TAMIL NADU ROAD DEVELOPMENT COMPANY LIMITED(TNRDC)
CHENNAI – 600 028

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Design, Manufacture, Supply, Erection, Testing and Commissioning of **400 KV Towers** with **Twin Moose conductors** for deviation of the existing overhead towers for formation of Northern Port Access Road (NPAR) section –I of Chennai Peripheral Ring Road(CPRR)

COMMERCIAL SPECIFICATION VOLUME – I,
TECHNICAL SPECIFICATION VOLUME – II
AND
PRICE SCHEDULE - VOLUME – III

Due date & Time for receipt of Tender : 15th March 2021 up to 15-00 Hrs
Due date & Time for opening of Tender : 15th March 2021 @ 15-30 Hrs

M/s.Tamil Nadu Road Development Company Ltd.,
No.171, II Floor, Tamil Nadu Maritime Board Building,
South Kesavaperumal Puram,
Pasumpon Muthuramalingam Road,
(Near Greenways Road MRTS Station),
Raja Annamalai Puram, Chennai 600 028

Tamil Nadu Road Development Company Ltd.

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COMMERCIAL SPECIFICATION VOLUME – I

Due date & Time for receipt of Tender : 15th March 2021 up to 15-00 Hrs
Due date & Time for opening of Tender : 15th March 2021 @ 15-30 Hrs

M/s.Tamil Nadu Road Development Company Ltd.,
No.171, II Floor, Tamil Nadu Maritime Board Building,
South Kesavaperumal Puram,
Pasumpon Muthuramalingam Road,
(Near Greenways Road MRTS Station),
Raja Annamalai Puram, Chennai 600 028

: TAMIL NADU ROAD DEVELOPMENT COMPANY LIMITED(TNRDC):

GENERAL INFORMATION ON TENDER

1.	Name of the work :		Design, Manufacture, Supply, Erection, Testing and Commissioning of **400 KV Towers** with **Twin Moose conductors** for deviation of the existing overhead towers for formation of Northern Port Access Road (NPAR) section –I of Chennai Peripheral Ring Road(CPRR).
2.	Tender documents Sale Commencement date Closing date	: :	11th February 2021 12th March 2021
3.	Pre bid meeting on	:	05th March 2021 @ 11.30 Hours
4.	Due date & time for receipt of Tenders	:	15th March 2021 up to 15.00 Hours
5.	Date & time of opening of Tenders	:	15th March 2021 @ 15.30 Hours
6.	Earnest Money Deposit	:	Rs.45,64,000/-
7.	Tender outer cover should be addressed to	:	**Chief General Manager** **M/s.Tamil Nadu Road Development Company Ltd.,** No.171, II Floor, Tamil Nadu Maritime Board Building, South Kesavaperumal Puram, Pasumpon Muthuramalingam Road, (Near Greenways Road MRTS Station), Raja Annamalai Puram, Chennai 600 028
8.	Submission of Tender	:	Two Cover System
9.	Clarification to be sought for from	:	**Chief General Manager** **M/s.Tamil Nadu Road Development Company Ltd.,** No.171, II Floor, Tamil Nadu Maritime Board Building, South Kesavaperumal Puram, Pasumpon Muthuramalingam Road, (Near Greenways Road MRTS Station), Raja Annamalai Puram, Chennai 600 028

10.	Place at which tenders will be opened	:	**M/s.Tamil Nadu Road Development Company Ltd.,** No.171, II Floor, Tamil Nadu Maritime Board Building, South Kesavaperumal Puram, Pasumpon Muthuramalingam Road, (Near Greenways Road MRTS Station), Raja Annamalai Puram, Chennai 600 028
11.	Cost of Tender document (Non Refundable)	:	Rs.56,000/- (inclusive of GST)

12. i. Tender document is also uploaded in TNRDC website **(**www.tnrdc.com**)** and the prospective bidders can get the specification by downloading from the web site. In such cases, the bidders will be required to pay the non-refundable fee as mentioned above, at the time of submission of Bids.

ii. The **Tenderers who have downloaded the Specification from TNRDC Website shall ensure whether any clarification/Amendment is issued to the Specification, before submission of their Tender, by visiting the web site.**

iii. The Demand Draft / Banker's Cheque shall be drawn in favour of **"M/s TAMIL NADU ROAD DEVELOPMENT COMPANY LIMITED(TNRDC)" , payable at Chennai.**

13. If the due date for receiving and opening the tender happens to be a declared holiday then the tender will be received and opened on the next working day.

14. **The tender documents submitted shall be in volumes with all the pages serially machine numbered.**

TENDER DOCUMENTS ARE NOT TRANSFERABLE

VOLUME – I

I N D E X

SECTION I
EARNEST MONEY DEPOSIT

1. Tenderer should pay the specified amount towards Earnest Money deposit as follows: **Earnest Money Deposit: Rs.45,64,000/-.**
2. A DEMAND DRAFT / BANKER's CHEQUE from any of the Nationalized / Scheduled / Foreign Banks with branches in India shall be drawn in favour of **TAMIL NADU ROAD DEVELOPMENT COMPANY LIMITED(TNRDC)**, "payable at Chennai".
3. Bank Guarantee from any Nationalised/Scheduled bank approved by RBI and the same shall be valid for 1 month beyond the validity period of the Bid.
4. The EMD will not carry any interest.
5. The Earnest Money Deposit will be refunded to the unsuccessful tenderers on application to the Chief General Manager, TNRDC after intimation of the rejection / non-acceptance of their tenders sent to them.
6. CHEQUE will not be accepted towards EMD and the tenders shall be rejected if EMD is not paid in the prescribed manner.
7. OTHERS INCLUDING Central and other State Government departments Undertakings and Corporations outside Tamil Nadu shall have to pay Earnest Money Deposit.
8. If, on opening the outer cover and Envelope "A", it is found that the DD/Bankers Cheque towards Earnest Money Deposit has not been enclosed along with the tender, then their offer will be SUMMARILY REJECTED without opening Envelope – B.
9. The Earnest Money Deposit made by the Tenderer will be forfeited if,
    a. The Tenderer withdraws the tender or backs out after acceptance,
    b. The Tenderer withdraws the tender before the expiry of validity period stipulated in the specification or fails to remit the Security Deposit,
    c. The Tenderer violates any of the provisions of these regulations contained herein,
    d. The Tenderer revises any of the items quoted during the validity period,
    e. The BQR evidences are found to be fraudulent/non-genuine, in addition to black listing in future contract with TANTRANSCO.

SECTION -II

BID QUALIFICATION REQUIREMENT

The Bidders shall become eligible to Bid, on satisfying the following 'Bid Qualification Requirements' and on production of the required documentary evidences along with the Tender.

1 a) <u>Supply of Towers:</u> The tenderer should have in house design department, designed towers and its foundations, should also have own tower testing facility in India and tested for Transmission line towers of 400 kV and above voltage rating in the last ten years for Electricity Boards / Power utilities. The tenderer should have minimum production capacity of **1750 MT per annum** in India.

b) W**ork experience** (i) The tenderer should have fabricated, galvanized and supplied minimum **875 MT** of 400 kV and above towers to Electricity Boards/Power utilities in India during the last ten years and which should have been in operation at least for two years as on the date of technical bid opening.

Alternatively, the tower suppliers from whom the bidder propose to procure the towers should have in house design department, designed both tower and its foundations, should also have own tower testing facilities in India and tested Transmission line towers of 400 KV and above voltage rating in the last ten years. Also the tower suppliers from whom the bidder propose to procure the towers should have manufactured, galvanized and supplied minimum **875 MT** of 400 kV and above towers to Electricity Boards/Power utilities in India during the last ten years and which should have been in operation at least for two years as on the date of technical bid opening and shall have minimum production capacity of **1750 MT per annum.** The TANTRANSCO should authorise the supplier. Copy should be enclosed. (The End-user Certificate should consists of date of Supply of Towers in Tonnage

and not in number. If the date of supply and weight in tonnage not mentioned in the End-user certificate, the same will not be considered for evaluation)

ii) The tenderer should have performed detailed survey, executed conventional foundations, supplied and erected towers and stringing done with tension stringing equipment, successfully tested and commissioned at least **1.70 circuit Km (Ckm)** of 400 kV Multi circuit Transmission line with Twin Moose conductor per phase in a single package to Electricity Boards/Power utilities in India in any one of the year during the last 10 (Ten) years and which should have been in satisfactory operation at least for two years as on the date of technical bid opening. (The End user Certificate should Consists of the Type/Configuration of Conductor such as Zebra Conductor/ Twin Moose Conductor)

d) The Tenderer should have complete set of tension stringing equipments of capacity 16 Tonnes or above for Twin Moose conductor.

e) The Experience as sub contractor will not be considered for qualifying experience criteria and offer of such tenders will be summarily rejected.

f) Financial requirements: Annual turnover of the tenderer during any one of the last three financial years (2017-18 to 2019-20) should be more than at least **Rs. 45.64 Crores**. A copy of Profit and Loss account and balance sheet for the last three financial years (2017-18 to 2019-20) duly certified by the Chartered Accountant shall be furnished along with the tender. Annual turnover certificate should be certified by the Auditor.

The attested copy of Income Tax return filed by the bidders, the attested copy of Sales Tax Clearance Certificate and the attested copy of enlistment certificate issued by NSIC containing the turnover details of the bidder for the respective period may also be furnished along with the tender as a proof for the Annual Turnover criteria.

g) The tenderer should furnish along with the tender the relevant documentary evidences/end users certificates to prove their/tower supplier's experience in design, testing of towers, manufacturing capacity, supply of towers, execution of works and satisfactory operation. (All the certificates for proof should be attested)

h) The end user certificate for the satisfactory performance of the works & the respective Purchase order/Work order for having executed the work specified in clause (a), (b) and (c) shall be furnished along with the tender.

i) The offers of the bidders not satisfying the above “Bid Qualification Requirements” will be summarily rejected.

j) All the BQR evidences along with LOA Copy and relevant BQR supporting documents should be in separate file (Separate Volume). BQR evidences/Proof of Certificate will not be considered if it is available in other file.

k) All the Tender Document should be continues Machine numbered. If not, the Bid will be summarily rejected.

l) Submission of irrelevant Documents will leads to the Rejection of the Bid.

m) End-User certificate should consist of the details of the issuing authority such as Name, Contact No, and Email Id etc.,

SECTION – III
REJECTION OF TENDERS

I. Tender will be summarily rejected if

a. the EMD requirements are not complied with,

b. Bid Qualification Requirements are not satisfied

II. Tender is liable to be rejected, if it is

a. not covering the supply of equipments/materials with all accessories,

b. with validity period less than that stipulated in this specification,

c. not in conformity with TANTRANSCO's commercial terms and Technical specifications,

d. not signed by the tenderer,

e. received from any Black listed Firm / Contractor,

f. received by Telex/Telegram/E-mail,

g. received from a tenderer whose past performance/vendor rating is not satisfactory,

h. not containing all required particulars as per Schedules prescribed in this specification,

i. received from consortium units of SSI, NCSI, TANSIDCO etc.,

j. the tenderer shall clearly indicate in the offer whether the company is a potentially sick industrial company or a sick industrial company in terms of Sec. 15 or sec. 23 of the sick industrial companies special provisions act 1985. Failure to disclose this information will make the tender liable for rejection.

k. Containing false and bogus certificates.

l. Received from the tenderer who is directly or indirectly connected with Government service or TANTRANSCO service or services of Local Authority.

m. Not marked Techno-Commercial Bid as "A" & Price bid as "B".

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SECTION – IV
INSTRUCTIONS TO TENDERERS

1.0. Sealed tenders in Two Cover System (a) Technical and Commercial terms without Price Bid and (b) Price Bid, in duplicate will be received for and on behalf of TAMIL NADU ROAD DEVELOPMENT COMPANY LIMITED herein after referred as TNRDC so as to reach on or before the due date prescribed. All the tenders shall be prepared and submitted strictly in accordance with the Instructions set forth herein. THE TENDERERS WHO DO NOT FULFILL THE "BID QUALIFICATION REQUIREMENTS" AS PER SECTION-II NEED NOT PARTICIPATE IN THE TENDER. OFFERS NOT SATISFYING THIS "BID QUALIFICAION REQUIREMENTS" WILL BE SUMMARITY REJECTED.

1.1.0. The Tamil Nadu Transparency in Tenders act 1998 and Tamil Nadu Transparency in Tender rules 2000 are applicable to this tender.

1.2.0. The Tenderers shall furnish their PAN & GST number, in their offer or other relevant documents without fail.

2.0. SCOPE OF WORK:

2.1.0. The scope of this specification is as per the Technical Specification for performance of Manufacture, supply, erection, stringing and commissioning of 400 KV line with TWIN MOOSE ACSR CONDUCTOR including cost of materials like Tower, Insulators, ACSR Moose conductors, earth wire, OPGW and other line stringing hardware as detailed below:

Design, Manufacture, Supply, Erection, Testing and Commissioning of 400 kV DC in MC towers with Twin Moose conductors for formation of Northern Port Access Road (NPAR) Section-I of Chennai Peripheral Ring Road (CPRR).

i) 3.0. SUBMISSION OF TENDER OFFER:

3.1. The Tenderer is expected to examine all instructions and Schedules detailed in the Specification and submit the Schedule of prices and other required particulars in the Schedules called for in the specification only as per the format enclosed herewith.

3.2. The Tender Documents can also be downloaded from TNRDC website (www.tnrdc.com). In such cases, the bidders will be required to pay the non-refundable fee as mentioned above, at the time of submission of Bids.

4.0. TWO PARTS TENDER:

4.1. The Tenders shall be in Two Parts as detailed below each in a separate sealed Envelope marked.

"ENVELOPE – A" AND "ENVELOPE-B"

The first envelope, called Envelope A shall contain:

a. Un priced bid as per Schedules (i.e. technical with Commercial Terms except Price.)

b. Any other information called for in the specification other than price.

THIS ENVELOPE- "A" SHOULD NOT CONTAIN ANY PRICE BID.

4.2. The second envelope, called Envelope-B, shall contain the PRICE BID.

4.3. The Tender in two parts shall be prepared in duplicate and put inside a separate sealed super scribed envelope (Envelope-A and Envelope-B) as instructed above.

4.4. The following should be enclosed along with the Tender offer inside the **Outer Cover or Envelope 'A'.**

i) Demand Draft / bankers' Cheque towards EMD.

If, on opening the Outer Cover and Envelope 'A', it is found that the above have not been enclosed along with the tender, then their offer will be SUMMARILY REJECTED without opening Envelope-B.

4.5. Envelope-A and Envelope-B and the overall envelope should be individually sealed, super scribed with

"Design, Manufacture, Supply, Erection, Testing and Commissioning of **400 KV Towers** with **Twin Moose conductors** for deviation of the existing overhead towers for formation of Northern Port Access Road (NPAR) section –I of Chennai Peripheral Ring Road(CPRR)."

4.6. The tender offers in complete shape in one envelope containing Envelope-A and Envelope-B, as required in Clause 4.3 shall be sent so as to reach the Office of the Chief Engineer/Civil/Transmission on or before 3.00 P.M. on the due date for submission of offers.

4.7. The tender documents shall be addressed to The Chief General Manager, TNRDC, South Kesavaperumalpuram, Greenways Road, RA puram, Chennai-600 028.

4.8. If any of the bidders indicate price in Envelope-A, the Bid will not be read out and will be rejected.

4.9. OPENING OF PRICE BID

4.9.1 Envelope-B will not be opened at the time of opening Envelope-A but will be authenticated on the covers by officers authorized to open the bids. Envelope-B so authenticated will be kept under the safe custody of the empowered Officer to open the tender. After ascertaining the technical suitability of Bidders, the Price Bid (Envelope-B) of the Bidders opening date, time, and place will be intimated to the Bidders. The Price Bids, all discounts offered etc will be read out to the Bidders or their representatives who choose to be present and recorded.

4.9.2 Arithmetical errors will be rectified on the following pattern.

a) If there is discrepancy between the unit price and the total price that is obtained by multiplying the unit price and the quantity, the unit price quoted or the unit price arrived from the total price whichever is less shall be taken. In case of discrepancy between the prices quoted in words and in figures, lowest of the two shall be considered.

b) If there is discrepancy between the quoted FOR(D) and the FOR(D)arrived by summing up the basic and GST, the lowest of the two shall be considered.

4.10. If the tenderer finds any ambiguity in any of the terms and conditions stipulated in this specification, he shall get it clarified from the Chief General Manager, TNRDC, South Kesavaperumalpuram, Greenways Road, RA puram, Chennai-600 028. If this is not done and subsequent to the opening of the tenders, it is found that the doubt, about the meaning or ambiguity in the interpretation, if any of the terms and conditions stipulated in the specification are raised by the tenderer either in this tender or by a separate letter, the interpretation or clarification issued by the Chief General Manager, TNRDC, South Kesavaperumalpuram, Greenways Road, RA puram, Chennai-600 028 on such terms and conditions shall be final and binding on the tenderer.

4.11. All tender offers shall be prepared by typing or printing in the formats enclosed with specifications. **One <u>original</u> and one <u>duplicate</u> of the original offer <u>which are identical</u> shall be submitted by each tenderer. The tender documents submitted shall be in volumes with <u>all the pages serially machine numbered.</u>**

4.12. All information in the tender offer shall be in ENGLISH only. It shall not contain interlineations, erasures or over writings except as necessary to correct errors made by the tenderer. Such erasures or other changes in the tender document shall be attested by the person signing the tender offer.

4.13. The tender offer shall contain full information asked for in the accompanying schedules and elsewhere in the specification.

