and prices)

Bidder's Name and Address :

Local Transportation, Insurance, and other Incidental Services.

S.No.	Item Description	Unit	Qty	Transport, Insurance and other Incidental Services						
				SAC Code	Whether SAC code is confirmed, Yes/No. If not, indicate applicable SAC code.	Unit Charges (INR)	Total Charges (INR)	Taxes & Duties		
								GST		
								Rate	Whether rate of GST is confirmed. If not, indicate applicable rate of GST.	Amount
1	220kV Control & Relay and Panels with complete automation with local SCADA system									
(a)	220kV Feeder Bays	No.	6	996519				18%		
(b)	220kV Transformer Bays	No.	4	996519				18%		
(c)	220kV Reactor Bays	No.	1	996519				18%		
(d)	220kV Bus Coupler Bays	No.	2	996519				18%		
(e)	220kV Bus Section Bays	No.	2	996519				18%		
(f)	220kV Bus Bar Protection	No.	2	996519				18%		
(g)	Time Synchronization equipment and Other common equipments pertaining to Relay & Protection System	Lot	1	996519				18%		
2	66kV Control & Relay and Panels with complete automation with local SCADA system									
(a)	66kV Feeder Bays	No.	18	996519				18%		
(b)	66kV Transformer Incomer Bays	No.	4	996519				18%		
(c)	66kV Bus Coupler Bays	No.	2	996519				18%		
(d)	66kV Bus Section Bays	No.	2	996519				18%		
(d)	Other common equipments pertaining to Relay & Protection System	Lot	1	996519				18%		
3	Automation & SCADA									
(a)	Substation automation equipment, Optic Fibre and other interface/ converter equipment	Set	1	996519				18%		
(b)	SCADA Equipments	Set	1	996519				18%		
(c)	FOTE Equipments along with teleprotection card (for remote end substation also)	Set	4	996519				18%		
(d)	Testing & Maintenance equipment									
(i)	Optical Time Domain Reflected Meter	No.	1	996519				18%		
(ii)	Fibre Splicing Machine	No.	1	996519				18%		
(iii)	Test Plug for testing & Isolation of Relay for testing	No.	1	996519				18%		
(iv)	Manufacture's Specific Maintenance tool	No.	1	996519				18%		
(e)	Remote HMI alongwith monitor for DTL control room	Set	1	996519				18%		
(f)	Inverter of suitable capacity for station HMI and peripheral devices i. e. printer etc.	Set	1	996519				18%		
4	Air Conditioning system (VRV/VRF) 220kV Relay & Protection Panels Room	Lot	1	996519				18%		
5	Air Conditioning system (VRV/VRF) 66kV Relay & Protection Panels Room	Lot	1	996519				18%		
6	Air Conditioning system (VRV/VRF) for Control Room Building	Lot	1	996519				18%		
7	Air Conditioning system (VRV/VRF) for Battery Room	Lot	1	996519				18%		
8	Air Conditioning system (VRV/VRF) for office space, Lab, conference hall etc.	Lot	1	996519				18%		
9	Ventilation system for 220kV GIS Hall	Lot	1	996519				18%		
10	Ventilation system for 66kV GIS Hall	Lot	1	996519				18%		

Design, Engineering, Supply, Erection, Testing & Commissioning of 220/66kV GIS Substation at Bharthal, including complete civil works & automation, along with LILO of 220kV D/C Bamnauli-DIAL Overhead Transmission Line at Bharthal, on a Turnkey Basis.

(Schedule of rates and prices)

Bidder's Name and Address :

Local Transportation, Insurance, and other Incidental Services.

S.No.	Item Description	Unit	Qty	Transport, Insurance and other Incidental Services						
				SAC Code	Whether SAC code is confirmed, Yes/No. If not, indicate applicable SAC code.	Unit Charges (INR)	Total Charges (INR)	Taxes & Duties		
								GST		
								Rate	Whether rate of GST is confirmed. If not, indicate applicable rate of GST.	Amount
	Sub-Total (E)									
F	LT Switchgear & other items									
1	LT Switchgear									
(a)	415V Main Switchboard	Set	1	996519				18%		
(b)	415V ACDB	Set	1	996519				18%		
(c)	415V MLDB	Set	1	996519				18%		
(d)	415V Emergency LDB	Set	1	996519				18%		
(e)	415V Air-conditioning & Ventilation DB	Set	1	996519				18%		
(f)	220V DCDB	Set	2	996519				18%		
2	Batteries and Battery Chargers									
(a)	220V, 600 AH Battery	Set	2	996519				18%		
(b)	220V, 600 AH, Battery Charger System	Set	2	996519				18%		
3	Generator Set along with control panel (250kVA, 440V)	Set	1	996519				18%		
4	Fire Protection for 220kV GIS building, Control Room Building, etc. (Portable type fire extinguishers system)	Lot	1	996519				18%		
5	Fire Protection for 66kV GIS building, Store, etc. (Portable type fire extinguishers system)	Lot	1	996519				18%		
6	Heat/Smoke Fire Detection system	Lot	1	996519				18%		
7	Illumination system for Control Room, 220kV GIS Building, control room building, etc. Illumination with LED base/Metal Halide Lamp	LS	1	996519				18%		
8	Illumination system for Control Room, 66kV GIS Building, control room building, store, etc. Illumination with LED base/Metal Halide Lamp	LS	1	996519				18%		
9	Switchyard/Street light system (High Mast Lighting System)	LS	1	996519				18%		
10	1.1kV Grade PVC insulated Al. conductor armoured power cables and copper conductor armoured control cables alongwith lugs, Glands and straight joints									
(a)	Power cables (XLPE)	LS	1	996519				18%		
(b)	Power cables (PVC)	LS	1	996519				18%		
(c)	Control Cable (PVC)	LS	1	996519				18%		
11	40 mm MS rod for Main Earthmat 220kV GIS system	LS	1	996519				18%		
12	40 mm MS rod for Main Earthmat 66kV GIS system	LS	1	996519				18%		
13	Lightning Mast/ GS Shield Wire	LS	1	996519				18%		
14	EOT Crane for 220kV GIS room with complete accessories	No.	1	996519				18%		
15	EOT Crane for 66kV GIS room with complete accessories	No.	1	996519				18%		

Design, Engineering, Supply, Erection, Testing & Commissioning of 220/66kV GIS Substation at Bharthal, including complete civil works & automation, along with LILO of 220kV D/C Bamnauli-DIAL Overhead Transmission Line at Bharthal, on a Turnkey Basis.