4.14. Deleted.

4.15. Deleted.

4.16. The tenders should be delivered in person and shall be handed over to the Chief General Manager, TNRDC, South Kesavaperumalpuram, Greenways Road, RA puram, Chennai-600 028 before 15.00 hrs. on the due date.

4.17. The TNRDC will not be responsible for any delay in receipt of the tender offer.

4.18. Telex/Fax/E-Mail or telegraphic offers will not be entertained and will be rejected.

4.19. Any offer received by the Purchaser after the due date and time specified for submission of tender offer will be declared late, rejected and returned unopened to the tenderer.

4.20. No tender offer shall be allowed to be modified subsequent to the deadline for submission of tender offers.

4.21.1. Tenderer shall bear all costs associated with the preparation and delivery of offers, and the PURCHASER will in no case be responsible or liable for these costs.

4.22. No offer shall be withdrawn by the tenderer in the interval between the deadline for submission and the expiry of the period of validity specified/extended validity of the tender offer.

4.23. Tenders received from Agents/Dealers will not be considered.

4.24. The tenderers are requested to furnish the exact location of the Registered Offices with detailed postal address and Pin code, Telephone and Fax nos. etc., in their tender so as to arrange inspection by the TANTRANSCO, if considered necessary.

5.0. PRE BID MEETING:

A pre bid meeting will be held on the subject tender, at the Office of the Chief General Manager, TNRDC, South Kesavaperumalpuram, Greenways Road, RA puram, Chennai-600 028, on the date and time mentioned as above.

6.0. TENDER OPENING:

6.1. The tender offers except price bid will be opened at **15.00 Hrs.** on the date notified, at the Office of the Chief General Manager, TNRDC, South Kesavaperumalpuram, Greenways Road, RA puram, Chennai-600 028 in the presence of tenderer's authorized representative who may wish to be present on the date of opening.

6.2. If the last date set for submission of tender offers and opening date happens to be a holiday, the tenders will be received and opened on the succeeding working day, without any changes in the timings indicated.

6.3. The duly authorized representative of the tenderers who are present shall sign the tender opening register.

6.4. The Tenderer's Name, prices, all discounts offered, and such other details as the TNRDC, at its discretion, may consider appropriate will be read out and recorded at the time of opening of the Financial Bid.

7.0. INFORMATION REQUIRED AND CLARIFICATIONS:

7.1. If any tenderer requires clarification it may be sought **before 15 Days of the tender opening.**

7.2. To assist in the examination, evaluation and comparison of tender offers, the TNRDC may, at its discretion, ask the tenderer for a clarification of his offers. All responses to requests for clarification shall be in writing and to the point only. No change in the price or substance of the offer shall be permitted.

7.3. The TNRDC will examine the tender offers to determine whether they are complete, whether any computational errors have been made, whether required sureties have been furnished, whether the documents have been properly signed and whether the offers are generally in order.

7.4. Prior to the detailed evaluation, the TNRDC will determine the substantial responsiveness of each offer to the Bidding Documents. A substantially responsive offer is one, which conforms to all the terms and conditions of the specification without any deviation.

7.5. The tender offers 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 TNRDC to the tenderers. While the offers are under consideration, tenderer and/or their representatives or other interested parties are advised to refrain from contacting by any means, the TNRDC/TANTRANSCO and/or TNRDC/TANTRANSCO's employees/representatives on matters related to the offer under consideration.

7.6. Mere submission of any Tender offer connected with these documents and specification shall not constitute any agreement. The tenderer shall have no cause of action or claim, against the TNRDC for rejection of his offer. The TNRDC shall always be at liberty to reject or accept any or offers at its sole discretion and any such action will not be called into question and the tenderer shall have no claim in that regard against the TNRDC.

8.0. Evaluation and Comparison of Tender Offers:

i) The tender offers received and accepted will be examined to determine whether they are in complete shape, all data required have been furnished, the tender offer is properly signed and the offers are generally in order and the tender offer conforms to all the terms and conditions of the specification without any deviation.

ii) For the purpose of evaluation of the tender offers, the following factors will be taken into account for arriving at the evaluated price.

a) The evaluated price will be all-inclusive price. The overall lowest amount quoted by the bidder inclusive of all charges will be considered.

b) The amount and percentage of GST shall be indicated in the offer.

c) If all the tenderers are from within the State of Tamil Nadu or if all the tenderers are from outside the State of Tamil Nadu, the GST shall be included for the evaluation of the price. If the tenderers are both from the State of Tamil Nadu as well as from the outside of Tamil Nadu, the GST quoted shall be excluded for the evaluation of price.

d) The bidder can choose to quote bought out items with GST. The same will be considered for evaluation purpose, while passing bills for the bought out items, only GST as mentioned in the offer would be allowed.

e) The bidders are requested to indicate in their offer the rate of GST, value on which shall be applicable and the category of service under which it is applicable. The GST quoted will also be included for the purpose of evaluation.

f) The quoted price shall be corrected for arithmetical errors.

g) In case of discrepancy between the price quoted in words and figures, the lower of the two shall be considered.

h) For bid evaluation, the exchange rate on the date of Technical Bid opening will be taken into account.

i) The offers will be evaluated as a whole package.

9.0. VALIDITY:

9.1. The tender offer shall be kept valid for acceptance for a **period of 180 days the date of opening of offers**. The offers with lower validity period are liable for rejection.

9.2. Further, the tenderer shall agree to extend the validity of the Bids without altering the substance, and prices of their Bid for further periods, if any required by the TNRDC/TANTRANSCO.

10.0. RIGHTS OF THE TNRDC:

Notwithstanding anything contained in this specification the TNRDC reserves the right to:

a. accept the lowest or any other tender,

b. revise the quantities at the time of placing of orders,

c. reject any or all the tenders or cancel without assigning any reasons therefore,

d. to split the Tender Quantity and place orders on one or more than one Firm to meet the delivery requirements.

e. to relax or waive or amend any of the conditions stipulated in the tender specification wherever deemed necessary in the interest of the TNRDC.

f. Recover losses if any sustained by TNRDC, from the supplier who pleads his inability to supply, and backs out of his obligation after award of contract. The Security Deposit paid shall be forfeited.

g. to cancel the orders for not keeping up the execution.

11.0. DEVIATIONS:

11.1. The tenderer shall furnish, if there are any deviations in the commercial and technical terms in the Schedule - B and C annexed. **Deviations mentioned elsewhere will not be considered.** If deviations are not furnished, it will be construed that the tenderer is accepting all terms specified in the specification. Similarly if any deviations are furnished in the Schedules-B and C, it will be construed that these are the only deviations and the tenderer is accepting all other terms of the specification and the offer will be taken for evaluation accordingly.

11.2. THE OFFERS OF THE TENDERERS WITH DEVAIATIONS IN COMMERCIAL TERMS OF THE TENDER WHICH COULD NOT BE ACCEPTED WILL BE REJECTED.

11.3. NO ALTERNATIVE OFFER WILL BE ACCEPTED.

11.4. The following details shall be furnished along with the Bid for evaluation of the Bidder's eligibility to perform the Contract.

a. Authenticated documentary evidence by the Chartered Accountant in support of qualifying requirements in the prescribed format i.e., Erection of 400 kV DC Lines,

supply and erection of Galvanized towers, financial requirements for the periods stipulated in Section-II and other evidences of qualifying requirements.

b. Confirmation to the compliance of the completion schedule specified.

c. The proposed methodology of construction, backed with the details of their construction equipment, planning and deployment organization, duly supported with broad calculations and quality control procedures proposed to be adopted justifying their capability of achieving the completion of work as per mile stones within the stipulated period of completion.

d. Copies of original documents defining the constitution or legal statutes, place of registration and principal place of business, written power of attorney of the signatory of the Bid to commit the Bidder.

e. Total monetary value of construction work performed during 2017-2018, 2018-2019 & 2019-2020 current order book position and balance capacity available.

f. Experience in works of a similar nature and quantum of each work during the period as mentioned in BQR and details of works underway or contractually committed by the Bidder and the other manufacturer and name and address of clients, e-mail address, contact number whom the Purchaser may contact for further information on those contracts.

g. Qualifications and experience of key site management and technical personnel proposed for the Contract.

h. Reports on the financial standing of the Bidder such as profit and loss statements and auditors' report for the past three years.

i. Evidence of adequacy of working capital for this contract (access to line(s) of credit/solvency Certification from Banker's etc.)

j. Authority to seek references from the Bidder's bankers. Name, address, telephone Numbers, FAX numbers of the Bidder's Bankers who may provide details if contacted by the Purchaser.

k. Information regarding any litigation, current or during the last three years in which the Bidder is involve, the parties concerned and disputed amount.

l. Testing facilities at the manufacturer's works.

m. Copies of type test reports for the 400 kV and above towers designed and tested by the Bidder and for other major materials.

n. Satisfactory performance certificate for at least 2 years issued by a SEB/Power Utility after commissioning of the line.

o. The Bidder shall have an established quality assurance system and organization designed to achieve high levels of work execution, equipment reliability during its manufacture. They shall furnish Quality Assurance Plan for the above. Sub Vendors'/Sub Suppliers' quality assurance plan shall also be furnished without fail.

p. Proposal for survey, manufacturing, erection methods and schedules in sufficient details to demonstrate the adequacy of the bidder's proposal to meet the technical

specification for supply and erection and completion period referred to in the bidding documents.

Even though the Bidder meets the qualifying criteria, they are subject to disqualification if they have,

- made misleading or false representation in the forms, statements and attachments submitted in proof of the qualification requirements and/or

- Record of poor performance such as abandoning the works, not properly completing the contract, inordinate delays in completion, litigation history or financial failures etc.

Not with standing anything stated above, the purchaser reserves the right to assess the Bidders capability to perform the contract, should circumstances warrant such assessment in the overall interest of the Purchaser.

12.0. INSPECTION OF SITE BY BIDDER:

12.1. Bidder shall inspect the site, examine and obtain all information required and satisfy themselves regarding matters and things such as access to site, communication, transport, right of way, the type and quantity of materials and facilities required for the satisfactory completion of work, the quantity of various sections of the work, the availability of local labour, availability and rates of materials, local working conditions, uncertainties of weather, obstructions and hindrances that may arise etc., which may affect the work or cost thereof, before submission of his BID. Ignorance of SITE CONDITIONS shall not be accepted by the owner as basis for any claim for compensation. The submission of a bid by the bidder will be construed as evidence that such an examination was made and any later claims/disputes in regard to rates quoted shall not be entertained.

12.2. If any temporary feeder road within site is considered essential for the proper execution of the work this shall have to be formed by the Contractor at his own cost with the prior approval of the Engineer. The Contractor shall organize their own arrangement to transport the men and materials in such a manner that the completion period will not be exceeded on any account.

12.3. The rates quoted by Bidder shall be based on their own knowledge and judgment of the conditions and hazards involved and shall not be based on any representations to the Engineer.

13.0. APPEAL:

Any tenderer aggrieved by the order passed by the Tender accepting Authority under section-10 of the Tamil Nadu Transparency in Tenders Act 1998 may appeal to the Government within ten days from the date of receipt of order.

14.0. BAR OF JURISDITION:

Save or otherwise provided in the Tamil Nadu Transparency in Tenders Act 1998 this Act no order passed or proceeding taken by any officer or authority under this Act shall be called in question in any Court, and no injunction shall be granted by any

Court in respect of any action taken/or to be taken by such Officer or authority in pursuance of any power conferred by or under this Act.

15.0. CONTRACT AGREEMENT DOCUMENT:

15.1.0. A draft copy of the AGREEMENT DOCUMENT has to be prepared by the successful TENDERER within 60 days from the date of receipt of detailed acceptance letter and sent to the Chief General Manager, TNRDC, South Kesavaperumalpuram, Greenways Road, RA puram, Chennai-600 028 for ACCEPTANCE. A copy of the specification for the preparation of draft contract document can be had from the Chief General Manager, TNRDC, South Kesavaperumalpuram, Greenways Road, RA puram, Chennai-600 028 at free of cost if required. After approval, the draft copy will be returned to the CONTRACTOR. Based on the approved copy, the CONTRACTOR will have to prepare one ORINGAL COPY along with the ARTICLES OF AGREEMENT in Non judicial Stamp paper of value not less than Rs.100/- and another DUPLICATE COPY of the contract document duly signing all the pages of both the copies and submit them within 15 days from the date of receipt of draft copy to the Chief General Manager, TNRDC, South Kesavaperumalpuram, Greenways Road, RA puram, Chennai-600 028 for executing the contract agreement. After the execution of agreement, the original copy will be retained in this office and the duplicate copy will be returned to the CONTRACTOR. Eight (8) true copies of this contract document shall be prepared by the CONTRACTOR and submitted to this office within 15 days of receipt of the approved duplicate copy of the contract agreement.

16.0 GENERAL CONDITIONS:

16.1. The tenderers should indicate clearly in the tenders whether the Company is a potentially sick Industrial Company or a sick Industrial Company in terms of Section-23 or Section-15 of sick industrial companies' special provisions Act 1985. Failure to supply this information will make the tender liable for rejection.

16.2. The Tenderers are requested to procure the equipments / materials only from reputed / qualified manufacturer as per Technical requirement stipulated in Technical Section.

16.3. The Type Tests for all the equipments / materials used for this project should have been conducted in any approved Government / Government recognized laboratories conforming to latest IS/IEC. The above type test certificates should accompany the drawings of the materials / equipments, duly signed under seal by the Institution, who have issued the type test certificate.

The above type test should have been conducted not earlier than five (Five) years as on the date of Tender Opening.

The original type test certificates shall be furnished for verification on request.

The purchaser reserves the right to demand repetition of some or all the type tests in the presence of purchaser's representative.

16.4. All the intending Tenderers are informed that in the event of documents furnished with the offer being found to be bogus or the documents containing false particulars, the EMD paid by such tenderers will be forfeited in addition to blacklisting them for future orders/contracts in TNRDC/ Tamil Nadu Transmission Corporation Limited.

16.5. The Tenderers should submit all the type tests as per ISS, drawings obtained from approved suppliers of TANTRANSCO/ Power utilities (State /Central) within fifteen days from the date of Contract Agreement and should get approval from TANTRANSCO for each material.

16.6. **Inspection**:

16.6.1. The purchaser or their representative shall have the right to inspect and/or test the goods/works to confirm their conformity to the Contractor. The Purchaser/owner shall notify the Contractor/supplier in writing of the identity of any representatives authorized for these purposes.

The inspections and tests may be conducted on the premises of the supplier/Contractor or their Sub Contractor at the point of delivery and /or at the goods' final destination. Where tests are conducted in the premises of Supplier/Contractor, all reasonable facility and assistance including access to drawings and production data shall be furnished at no charge to the Purchaser/Owner.

Should any inspected or tested goods fail to conform to specifications, the Owner/Purchaser may reject them and the supplier/contractor shall either replace the rejected goods or make all alterations necessary to meet specification requirements free of cost to the Purchaser/Owner within one week of intimation.

The Purchaser/Owner's right to inspect, test and where necessary reject the goods after the arrival of goods at the site, shall in no way be limited or waived by reason of the goods having been previously inspected, Tested and passed by the Purchaser/Owner or their representative prior to the goods' dispatch.

16.6.2. Not less than 15 (Fifteen) days advance intimation shall be given about the quantity of materials that will be ready for inspection by the officers of TNRDC/TANTRANSCO/ Third agency authorized by the TNRDC/TANTRANSCO. The materials should not be dispatched without instruction from the TNRDC/TANTRANSCO.

17.0. QUALIFICATION REQUIREMENT FOR PROCUREMENT & SUPPLY OF MATERIALS:

The bidder should have assured access to supply of Moose ACSR, Zebra Earth wire, OPGW Insulators, Hardware fittings & Accessories for conductor and Earth wire, GI Bolt & nut, GI Anti theft Bolt & nut and washers etc. qualified manufacturers meeting the following minimum requirement and must demonstrate that based on known commitments they will be available for use in the proposed contract.

The qualified manufacturer should have designed, manufactured, type tested and supplied hardware fittings for 400 kV or above voltage transmission line at least 25% of the quantity of line materials (like Moose ACSR, Earth wire, OPGW Insulators, Hardware fittings & Accessories for conductor and Earth wire) required for transmission line, directly to Electricity Boards/Power utilities in India or to the Turnkey contractors who have executed

the line to Electricity Boards/Power utilities in India in any one year during the last ten years and at least 10% of the quantity required for the transmission line should have been in satisfactory operation for a minimum period of two years as on date of technical bid opening or at the time of sub vendor approval.

Further, qualified manufacturer should also have type tested Twin tension and suspension strings suitable for Moose ACSR for 400 KV voltage rating in a period not later than 10 years as on date of technical bid opening or at the time of sub vendor approval.

For spacer dampers for Twin bundle/Twin conductor and vibration dampers for earth wire, the experience should include at least the supply of 1000 Nos of spacer dampers for Twin bundle/Twin conductor and 100 Nos of vibration dampers for earth wire for 400 KV or above voltage transmission line and at least 10% of the quantity required for the transmission line should have been in satisfactory operation for a minimum period of two years as on date of bid opening. (For accessories for galvanized steel earth wire, the requirement of voltage level shall not be applicable).

In case of procurement of spacer damper for Twin ACSR from those approved sub vendors having satisfactory operation period of more than 2 years for Twin Spacer damper as on date of opening of technical bid then the sub vendor shall provide performance guarantee for 60 months from the date of energization instead of 36 months.

After award and at the time of execution of work in case of any sub vendor substituted for the originally proposed and approved sub vendor, the new sub vendor shall also satisfy the requirements specified and the approval obtained from the Board for the new sub vendor.

If the line materials are proposed for procurement from sub vendor companies approved earlier for similar 400 kV and above transmission line projects executed by TANTRANSCO, furnishing of required documents for sub vendor approval for this project is not required, however prior intimation shall be given & acceptance to be obtained from TNRDC/TANTRANSCO before initiating the procurement process.

The successful bidders shall procure any individual item(s) from the manufacturer(s) meeting the above requirement after obtaining approval for the respective item(s).

The manufacturer(s) meeting the above requirement for any individual item or items shall be considered qualified for the respective item or items. The tenderer shall furnish the end user certificate of the qualified manufacturers to prove their experience in supply and satisfactory performance of materials. The tenderer shall furnish the type test certificates for all the materials conducted in a period not later than 10 years as on date of opening of technical bid or at the time of sub vendor approval from a reputed/approved laboratory (by Government /Power utility) for having conduct.

SECTION – V

COMMERCIAL AND GENERAL CONDITIONS OF CONTRACT

1.0 GENERAL:

1.1 DEFINITION OF TERMS:

1.1.1 In construing these General conditions and the annexed specification, the following words shall have the meanings herein assigned to them unless there is something in the subject or context inconsistent with such construction.

1.1.2. "The TNRDC / Owner / Purchaser / Employer" shall mean the Tamil Nadu Road Development Company Limited, Chennai and shall include their legal representatives, successors and permitted assignees.

1.1.3. "The Contractor / Supplier" shall mean the Tenderer whose tender has been accepted by the Corporation and shall include the Tenderers' legal/personal representatives, successors and assignees.

1.1.4. "The Sub-Contractor" shall mean the person named in the Contract for any part of the work or any person to whom any part of the Contract has been sublet with the consent in writing of the Owner/Engineer shall include legal representatives, successors and permitted assigns of such person.

1.1.5. "Engineer" shall mean the Chief General Manager, TNRDC, South Kesavaperumalpuram, Greenways Road, RA puram, Chennai-600 028. In case, where no such Engineer has been so appointed, the work "Engineer" shall mean the "TNRDC' or its duly authorized Representative. "Engineer's Representative" means any resident Engineer or Assistant of the engineer or any clerk appointed for works from time to time by the Employer or the Engineer whose duties and authority will be noticed to the Contractor in writing by the Engineer.

1.1.6. "The Goods" means all the equipment, machinery and/or other materials, which the Contractor is required to supply to the TNRDC/TANTRANSCO under the contract.

1.1.7. "Plant, Work or Works" shall mean and include plant materials to be provided and work and / or services to be done by the Contractor under the Contract. This also includes all temporary works of every kind required in or about the execution of the works.

1.1.8. "Services" means services auxiliary to the detailed engineering, fabrication, supply, erection, testing and commissioning of 400 KV transmission line including cost of all materials under turnkey contract and such as transportation and Insurance, and any other incidental services, such as in testing and commissioning, providing of technical assistance, training and other such obligations of the supplier/Contractor under the Contract, whether specified or not but necessary for completion of the work.

1.1.9. "The Contract" shall mean the Agreement and include the general conditions, specifications, schedules, sections, drawings, form of tender, covering letter,

schedule of prices or the final general conditions, any specific conditions applying to the particular contract, specification and drawings, Contractor's quotation and subsequent correspondence lists under reference and the agreement to be entered as per the conditions of supply or work with these general conditions.

1.1.10. "The Specification" shall mean all technical and other stipulations annexed to these general conditions.

1.1.11. "The Site" shall mean the place where equipments are to be installed/ erected and serviced for commercial operation and also include all the area in which operation in respect of the works are carried out. This term shall also include material stocking yard and the area where temporary structures are put up for installing any part of the work etc.

1.1.12. "Tests and Completion" shall mean such tests as prescribed by the Engineer before the line is taken over by the TANTRANSCO.

1.1.13. "Commercial Use" shall mean that use of the work, which the Contract contemplates or usage when it is to be commercially available.

1.1.14. "Guaranteed Period" shall mean 36 months for all equipments / materials and accessories from the date of commissioning of the whole work.

1.1.15. "Month shall mean calendar month.

1.1.16. "Writing" shall include any manuscript, typewritten, print out or seal as the case may be.

1.1.17. "Persons" shall include firm, Company, Corporation and other body of persons whether incorporated or not.

Words imparting the singular meaning shall also include the plural and vice versa where the context so requires.

2.0. **CONTRACTOR TO INFORM HIMSELF FULLY**:

The Contractor shall be deemed to have carefully examined the general conditions and specifications. If he shall have any doubt as to the meaning of any portion of these general conditions of the Contract, he shall set forth the particulars thereof, and send them to the Engineers in writing, in order that such doubt may be clarified.

3.0. ENHANCEMENT OF RATES:

No representation for enhancement of rates will be considered during the currency of the Contract.

4.0. **SUB – LETTING OF CONTRACT**:

4.1. The Contractor shall not, without the consent in writing of the TNRDC/TANTRANSCO, assign or sublet his contract including supply of material or any substantial part thereof, provided that any such consent shall not relieve him from any obligation, duty or responsibility, liability under the Contract. If the Contractor sublets or changes the sub-contractor without notification to the TNRDC/TANTRANSCO, then TNRDC shall not make payments for such works/materials. If any defects/damages in works or materials are noticed in such unauthorized sublet portion within the

expiry of guarantee period/TANTRANSCO reserves the right to rectify/redo the defective goods/ works at its own cost; and such cost/damages will be recovered from Contractor.

4.2. The tenderer should furnish an Undertaking that he is responsible for any portion of works if carried out by the sub-contractor and he is jointly and severally accountable to the Tamil Nadu Transmission Corporation Limited, in the event of defective design or defaults in the performance.

5.0. **DEPARTURE FROM CONTRACT TERMS**:

5.1. No alterations, amendments, omissions, additions, suspensions or variations of works (hereinafter referred to as variation under the Contract as shown in the Specifications) shall be made by the Contractor except as directed in writing by the Engineer. However the Engineer shall have full powers subject to the provision hereinafter contained from time to time during the execution of the Contract by notice in writing, to instruct the Contractor to make such variations without prejudice to the Contractor and the Contractor shall carry out such variations occurred in the Specifications. If any suggested variations occurred in the Specification, and in the Contractor's opinion, if carried out, prevent the Contractor from fulfilling any of the Contractor's obligations or guarantee under the Contract, the Contractor, shall notify the Engineer thereof in writing and the Engineer shall decide forthwith whether or not the same shall be carried out, and if the Engineer confirms Contractor's instructions, Contractor's obligations and guarantee shall be modified to such an extent as may be justified. The difference of cost, if any, occasioned by any such variations, shall be added to or deducted from the Contractor's price as the case may require.

5.2. The amount of such difference, if any, shall be ascertained and determined in accordance with the rate specified in the Schedule of prices, so far as the same may be applicable and where rates are not contained in the schedule or not applicable, they shall be settled as indicated elsewhere. But the TNRDC shall not become liable for the payment of any charges in respect of any such variations unless the instructions for the performance of the same shall have been given in writing by the Engineer.

5.3. In the event of the Engineer requiring any variation, such reasonable and proper notice shall be given to the Contractor as will enable him to make his arrangements accordingly and in cases where goods or materials or works are already prepared, executed and required to be altered, a reasonable sum in respect there or, shall be allowed by the Engineer, provided that no such variations shall except with the consent in writing from the Contractor, be such as will involve as an increase or decrease of the total price payable under the contract by more than 25% thereof, in any case in which either then or later will in the Contractor's opinion involve a claim

for additional payment, then the Contractor shall as soon as reasonably possible after the receipt of instructions aforesaid, advise the Engineer to that effect.

6.0. **ENGINEER'S DECISION**:

Engineer's decisions shall be final in respect of all matters, which are left to the decision of Engineers. The Engineer shall if required to do so by the Contractor give in writing a decision, there on and his reasons for such decision.

7.0. **CONSTRUCTION OF CONTRACT**:

The Contract shall in all respects be construed and operated as a Contract as defined in the Indian Contract Act, 1972 as amended from time to time.

8.0. **PATENT RIGHTS**:

In the event of any claims or demand being made or action being brought against the TNRDC/TANTRANSCO for infringement or alleged infringement of any patent rights in respect of any design, machine, plant, work materials or things used or supplied by the Contractor under the Contract, the Contractor shall indemnify the TNRDC/TANTRANSCO against all costs and expenses arising from or incurred by reasons of any claims. The TNRDC/TANTRANSCO shall notify the Contractor immediately any claims so made. The Contractor may, if he so desires, and shall if so required by the TNRDC/TANTRANSCO and with the assistance of the TNRDC/TANTRANSCO defend such claims at the Contractor's own expenses or carry on negotiations for settlement of the claim. No such design, machine, work, material, plant or thing shall be used by the Contractor for any purpose, or in any manner other than that for which the Contractor has supplied them or specified or implied under the Contract.

9.0. **DEATH, BANKRUPTCY ETC**.:

If the Contractor dies or commits an act of Bankruptcy or being a corporation goes into liquidation, except for reconstitution purposes, or if his business is carried on by a receiver, the executors/successors of Contractor or any such receiver, liquidator or any person in whom the contract may become vested shall forthwith be given notice thereof in writing to the TNRDC and shall for one month, during which he shall take all reasonable steps to prevent stoppage of the works, have the option of carrying out the contract subject to his or their providing such guarantee as may be required by the TNRDC but not exceeding the value of the work for the time being remaining unexecuted. In the event of stoppage of the works, the period of option under this clause shall be fourteen days only provided that the above option should not be exercised, the contract may be terminated by the TNRDC by notice in writing to the Contractor.

10.0. **RESOLUTION OF DISPUTES**:

10.1. The Purchaser and the supplier / Contractor shall make every effort to resolve amicably by negotiations any disagreement or dispute arising between them in connection with the Contract.

10.2. **JURISDICTION FOR LEGAL PROCEEDINGS**:

No suit or any proceedings in regard to any matter arising in any respect under this Contract shall be instituted in any Court, save in the High Court of Madras. It is agreed that no other court shall have jurisdiction to entertain any suit or proceedings, even though, part of the cause of action might arise within their jurisdiction.

11.0. **ARBITRATION**: Arbitration is not applicable.

12.0. **GUARANTEE**:

12.1. The supplier shall guarantee that the goods under the Contract are new, unused of the most recent or current models and incorporated all recent improvements in design and materials unless provided otherwise in the Contract. The supplier shall further guarantee that the goods supplied under this Contract shall have no defects arising from design, materials or workmanship, installation and erection, if that may develop under normal use of the supplied goods. The supplier shall also guarantee the performance of the works executed by him including the performance of all the materials/goods supplied by him.

12.2. This guarantee for goods and works shall remain **valid for 36 months** for the specified works **from the date of completion of works in all respects and taking over by the TANTRANSCO**.

12.3. The purchaser shall promptly notify supplier/Contractor in writing of any claims arising under this guarantee in respect of goods. Upon receipt of such notice, the Contractor shall, with all reasonable speed, repair or replace the defective works or parts thereof, free of cost at site. All the expenses towards transportation of defective parts to Contractor's works and of repaired/replaced parts to site shall be borne by the Contractor.

12.4. If the Contractor, having been notified, fails to remedy the defects within 14 days, the Contractor will proceed to take such remedial action as may be necessary, at the Contractor's risk and expenses and without prejudice to any other rights which the Contractor may have against the Supplier under Contract. All expenses in this regard will be recovered from Contractor.

13.0. **PERFORMANCE GUARANTEE**:

The successful tenderer shall furnish a performance guarantee within 15 days from the date of commissioning or taking over by TANTRANSCO for **5 % of the Contract value in the form of irrevocable Bank Guarantee** on non-judicial stamp paper of value no less than Rs.100/- **for the period of 36 months from the date of commissioning and taking over by TANTRANSCO**. This performance guarantee obtained from a Nationalized / Scheduled bank and approved by the purchaser, shall be kept valid till the end of the guarantee period indicated in Clause 12.2. The performance guarantee shall be of a single Bank Guarantee obtained from a

Nationalised/Scheduled Bank. For the **belated** submission of performance Guarantee, the **interest rate at 22% P.A.** for the delayed period shall be levied and recovered from the contractor's bill.

14.0. **SECURITY DEPOSIT**:

14.1. The successful tenderer will have to furnish **security deposit for 5% of the total value of the Contract,** in the form of DD/Banker's Cheque / Irrevocable Bank Guarantee from any Nationalized/Scheduled Bank in non-judicial **stamp paper of value not less than Rs.100/-**. The security deposit shall have to be furnished **within 15 days of receipt of letter of award**. For the **belated** submission of Security Deposit, the **interest rate at 22% P.A.** for the delayed period shall be levied and recovered from the tenderers' first bill. Failure to remit SD within stipulated time may lead to forfeiture of EMD and proposed award of Contract would be cancelled. The Bank Guarantee should be valid till the date of completion of work are taking over by TANTRANSCO.

14.2. The Security deposit will be released to the supplier only if the Contract is completed to the satisfaction of the purchaser. If the purchaser incurs any loss or damages on account of breach of any of the clauses or any other amount arising out of the Contract becomes payable by the Supplier to the purchaser, then the purchaser will in addition to such other rights that he shall have under the law, appropriate the Security Deposit and such amount that is appropriated will not be refunded to the Contractor.

14.3. The combined Security Deposit cum Performance Guarantee for 5% of the contract value is acceptable.

14.4. If combined SD cum PG furnished, it shall be returned after the expiry of guarantee period and validity shall be ensured till the expiry of Guarantee period.

15.0 RECOVERIES FROM THE CONTRACTOR:

Any difference in payment due from the Contractor to the TNRDC shall be recovered from the performance guarantee/Security Deposit or by adjustment from any payment due to the Contractor from the TNRDC or otherwise.

16.0 ACCEPTANCE OF TENDER:

The final acceptance of the tender will rest with the TNRDC, which does not bind itself to accept the lowest or any other tender without assigning any reason thereof.

17.0 DISCOUNT / REBATES:

Discount/rebates offered on whatever account shall be clearly indicated for the specific purpose, quantities for which the same is intended. Otherwise, the discount/ rebate offered will not be considered while comparing the cost. Conditional discount/ rebate will not be accepted and such terms will not be taken for tender evaluation.

18.0 LIQUIDATED DAMAGES:

If the handing over of the work fully completed in all respects, is delayed beyond the scheduled date or extension thereof for commissioning as given under the Contract, the Contractor shall pay to the TNRDC an amount calculated at the rate of **half percent (0.5%) per completed week of delay** of the value of the total Contract price as liquidated damages subject to a **maximum 10% of the total actual value of work executed as per final bill**. In respect of contracts where supply effected in part or works executed in part, could not be beneficially used by the TANTRANSCO due to such incomplete execution, liquidated damages shall be worked out on the basis of entire contract price only as per final bill and not on the value of delayed portion.

The defaulting Contractors should be made liable to pay to the TNRDC, in addition to Liquidated Damages for delay, the actual difference in price, wherever TNRDC orders the delayed quantity to be supplied/executed by other agencies at a higher rate.

19.0. **PRICES**:

19.1. Prices for erection works under the scope of the specification shall be on FIRM price basis and to be furnished by the tenderer in the manner specified in the price schedule. The bidder shall furnish the bill of quantities of all goods/ materials required and being supplied for commissioning of the complete equipments.

19.2. The bidder shall quote FIRM prices including transit insurance and unloading at site, works contract tax & labour welfare fund. Break up of price indicating Ex-works price, packing, forwarding, GST, erection, testing, commissioning charges, GST etc. shall be furnished.

19.3. The bidders are requested to indicate in their offer the rate of GST, value on which shall be applicable, total GST amount and the category of service under which it is applicable. The GST quoted will also be included for the purpose of evaluation.

19.4. The tenderer should quote their rates taking into account the GST.

19.5. In case any bidder quotes as the rates is inclusive of GST or not mentioning about the GST, it will be construed that the rate quoted is inclusive of applicable GST and the rates will be back worked and the prevailing tax will be deducted from the running bills. The GST so deducted will be admitted and paid on production of evidences as mentioned above.

19.6. The price break up details shall be furnished for supply of all materials including bought out items so that any variation in GST due to statutory variation within the contract delivery period shall be considered and may be borne by TNRDC. In case of delayed delivery, the GST duty prevailed on the date of actual delivery or the GST applicable on the contractual delivery period whichever is less shall be admitted.

20.0. **TERMS OF PAYMENT**:

20.1. The works shall be executed with the supply of equipments/materials required in an orderly manner of requirement as per erection schedule. The bills will also be arranged to be cleared by the purchaser only as per the approved orderly sequential schedule of erection. The successful Contractor shall furnish well in advance the equipments/materials required for arranging funds. Payment will not be made for the unscheduled delivery of materials/equipments.

20.2. The following payments shall apply.

a) FOR THE CONTRACT COMPLETION WITHIN COMPLETION PERIOD

i) 70% of the all inclusive price (including GST) of the materials/ equipments of each consignment will be made within reasonable time after receipt of materials / equipments in good condition at site and submission of bills with required documents and on physical verification by the purchaser. The payment will be made within the reasonable time.

ii) Payment for 20% of the value of materials/ equipments will be made within reasonable time after satisfactory completion of erection of the supplied materials/ equipments along with 90 % of the value of erection charges and on submission of bill with required documents. The payment will be made within the reasonable time.

iii) 5% of the value of equipments/materials and 5% of the erection charges will be made after completion of successful testing and commissioning of the line and on submission of bill with required documents. The payment will be made within the reasonable time.

iv) The balance 5% of the value of equipments/materials and 5% of the erection charges will be made within reasonable time on completion of contract and on submission of bill with required documents. The payment will be made within the reasonable time.

b) FOR THE CONTRACT COMPLETION BEYOND THE COMPLETION PERIOD :-

i) 70% of the all inclusive price (including GST) of the materials/ equipments will be made within reasonable time on receipt of the materials/equipments in good condition at site after deducting LD at the rate of 0.50% per week on the value of materials/equipments so delayed on submission of bills with required documents and on physical verification by the purchaser. The payment will be made within the reasonable time.

ii) 20% of the value of materials/ equipments will be made within reasonable time after satisfactory completion of erection of the supplied materials/ equipments along with 90 % of the value of erection charges after deducting LD at the rate of 0.50% per week on the value of work so delayed and on submission of bill with required documents. The payment will be made within the reasonable time.

iii) 5% of the value of equipments/materials and 5% of the erection charges will be made within reasonable time after completion of successful testing and commissioning of the line and on submission of bill with required documents. The payment will be made within the reasonable time.

iv) Balance 5% of the value of equipments/materials and 5% of the erection charges will be made within reasonable time on closure of contract and on submission of bill with required documents after adjusting the total leviable LD.