(Schedule of rates and prices)

Bidder's Name and Address :

Local Transportation, Insurance, and other Incidental Services.

S.No.	Item Description	Unit	Qty	Transport, Insurance and other Incidental Services						
				SAC Code	Whether SAC code is confirmed, Yes/No. If not, indicate applicable SAC code.	Unit Charges (INR)	Total Charges (INR)	Taxes & Duties		
								GST		
								Rate	Whether rate of GST is confirmed. If not, indicate applicable rate of GST.	Amount
16	EOT Crane for store room	No.	1	996519				18%		
17	Tertiary Loading equipments for one 160 MVA Transformer									
i.	33kV, O/D type isolator with earth switch MOM type	No.	1	996519				18%		
ii.	33kV, O/D type CT, ratio 400-200-100/1-1-1A	No.	3	996519				18%		
iii.	33kV, O/D type 630A, SF6 Circuit Breaker	No.	1	996519				18%		
iv.	Control & Relay Protection Scheme	No.	1	996519				18%		
v.	11kV, O/D type Potential Transformer of ratio (11kV/ $\sqrt{3}$)/(110V/ $\sqrt{3}$)-(110V/ $\sqrt{3}$)	No.	3	996519				18%		
vi.	11kV Surge Arrester	No.	3	996519				18%		
vii.	33kV XLPE Power Cable with termination kit (2 Run x 3C x 400 Sq.mm, Copper)	Lot	1	996519				18%		
18	11kV equipments for loading 1000 KVA Auxilary Transformer									
i.	11kV switchgear, 3 Panel Board (1 incomer, 1 outgoing and 1 bus-coupler) alongwith associated control & relay system, 11kV cables etc.	LS	1	996519				18%		
	Sub-Total (F)									
G	CCTV System with remote Operations									
1	Supply of compact type day and night network PTZ camera with outdoor housing - as per specifications	Nos.	8	996519				18%		
2	Supply of compact type day and night network fixed camera with outdoor housing - as per specifications	Nos.	8	996519				18%		
3	Network Video Management Software for 32 cameras as per specifications	No.	1	996519				18%		
4	NVMS client License Pack for 2 users as per specifications	No.	1	996519				18%		
5	Video management workstation Server with Storage hardware with suitable capacity for continuous recording for 30 Days Minimum as per specifications	No.	1	996519				18%		
6	Video analytic software for fixed type cameras (2 camera per site)	Nos.	3	996519				18%		
7	The contractor is responsible for supplying and laying of armoured Fibre Optics cables through HDPE Conduit by digging and laying through cable trench as per the site requirements including the supply of converters and other accessories (suitable for outdoor application) required to complete the connectivity in all respect as per the direction of Engineer-in-Charge.	LS	1	996519				18%		
8	Auxiliary structure with all required poles/mast & related mount with all accessories. Pole/Mast (G.I.) : Length - 9 mtrs and should be ISI make Mounting : to be grounded in concrete structure should be self-supporting in the ground.	Lot	1	996519				18%		
9	32" LCD monitor Diagonal Industrial Grade Panel for 24x7 applications as per specification.	Nos.	2	996519				18%		
10	24" Client PC TFT LCD monitor as per specification	Nos.	2	996519				18%		

Design, Engineering, Supply, Erection, Testing & Commissioning of 220/66kV GIS Substation at Bharthal, including complete civil works & automation, along with LILO of 220kV D/C Bamnauli-DIAL Overhead Transmission Line at Bharthal, on a Turnkey Basis.

(Schedule of rates and prices)

Bidder's Name and Address :

Local Transportation, Insurance, and other Incidental Services.

S.No.	Item Description	Unit	Qty	Transport, Insurance and other Incidental Services						
				SAC Code	Whether SAC code is confirmed, Yes/No. If not, indicate applicable SAC code.	Unit Charges (INR)	Total Charges (INR)	Taxes & Duties		
								GST		
								Rate	Whether rate of GST is confirmed. If not, indicate applicable rate of GST.	Amount
11	16 port Network Switch with fibre optic connectivity along with all related accessories - as per specifications.	No.	1	996519				18%		
12	Heavy duty with weather proof Power supply units for outdoor cameras	Nos.	16	996519				18%		
13	2 KVA On line UPS system for Power distribution with 60 Minutes power back up with all related accessories at all locations - as per specifications	No.	1	996519				18%		
14	Supply & laying of 3Core X 1.5 sq mm armoured Power cable - as per specifications	LS	1	996519				18%		
15	Supply and laying of Twisted pair shielded un-armored cable (CAT-6) - as per specification (from Terminal box to camera etc.)	LS	1	996519				18%		
16	Supply and laying of 25 mm GI conduits with all necessary accessories - ISI mark	LS	1	996519				18%		
17	Control console wooden table cabinet along with computer chair to accommodate Video Management Work station, Network switch, UPS of Reputed make	No.	1	996519				18%		
	Sub-Total (G)									
H	LILO arrangement of 220kV D/C Bamnauli-Dial Overhead line.									
1	Supply of D/C MONOPOLE									
(a)	Double Circuit Tension DPD Dead End type (60-90deg.) BXA Height 28 meter	No.	1	996519				18%		
2	Supply of high temperature low sag (HTLS) Conductor as per specification	KM	1	996519				18%		
3	Supply of OPGW with accessories	KM	0.2	996519				18%		
4	Single I suspension hard ware fittings along with clamps	Set	6	996519				18%		
5	Single "I" Suspension Pilot Hardware fittings along with clamps	Set	12	996519				18%		
6	Single Tension Hardware fittings suitable for HTLS conductor along with clamps	Set	30	996519				18%		
7	Long Rod Polymer Insulator									
(a)	160 KN	No.	30	996519				18%		
(b)	90 KN	No.	12	996519				18%		
8	Vibration Dampers for HTLS Conductor	No.	12	996519				18%		
9	Supply of Tower Accessories									
(a)	Pipe Type Earthing of Towers	Set	2	996519				18%		
(b)	Number Plate (1 set = 2 no.)	Set	1	996519				18%		
(c)	Phase Plate (Set of two, One set contains IR, IY, IB)	Set	1	996519				18%		
(d)	Danger Plate (1 set = 2 no.)	Set	1	996519				18%		
(e)	Circuit Plate (1 set = 2 nos. circuit I & II)	Set	1	996519				18%		
(f)	Anticlimbing Device including cost of Barbed Wire, MS Angle etc.	No.	1	996519				18%		