20.3. The payment for works shall be made at monthly intervals in accordance with the conditions set out herein.

The payments will be made by the TNRDC based on the recommendations and authorisation of the bill by the concerned Superintending Engineer / General Construction Circle. The following documents shall be furnished by the Contractor for arranging payment by the Purchaser.

i. Copies of the supplier's invoice showing goods description, quantity, unit price and total amount in quadruplicate.
ii. Delivery note/Railway receipt/Truck receipt in original.
iii. Manufacturer's/supplier's guarantee certificate covering the guarantee period of 36 months from the date of commissioning and taking over of the entire works.
iv. Inspection certificate issued by the nominated inspection agency and the report, if stipulated.
v. Certificate of Origin.
vi. Proof of having taken joint insurance.

20.4. **INTERIM PAYMENT CERTIFICATE**:

20.4.1.a) The Contractor shall submit an application for interim payment in four copies to the nominated Engineer's representative at the end of each month in a form approved by the Engineer. The application shall include the following items as applicable, which shall be taken into account in the sequence listed.

i. The estimated contract value of the permanent works executed up to the end of the month in question, obtained by applying the basic unit rates and prices in the bill of quantities by the Engineer's nominated representative.
ii. The estimated Contract value of the permanent works obtained as in (i) of the above up to the end of the previous month.
iii. Any other sum to which Contractor may be entitled to under the Contract.

b) Within thirty (30) days of receipt of the said application for interim payment, it shall be approved/amended such that in the opinion of the Engineer's representative the certificate reflects the amount due to the Contractor in accordance with the Contract. In cases where there is a difference of opinion, as to the value of any item, the Engineer's view shall prevail. When the Engineer/ Engineer's representative has determined the amount due to the Contractor, a certificate called 'Interim Payment Certificate' certifying the amount due to the Contractor shall be issued.

c) No interim payment certificate shall be issued for a sum of less than Five (5) percent of the estimated Contract price involving the works portion only.

20.5. **PAYMENT FOR MATERIALS PROCURED FOR PERMANENT WORKS**:

The Contractor shall be entitled to such sum as the Engineer/ Engineer's representative may consider proper in respect of materials intended for but yet to incorporate in the permanent works, provided that:

a) The materials are in accordance with the specification for the permanent works, test certificates for the Acceptance and routine tests carried out as per relevant ISS may be furnished.

b) Such materials have been delivered to site and are properly stored and protected against loss or damage or deterioration to the satisfaction of the Engineer / Engineer's representative.

c) The Contractor's records of the requirements, orders, receipts and use of materials are kept in a format approved by the Engineer and such records shall be made available for inspection by the Engineer/ Engineer's representative.

d) The Contractor shall submit with his monthly statement giving the estimated value of the materials at site together with such documents as may be required by the Engineer/ Engineer's representative for the purpose of valuation and ownership of the materials.

Ownership of such materials shall be deemed to vest with the purchaser.

20.6**. CORRECTIONS**:

The Engineer, by an Interim Payment Certificate makes any corrections or modifications in any previous certificate (other than one purporting to be a Final Payment Certificate), which shall have been issued by him and shall have power to modify or withhold any Interim Payment Certificate if the works or any part thereof are not carried out to his satisfaction.

20.7. **FINAL ACCOUNT**:

a) Not later than three (3) months after the handing over of the works complete in all respects i.e. after successful testing and commissioning, the Contractor shall submit a draft statement of 'final account' and supporting document to the Engineer/ Engineer's Representative showing in detail the value of the works done in accordance with the Contract (hereinafter called for "Contractor's Draft Final Account").

b) Within three (3) months after receipt of the Contractor's Draft Final Account and all information reasonably required for its verification, the Engineer/ Engineer's representative shall determine the value of all matters to which the Contractor is entitled to under the Contract. The Engineer / Engineer's representative shall then issue to the Contractor a statement (hereinafter called "Engineer's Draft Final Account") showing the final amount to which the Contractor is entitled to under the Contract. The Contractor shall sign the Engineer's Draft Final Account as an acknowledgment of the full and final value of the work performed under the Contract

and shall promptly submit a signed copy (hereinafter called "Final Account") to the Engineer/ Engineer's representative.

20.8. **FINAL CERTIFICATE**:

On receipt of Final Account, the Engineer / Engineer's representative shall promptly prepare and issue to the Engineer and the Contractor a "Final Payment Certificate" certifying any further amounts due to the Contractor in respect of the Contract.

20.9. In the case of delay in execution of Contract, 10% payment in each time shall be retained and released after finalisation of LD.

21.0. **STORAGE CUM-WORKS INSURANCE:**

21.1. The Contractor shall take necessary insurance against loss, damage, theft, pilferage, fire accidents and damages during storage/transit from his stores to site for all the materials/goods for the purpose or incorporating in the work.

21.2. The contractor shall also take necessary insurance for transporting, Storage at site and erection of the equipments before commencement of work/Transporting.

21.2. The insurance shall also cover any loss, damages, accidents etc., caused due to the negligence of the Contractor in the course of operations (Transportation, Erection, testing and commissioning) carried out for the purpose of complying with the contractual obligations thereof. The entire cost of such insurance shall be borne by the Contractor at no extra cost to TNRDC. The insurance shall cover the materials, erection and commissioning portions comprehensively during the entire period of Contract.

21.3. The insurance as per claims shall be in joint names of the TNRDC and the Contractor so that the TNRDC and the Contractor are covered for the entire period of Contract from the commencement of the Contract till handing over of all the works, completed in all respects to the Engineer. It is the responsibility of Contractor to insure as above and at his own cost. TNRDC will not bear any amount towards insurance premium etc.

21.4. The insurance shall be effected with the nationalized insurer / IRDA approved Insurer and in the terms approved by the TNRDC. The contractor, whenever required, shall produce/deposit to the Engineer the policies of insurance and the receipts for payments of the current premium.

22.0. **THIRD PARTY INSURANCE**:

22.1. The contractor shall except in and so far as the Contract provides indemnify the TNRDC against all losses and claims in respect of injuries or damage to any property whatsoever while they arise out of or in consequence of the execution or works and against all claims, proceedings, damages, costs, charges, expenses whatsoever in respect of or in relation thereto. Accordingly, the contractor shall before commencement of execution of the works, insure against his liability for any material or physical damage, loss or injury which may occur to property Including that of the

TNRDC or to any person, including any employee of the TNRDC, by or arising out of the execution of the works or in carrying out the Contract. The insurance shall be effected and maintained as in Clause 21.3.

22.2. The terms of the insurance shall include a provision whereby in the event of any claim in respect of which the Contractor would be entitled to receive indemnity under the policy being brought or made against the TNRDC, the insurer will indemnify the TNRDC against such claims and any costs.

23.0. **INSURANCE AGAINST ACCIDENTS, ETC., TO WORKMEN**:

23.1. The TNRDC shall not be liable in respect of any damages or compensation payable by law in respect of or in consequence of an accident of injury to any workman or other person in the employment of the Contractor or sub-contractor, save and except an accident or injury resulting from any act or default of the TNRDC, its agent or servant. The Contractor shall indemnify and keep indemnified the Employer against all such damages and compensation, against all claims, proceedings, costs, charges and expense whatsoever in respect thereof or in relation thereto.

23.2. The Contractor shall insure against such liability with a Nationalized Insurer approved by the TNRDC/TANTRANSCO and shall continue such insurance during the whole of the time that any persons are employed by him on the works and shall when required produce/deposit to the Engineer, such policy of insurance and the receipt for payment of the current premium provided always that, in respect of any persons employed by any sub-contractor, the contractor's obligation to ensure as aforesaid under this sub clause shall be satisfied, if the sub contractor shall have insured against the liability in respect of such person in such manner that the TNRDC is indemnified under the policy, then the contractor shall require such sub-contractor to produce / deposit to the Engineer, when required, such policy of insurance and the receipt of payment of the current premium. TNRDC will not bear any cost towards insurance premium.

24.0. **REMEDY ON CONTRACTOR'S FAILURE TO INSURE**:

If the Contractor shall fail to effect and keep in force the insurance referred to in clauses 21.0., 22.0., 23.0., hereof, or any other insurance which may be required to effect under terms of contract, then the TNRDC may effect and keep in force any such insurance and pay such premium/ premia as may be necessary for that purpose and from time to time and to deduct the amount so paid by the TNRDC, as aforesaid from any money due or which may become due to the Contractor or recover the same as a debt from the Contractor.

25.0. **STANDARD**:

The goods supplied under this contract shall conform to the standards mentioned in the Technical Specifications and when no applicable standard is mentioned, to the standard specified by the Institution of Central / State Government or internationally

recognized Institutions shall be applicable and such standards shall be the latest issued by the concerned institution.

26.0. **INSPECTION**:

26.1. The purchaser or his representative shall have the right to inspect the goods/works to confirm their conformity to the Specification. The Purchaser/Owner shall notify the Contractor in writing of the identity of any representatives authorized for these purposes.

26.2. The inspections may be conducted on the premises of the Supplier/Contractor or his Sub-Contractor at the point of delivery and/or at the goods' final destination. Where inspections are conducted in the premises of Supplier/Contractor, all reasonable facility and assistance including access to drawings and production data shall be furnished at no charge to the Purchaser/Owner.

26.3. Should any inspected goods fail to conform to specifications, the Owner/Purchaser may reject them and the supplier/contractor shall either replace the rejected goods or make all alterations necessary to meet specification requirements free of cost to the Purchaser/Owner within one week of intimation.

26.4. The Purchaser/Owner's right to inspect, and where necessary, reject the goods after the goods arrival at the site, shall in no way be limited or waived by reason of the goods having been previously inspected, tested and passed by the Purchaser/Owner or his representative prior to the goods dispatch.

26.5. Nothing in clause 28.0. shall in any way release the Contractor from any guarantee or other obligations under this Contract.

27.0. **PACKING**:

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

27.2. The packing, marking and documentation within and outside the package shall comply strictly with such special requirements as shall be expressly provided for in the Contract or in any subsequent instructions issued by the Purchaser.

28.0. **DELIVERY OF GOODS AND DOCUMENTS RELATED THERETO**:

28.1. Delivery of goods shall be made by the Contractor in accordance with the terms specified by the Purchaser in its schedule of requirements and under the conditions listed in para 28.2.

28.2. The Contractor shall open stores at the site and all the materials/ equipments required for the works shall be consigned in the name of Officer designated by

TNRDC/TANTRANSCO. All incidental liabilities like demurrage, damage, loss, etc., shall be the sole responsibility of the contractor.

29.0**. INCIDENTAL SERVICES**:

The Contractor is required to provide any or all the services broadly outlined in the Technical specification. Any other minor incidental service related to the scope of work like providing necessary assistance whether specifically mentioned or not must be carried out by the Contractor at his own cost. All tools, Tackles Plant etc., required for completion of above works shall be brought by the Contractor.

30.0. **CHANGE ORDER**:

30.1. The Purchaser may at any time by a written order give to the Contractor to make changes within the general scope of the Contract in any or more of the following:

a) Drawings, designs or specifications for the goods to be furnished under the Contract to be specifically manufactured for the Purchaser.
b) The method of Packing.
c) The services to be provided by the Contractor.

30.2. If any such changes cause an increase or decrease in the cost for the Supplier's performance of any part of the work under the Contract whether changed or not changed by the order, variation in price discussed elsewhere in the specification, shall be made in the contract price. Any claims by the supplier for adjustment under this Clause must be asserted within fifteen (15) days from the date of the supplier's receipt of the Purchaser's Amendment Order.

31.0. **CONTRACT AGREEMENT**:

31.1. Subject to Clause 30.2. no variation or modification in the terms of the Contract shall be made except through an amendment signed by both the Parties.

31.2. **VARIATION, ALTERATION, ADDITION AND OMISSION IN RESPECT OF WORKS:**

31.2.1. The Engineer shall, after the Award of Contract, make any variation in form, quality or quantity for the works or any part thereof that may in his opinion be necessary and for that purpose, or for any other reason it shall, in his opinion be desirable, he shall have power to order the Contractor to do and the Contractor shall do any of the following:

a. Increase or decrease the quantity of any work included in the contract.
b. Omit any such works.
c. Change the Character or quality or kind of any such work as required by the Engineer.
d. Change the levels, lay-out position & dimensions of any part of the works and
e. Execute additional work of any kind necessary for the completion of the unit and no such variation shall in any way vitiate or invalidate the contract, but the value if any of all such variations shall be taken into account in ascertaining the amount of contract price.

31.2.2 No such variation shall be made by the Contractor without an order in writing by the Engineer. Provided that no order in writing shall be required for increase or decrease in the quantity of any work, where such increase or decrease is not the result of an order given under this clause but is the result of the quantities exceeding or being less than those stated in the bill of quantities. Provided also that if for any reason the Engineer shall consider if desirable to give any such order verbally, the Contractor shall comply with such order and it shall be deemed to be an order in writing within the meaning of this Clause. Provided further that the Contractor shall within Seven days confirm in writing to the Engineer of such order and such confirmation shall not be contradicted in writing within Fourteen days by the Engineer, it shall be deemed to be an order in writing by the Engineer.

31.2.3 **VALUATION OF VARIATIONS**:

All extra or additional work done or work omitted by order of the Engineer shall be valued at the rates and prices set out in the Contract.

The Contractor is bound to execute all supplemental items that are found essential incidental and inevitable during execution of the Contract at the rates to be worked out as below.

31.2.4 **RATES FOR SUPPLEMENTAL ITEMS**:

In the case of authorized supplemental items of works if any executed by the CONTRACTOR the rate will be decided generally as per the guidelines contained in G.O.Ms.No.1241, dated 13.10.1978 which are outlined below:

i. The Derivation of a suitable rate for supplemental item if technically feasible will be done from the relevant/accepted rate in the CONTRACT.

ii. If such derivation is not technically feasible, as rate based on the schedule of rates relevant to the tender date will be worked out and the tender premium plus or minus as the case may be if any shall be added to this rate and this rate shall be offered for acceptance by the CONTRACTOR.

iii. If during the period of execution of this supplemental item of work, the schedule of rates have changed, then a rate based on the schedule of rates prevailing at the time of execution of the supplemental item of work shall be worked out and offered for acceptance and in such a case no tender premium shall be added to this rate.

31.2.5. **VARIATION EXCEEDING TWENTY FIVE (25) PERCENT**:

If on certified completion of the entire works, it shall be found that a reduction or increase greater than 25 percent of the sum specified in the letter of acceptance, excluding all fixed sums, provisional sums and allowance for day woks, if any, results from:

a. The aggregate effect of all variation orders, and

b. All adjustments upon measurement of the estimate quantities set out in the bill of quantities, excluding all provisional sums, day works and adjustments of price made under Measurement Clause hereof but not from any other clause. The amount of

Contract price shall be adjusted by such sum as may be agreed between the Contractor and the Engineer or, failing agreement, fixed by the Engineer having regard to all works and relevant factors, including general overhead costs of the Contract.

c. **Additional quantity:** Additional quantity when exceeds more than 25% of the scheduled quantity in any item due to various technical parameters, the tenderer should offer a rebate on the quoted rate in the tender itself for that exceeded quantity. The above rebate will not be considered for bid evaluation. The rates payable for such extra quantities beyond 25% of the scheduled quantities shall be at the rate after deducting the rebate.

31.2.6**. CLAIMS:**

The contractor shall send to the Engineer's representative once in every month an account giving particulars, as full and detailed as possible, of all claims for any additional payment to which the Contractor may consider himself entitled and of all extra or additional work ordered by the Engineer which he has executed during the preceding month.

31.2.7.No final or interim claim for payment for any such work or expense will be considered which has not been included in such particulars. Provided always that the Engineer shall be entitled to authorize payments to be made for any such work or expense, notwithstanding the Contractor's failure to comply with this condition, if the Contractor has, at the earliest opportunity notified the Engineer in writing that he intends to make a claim for such work.

32.0 **DELAY IN THE CONTRACTOR'S PERFORMANCE**:

32.1. Delivery of the goods and performance of services shall be made by the Contractor in accordance with the time schedule specified by the purchaser.

32.2. Any unexecuted delay by the Contractor in the performance of his obligations shall render the Contractor liable to any or all of the following sanctions, Forfeiture of Performance Guarantee / Security Deposit / Imposition of liquidated damages and / or termination of the Contractor for default.

32.3. If at any time during the performance of the Contract, the Contractor should encounter emergent conditions of services, the Contractor shall promptly notify the Purchaser in writing within a Fortnight of such occurrence of the eventualities its likely duration and its cause(s). As soon as practicable after receipt of Contractor's notice, the Purchaser shall evaluate the situation and may at his discretion extend the Contractor's time for performance, in which case the extension shall be ratified by the parties by amendment of the Contract.

33.0. **FORCE MAJEURE**:

33.1. If at any time, during the continuance of the Contract, the performance in whole or in part, in any obligation under this contract, shall be prevented or delayed by reasons of any war, hostility, acts of public enemy, acts of civil commotion, strikes, lockouts, sabotages, fires, floods, explosions, epidemics, quarantine restrictions or other acts of God

(hereinafter referred to as eventualities) then provided notice of the happening of any such eventuality is given by the Contractor to the TNRDC within 15 days from the date of eventuality, be entitled to terminate this contract nor shall have any claim for damages against the other in respect of such non-performance or delay in performance and deliveries under this contract, shall be resumed as soon as practicable after such eventuality has ceased to exist.

33.2. Provided that if the performance in whole or part by the Contractor on any obligation under this contract is prevented or delayed by reasons of any eventuality for a period exceeding 60 days, the TNRDC may at its option, terminate this Contract by a notice in writing. Force Majeure Clause is not applicable to the Sub-Supplier/Sub-Contractor of materials/Works.

34.0 TERMINATION FOR DEFAULT:

34.1. The purchaser may, without prejudice to any other remedy for breach of contract, by written notice of default sent to the Contractor, terminate the contract in whole or in part:

a. If the Contractor fails to delivery any or all the goods and services within the time period(s) specified in the contract or any extension granted by the purchaser.

b. If the Contractor fails to perform any other obligations under the contract.

34.2. In the event, the purchaser terminates the contract in whole or in part, pursuant to Clause 34.1, the purchaser may procure, upon such terms and in such manner, as it deems appropriate, goods and services similar to those undelivered/unexecuted and the Contractor shall be liable to the Purchaser for any excess costs including L.D. for such similar goods/services. However, the Contractor shall continue performance of the contract to the extent not terminated.

35.0. **TERMINATION OF CONTRACT IN RESPECT OF WORKS**:

35.1. The Purchaser may without prejudice to any other remedy for breach of contract, by written notice of default sent to the Contractor, terminate the contract. If the Contractor shall become bankrupt of having received an order made against him or shall present his petition for bankruptcy or shall make an arrangement with or assignment in favour of his creditors or shall agree to carry out the contract under a committee of inspection of his creditors or being a Corporation, shall go into liquidation (other than a voluntary liquidation for the purposes of amalgamation or reconstruction) or if the Contractor shall assign the contract without the consent in writing of the employer first obtained or shall have an execution in writing of the employer first obtained or execution levied on his goods, or if the Engineer shall certify in writing to the employer that in his opinion, the Contractor

a. has abandoned the contract or,

b. without reasonable excuse has failed to commence the works or has suspended the progress of works for twenty eight days (28) after receipt from the Engineer written notice to proceed, or

c. Despite previous warning by the Engineer, in writing is not executing the works in accordance with the contract or is persistently or flagrantly neglecting to carry out his obligations under this contract, or

d. has to the detriment of good workmanship or in defiance of the Engineer's instructions to the contrary, subject any part of the contract. Then the Employer may after giving thirty days (30) notice in writing to the Contractor enter upon the site and expel the Contractor there from without thereby avoiding the contract or releasing the Contractor from any of the obligations or liabilities under the contract or affecting the rights and powers conferred on the Employer or the Engineer by the contract and may himself complete the works or may employ any other Contractor or complete the works. The Employer or such other Contractor may use for such completion so much of the constructional tools and plants, temporary works and materials which have been deemed to the reserved exclusively for the execution of the works, under the provisions of the contract as he or they may think proper and the employer may at any time sell any of the constructional tools and plant and unused materials and apply the proceeds of sale in or towards the satisfaction of any sums due or which may become due to him from the contractor under the contract.

35.2. **VALUATION ON DATE OF FORFEITURE**:

The Engineer shall, as soon as practicable after any such entry and expulsion by the Employer, fix and determine ex-parte or after reference to the parties of such investigations or enquiries as he may think fit to make or institute and shall certify that amount, if any, had at the time of such entry and expulsion by reasonably earned by or would reasonably accrue to the contractor in respect of work then actually done by him under the contract and the value of any one of the said unused or partially used materials of any constructional plant and any temporary works.

35.3**. PAYMENT AFTER FORFEITURE**:

If the purchaser shall enter and expel the Contractor under this clause, he shall not be liable to pay to the Contractor any money on account of the contract until the expiry of the period of contract and thereafter until the cost of execution and any and all other expense incurred by the employer have been ascertained and the amount thereof certified by the Engineer.

36.0. **TERMINATION OF WORKS**:

36.1. The Employer shall be entitled to terminate the contract in respect of the works portion at any time for the employer's convenience after giving 30 days prior notice to the Contractor.

36.2. In the event of such termination, the Contractor shall,

a. with all reasonable despatch, remove from the site all constructional plant and shall give similar facilities to his sub-Contractor also.

b. be paid by the Employer in so far as such amounts or items shall not have already been covered by payments on account made to the Contractor for all the works

executed prior to the date of termination at the rates and prices provided in the contract and in addition:

i. The amount payable in respect of any preliminary items, so far as the work or services comprised therein has been carried out or performed and a proper proportion as certified by the Engineer of any such items, the work or service comprised which has been partially carried out or performed.

ii. The cost of materials or goods reasonably ordered for the works, which shall have been delivered to the Contractor or of which the Contractor is legally liable to accept delivery, such materials or goods becoming the property of the employer upon such payments being made by him.

iii. A sum to be certified by the Engineer, being the amount of any expenditure reasonably incurred by the Contractor in expectation of completing the whole of the works in so far as such expenditure shall not have been covered by payment in this Sub-clause mentioned before.

iv. The reasonable cost of removal of constructional plant under Clause-36.2. and if required by the Contractor return thereof to the Contractor's main plant yard with transportation cost.

v. Provided always that against any payment due from the Employer under the aforesaid Clause. The Employer shall be entitled to be credited with any outstanding balances due from the Contractor in respect of constructional plants and materials and any other sums which on the date of termination were recoverable by the Employer from the Contractor under the terms of contract.

37.0. **APPLICABLE LAW**:

The contract shall be interpreted in accordance with the Laws of India.

38.0. **LABOUR AND EMPLOYEES**:

38.1. **ENGAGEMENT OF LABOUR:**

The Contractor shall make his own arrangements for the engagement of all labour, local or otherwise, save in so far as the contract otherwise provides, for the transport, housing, feeding and payment thereof, in accordance with labour law. No idle labour payment will be made.

38.2. **FESTIVALS AND RELIGIOUS CUSTOMS**:

The Contractor shall in all dealings with labour in his employment have due regard to all recognised festivals, day of rest for religious or other local customs.

38.3. **SUPPLY OF WATER:**

The Contractor shall, so far as is reasonably practicable having regard to the local conditions, provide on the site to the satisfaction of the Engineer's representative, an adequate supply of drinking and other water for use of Contractor's staff and workers.

38.4. **SUPPLY OF POWER:**

The Low Tension supply to the Contractor's tools and plants for works and for lighting will be metered at the appropriate tariff rate. The power supply will be provided at one point and the Contractor may put up and maintain their distribution system at their own cost from the point of take off from the main board.

38.5. **EPIDEMICS:**

In the event of outbreak of illness of an epidemic in nature, the Contractor shall comply with and carry out such regulations, order and requirements as may be made by the Government or the local medical or sanitary authorities for the purpose of dealings with and overcoming the same.

38.6. DISORDERLY CONDUCT, ETC.:

The Contractor shall at all times take reasonable precautions to prevent any unlawful, riot or disorderly conduct by or amongst his employees/workers and for the preservation of peace and protection of persons and property in the neighbourhood of the works against the same.

38.7. OBSERVANCE BY SUB-CONTRACTOR:

The Contractor shall be responsible for observance by the sub-Contractor of the foregoing provisions.

38.8. RETURNS OF LABOUR, ETC.:

The Contractor shall, if required by the Engineer, deliver to the Engineer's representative or at his Office, a return in detail in such form and at such intervals as the Engineer may prescribe showing the supervisory staff and the numbers of the several classes of labour from time to time employed by the Contractor on site and similar information regarding those employed by the Contractor in respect of constructional plant as the Engineer's representative may require.

38.9. EMPLOYEES:

38.9.1. The Contractor shall provide and employ on the site in connection with the execution of works or services rendered. a) Only such technical assistants as are skilled and experienced in their respective field of work and such sub agents, foremen and leading hands as are competent to give proper supervision to the work they are required to supervise and b) (i) Such skilled, semi-skilled and unskilled labour as is necessary for the proper and timely execution of the works.

(ii) The Engineer's representative shall be at liberty to object to and required the Contractor to remove forthwith from the works any person employed by the Contractor in or about the execution of the works who in their opinion misconducts himself, or is incompetent or negligent in the proper maintenance of his duties or whose employment is otherwise considered undesirable and such person shall not again be employed upon the works without the written permission of the Engineer.

Any person so removed from the works shall be replaced as soon as possible by a competent substitute approved by the Engineer.

38.9.2. The following basic amenities among others, shall be provided as conforming to the relevant labour laws etc.

First Aid

Washing and bathing places

Latrine and urinals

Shelter during rest

Crèches

Canteen

Shed for workers

Lighting and Guarding.

39.0**. LOCALLY PROCURED MATERIALS, WORKMANSHIP INSPECTION, TESTS ETC** :

39.1 QUALITY OF MATERIALS AND WORKMANSHIP:

All materials and workmanship shall be of the respective kinds described in the contract and in accordance with the Engineer's instructions and shall be

Subjected to change from time to time to such tests as the Engineer may direct at the place of manufacture or fabrication or on the site or at all or any such places. The Contractor shall provide such assistance, instruments, machines, labour and materials as are normally required for examining, measuring and testing any work and the quality, weight or quantity of any materials used and shall supply samples of materials before incorporation in the works, for testing as may be selected and required by the Engineer.

39.2 COST OF SAMPLES:

All samples shall be supplied by the Contractor at his own cost, if the supply thereof is clearly intended by or provided for in the contract.

39.3 COST OF TESTS:

The cost of making any test as per IEC / ISS shall be borne by the Contractor, if such test is clearly intended by or provided for in the contract.

39.4 COST OF TESTS NOT PROVIDED FOR:

If any test is ordered by the Engineer which is either

a. not so intended by or provided for

b. is not so particular or

c. though so intended or provided for is ordered by the Engineer to be carried out by an independent person or agency at any place other than the site of the place of manufacture or fabrication of the materials tested, then the cost of such tests shall still be borne by the Contractor. If the tests show that the workmanship or materials are not in accordance with the provisions of the contract, on the Engineer's instructions the same be replaced with new one conforming to specification at Contractor's cost.

39.5. EXAMINATION OF WORK BEFORE COVERING UP:

No work shall be covered up or out of view without the approval of the Engineer or the Engineer's representative and the Contractor shall afford full opportunity for the Engineer or the Engineer's representative to examine and measure any work which is about to be covered up or put out of view and to examine foundations before permanent work is placed thereon. The Contractor shall give due notice to the Engineer's representative whenever any such work or foundation is ready or about to be ready for examination and the Engineer's representative shall without delay act accordingly and attend for the purpose of examining and measuring such work or of examining such foundations.

39.6. UNCOVERING AND MAKING OPENINGS:

The contractor shall uncover any part of the works or make openings in or though the same as the Engineer may from time to time direct and shall reinstate and make good such part or parts to the satisfaction of the Engineer. If any such part or parts have been covered up or put out of view after compliance with the requirement of clause 39.5. supra, and or found to be executed in accordance with the contract, the expenses of uncovering, making opening in or through, reinstating and making good of the same shall be borne by the Employer, but in all other cases, these costs shall be borne by the Contractor.

39.7. INSPECTION OF OPERATION:

The Engineer and any person authorized by him shall at all times have access to the works and to all workshops and places where work is being prepared or from where materials are being obtained for the works and the Contractor shall afford every facility and every assistance in or in obtaining the right to such access.

39.8. REMOVAL OF IMPROPER WORK AND MATERIALS:

i. The Engineer/Engineer's representative shall during the progress of the works have power to order in writing from time to time.

a. The removal from the site within one week of receipt of notice, of any materials which in their opinion are not in accordance with the contract.

ii. In case of default on the part of the Contractor in carrying out such an order, the employer shall be entitled to employ and pay other persons to carry out the same and all Expenses consequent therein or incidental thereto shall be recoverable from the Contractor by the employer from any money due or which may become due to the contractor.

40.0. GENERAL RESPONSIBILITIES OF THE CONTRACTOR:

40.1. WORKS EXECUTIONS:

The Contractor shall, subject to provisions of the Contract and with due care and elegance execute the works and provide all labour including the supervision thereof, materials, constructional plant and all other things, whether of a temporary or permanent nature, required in and for such execution, so far as the necessity for providing the same is specified in or is reasonably to be inferred from the contract.

40.2 WORKS SAFETY:

The Contractor shall take full responsibility for the adequacy and safety of all site operations and methods of construction.

40.3 SUPERVISION BY THE CONTRACTOR:

The Contractor shall provide all necessary supervision during the execution of the works and as long as thereafter as the Engineer may consider necessary for the proper fulfilment of Contractor's obligations under the contract.

40.4. SETTING OUT OF WORKS:

The Contractor shall be responsible for the true and proper setting out of works in relating to the transmission line data and for the corrections of the design position, levels, dimensions and alignment of all parts of the works and for the provision of all necessary instruments, appliances, equipments, tools and plants and labour in connection therewith. If at any time during the progress of the works any error shall appear or arise in the design, positions levels, dimensions or alignment of any part of the works, the contractor on being required so to do by the Engineer/Engineer's representative shall at his own cost, rectify such error to the satisfaction of the Engineer/Engineer's representative shall not in any way relieve the Contractor of his responsibly for the correctness thereof and the Contractor shall carefully protect and preserve all bench marks, sight rails, pegs and such other things used in setting out of the works.

40.5. CARE OF THE WORK:

From the date of commencement of the works until the date stated in the certificate of completion for the whole of the works, the Contractor shall take full responsibility for the care thereof. In case any damage, loss or injury shall happen to the works, or any part thereof, from any cause whatsoever, the Contractor shall at his own cost, repair and make good the same, so that at the completion, the permanent works shall be in good order and in condition and in conformity in every respect with the requirements of the contract. In the event of any such damage, loss or injury happening from any of the expected risks, the Contractor shall, to the extent required repair/make good the same at the cost of the employer.

The expected risks are war hostilities (whether war be declared or not), invasion, and attack of foreign enemies, rebellion, revolution, insurrection of military or usurped power, civil war or any such operations of the forces of nature.

40.6. WATCHING AND LIGHTING:

The Contractor shall in connection with the works provide and maintain at his own cost all lights, guards, fencing and watching when and where necessary or as required by the Engineer/Engineer's representative or by any duly constituted authority for the protection of the works or for the safety and convenience of the Public and others.

40.7. CONTRACTOR TO KEEP SITE CLEAR:

During the progress of the works, the Contractor shall keep the site free from all unnecessary obstruction and shall dispose of any construction plants, surplus materials and clear away and remove from the site any wreckage, rubbish or temporary works no longer required.

40.8. CLEARANCE OF SITE ON COMPLETION:

On the completion of the works, the contractor shall clear away and remove from the site all constructional plants, surplus, materials, rubbish and temporary works of every kind and leave the whole of the site and works clear and in workman like condition to the satisfaction of the Engineer. If the site is not cleared, the same will be done by the Employer and the cost will be recovered from the Contractor. Any materials/tools etc., at the site will become the property of the employer and Contractor shall have not claim over it.

40.9. WORK TO BE DONE TO THE SATISFACTION OF ENGINEER/ENGINEER'S REPRESENTATIVE:

Save in so far as it legally or physically impossible, the Contractor shall execute and maintain the works in strict accordance with the contract to the satisfaction of the Engineer/Engineer's representative and shall comply with and adhere strictly to their instructions and directions on any matter whether mentioned in the contract or not, touching or concerning the works. The Engineer may from time to time delegate in writing to the Engineer's representative any of the powers, authorities vested in the Engineer and furnish to the Contractor a copy of all such written delegation of power and authorities. Any written instruction or approval given by the Engineer's representative to the contractor within the terms of such delegation, but not otherwise shall bind the Contractor and employer as though it had been given by the Engineer provided always as follows:

a. Failure of the Engineer's representative to disapprove any work or materials shall not prejudice the power of the Engineer thereafter to disapprove such work or materials and to order the pulling down, removal or breaking thereof.

b. If the Contractor shall be dissatisfied by reason of any decision of the Engineer's representative, he shall be entitled to refer the matter to the Engineer who shall there upon confirm, reverse or vary such decisions.

40.10. PLANT, TEMPORARY WORKS AND MATERIALS:

All constructional plant, temporary works and materials provided by the Contractor shall when brought to the site, be deemed to be exclusively intended for the execution of the works and the Contractor shall not remove the same or any part thereof except for the purpose of moving it from one part of the site to another part.

40.11 REMOVAL OF PLANT, ETC:

Upon completion of work, the Contractor shall remove from the site all the said constructional plant and temporary works remaining thereon and any unused materials provided by the Contractor.

40.12. PURCHASER NOT LIABLE FOR DAMAGE TO PLANT ETC.:

The Contractor shall note that purchaser shall not at any time be liable for the loss of or damage to any of aforesaid constructional plant, temporary works or materials.

41.0. COMMENCEMENT OF WORKS, PROGRAMME OF WORKS, TIME FOR COMPLETION ETC:

41.1. PROGRAMME OF WORKS:

i. The Contractor shall on award of the contract submit to the Engineer for approval a programme showing the order or procedure in which he proposes to carry out the works. The Contractor shall whenever required by the Engineer/Engineer's representative also provide in writing his information for a general description of the arrangements and methods which the Contractor proposes to adopt for the execution of works.

ii. If at any time it should appear to the Engineer that actual progress of works does not conform to the approved programme referred to Clause-41.1. (i) the Contractor shall produce at the request of the Engineer a revised programme showing the modifications to the approved programme necessary to ensure completion of the works within the time for completion as defined in clause-41.2.

iii. The submission and approval by the Engineer/Engineer's representative of such programme or furnishing of such particulars shall not relieve the Contractor of any of his duties or responsibilities under the Contract.