Design, Engineering, Supply, Erection, Testing & Commissioning of 220/66kV GIS Substation at Bharthal, including complete civil works & automation, along with LILO of 220kV D/C Bamnauli-DIAL Overhead Transmission Line at Bharthal, on a Turnkey Basis.

(Schedule of rates and prices)

Bidder's Name and Address :

Local Transportation, Insurance, and other Incidental Services.

S.No.	Item Description	Unit	Qty	Transport, Insurance and other Incidental Services						
				SAC Code	Whether SAC code is confirmed, Yes/No. If not, indicate applicable SAC code.	Unit Charges (INR)	Total Charges (INR)	Taxes & Duties		
								GST		
								Rate	Whether rate of GST is confirmed. If not, indicate applicable rate of GST.	Amount
10	Petty items to complete the job	LS	1	996519				18%		
	Sub-Total (H)									
	SUB-TOTAL - I: MAIN EQUIPMENTS [(A) to (H)]									
II	Testing/ Maintenance Equipments and Mandatory Spares									
	Testing & Maintenance Equipments for GIS									
1	SF6 Gas filling and evacuating plant	Set	1	996519				18%		
2	SF6 Gas Analyser	Set	1	996519				18%		
3	SF6 gas leak detector	Set	1	996519				18%		
4	Gas masks	Nos.	10	996519				18%		
5	Partial Discharge Monitoring System	Set	1	996519				18%		
6	Contact resistance meter	Set	1	996519				18%		
7	Digital Insulation test kit, 10 kV	Set	1	996519				18%		
8	Oil Breakdown Voltage test kit, 100 kV	Set	1	996519				18%		
9	Clamp on meter suitable for measuring the secondary current of CT in mA and load current upto 300 A	Set	1	996519				18%		
10	Transformer winding resistance meter	Set	1	996519				18%		
11	Digital Earth resistance meter complete with all accessories	Set	1	996519				18%		
12	Thermoscanning camera for substation	Set	1	996519				18%		
	SUB-TOTAL - II : TESTING EQUIPMENTS									
III	MANDATORY SPARES									
1	Spares for 220kV GIS									
i	220kV GIS	LS	1	996519				18%		
ii	245kV CB	LS	1	996519				18%		
iii	245kV CT (single phase current transformers of each rating)	LS	1	996519				18%		
iv	245kV VT (Single phase VT complete with all Gaskets and mounting hardware.)	LS	1	996519				18%		
v	245kV Isolators & ES	LS	1	996519				18%		
vi	220kV Surge Arrester	LS	1	996519				18%		

Design, Engineering, Supply, Erection, Testing & Commissioning of 220/66kV GIS Substation at Bharthal, including complete civil works & automation, along with LILO of 220kV D/C Bamnauli-DIAL Overhead Transmission Line at Bharthal, on a Turnkey Basis.

(Schedule of rates and prices)

Bidder's Name and Address :

Local Transportation, Insurance, and other Incidental Services.

S.No.	Item Description	Unit	Qty	Transport, Insurance and other Incidental Services						
				SAC Code	Whether SAC code is confirmed, Yes/No. If not, indicate applicable SAC code.	Unit Charges (INR)	Total Charges (INR)	Taxes & Duties		
								GST		
								Rate	Whether rate of GST is confirmed. If not, indicate applicable rate of GST.	Amount
2	Spares for 66kV GIS									
i	66kV GIS	LS	1	996519				18%		
ii	66kV Circuit Breaker	LS	1	996519				18%		
iii	66kV Isolator & ES	LS	1	996519				18%		
iv	66kV CT	LS	1	996519				18%		
v	66kV Voltage Transformer	LS	1	996519				18%		
vi	66kV Surge Arrester	LS	1	996519				18%		
3	Spare for DG Set	LS	1	996519				18%		
4	Spare for Battery	LS	1	996519				18%		
5	Spare for Battery Charger	LS	1	996519				18%		
6	Spare for Relay & Protection Panels	LS	1	996519				18%		
7	Spare for Sub station Automation	LS	1	996519				18%		
8	Spare for Illumination System	LS	1	996519				18%		
9	Spare for Fire Fighting system	LS	1	996519				18%		
10	Spare for LT switchgear	LS	1	996519				18%		
11	Spares for 220/66/11kV, 160 MVA Transformer									
a	HV bushing of Transformer with complete metal parts and gaskets	No.	3	996519				18%		
b	MV bushing of Transformer with complete metal parts and gaskets	No.	3	996519				18%		
c	LV bushing of Transformer with complete metal parts and gaskets	No.	3	996519				18%		
d	Set of gaskets	Set	3	996519				18%		
e	PRV	No.	3	996519				18%		
f	SPR	No.	3	996519				18%		
g	WTI	No.	3	996519				18%		
h	OTI	No.	3	996519				18%		
i	Buchholz Relay with complete contacts	No.	3	996519				18%		
j	CT for WTI	No.	3	996519				18%		
k	Set of Oil Circulating pump assembly complete with Motor OFAF	Set	3	996519				18%		
	SUB-TOTAL - III : MANDATORY SPARES									

Design, Engineering, Supply, Erection, Testing & Commissioning of 220/66kV GIS Substation at Bharthal, including complete civil works & automation, along with LILO of 220kV D/C Bamnauli-DIAL Overhead Transmission Line at Bharthal, on a Turnkey Basis.
(Schedule of rates and prices)

Bidder's Name and Address :

Local Transportation, Insurance, and other Incidental Services.