41.2. COMPLETION PERIOD:

The work covered in the scope of this Contract, shall be completed and handed over to the utility within a maximum period of **12 (Twelve) months from the date of taking over of site. The Contractor shall take over the site within 15 days from the date of agreement and commence the works.** Any delay in completion of works would attract Liquidated damages as specified in the Specification.

41.3. EXTENSION OF TIME FOR COMPLETION:

No extension of time for services to be rendered including procurement of necessary materials granted to the Contractor shall affect or prejudice the right of the TNRDC/TANTRANSCO against the Contractor or relieve the Contractor of his obligations for the due payment of damage whether duly ascertained or certified or not any sum against the payment of which he is bound to indemnify to the TNRDC/TANTRANSCO. Extension of time will be given if the delay is on the account of TNRDC/TANTRANSCO.

Should the amount of extra or additional work of any kind or any cause of delay referred to in these conditions or special circumstances of any kind whatsoever which may occur, other than through a default of the Contractor, be such as fairly to entitle the Contractor, to an extension of time for the completion of the works, the Engineer shall determine the extent of such an extension and shall notify Contractor accordingly provided that the Engineer is bound to take into account any extra or additional work or other special circumstances unless the Contractor has within 28 days after such work has commenced, or such circumstances have arisen, or as soon thereafter as is practicable, submitted to the

Engineer/Engineer's representative full and detailed particulars of any extension of time to which he may consider himself entitled in order that such submission may be investigated at the time.

41.4. NO NIGHT WORK OR WORK ON SUNDAYS AND HOLIDAYS:

Subject to any provision to the contrary in the contract, none of the permanent work shall, save as herein after provided be carried during the night or on Sundays or on declared holidays or other locally recognised days of rest. Except when the work is unavoidable or is absolutely necessary for the saving of life or property for the safety of the works in which case the Contractor shall advise the Engineer / Engineer's representative accordingly to obtain written permission thereof, if necessary.

41.5. RATE OF PROGRESS:

If for any reason, which does not entitle the Contractor to an extension of time, the rate of progress of the works or any erection is at any time in the opinion of the Engineer, too slow to ensure completion by the prescribed time or extended time for completion, the Engineer shall so notify the Contractor in writing and the Contractor shall thereupon take such steps as are necessary and the Engineer may approve to expedite progress so as to complete the work or such section by the prescribed time or extended time. The Contractor shall not be entitled to take additional payment for taking such steps, if necessary, as a result of any notice given by the Engineer under this clause, the Contractor shall seek Engineer's permission to do any work on Sundays or other holidays or other locally recognised days of rest.

41.6. DISRUPTION OF PROGRESS:

i. The Contractor shall give written notice to the Engineer whenever planning or progress of the works is likely to be delayed or disrupted unless any further drawings or order including a direction, instruction or approval is issued by the Engineer within a reasonable time. The notice shall include the details of drawings or order required and any delay or disruption likely to be suffered if it is late.

ii. If by reason of any failure or inability of the Engineer to issue within a reasonable time in all circumstances any drawing or order requested for by the Contractor in accordance with Clause-41.7. (i) Supra, the Contractor suffers delay and/or incurs cost, then the Engineer shall take such delay into account in determining any extensions of time to which the Contractor is entitled.

41.7 SUSPENSION OF WORKS:

The Contractor shall on the written order of the Engineer, suspend the progress of the works or any part thereof for such time or times and in such manner as the Engineer may consider necessary and shall during such suspension properly protect and secure the work, so far as is necessary in the opinion of the Engineer. The extra cost incurred by the Contractor in giving effect to the Engineer's instructions under this clause shall be borne and paid by the Employer unless such suspension is:

a. otherwise not provided for in the contract or

b. necessary by reason of some default on the part of the Contractor,

c. necessary by reason of climatic conditions on the site, or

necessary for the proper execution of works or for the safety of the works or any part thereof in so far as such necessity does not arise from any act or default by the Engineer/Engineer's representative or from any of the expected risks defined in this specification. Provided that the Contractor shall be entitled to recover any such extra cost unless he gives written notice of his intention of claim to the Engineer within twenty eight days of the Engineer's order. The Engineer shall settle and determine such extra payment and/or extension of time to be made to the Contractor in respect of such claim as shall in the opinion of the Engineer be fair and reasonable.

41.8. SUSPENSION LASTING MORE THAN NINETY DAYS:

If the progress of the works or any part thereof is suspended on the written order of the Engineer and if permission to resume work is not given by the Engineer within a period of ninety days from the date of suspension then, unless such suspension is within paragraph (a), (b), (c) or (d) of above the Contractor may serve a written notice on the Engineer requiring permission within twenty eight days (28) from the receipt thereof to proceed with the works, or that part thereof in regard to which progress is suspended and if such permission is not granted within that time, the contractor by a further written notice so served may but is not bound to elect or treat the suspension where it affects part only of the works as an omission of such part or where it affects the whole works as an abandonment of the contract by the Employer.

42.0. MEASUREMENT:

42.1. QUANTITIES:

The route along with the details like length of each segment, land use category, nearest settlement, angle point location (Longitude, Latitude), deflection angle of 400 KV transmission route based on actual detailed survey/ are furnished for reference. The bidder shall also carry out check survey as may be required for verification, collection of additional information/data/details to suit the site conditions and the actual route fixed. Based on the actual survey, the quantities arrived & indicated in the schedule "A1", "A2" as tentative estimated quantities of work. They are not to be taken as the actual and correct quantities of the work to be executed by the contractor in fulfilment of his obligations under the Contract. Any other item if found essentially required for the completion of the line, it may be included and arrived at separately. Erection of additional Tower/angle towers or change in type of tower for any deviation of route due to court case or any other reason beyond the control of the contractor shall be intimated and approval obtained.

42.2. WORKS TO BE MEASURED:

The Engineer shall, except as otherwise stated ascertain and determine by measurement the value in terms of the contract of work done in accordance with the Contract. He shall, when he requires any part or parts of the works to be measured, give notice to the Contractor, authorized agent or representative, who shall forthwith attend to or send a qualified agent to assist the Engineer/ Engineer's representative in making such

measurement and shall furnish all particulars such measurement and shall furnish all particulars required by either of them. Should the Contractor not attend or neglect or omit to send such agents, then the measurement made by the Engineer/Engineer's representative shall be taken to be the correct measurement of the works and any claim later on by the Contractor will not be accepted.

43.0. METHOD OF MEASUREMENT OF WORK:

43.1. The works shall not be measured except where otherwise specifically described henceforth:

i. The general assembly tower design drawings, erection drawings, Bill of materials and foundation drawings etc., relevant to the erection and commissioning of the tendered line complete shall be supplied by the Purchaser.

ii. The payment for works like foundations including stub setting shall be made immediately after completion of concrete, refilling and consolidation etc., to the satisfaction of the Engineer.

iv. The payment for tower erection shall be made on per tower basis erected with the weight of tower as per the approved bill of materials.

v. The payment for stringing, both for power conductor, ground wire and OPGW shall be made on actual route length of the line which is strung after completion of installation of all associated materials like hardware, insulators, groundings etc.

The above measurement is purely for the purpose of progressive payments and the line construction will be taken over by the TANTRANSCO only after the line is complete in all respect and has satisfactorily withstood all the tests mentioned in the appropriate sections. The responsibility of the Contractor does not cease until a certificate is issued by the TANTRANSCO, for having taken over the line from the contractor and will cease only on expiry of the guarantee period of work.

44.0. CERTIFICATION OF COMPLETION OF WORKS:

When the whole of the works have been substantially completed and have satisfactorily passed any final test that is prescribed in the contract, the Contractor may give a notice to that effect to the Engineer / Engineer's representative. Such notice shall be in writing and shall be deemed to be a request by the Contractor for the Engineer to issue a certificate of completion in respect of the works. The Engineer shall, within twenty one (21) days of the date if delivery of such notice, either issue to the Contractor with a copy to the Employer, a certificate of completion stating the date on which, in his opinion, the works were substantially completed in accordance with the contract or give instructions in writing to the Contractor specifying all the works which in the Engineer's opinion, requires to be done by the Contractor before the issue of such certificate. The Engineer shall also notify the Contractor of any defects in the works affecting substantial completion that may appear after such instructions and before the completion of the works specified therein. The Contractor shall be bound to receive such certificate of completion within twenty one (21) days of completion to the satisfaction of the Engineer of the works specified and making good any defect so notified.

45.0. NOTICES:

45.1. All notices given by one party to the other including written orders given by the Employer, Employer/Engineer's representative to the Contractor under the terms of the contract shall be in writing or if by Telegram/Telex/Fax/E-Mail be confirmed in writing. Period of notice shall be 14 days unless otherwise stated.

45.2. For the purpose of issuing notices to the purchaser in respect of works and supply of goods, the following is the address of the Purchaser.

The Chief General Manager,
Tamil Nadu Road Development Company Limited(TNRDC),
South Kesavaperumalpuram, Greenways Road,
RA puram, Chennai-600 028.

45.3. For the purpose of issuing notices for the works concerned to them to the Engineer's Representative, the address is as follows:

The Chief General Manager,
Tamil Nadu Road Development Company Limited(TNRDC),
South Kesavaperumalpuram, Greenways Road,
RA puram, Chennai-600 028

46.0. DUTIES AND POWERS OF THE ENGINEER AND ENGINEER'S REPRESENTATIVE:

46.1. The duties of the Engineer are to issue directions, decisions, certificates and orders as specified in the contract except those actions, which will be issued subject to the approval of the employer. These actions are:

a. Approving sub-letting of any part of the works as discussed elsewhere.
b. Determining extension of time discussed elsewhere.
c. Issuing a variation order discussed elsewhere.
i. In an emergency situation as reasonably determined by the Engineer.
ii. If such variation ordered would not increase the contract price.

46.2. The Engineer's representatives are responsible to the Engineer and their duties are to watch and supervise the works efficiently and examine any materials to be used or workmanship employed in connection with the works. He has no authority to, i) relieve the contractor of any of his duties or obligations under the contract not except as expressly provided hereunder or elsewhere in the contract.

i) order any work involving delay or any extra payment
ii) make any variations in the works.

46.3. The Engineer may from time to time delegate in writing to the Engineer's representative any of the powers, authorities vested in the Engineer and furnish to the Contractor a copy of all such delegation of powers and authorities. Any written instructions or approval given by the Engineer's representative to the Contractor within the terms of such delegation, but not otherwise, shall bind the Contractor and the employer as though it has been given by the Engineer provided always as follows:

a. Failure of the Engineer's representative to disapprove any work or materials shall not prejudice the power of the Engineer thereafter to disapprove such works or materials and to order the pulling down, removal or breaking thereof.

b. If the Contractor shall be dissatisfied by reason of any decision of the Engineer's representative, he shall be entitled to refer the matter to the Engineer, who shall there upon confirm, reverse or vary such decision as the case may be.

47.0. PROGRAMME AND PROGRESS OF ERECTION:

The successful tender shall furnish at the beginning of each month, three copies of programme of work for the month and the progress of erection during the previous month. Bar chart shall be furnished by the successful tenderers immediately on receipt of contract for material supply and work portion.

48.0. POWER TO RECOVER DUES TO TNRDC:

In every case in which provision is made for recovery of money from the tenderer, TNRDC shall be entitled to retain or deduct the amount thereof from any money that may be due or become due to the tenderer under these contract and/ or any other contract or contracts or any other account whatsoever.

49.0. DEDUCTIONS FROM CONTRACT PRICE:

All cost, damages or expenses which the purchaser may have paid for which under the contract the tenderer is liable, will be deducted by the purchaser from any money due or becoming due by him to the tenderer under the contract or may be recovered by action of law or otherwise from the tenderer.

50.0. INTEREST ON MONEY DUE TO THE TENDERER:

No omission by the Engineer to pay the amount due upon certificates shall vitiate or make void the contract, nor shall the tenderer be entitled to interest upon any balance which may on the final settlement of his accounts be found due to him.

51.0. PRICES:

51.1. The quoted rates for erection shall be FIRM on all accounts. The rates for erection should include handling charges, erection and handing over to the TANTRANSCO. The price break up details shall be furnished for supply of all materials including bought out items so that any variations in duties and taxes within the delivery period may be borne by TNRDC.

51.2. If for any reason the tenderer has to resort to a mode of transport other than what was contemplated by him at the time of tendering to step up his delivery commitment and consequently has to incur more expenditure, the TNRDC shall not under any circumstances, reimburse such extra expenditure and the price will not exceed the first rates accepted by the TNRDC.

51.3. Under no circumstances shall a tenderer alter his price during the validity period after tenders are opened. Any tenderer who does so resulting in recalling of tenders by the TNRDC or additional expenditure to the TNRDC shall not only lose his earnest money deposit but also run the risk of being black listed by the TNRDC/TANTRANSCO

which reserve the right under the law to recover damages resulting there from in addition to forfeiture of EMD.

51.4. 'FIRM' unit rates shall be quoted for all the items. No variation shall be allowed in erection rates for any reasons whatsoever. The quantities mentioned in the schedule are tentative only. The actual quantities of tower, type of towers shall be based on the check survey to be carried out along the route already fixed and shall include all the items essentially required for the Line commissioning whether mentioned in the schedules attached or not. Payment will be made to the actual quantities executed as necessitated by the detailed check survey and as approved by the Engineer & based on the unit rates quoted and accepted in the price schedule.

51.5. Additional quantity: **Additional quantity when exceeds more than 25% of the scheduled quantity in any item due to various technical parameters, the tenderer should offer a rebate on the quoted rate in the tender itself for that exceeded quantity. The above rebate will not be considered for bid evaluation. The rates payable for such extra quantities beyond 25% of the scheduled quantities shall be at the rate after deducting the rebate.**

51.6. All the information required in the various prices and other schedules must be completed otherwise the tenders are likely to be rejected.

51.7. The Contractor will establish a pocket store at a suitable location near the site at his cost and arrange for proper storing and safe custody of materials. The Contractor shall maintain a register for receipts and issues, which will be subject to inspection by TNRDC/TANTRANSCO's Officials. The materials will be measured and check measured by Engineer as and when received. The Contractor will provide fencing and lighting etc. at his cost for the safe custody of materials. Necessary insurance against theft, pilferages, fire sabotage etc. and other natural calamities should be done as discussed elsewhere.

52.0. PROGRESS OF WORK:

52.1. If it is found that the progress of works is not commensurate with the programme of completion, TNRDC will be entitled to terminate the contract in part or full giving 15 days notice and get the balance works completed departmentally or through other agencies at tenderer's cost and risk.

52.2. The Contractor shall furnish to the TNRDC/TANTRANSCO a BAR/PERT chart relating to the work concerned, within fortnight from the receipt of Letter of Award.

52.3. They shall also furnish fortnight progress reports in triplicate on the last day of work concerned. i) Item of work, ii) Schedule of progress for the month, iii) Actual progress, iv) Reasons for shortfall, if any, v) steps taken to meet the short fall.

53.0. TAXES AND DUTIES AND STATUTORY LEVIES:

53.1. Contractor is entirely responsible for all taxes, levies, duties, license fees, etc., incurred until delivery of the contracted goods to the Purchaser

53.2. The rates quoted by the Contractor should be inclusive of all taxes & duties if any for the materials to be brought to the site. TNRDC will not pay any tax and Duty to the Contractor other than GST. But, for the erection labour, the rates quoted should be exclusive of GST

53.3. The TNRDC will not reimburse any works contract tax but excluding GST or Duties. Based on the notification on GST , the tax implication will be changed as per GST rules

53.4. In case any bidder quotes as the rates is inclusive of or not mentioning about the GST, it will be construed that the rate quoted is inclusive of applicable GST and the rates will be back worked and the prevailing tax will be deducted from the running bills. The GST so deducted will be admitted and paid on production of evidences as mentioned above based on the guidance given in the government notification on GST

53.5. LABOUR WELFARE FUND:

Contribution towards Labour Welfare Fund at 1.0% of the civil work portion of bill will be deducted from the Contractor's bill and the same will be deposited in the Labour Welfare Office as per the Lr No.CFC/GI/FC/P.II/DFC/T/AAO/T/D28/255/14, dated. 26.6.2014.

54.0. INCOME TAX RECOVERY:

As per the standing instruction of the Government of India on the deduction of Income Tax at source, recovery towards Income Tax of the values of the work done will be made from relevant bills. The tenderer should also furnish PAN number.

55.0. COMPLIANCE WITH REGULATIONS:

55.1. Unless otherwise specified, works shall be carried out in accordance with the Electricity Act 2003, Indian Electricity Rules and Tamil Nadu transparency in Tender Act 1998 and Rules 2000 or any revisions thereof which may be issued during the currency of the contract and the requirements of any other Regulations and Acts in India to which the TNRDC/TANTRANSCO may be subjected to.

55.2. All railway tracks, communication line or other important track crossing and routing the line through Air field region shall conform to the relevant rules and procedures as may be laid down by Railway, Communications, Aviation or other concerned authorities from time to time.

55.3. Aviation signals will have to be provided at the top of the tower in the vicinity of civil and military aerodromes or airfield regions, if any. Similar provisions will have to be made on the special river crossing towers.

56.0. PERMITS AND PRIORITES:

The Contractor shall himself arrange for permits required for the operation of the vehicles used in construction works. No extension shall however, be admissible to the Contractor in the completion schedule for the erections of the transmission line, if such permits or priorities are not granted.

57.0. ACCOUNTING OF SURPLUS MATERIALS:

On completion of the works, all surplus materials for which payments have been made by the TNRDC shall be handed over to the Engineer at the TNRDC/TANTRANSCO's stores at the cost of the Contractor. If the materials are not returned and/or in the opinion of the Engineer in-charge of the work, not in a fit condition for use, they will be treated as sold to the Contractor at the rate equal to the Stores issue rate plus 10 percentage charges or at the prevailing market rates plus incidental charges, whichever is higher and recoveries made accordingly. **The templates comprising of all parts for each type of tower shall be handed over to the departmental stores after completion of works as directed by the TNRDC/TANTRANSCO.**

58.0. USE OF ROADS:

The Contractor shall make his own arrangements for obtaining permission for using private roads, pathway etc. in connection with the construction work.

59.0. WASTAGE AND LOSSES:

No claims towards wastage and losses of materials during execution will be allowed.

60.0. CONTRACTOR'S REPRESENTATIVE AND WORKMAN:

60.1. Contractor shall employ at least one Engineer whose name or names shall have previously been communicated in writing to the TNRDC/TANTRANSCO Engineer by the Contractor, to supervise the erection of the plant and carrying out the works. The said representative or if more than one shall be employed, then one of such representatives, shall be present at the site during working hours, and any written request/letter given to the authorized said representative of the Contractor, shall be deemed to have been given to the Contractor.

60.2. The Engineer shall be at liberty to object to any representative or persons employed by the Contractor in the execution or otherwise about the works who shall misconduct himself or be incompetent or negligent, and the Contractor shall remove the person so objected to, upon receipt of notice, in writing from the Engineer requiring him to do so, and shall provide in his place, a competent representative or persons at the Contractor's expense and to the satisfaction of the Engineer.

61.0. EMPLOYMENT OF PROFESSIONALLY QUALIFIED PERSONNEL

The Contractor should see that one B.E., / Electrical and one B.E., / Civil or equivalent Engineering Degrees with 3 years experience or retired Assistant Engineers / Assistant Executive Engineers / Electrical and Civil of E.Bs, PWDs or other Engineering Departments respectively are always at site of the work during working hours personally checking all items of work and paying extra attention to such works as may demand special attention e.g. availing line clears, reinforced concrete works etc. In addition, Diploma holder in Civil and Electrical each shall be available at site.

An amount of Rs.6,000/= per month per person for Graduate Engineers and Rs.4,000/= per month per person for Diploma Holders will be recovered as penalty for non-employment of technical personnel specified above.

62.0. EMPLOYMENT OF EX-SERVICEMEN:

Attention of the TENDERER is invited to the Public Works Department G.O.Ms.No.2385, dt. 13.09.1945 or any other latest orders of the Government according to which the CONTRACTOR must offer employment to Ex-Servicemen as far as possible at local rates and a report shall be sent to the SITE ENGINEER for his reference.

The number of Ex-servicemen to whom he can so offer employment should be mentioned in the tender and he should also undertake in the agreement to offer such employment to such number.

Suitable Clauses in the final agreement will be inserted to this effect.

63.0. TOOLS AND PLANTS FOR THE EXECUTION OF THE CONTRACT:

All tools and plant, equipment and tackle, compressors etc., required for the complete and satisfactory execution of the contract shall be arranged for by the Contractor at his own cost.

64.0. MATERIALS BROUGHT TO THE SITE OF WORKS:

All materials, tools and tackle brought to be delivered at the site for the purpose of the work shall from the time of their being so brought vest in and be the property of purchaser but may be used for the purpose of the work but for that purpose only and shall not on any account be removed or taken away by the Contractor or any other person without the express permission in writing of the Engineer but the Contractor shall nevertheless be solely liable and responsible for any loss or destruction thereof or damage thereto unless resulting from causes beyond the Contractor's control. The purchaser shall have lieu of such materials, tools end tackle etc. for any sum or sums which may at any time prior to the completion of the works be due or owing to him by the Contractor in respect of or by reason of the contract and shall be at liberty to sell and dispose of any such materials, tools and tackles etc. for any sum which may at any time prior to the completion of the works be so due or owing to him by the Contractor, in respect of or by reason of the Contractor and in such manner as he thinks fit and to apply the process in or towards the satisfaction of such sum or sums so due, for owing as aforesaid but subject to lien and power of sale and disposal, such surplus materials tools and tackle shall belong to the Contractor and may be removed and disposed of by him as he shall think fit.

65.0. CONTRACTOR TO KEEP INVENTORY OF PLANTS ETC:

The Contractor shall prepare and maintain an inventory of all materials, temporary rolling stock, tools, plant purchased or hired or use of employment for any of the purposes of this contract and such inventory or a copy there of shall at all times be available for inspection by the Engineer. On the completion of the contract all such

materials, rolling stock and plant as shall have been hired shall be removed forthwith by the Contractor and returned to the parties from whom the same have been hired.

66.0. LIABILITY FOR ACCIDENTS TO PERSONS:

66.1. The Contractor shall indemnify and save harm to the purchaser against all actions, suits, claims, demands, cost or expenses arising in connection with injuries suffered, prior to the date when the works or plant shall have been taken over by person employed by the Contractor or his sub-Contractor on the works whether under the General Law or under the Workers Compensation Act 1923 or any other statute in force at the date of the contract dealing with question of liability of employer for injuries suffered by employees and have taken steps properly to insure against any claims there under. Contractor should take insurance cover to all his workmen for injuries, disablement and death. All compensation against workmen's compensation act should be settled by the Contractor.

66.2. On the occurrence of an accident which results in the death of the workmen employed by the Contractor or which is due to the contract work and of so serious as to be likely to result in the death of any such workman, the Contractor shall within 24 hours of happening of such accident intimate in writing to the concerned Engineer and such Officers required by the provision of the Workmen's Compensation Act, the fact of such accident. The Contractor shall indemnify the TNRDC against all loss or damage sustained by the TNRDC resulting directly or indirectly from his failure to give information in the manner aforesaid including the penalties or fines if any payable by the TNRDC as a consequence of the TNRDC's failure to give notice under the Workmen's Compensation Act or otherwise conform to the provisions of the said act in regard to such accident.

66.3. In the event of any claim being made, or action brought against the purchaser involving the contractor and arising out of the matters referred to and in respect of which the Contractor is liable under the clause the Contractor shall be immediately notified thereof, and he shall with the assistance, if so required, of the purchaser but at the sole expense of the Contractor, conduct all negotiations for the settlement of the same or any litigation that may arise there from. In such cases the Purchaser shall at the expenses of the Contractor afford all available assistance for any such purpose.

66.4. In the event of an accident in respect of which compensation may become payable under Workmen's Compensation Act VIII of 1923 and any subsequent amendment thereof, whether by the Contractor or by the TNRDC/TANTRANSCO, as principle it shall be lawful for the Engineer to retain out of moneys due and payable to the Contractor such sum or such sums of money as may be in the opinion of the said Engineer be sufficient to meet such liability. The opinion of the Engineer shall be final in regard to all matters arising under this Clause and will not be subject to any claim.

66.5. Liability for damage or loss to third party including inspection Officers due to act of the Contractor or by his sub-contractor connected with the execution of this contract shall be fully borne by the Contractor. The Contractor shall maintain such detailed records to furnish information regarding engagement and discharge of all workmen employed under this contract as to be adequate for the timely and full settlement of claims under the Workmen's Compensation Act. All cases of accidents or injuries shall be reported to the Engineer with all full details required for the settlement under the Workmen's Compensation Act. The Contractor should report about all accidents within 24 Hours to the Engineer of the TNRDC in the preliminary accident form. He should furnish other particulars such as medical certificates, wage particulars, fitness certificates, and proof of having paid the compensation fixed by the TNRDC etc. in the due course without delay.

67.0. LIABILITY FOR DAMAGE TO WORKS AND PLANTS:

67.1. The Contractor during the progress of the work shall take every reasonable, proper, timely and useful precaution against accident or injury to the workmen from any cause and shall remain answerable and liable for all the accidents or injuries thereto which until the same, or be occasioned by the acts of omissions of the Contractor or his workmen or his sub-contractors and all losses and damages to the works as aforesaid, shall be made in the most complete and substantial manner by and at the sole cost of the Contractor and to the reasonable satisfaction of the Engineer. Should such loss or damage happen to units of works or plant or materials falling outside the scope of this Contract and due to the lapses of the Contractor, these shall be replaced or compensated for by the Contractor to the satisfaction of the Engineer.

67.2. In the case of loss or damage to any portion of the work occasioned by the causes, the same shall, if required by the purchaser, be made good by the Contractor in like manner but at the cost of the purchaser at a price to be agreed between the Contractor and the purchaser and the purchaser shall pay to the Contractor the contract value of the portion of the work so lost or damaged or any balance of such contract value remaining unpaid as the case may be.

67.3. Until the work shall be or deemed to be taken over as aforesaid, the Contractor shall also be liable for and shall indemnify, the purchaser in respect of all damage or injury to any person or to any property of the purchaser or other occasioned by the act of the Contractor or his workmen or his sub-contractors or by defective design, work or materials but not due to cause beyond his reasonable control.

67.4. Provided that the Contractor shall not be eligible under the contract for any loss of profit or loss of contracts or any claims made against the purchaser not already provided for in the contract, not for any damage or injury caused by or arising from the acts of the purchaser or of others (save as to damage by fire, as hereinafter provided) due to the circumstances over which the Contractor has not control nor

shall his total liability for loss, damage or injury exceed the total value of the contract.

68.0. DISPUTE PREVENTION:

In order to prevent disputes from arising (either before the commencement, during the progress or after the completion of the works by the Contractor or after entry on and taking possession of the works by the purchaser rightly or wrongly or after the abandonment of the works by the Contractor) as to any and every claim by the Contractor whether arising, under or out of the Contract or from the breach or alleged breach thereof or in any way incidental thereto, or connected therewith, or not herein provided for, including without limiting the generality of the foregoing provisions, question as the quality, quantity and kind of materials, labour, supervisions, workmanship, plant and temporary works, the order of the works and the several parts thereof, the prescribed or extended times (if any) for completion of the works, the measurement and valuations of the works, and materials, and all additional, altered, modified, substituted or omitted works and certificates or satisfaction and for payment and as to all other matters and things in the contract documents left to or dependent, on the decision, opinion, order, direction, requisition and or certificate of the Engineer, his measurement, valuation, decision shall be final and binding on the Contractor and the purchaser (fraud or fraud and collusion only excepted) and the purchaser shall not liable in respect of any claim by the Contractor in respect of any of the matters or things aforesaid unless and until the liability of the purchaser and the amount of such liability in respect of the claim shall have been certified by the Engineer, whose certificate shall be a condition precedent to any liability of the purchaser or any right of action against the purchaser in respect of such.

69.0. DETAILS CONFIDENTIAL:

69.1. The Contractor shall treat the specifications, contract document etc., as confidential.

69.2. The materials and services covered under these specifications shall be performed as per requirements of the relevant standards referred herein after against each of equipment and services.

69.3. No extension of time for services to be rendered including procurement of necessary materials granted to the Contractor shall affect or prejudice the right of the TNRDC against the payment of which he is bound to indemnify to the TNRDC. Extension of time will be given if the delay is on the account of TNRDC/TANTRANSCO.

70.0. INSURANCES:

The Contractor at his own cost shall arrange, secure and maintain comprehensive insurance as may be necessary and for all such amount to protect the interests and the interest of Owner (Purchaser), against all risks. Any loss or damage to the materials during supply, handling, transporting, storage and erection, till such time

the plant is taken over by the Owner shall be to the account of the Contractor. The Contractor shall be responsible for lodging all claims and make good for the damage or loss by way or repairs and/or renewals or replacement of the portion of works damaged or lost. The transfer of title shall not in any way relieve the Contractor of the above responsibilities during the period of contract **(Copy of insurance certificate to be produced before commencement of work/Transport to concerned SE/GCC)**

71.0. SECURITY:

The Contractor shall have total responsibility for all materials in his custody stored, loose, semi assembled and/or erected by him at site. The contractor shall make suitable security arrangements to ensure the protection of all materials and works from theft, fire, pilferage and any other damage or loss. All materials of the Contractor shall enter and leave the work site only with the written permission of the Engineer in the prescribed manner. It shall be the responsibility of the Contractor to arrange for the security till the works are finally taken over by the Engineer.

72.0. INDEMNIFICATION OF OWNER:

The Contractor shall ensure all his personnel, tools and plants etc. and shall also take third party liability cover to indemnify the Owner of all liabilities, which may come up due to any act or omission on the part of the Contractor and cause harm/damage to other Contractor/representatives of the Owner or all or any body rendering service to the Owner or is connected with Owner's work in any manner whatsoever. The Contractor shall necessarily indemnify the Owner in all these respects and the indemnification and insurance policy shall be to the approval of Engineer.

The recommended value for Third party insurance policy to be taken by the Contractor is as follows:

Maximum liability for injury to any person Rs.1,00,000/=

Maximum liability for any one accident Rs.2,00,000/=

Maximum liability for total number of accidents during the contract period Rs.10,00,000/=

If the total liability exceeds Rs.10,00,000/= prior to completion of contract, then the Contractor shall arrange to renew the policy for the same amount to cover the balance completion period. However, irrespective of the value of policy, the Contractor shall indemnify the Owner for all liabilities.

73.0. ELECTRICAL SAFETY REGULATIONS:

No work shall be carried out on any live equipment/material. The Engineer must make the equipment/material safe and a permit to work issued before any work is carried out. The contractor shall employ the necessary number of qualified, full time electricians to maintain his temporary electrical installation, wherever necessary.

74.0. CO-ORDINATION MEETINGS:

74.1. Co-ordination meetings between the Engineer and the Contractor shall be held to monitor the progress of works.

74.2 The Contractor will also be called upon to attend to design co-ordination meetings with Engineers, other Contractors and consultants of the owner during the period of contract. The Contractor shall attend all such meetings at his own cost as and when required and fully co-operate with the Engineer/owner and other agencies involved during these discussions.

75.0 CONSTRUCTION MATERIALS:

The tenderer has to verify the quarries and availability of materials himself personally about quality and quantity required for the work. It is the responsibility of the tenderer to arrange for the best class of materials as per ISS.

Format for BANK GUARANTEE FOR EMD / BID SECURITY

WHEREAS _____ (Name of the Bidder) (hereinafter called the Contractor) wishes to submit his tender for **"Design, Manufacture, Supply, Erection, Testing and Commissioning of 400 KV Towers with Twin Moose conductors for deviation of the existing overhead towers for formation of Northern Port Access Road (NPAR) section –I of Chennai Peripheral Ring Road(CPRR)"** herein after called "the Tender" KNOW ALL MEN by these present that we _____ (Name of Bank) _____ having our Registered Office at (_____) (hereinafter called the 'Bank') are bound unto M/s Tamil Nadu Road Development Company Limited (TNRDC) (hereinafter called "the Employer") the sum of Rs._____(Rupees_____ _____) for which payment can truly be made to the said Employer. The Bank bind themselves, their successors and assigns by these presents with the common seal of the Bank this day _____ of 2018 and undertake to pay the amount of _____ (Rupees _____) to the employer upon receipt of a written demand and without demur and without the employer having to substantiate his demand.

The conditions of this obligation are:

If the Tenderer withdraws his tender during the period of Tender validity specified in the Form of Tender Or

If the Tenderer having been notified of the acceptance of his Tender by the Employer during the period of tender validity Or

If the Tenderer fails or refuses to execute the Form of Agreement in accordance with the Instructions to Bidders, if required Or

Fails or refuses to furnish the Performance Security, in accordance with the Instruction to Bidders.

We undertake to pay the employer up to the above amount upon receipt of his first written demand and without demur and without the employer having to substantiate his demand, provided that in his demand the Employer will note that the amount claimed by him is due to the occurrence of any one of the above conditions, specifying the occurred condition or conditions.

This guarantee will remain in force up to ----------(Date) and including the date 28 days beyond the validity of the bid as such deadline is stated in the Instructions to Bidders or as it may be extended by the Employer, at any time prior to the closing date for submission of the Tender Notice of which extension to the Bank is hereby waived. Any demand in respect of this guarantee should reach the Bank not later than the above date of expiry of this guarantee.

Notwithstanding anything contained herein.

i) Our liability under this Guarantee shall not exceed the guaranteed amount **Rs. ----------/- (Rupees ----------only)**

This Guarantee shall be valid upto ----------20___ (**Expiry date**) and

ii) We shall be liable to pay the guaranteed amount under this guarantee only and if we receive a written claim or demand duly signed by a duly Authorised official of the Employer before the ----------20___ (**Expiry date**) as mentioned above.