S.No.	Item Description	Unit	Qty	Transport, Insurance and other Incidental Services						
				SAC Code	Whether SAC code is confirmed, Yes/No. If not, indicate applicable SAC code.	Unit Charges (INR)	Total Charges (INR)	Taxes & Duties		
								GST		
								Rate	Whether rate of GST is confirmed. If not, indicate applicable rate of GST.	Amount
	GRAND TOTAL [I+II+III]									

Note : Bidder is required to quote prices in this Schedule for all the individual items/sub-items.
HSN/SAC Code shall be filled/confirmed by Bidder.
Currency shall be only in INDIAN Rupee in accordance with clause 14.2 Section-ITB Volume I of the bidding documents.
Please refer NIT/Tender Document for list of Mandatory Spares.
In case any additional equipment is required, the same shall be supplied without any additional payment and the offer should be complete and comprehensive.
Date :

Place :

Signature : _____

Printed Name _____

Designation _____

Common Seal

Tender No. T26P630001								Price Schedule-3		
Design, Engineering, Supply, Erection, Testing & Commissioning of 220/66kV GIS Substation at Bharthal, including complete civil works & automation, along with LILO of 220kV D/C Bamnauli-DIAL Overhead Transmission Line at Bharthal, on a Turnkey Basis.										
(Schedule of rates and prices)										
Bidder's Name and Address :										
Installation Charges										
	Item Description	SAC Code	Whether SAC code is confirmed. If not, indicate applicable SAC code.	Unit	Qty	Unit Charges (INR)	Total Charges (INR)	Taxes & Duties		
								GST		
								Rate	Whether rate of GST is confirmed. If not, indicate applicable rate of GST.	Amount
1	2	3	4	5	6	7	8= 6x7	9	10	11
I	Main Material & equipments									
A	245kV GIS Equipment									
1	245kV, SF6, GIS 160 MVA Transformer Bay Module: 245kV, 1600 A, SF6 gas insulated 160 MVA transformer bay module each comprising of SF6 gas insulated circuit breaker, current transformer, bus-bar disconnectors with common grounding switch, line disconnector, safety grounding switches, local control cubicle, SF6 gas monitoring system for complete bay, gas insulated terminal connection for connecting transformer with GIS through SF6/air bushings/ SF6 duct etc. to complete transformer bay module.	998736		Set	4			18%		
2	245kV, SF6, GIS 50 MVAR Reactor Bay Module: 245kV, 1600 A, SF6 gas insulated Reactor bay module each comprising of SF6 gas insulated circuit breaker, current transformer, bus-bar disconnectors with common grounding switch, line disconnector, safety grounding switches, local control cubicle, SF6 gas monitoring system for complete bay, gas insulated terminal connection for connecting Reactor with GIS through XLPE cable to complete reactor bay module.	998736		Set	1			18%		
3	245kV, SF6, GIS Feeder Bay Module: 245kV, 1600A, SF6 gas insulated feeder bay module each comprising of SF6 gas insulated circuit breaker, current transformer, two bus-bar disconnectors with common grounding switch, line disconnector, high speed fault making grounding switch, PT with disconnector, surge arrester, local control cubicle, SF6 gas monitoring system for complete bay, gas insulated terminal connection for connecting feeder with GIS through SF6/Air bushings or indoor cable terminal, SF6 duct etc., to complete feeder bay module.	998736		Set	6			18%		
4	245kV, SF6, GIS Busbar Module: 245kV, 3 single phase (isolated) units, SF6 gas insulated, metal enclosed 2500A bus bars each enclosed in bus enclosures running along the length of the switchgear to interconnect each of circuit breaker bay module. Each bus bar set shall be complete with voltage transformer, disconnector and safety grounding switch, SF6 gas monitoring system for complete bay etc.	998736		Set	2			18%		
5	245kV, SF6, GIS Bus Coupler Bay Module: 245kV, 2500A, SF6 gas insulated bus coupler bay module comprising of SF6 gas insulated circuit breaker, current transformer, disconnectors with safety grounding switches, local control cubicle, SF6 gas monitoring system etc. for complete bay.	998736		Set	2			18%		
6	245kV, SF6, Bus Sectionaliser Bay Module: 245kV, 2500A, SF6 gas insulated bus sectionaliser bay module comprising of SF6 gas insulated circuit breaker, current Transformer, two disconnectors with safety grounding switches, SF6 Gas monitoring system for complete bay etc.	998736		Set	2			18%		
7	245kV, 1600A, SF6/Air Bushing for Connecting GIS to AIS alongwith support structure	998736		No.	21			18%		
8	245kV, 1600A, 1 Phase SF6 GIS Bus duct alongwith support structure	998736		Lot	1			18%		
	Sub-Total (A)									

Tender No. T26P630001								Price Schedule-3		
Design, Engineering, Supply, Erection, Testing & Commissioning of 220/66kV GIS Substation at Bharthal, including complete civil works & automation, along with LILO of 220kV D/C Bamnauli-DIAL Overhead Transmission Line at Bharthal, on a Turnkey Basis.										
(Schedule of rates and prices)										
Bidder's Name and Address :										
Installation Charges										
	Item Description	SAC Code	Whether SAC code is confirmed. If not, indicate applicable SAC code.	Unit	Qty	Unit Charges (INR)	Total Charges (INR)	Taxes & Duties		
								GST		
								Rate	Whether rate of GST is confirmed. If not, indicate applicable rate of GST.	Amount
1	2	3	4	5	6	7	8= 6x7	9	10	11
B	66kV GIS Equipment									
1	72.5kV, SF6, GIS Feeder Bay Module: 72.5kV, 2000A, SF6 gas insulated feeder bay module each comprising of SF6 gas insulated circuit breaker, current transformer, two bus-bar disconnectors with one earthing switch, line disconnector with one normal & one high speed fault make grounding switch, surge arrestors, SF6 gas monitoring system for complete bay, PT with disconnector switch, gas insulated terminal connection for connecting 66kV feeder bays will be through XLPE cable with suitable run and size cable termination enclosure and accessories with GIS, local control cubicle etc., to complete feeder bay module.	998736		Set	18			18%		
2	72.5kV, SF6, GIS Incomer/Transformer Bay Module: 72.5kV, 2500A, SF6 gas insulated transformer bay module each comprising of SF6 gas insulated circuit breaker, current transformer, Two nos. of bus-bar disconnectors with common grounding switch, line disconnector with one normal & one high speed fault make grounding switch, surge arrestors, SF6 gas monitoring system for complete bay, gas insulated terminal connection for connecting transformer (XLPE cable/SF6) through XLPE cable suitable run and size with cable end box and accessories with GIS, local control cubicle etc., to complete transformer bay module.	998736		Set	4			18%		
3	72.5kV, SF6, GIS Bus Coupler Bay Module: 72.5kV, 2500A, SF6 gas insulated bus coupler bay module comprising of SF6 gas insulated circuit breaker, current transformer, two nos. of disconnectors with earthing switches, SF6 gas monitoring system for complete bay, local control cubicle etc.	998736		Set	2			18%		
4	Bus Sectionaliser Bay: 72.5kV, 2500A, SF6 gas insulated bus Sectionaliser bay module comprising of SF6 gas insulated circuit breaker, current transformer, two nos. of disconnectors with earthing switches, SF6 gas monitoring system for complete bay, local control cubicle etc.	998736		Set	2			18%		
5	72.5kV, SF6, GIS Busbar Bay Module: 72.5kV, 3000A, 3-phase or single-phase encapsulated unit, SF6 gas insulated, metal enclosed bus bars each enclosed in bus enclosures running along the length of the switchgear to interconnect each of circuit breaker bay module. Each bus bar set shall be complete with voltage transformer, disconnectors with safety grounding switch, local control cubicle, SF6 gas monitoring system etc.	998736		Set	2			18%		
	Sub-Total (B)									
C	Transformer and Associated Equipment									
1	220/66/11kV, 160 MVA Power Transformer with bushings and all accessories and first filling of oil with 10% spare quantity oil.	998736		No.	3			18%		
2	NIFPES For 160 MVA Power Transformers	998736		No.	3			18%		
3	Oil Storage Tank as per specification	998736		No.	1			18%		
4	17.5kV Neutral CT of ratio 800-400/1A for 220kV Neutral of Transformer.	998736		No.	3			18%		
5	17.5kV Neutral CT of ratio 2000-1000/1A for 66kV Neutral of Transformer.	998736		No.	3			18%		
6	1000 KVA, 11/0.433kV, 170kVp BIL at 11kV side, three phase, transformer including bushing accessories and first filling of oil	998736		No.	2			18%		

Tender No. T26P630001								Price Schedule-3		
Design, Engineering, Supply, Erection, Testing & Commissioning of 220/66kV GIS Substation at Bharthal, including complete civil works & automation, along with LILO of 220kV D/C Bamnauli-DIAL Overhead Transmission Line at Bharthal, on a Turnkey Basis.										
(Schedule of rates and prices)										
Bidder's Name and Address :										
Installation Charges										
	Item Description	SAC Code	Whether SAC code is confirmed. If not, indicate applicable SAC code.	Unit	Qty	Unit Charges (INR)	Total Charges (INR)	Taxes & Duties		
								GST		
								Rate	Whether rate of GST is confirmed. If not, indicate applicable rate of GST.	Amount
1	2	3	4	5	6	7	8= 6x7	9	10	11
	Sub-Total (C)									
D	Material for Termination of Transformers/Feeders									
1	216kV, 10kA, Single Phase LA with surge/discharge counter, milli ampere meter and terminal connector etc	998736		No.	21			18%		
2	60kV, 10kA Single Phase LAs with discharge counter, milli ampere meter and terminal connectors etc	998736		No.	63			18%		
3	66kV Bus Post Insulator with Corona Ring etc.	998736		No.	126			18%		
4	Steel for support structure for double support gantry, 220/66kV O/D surge arrester, 66kV BPI, 66kV H pole, tertiary support structure, etc.	998736		Lot	1			18%		
5	ACSR Zebra conductor along with fittings and 4" IPS Al. tube	998736		Lot	1			18%		
6	66kV XLPE Power Cable with termination kit (Double Run, single core, 1200 Sq.mm, Copper) for connecting 3 no. 160 MVA Transformer to 66kV GIS	998736		Lot	1			18%		
7	66kV XLPE Power Cable with termination kit (Single run, single core, 1200 Sq.mm, Copper) for connecting 66kV GIS Outgoing feeder bays to H-pole arrangement.	998736		Lot	1			18%		
8	Petty items required for completion of job	998736		LS	1			18%		
	Sub-Total (D)									
E	Sub-Station Automation System and Relays & Protection Panels									
1	220kV Control & Relay and Panels with complete automation with local SCADA system									
(a)	220kV Feeder Bays	998736		No.	6			18%		
(b)	220kV Transformer Bays	998736		No.	4			18%		
(c)	220kV Reactor Bays	998736		No.	1			18%		
(d)	220kV Bus Coupler Bays	998736		No.	2			18%		
(e)	220kV Bus Section Bays	998736		No.	2			18%		
(f)	220kV Bus Bar Protection	998736		No.	2			18%		
(g)	Time Synchronization equipment and Other common equipments pertaining to Relay & Protection System	998736		Lot	1			18%		
2	66kV Control & Relay and Panels with complete automation with local SCADA system									
(a)	66kV Feeder Bays	998736		No.	18			18%		
(b)	66kV Transformer Incomer Bays	998736		No.	4			18%		
(c)	66kV Bus Coupler Bays	998736		No.	2			18%		
(d)	66kV Bus Section Bays	998736		No.	2			18%		
(d)	Other common equipments pertaining to Relay & Protection System	998736		Lot	1			18%		
3	Automation & SCADA									

Tender No. T26P630001

Price Schedule-3

Design, Engineering, Supply, Erection, Testing & Commissioning of 220/66kV GIS Substation at Bharthal, including complete civil works & automation, along with LILO of 220kV D/C Bamnauli-DIAL Overhead Transmission Line at Bharthal, on a Turnkey Basis.

(Schedule of rates and prices)

Bidder's Name and Address :

Installation Charges

1	Item Description	SAC Code	Whether SAC code is confirmed. If not, indicate applicable SAC code.	Unit	Qty	Unit Charges (INR)	Total Charges (INR)	Taxes & Duties		
								GST		
								Rate	Whether rate of GST is confirmed. If not, indicate applicable rate of GST.	Amount
2	3	4	5	6	7	8= 6x7	9	10	11	
(a)	Substation automation equipment, Optic Fibre and other interface/ converter equipment	998736		Set	1			18%		
(b)	SCADA Equipments	998736		Set	1			18%		
(c)	FOTE Equipments along with teleprotection card (for remote end substation also)	998736		Set	4			18%		
(d)	Testing & Maintenance equipment									
(i)	Optical Time Domain Reflected Meter	998736		No.	1			18%		
(ii)	Fibre Splicing Machine	998736		No.	1			18%		
(iii)	Test Plug for testing & Isolation of Relay for testing	998736		No.	1			18%		
(iv)	Manufacture's Specific Maintenance tool	998736		No.	1			18%		
(e)	Remote HMI alongwith monitor for DTL control room	998736		Set	1			18%		
(f)	Inverter of suitable capacity for station HMI and peripheral devices i. e. printer etc.	998736		Set	1			18%		
4	Air Conditioning system (VRV/VRF) 220kV Relay & Protection Panels Room	998736		Lot	1			18%		
5	Air Conditioning system (VRV/VRF) 66kV Relay & Protection Panels Room	998736		Lot	1			18%		
6	Air Conditioning system (VRV/VRF) for Control Room Building	998736		Lot	1			18%		
7	Air Conditioning system (VRV/VRF) for Battery Room	998736		Lot	1			18%		
8	Air Conditioning system (VRV/VRF) for office space, Lab, conference hall etc.	998736		Lot	1			18%		
9	Ventilation system for 220kV GIS Hall	998736		Lot	1			18%		
10	Ventilation system for 66kV GIS Hall	998736		Lot	1			18%		
	Sub-Total (E)									
F	LT Switchgear & other items									
1	LT Switchgear									
(a)	415V Main Switchboard	998736		Set	1			18%		
(b)	415V ACDB	998736		Set	1			18%		
(c)	415V MLDB	998736		Set	1			18%		
(d)	415V Emergency LDB	998736		Set	1			18%		
(e)	415V Air-conditioning & Ventilation DB	998736		Set	1			18%		
(f)	220V DCDB	998736		Set	2			18%		
2	Batteries and Battery Chargers									
(a)	220V, 600 AH Battery	998736		Set	2			18%		
(b)	220V, 600 AH, Battery Charger System	998736		Set	2			18%		
3	Generator Set along with control panel (250kVA, 440V)	998736		Set	1			18%		
4	Fire Protection for 220kV GIS building, Control Room Building, etc. (Portable type fire extinguishers system)	998736		Lot	1			18%		
5	Fire Protection for 66kV GIS building, Store, etc. (Portable type fire extinguishers system)	998736		Lot	1			18%		
6	Heat/Smoke Fire Detection system	998736		Lot	1			18%		

Tender No. T26P630001

Price Schedule-3

Design, Engineering, Supply, Erection, Testing & Commissioning of 220/66kV GIS Substation at Bharthal, including complete civil works & automation, along with LILO of 220kV D/C Bamnauli-DIAL Overhead Transmission Line at Bharthal, on a Turnkey Basis.

(Schedule of rates and prices)

Bidder's Name and Address :

Installation Charges

1	Item Description	SAC Code	Whether SAC code is confirmed. If not, indicate applicable SAC code.	Unit	Qty	Unit Charges (INR)	Total Charges (INR)	Taxes & Duties		
								GST		
								Rate	Whether rate of GST is confirmed. If not, indicate applicable rate of GST.	Amount
2		3	4	5	6	7	8= 6x7	9	10	11
7	Illumination system for Control Room, 220kV GIS Building, control room building, etc. Illumination with LED base/Metal Halide Lamp	998736		LS	1			18%		
8	Illumination system for Control Room, 66kV GIS Building, control room building, store, etc. Illumination with LED base/Metal Halide Lamp	998736		LS	1			18%		
9	Switchyard/Street light system (High Mast Lighting System)	998736		LS	1			18%		
10	1.1kV Grade PVC insulated Al. conductor armoured power cables and copper conductor armoured control cables alongwith lugs, Glands and straight joints									
(a)	Power cables (XLPE)	998736		LS	1			18%		
(b)	Power cables (PVC)	998736		LS	1			18%		
(c)	Control Cable (PVC)	998736		LS	1			18%		
11	40 mm MS rod for Main Earthmat 220kV GIS system	998736		LS	1			18%		
12	40 mm MS rod for Main Earthmat 66kV GIS system	998736		LS	1			18%		
13	Lightning Mast/ GS Shield Wire	998736		LS	1			18%		
14	EOT Crane for 220kV GIS room with complete accessories	998736		No.	1			18%		
15	EOT Crane for 66kV GIS room with complete accessories	998736		No.	1			18%		
16	EOT Crane for store room	998736		No.	1			18%		
17	Tertiary Loading equipments for one 160 MVA Transformer									
i.	33kV, O/D type isolator with earth switch MOM type	998736		No.	1			18%		
ii.	33kV, O/D type CT, ratio 400-200-100/1-1-1A	998736		No.	3			18%		
iii.	33kV, O/D type 630A, SF6 Circuit Breaker	998736		No.	1			18%		
iv.	Control & Relay Protection Scheme	998736		No.	1			18%		
v.	11kV, O/D type Potential Transformer of ratio (11kV/√3)/(110V/√3)-(110V/√3)	998736		No.	3			18%		
vi.	11kV Surge Arrester	998736		No.	3			18%		
vii.	33kV XLPE Power Cable with termination kit (2 Run x 3C x 400 Sq.mm, Copper)	998736		Lot	1			18%		
18	11kV equipments for loading 1000 KVA Auxiliary Transformer									
i.	11kV switchgear, 3 Panel Board (1 incomer, 1 outgoing and 1 bus-coupler) alongwith associated control & relay system, 11kV cables etc.	998736		LS	1			18%		
	Sub-Total (F)									
G	CCTV System with remote Operations									
1	Supply of compact type day and night network PTZ camera with outdoor housing - as per specifications	995468		Nos.	8			18%		
2	Supply of compact type day and night network fixed camera with outdoor housing - as per specifications	995468		Nos.	8			18%		
3	Network Video Management Software for 32 cameras as per specifications	995468		No.	1			18%		
4	NVMS client License Pack for 2 users as per specifications	995468		No.	1			18%		

Tender No. T26P630001

Price Schedule-3

Design, Engineering, Supply, Erection, Testing & Commissioning of 220/66kV GIS Substation at Bharthal, including complete civil works & automation, along with LILO of 220kV D/C Bamnauli-DIAL Overhead Transmission Line at Bharthal, on a Turnkey Basis.

(Schedule of rates and prices)

Bidder's Name and Address :

Installation Charges

1	Item Description	SAC Code	Whether SAC code is confirmed. If not, indicate applicable SAC code.	Unit	Qty	Unit Charges (INR)	Total Charges (INR)	Taxes & Duties		
								GST		
								Rate	Whether rate of GST is confirmed. If not, indicate applicable rate of GST.	Amount
2		3	4	5	6	7	8= 6x7	9	10	11
5	Video management workstation Server with Storage hardware with suitable capacity for continuous recording for 30 Days Minimum as per specifications	995468		No.	1			18%		
6	Video analytic software for fixed type cameras (2 camera per site)	995468		Nos.	3			18%		
7	The contractor is responsible for supplying and laying of armoured Fibre Optics cables through HDPE Conduit by digging and laying through cable trench as per the site requirements including the supply of converters and other accessories (suitable for outdoor application) required to complete the connectivity in all respect as per the direction of Engineer-in-Charge.	995468		LS	1			18%		
8	Auxiliary structure with all required poles/mast & related mount with all accessories. Pole/Mast (G.I.) : Length 9 mtrs and should be ISI make Mounting : to be grounded in concrete structure should be self-supporting in the ground.	995468		Lot	1			18%		
9	32" LCD monitor Diagonal Industrial Grade Panel for 24x7 applications as per specification.	995468		Nos.	2			18%		
10	24" Client PC TFT LCD monitor as per specification	995468		Nos.	2			18%		
11	16 port Network Switch with fibre optic connectivity along with all related accessories - as per specifications.	995468		No.	1			18%		
12	Heavy duty with weather proof Power supply units for outdoor cameras	995468		Nos.	16			18%		
13	2 KVA On line UPS system for Power distribution with 60 Minutes power back up with all related accessories at all locations - as per specifications	995468		No.	1			18%		
14	Supply & laying of 3Core X 1.5 sq mm armoured Power cable - as per specifications	995468		LS	1			18%		
15	Supply and laying of Twisted pair shielded un-armored cable (CAT-6) - as per specification (from Terminal box to camera etc.)	995468		LS	1			18%		
16	Supply and laying of 25 mm GI conduits with all necessary accessories - ISI mark	995468		LS	1			18%		
17	Control console wooden table cabinet along with computer chair to accommodate Video Management Work station, Network switch, UPS of Reputed make	995468		No.	1			18%		
	Sub-Total (G)									
H	LILO arrangement of 220kV D/C Bamnauli-Dial Overhead line.									
1	Detailed survey including preparation of Profile etc. (consider from Tension to Tension tower)	998736		KM	0.2			18%		
2	Check Survey	998736		KM	0.2			18%		
3	Detail soil investigation	998736		LOC.	1			18%		
4	ETC of D/C MONOPOLE							18%		
(a)	Double Circuit Tension DPD Dead End type (60-90deg.) BXA Height 28 meter	998736		No.	1			18%		
5	Testing of Double Circuit Monopole							18%		
(a)	Double Circuit Tension DPD Dead End type (60-90deg.) BXA Height 28 meter	998736		No.	1			18%		

Tender No. T26P630001

Price Schedule-3

Design, Engineering, Supply, Erection, Testing & Commissioning of 220/66kV GIS Substation at Bharthal, including complete civil works & automation, along with LILO of 220kV D/C Bamnauli-DIAL Overhead Transmission Line at Bharthal, on a Turnkey Basis.

(Schedule of rates and prices)

Bidder's Name and Address :

Installation Charges

1	Item Description	SAC Code	Whether SAC code is confirmed. If not, indicate applicable SAC code.	Unit	Qty	Unit Charges (INR)	Total Charges (INR)	Taxes & Duties		
								GST		
								Rate	Whether rate of GST is confirmed. If not, indicate applicable rate of GST.	Amount
2	3	4	5	6	7	8= 6x7	9	10	11	
6	Installation of necessary hardware, hoisting of insulator strings, installation and stringing of HTLS conductor including fixing of conductor accessories to complete the job	998736		KM	1			18%		
7	ETC of Tower Accessories							18%		
(a)	Pipe Type Earthing of Towers	998736		Set	2			18%		
(b)	Number Plate (1 set = 2 no.)	998736		Set	1			18%		
(c)	Phase Plate (Set of two, One set contains IR, IY, IB)	998736		Set	1			18%		
(d)	Danger Plate (1 set = 2 no.)	998736		Set	1			18%		
(e)	Circuit Plate (1 set = 2 nos. circuit I & II)	998736		Set	1			18%		
(f)	Anticlimbing Device including cost of Barbed Wire, MS Angle etc.	998736		No.	1			18%		
8	Petty items to complete the job	998736		L/S	1			18%		
9	Dismantling of Six HTLS conductors & one earthwire/ OPGW including disc/polymer insulators, hardware fittings and other accessories etc. and transportation from site to other site for tentative.	998736		KM	0.2			18%		
	Sub-Total (H)									
	SUB-TOTAL I : MAIN EQUIPMENTS [(A) to (H)]									
II	Civil Works									
A	Foundations for									
1	160 MVA, 220/66/11kV, Power Transformers with accessories, NCT, soak pit and sump well, etc.	995423		No.	3			18%		
2	220kV LA	995423		No.	21			18%		
3	220kV SF6/Air Bushings	995423		No.	21			18%		
4	66kV LA	995423		No.	9			18%		
5	66kV BPI	995423		No.	18			18%		
6	1000 KVA, 11/0.433kV LT Transformer	995423		No.	2			18%		
7	250 KVA DG Set	995423		No.	1			18%		
8	66kV H-pole arrangement with LA & BPI	995423		No.	18			18%		
9	Tertiary Loading Equipments	995423		LS	1			18%		
10	Switchyard/Street light system (High Mast lighting System)	995423		LS	1			18%		
B	RCC in foundation including earth work in excavating disposal of surplus earth PCC, RCC reinforcement steel, for structures and equipments	995423		LS	1			18%		
C	Cable Trench including all types of crossings	995423		LS	1			18%		
D	Site surfacing (gravelling) & Anti weed Treatment including yard development	995423		LS	1			18%		
E	Roads (including all crossings), road in front of ICTs with connecting rail	995423		LS	1			18%		

Tender No. T26P630001

Price Schedule-3

Design, Engineering, Supply, Erection, Testing & Commissioning of 220/66kV GIS Substation at Bharthal, including complete civil works & automation, along with LILO of 220kV D/C Bamnauli-DIAL Overhead Transmission Line at Bharthal, on a Turnkey Basis.

(Schedule of rates and prices)

Bidder's Name and Address :

Installation Charges

1	Item Description	SAC Code	Whether SAC code is confirmed. If not, indicate applicable SAC code.	Unit	Qty	Unit Charges (INR)	Total Charges (INR)	Taxes & Duties		
								GST		
								Rate	Whether rate of GST is confirmed. If not, indicate applicable rate of GST.	Amount
2	3	4	5	6	7	8= 6x7	9	10	11	
F	Storm Water drainage, Rain water harvesting, Water conservation management & waste management	995423		LS	1			18%		
G	Main Gates and Switchyard Fencing along with gates	995423		LS	1			18%		
H	Buildings (including foundations)									
1	220kV GIS Building as per design requirement	995423		LS	1			18%		
2	66kV GIS building as per design requirement	995423		LS	1			18%		
3	Store room as per design requirement	995423		LS	1			18%		
4	Pumphouse alongwith pump etc.	995423		LS	1			18%		
5	Security Room, Site offices and Parking Shed	995423		LS	1			18%		
I	Transformer RCC fire walls	995423		No.	2			18%		
J	RCC frame Boundary wall with brick panneling including gates for complete substation	995423		meter	360			18%		
K	Land filling with good earth including watering, compacting etc. as per standard CPWD specifications of work	995423		Cu.m.	11500			18%		
L	Horticulture work including landscaping and Plantation as per design requirement	995423		LS	1			18%		
M	Furniture of Reputed make for complete Control Room Building including control room, office space, conference hall etc.	995423		LS	1			18%		
N	Soil Investigation	995423		LS	1			18%		
O	Demolition/Dismantling of existing fencing/structures, clearing of vegetation/tree, ground preparation, recovery of material with scrap value and Petty work as per site condition etc. (if any)	995423		LS	1			18%		
P	Petty work required for completion of job, if any	995423		LS	1			18%		
	SUB-TOTAL II : Civil Works									
	GRAND TOTAL [I+II]									

Bidder is required to quote prices in this Schedule for all the individual items/sub-items.

HSN/SAC Code shall be filled/confirmed by Bidder.

Currency shall be only in INDIAN Rupee in accordance with clause 14.2 Section-ITB Volume I of the bidding documents.

In case any additional equipment is required, the same shall be supplied without any additional payment and the offer should be complete and comprehensive.

Date:

Place :

Signature : _____

Printed Name _____

Designation _____

Common Seal

Tender No. T26P630001		Price Schedule-4	
Design, Engineering, Supply, Erection, Testing & Commissioning of 220/66kV GIS Substation at Bharthal, including complete civil works & automation, along with LILO of 220kV D/C Bamnauli-DIAL Overhead Transmission Line at Bharthal, on a Turnkey Basis.			
Bidder's Name and Address :			
GRAND SUMMARY OF THE QUOTED BID PRICE.			
S.No	DESCRIPTION	Total Price (INR)	
		PRICE	GST
1	TOTAL PRICE SCHEDULE-1 Plant and Equipment (including Mandatory Spares) to be supplied.		
2	TOTAL PRICE SCHEDULE-2 Local Transportation, Insurance and other Incidental Services.		
3	TOTAL PRICE SCHEDULE-3 Installation Charges		
	GRAND TOTAL 'I' = [1 + 2 + 3]	-	-
*currency in accordance with ITB 14.2, Vol.-I of the Bidding Documents.			
We declare that the following are our quoted bid price in INR for the entire Scope of work as specified in the specifications and documents:			
A. Quoted Bid Price Excluding taxes & duties (Grand Summary of the quoted Bid Price as in I above.):			
i. In Figures:INR			
ii. In Words: INR:			
B. Applicable Taxes & Duties and other levies, payable additionally, in respect of the transaction between the Owner and the Contractor (Total Amount to be mentioned).			
i. GST (Total Amount to be mentioned)			
ii. Total taxes & duties(i) :			
C. Total Quoted Bid Price including Taxes and Duties and other levies, if contract is awarded to us i.e A+B above			
i. In Figures:INR			
ii. In Words: INR:			

Date :

Place :

Signature : _____

Printed Name _____

Designation _____

Common Seal _____