SIGNATURE OF AUTHORISED REPRESENTATIVE OF THE BANK _____
NAME AND DESIGNATION _____
SEAL OF THE BANK _____
SIGNATURE OF THE WITNESS _____
NAME OF THE WITNESS _____
ADDRESS OF THE WITNESS _____

Format for BANK GUARANTEE FOR PERFORMANCE SECURITY

BG No …… dated ……20__

To

Tamil Nadu Road Development Company Ltd.,

171, 2nd Floor, Tamil Nadu Maritime Board Building,

South Kesavaperumal Puram,

Pasumpon Muthuramalingam Road (Greenways Road),

Raja Annamalai Puram, Chennai – 600 028

Bank Guarantee No. ……dated ……for **Rs. ……/- (Rupees ……only)**

WHEREAS vide the Letter Of Award (LOA) / Work order no…….. dated ……. for **"Design, Manufacture, Supply, Erection, Testing and Commissioning of 400 KV Towers with Twin Moose conductors for deviation of the existing overhead towers for formation of Northern Port Access Road (NPAR) section –I of Chennai Peripheral Ring Road(CPRR)"** (hereinafter referred to as **"The Contract"**) **M/s**……, a company incorporated under the Companies Act, 1956, having its registered office at…….. (address) (hereinafter referred to as "**The Contractor"** which expression shall unless repugnant to or inconsistent with the context mean and include its successors and assigns) has been awarded by **M/s Tamil Nadu Road Development Company Ltd**, a company incorporated under the Companies Act, 1956, having its Registered office at No. 171, 2nd Floor, Tamil Nadu Maritime Board Building, South Kesavaperumal Puram, Pasumpon Muthuramalingam Road (Greenways Road), Raja Annamalai Puram, Chennai – 600 028 (hereinafter referred to as "**The Employer**" which expression shall unless repugnant to or inconsistent with the context mean include its successors and assigns), the contract for **"Design, Manufacture, Supply, Erection, Testing and Commissioning of 400 KV Towers with Twin Moose conductors for deviation of the existing overhead towers for formation of Northern Port Access Road (NPAR) section –I of Chennai Peripheral Ring Road(CPRR)"**

AND WHEREAS it has been stipulated by you in the said contract that the Contractor shall furnish you a Performance Guarantee, within 7 days of receipt of the Letter of Award / Work order by a specified Scheduled / Nationalised Bank, for the sum specified therein as security for compliance with the contractor's obligations in accordance with the Contract and against any breach or non-performance of the terms and conditions contained in the contract.

AND WHEREAS we ……**BANK**, having its Head Office at ……and amongst others, a branch office situated at……, have agreed to furnish a Performance Guarantee for a sum of **Rs. ----------/- (Rupees ----------only)** (hereinafter referred as the Guaranteed amount) as security for compliance of the contractor's obligations under the contract.

NOW THEREFORE we hereby affirm that we as the Guarantor are responsible to you on behalf of the Contractor, for the guaranteed amount and we irrevocably undertake to pay you upon your first written demand and without demur or argument, any sum or sums within the limits of the guaranteed amount as aforesaid without your needing to prove or to show grounds or reasons for your demand for the sum specified herein. The guaranteed amount shall be payable merely on demand by the Employer. Any letter stating that the amount claimed in the demand notice/letter is due and payable, signed by a duly authorized official of the Employer to this effect, shall be final, binding or conclusive upon us.

We, hereby agree to pay on demand the guaranteed amount without demur by crediting to the Bank Account of the Employer, the details of which are to be informed to us by you during the validity of the guarantee.

Our liability under this Guarantee shall not be affected by any change in the constitution of the Contractor or of the Guarantor.

We hereby undertake that this Guarantee is absolute, irrevocable and unconditional and shall be enforceable against us notwithstanding any security or securities comprised in any instrument executed or to be executed by the contractor in favour of the Employer.

We hereby also agree that this guarantee shall not be wholly or partially satisfied or exhausted by any payments made to or settled with the Employer by the Contractor and shall be valid and binding on us and operative until the expiry of this Guarantee.

We, further agree that no change or addition to or other modification of the terms of the contract or of the works to be performed there under or of any of the contract documents which may be made between you and the Contractor shall in any way release us from any liability under this guarantee, and we hereby waive notice of any such change, addition or modification.

The jurisdiction in relation to this Guarantee shall be Courts at Chennai and Laws of India shall be applicable. This guarantee shall be valid up to ----------20__ (hereinafter referred to us as the **"Expiry Date"**) **52 Months** from the date of Bank Guarantee or **03 months** beyond the defect liability period whichever is later.

Notwithstanding anything contained herein.

iii) Our liability under this Guarantee shall not exceed the guaranteed amount **Rs_____/- (Rupees _____only)**

This Bank Guarantee shall be valid up to ----------20___ (Expiry date) and

iv) We shall be liable to pay the guaranteed amount under this guarantee only and if we receive a written claim or demand duly signed by a duly Authorised official of the Employer before the ----------20___ (Expiry date) as mentioned above.

IN WITNESS WHEREOF we have executed this guarantee on this ……20__.

Signature of Authorised Representative of the Bank ……..

Name and Designation …….

Seal of the Bank …….

Signature of Witness …….

Name of Witness …….

TAMIL NADU ROAD DEVELOPMENT COMPANY LIMITED
CHENNAI – 600 028

◈◈◈◈

Design, Manufacture, Supply, Erection, Testing and Commissioning of **400 KV Towers** with **Twin Moose conductors** for deviation of the existing overhead towers for formation of Northern Port Access Road (NPAR) section –I of Chennai Peripheral Ring Road(CPRR).

TECHNICAL SPECIFICATION
VOLUME – II

Due date & Time for receipt of Tender : 15th March 2021 up to 15-00 Hrs
Due date & Time for opening of Tender : 15th March 2021 @ 15-30 Hrs

The Chief General Manager,
Tamil Nadu Road Development Company Limited(TNRDC),
South Kesavaperumalpuram, Greenways Road,
RA puram, Chennai-600 028

VOLUME – II

TECHNICAL SPECIFICATION

Sl. No.	CHAPTER No.	DESCRIPTION
1	I A	GENERAL TECHNICAL REQUIREMENTS
2	I B	DESIGN OF TOWERS & FOUNDATIONS AND SUPPLY OF TOWERS & TOWER ACCESSORIES
3	II A	DETAILED SURVEY, OPTIMISATION OF TOWER LOCATIONS AND CHECK SURVEY
4	II B	ERECTION, AND COMMISSIONING
5	III	OPTICAL FIBRE GROUND WIRE DESIGN, SUPPLY AND INSTALLATION
6	IV	SPECIFIC TECHNICAL REQUIREMENTS
7	V	QUALIFICATION REQUIREMENTS FOR SUPPLY OF LINE MATERIALS & DETAILED TECHNICAL SPECIFICATION
8	VI	GUARANTEED TECHNICAL PARTICULARS AND DATA REQUIREMENT SHEETS
9	VII	TOWER SCHEDULE
10	IX	GPS COORDINATES
11	X	GENERAL NOTES
12	XI	KEY PLAN

VOLUME - II

TECHNICAL SPECIFICATION

CHAPTER-1A

GENERAL TECHNICAL REQUIREMENTS

1.0 INTRODUCTION :

1.1 TAMIL NADU TRANSMISSION CORPORATION intends to construct 400 kV MC Transmission Line as detailed below:

Name of work:

Design, Manufacture, Supply, Erection, Testing and Commissioning of **400 KV Towers** with **Twin Moose conductors** for deviation of the existing overhead towers for formation of Northern Port Access Road (NPAR) section –I of Chennai Peripheral Ring Road(CPRR).

1.2. The scope of works envisaged in this specification for the line is as follows:

i) Performance of detail Engineering, Such as preliminary survey and detail survey, spotting of towers as per the detailed survey, Preparation of profile, pit marking, design of foundation and Towers for various soils including special foundations where ever necessary, laying of foundation, erection of towers, stringing of conductors, ground wire, OPGW including hoisting of insulator strings, installation of conductor, ground wire and OPGW accessories, installation of aviation signal equipments and commissioning of the line using Twin Moose ACSR Conductor for 400 kV MC line per phase, 7/3.66 mm Galvanised steel Earthwire and OPGW.

ii) Design, type testing and Fabrication of all types of MC towers for 400KV and fabrication of all types of DC towers for 400 kV line as specified, body and leg extensions as per the GA drawings, bill of materials, detailed engineering, proto inspection, supply of galvanized towers, supply of Hot dip galvanized steel bolts & nuts with washers and supply of tower accessories, inspection before despatch, packaging and delivery at site.

iii. Construction of tower protection works such as revetment and retaining walls etc.,

iv. Supply of all line materials such as MOOSE ACSR, ZEBRA ACSR, GS Ground wire, OPGW, Insulators, Accessories for Conductor, Earth wire and OPGW, OFC Approach cable, Insulator hardware fittings, etc.

v. Submission of required number of Railway crossing drawings with tower leg member design calculations, foundation design calculations and EHT crossing drawings to process the approval from concerned Department including submission of as-built drawings as per actual completion.

CHAPTER- IB
DESIGN OF TOWERS & FOUNDATIONS
AND
SUPPLY OF TOWERS WITH ACCESSORIES.

1.1

a) For 400 kV MC line, the successful tenderer has to design of tower foundation and towers, Type testing of Towers preparing general assembly drawings, BOM, shop floor drawings for towers for manufacturing the required number of towers, extensions and design of foundations, preparing foundation drawings to carry out the tower foundations. All the detailed designs along with the drawings have to be submitted for approval to the employer before execution of works.

1.2 COMPLETENESS:

All the necessary equipments and materials required for works even though they have not been specifically included in this Specification but are necessary for the successful operation of the line are deemed to be included in the Specification.

2.0 STANDARDS:

The Indian Standard specification (IS) mentioned below or equivalent IS and International Standards as amended up to date shall be applicable to the material and process used in the manufacture of towers and tower accessories, equivalent JIS and International Standards, with English translation, will also be applicable.

Sl. No.	Indian Standards (IS)	Title	International & Internationally recognized Standard
1.	IS: 2	Rules for rounding off numerical values	
2.	IS: 209	Specification for Zinc.	
3.	IS: 278	Specification for Galvanized steel barbed wire for fencing	
4.	IS: 432	Mild steel & medium tensile steel bars & hard drawn steel wire for concrete reinforcement.	
5.	IS: 456	Code of practice for plain and reinforced concrete	
6.	IS:802(part 1/sec1) IS:802(part-1/sec-2)	Code of practice for use of structural steel in overhead transmission line towers: Materials and loads permissible stresses	
7.	IS:802(Part-2)	Code of practice for use of structural steel in overhead transmission line: Fabrication, galvanizing, inspection and packing	
8.	IS: 802 (Part-3)	Code of practice for use of structural steel in overhead transmission line: Testing.	
9.	IS: 808 Part-V Part-VI	Dimensions for hot rolled steel beams, column hannels & Angle sections. Equal leg angles Unequal leg angles	
10.	IS: 1367 (Part-1)	Technical supply conditions for threaded steel fasteners	

11.	IS: 1573	Specification for Electroplated coatings for zinc on iron and steel.	
12.	IS: 1893	Criteria for earthquake resistant design of structures	
13.	IS: 2016	Specification for Plain washers	ISO/R887-1968
14.	IS: 2062	Specification for Steel for general purpose	
15.	IS: 2551	Danger notice plates	
16.	IS: 2629 4759	Recommended practice for hot dip galvanizing of iron and steel	
17.	IS: 2633	Method of testing uniformity of coating *on* zinc Coated articles	
18.	IS: 3063	Specification for single coil rectangular section spring washers for bolts, nuts and screws	DIN-127-1970
19.	IS: 3757	High strength structural bolts	
20.	IS: 4091	Code of practice for design and construction of foundations for transmission line towers and poles	
21.	IS: 5358	Specification for Hot dip zinc coating on structural steel and other allied products	
22.	IS: 5358	Specification for Hot dip galvanized coating on fasteners	
23.	IS:5613 Section 1 Section 2	Code of practice for design, installation & maintenance of overhead power lines: (Up to 220 KV) Design Installation and maintenance	
24.	IS:5613 Section 1 Section 2	Code of practice for design, installation & maintenance of overhead power lines: (400 KV lines) Design Installation and maintenance	
25.	IS: 6610	Specification for Heavy washers for steel structures	
26.	IS-6639	Specification for Hexagonal bolts for steel structures	
27.	IS: 6745	Specification for Methods for the determination of the weight of zinc coating on zinc coated iron and steel articles	
28.	IS: 7215	Specification for Tolerance for Fabrication of steel structures	
29.	IS: 8500	Specification for welded structural steel (Medium and High Strength Quality)	
30.	IS: 10238	Step bolts for steel structures	
31.	IS:12427 &1367 Part 3-1991	Transmission tower bolts	
32.		Indian Electricity Rules 1956	
33.		Regulation for Power Line crossings for Railway tracks-1987	
34.	C B I & P Publication No. 268 & 290	Transmission line Manual	

The standards mentioned above are available from:

Abbreviation	Name and address
BIS	Bureau of Indian Standards, Manak Bhavan, 9, Bahadur Shah Zafar Marg, New Delhi 110 001, India

3.0 MATERIALS AND WORKMANSHIP:

All materials used in the manufacture of the tower and tower accessories shall be conforming to relevant standards given in Clause 2.0.

4.0 TYPE OF TOWERS:

For 400 kV MC line, the successful tenderer has to design the tower foundation and towers and named as QA, QB, QC and QD for WIND ZONE –5 and for 400 kV DC line the towers shall be of the types DA, DB, DC and DD for WIND ZONE – 5 as described below:

Type of Tower	Designation of towers for 400 kV MC line	Designation of towers for 400 kV DC line	Type of string	Typical use
Tangent tower (0° -2°)	QA	DA	Suspension	To be used for straight run and up to 2° Line deviation
Small Angle tower (0°-15°)	QB	DB	Tension	To be used for line deviation from 0° to15°
Medium Angle tower (0°-30° deg.)	QC	DC	Tension	To be used for line deviation from 0° to 30°. To be used for transposition of line with suitable modification.
Large Angle & dead end tower (30° - 60° & Dead End)	QD	DD	Tension	To be used for line deviation from 30° to 60° and for dead end.

Note:- i) The angle of line deviation specified above are for the design span. The span may, however, be increased up to an optimum limit with reduced angle of line deviation, if adequate ground and phase clearances are available. The tenderer shall indicate optimum limit of spans for each type of above-mentioned towers with reduced angle of deviation with supporting calculations (tower capacity charts).

ii) Design for suitable single circuit tower/gantry if required for crossing of any EHT lines or wherever necessary.

4.1.0. EXTENSIONS (For 400 kV DC/MC Towers):

4.1.1.0. The double circuit/Multi circuit towers shall be designed so as to be suitable for adding 3 m, 6 m, 9 m and 12 m body extensions for maintaining adequate ground clearance. The strength of tower members for all loading cases shall be adequate with and without extensions. Wherever 18 m & 25 m extensions are required the spans shall be reduced to 300 m.

4.1.2.0. To spot the tower in the hilly terrain the Bidder shall have to design leg extensions/Hill side extensions for all types of towers ranging from 1.5, 3.0, 4.5, 6.0 & 9 m suitable to be fitted to normal towers as well as towers with extensions. The standard tower shall have suitable arrangement to facilitate such arrangements.

4.1.3.0. The quantities of hillside extensions shall be finalized only after completion of detailed survey.

4.1.4.0 To spot the towers in hilly terrain, leg extension shall be provided to avoid cutting of natural earth and to accommodate the towers in natural slope.

4.1.5.0 To cross major rivers without any tower in middle of the river, special High – tall towers shall be provided on the bank of the river.

5.0. CONFIGURATION AND TYPE OF CONNECTIONS:

5.1.0. The tenderer shall submit single line drawings of towers for the proposed guaranteed weights.

5.2.0. The Multi circuit tower shall be of vertical configuration. All member connections used in the tower and extensions shall be of bolted type. The 400 kV MC line with TWIN **"ACSR Moose"** conductor shall have vertical **I** configuration with **I** string insulators.

6.0. ROAD, POWER LINE, TELECOMMUNICATION LINE AND RAILWAY CROSSING :

6.1.0. ROAD CROSSING :

At road crossings, the towers shall be fitted with normal single suspension/double tension insulator strings as required so that ground clearances at the highest point of the road at maximum temperature in still air is not less than the specified values. The effects of conductor creep and broken conductor in the adjacent span is also to be taken into account in addition to above ground clearance.

6.1.1 Provision of double suspension/double tension insulator strings shall be made while crossing major Highway/river/canal/slurry land/railway and EHT crossing.

6.2.0. POWER LINE CROSSINGS :

Where the line has to cross over another line of the same voltage or lower voltage towers with single suspension/double tension string and suitable extensions shall be used. Where long shutdowns are envisaged it would be preferable to undertake power line crossings on suspension towers followed by angle towers suitably guyed.

6.2.0.TELE-COMMUNICATION LINE CROSSINGS :

The crossings shall be designed in such a manner that the clearance between conductors of the power line and the telecommunication wires is not less than specified value given in Chapter-IV. For further details, the contractor shall refer to Code of Practice for Crossings between Power and Tele-communication Lines - 1974, copies of which can be had from P&T Department. The detailed proposal for all crossings shall be submitted by the contractor to forward the proposal to the competent authority concerned through TNRDC/TANTRANSCO and TNRDC/TANTRANSCO will assist to get the approval. The required charges / fees, if any shall be paid by the contractor, which will be reimbursed by the TNRDC later based on the actual receipts & evidences.

6.3.0.RAILWAY CROSSINGS:

Railway crossings shall be supported on dead end type towers on either side, depending on the merits of each case and shall be constructed in conformity with the specification laid down by the Railway Authorities. The following special conditions shall be observed. The maximum span crossing the tracks shall be 300 m or 80% of the design span, whichever is lesser. The minimum distance from the nearest track to the tower shall be the tower height plus six meters.

The minimum clearances between the rails and the bottom conductors as per the requirements of Railway Authorities. No crossing shall be located over a booster transformer, traction switching station, traction substation, or a track cabin location in an electrical area. The detailed proposal for all crossings shall be submitted by the contractor to forward the proposal to the competent authorities through TANTRANSCO and TANTRANSCO will assist to get the approval. The required charges / fees, if any shall be paid by the contractor, which will be reimbursed by the TANTRANSCO later based on the actual receipts & evidences.

6.4.0. Clearances from buildings, the clearance from and above the buildings, which are existing on the route and can't be avoided shall be given as per the provisions of IE Rules 1956.

6.5.0. Statutory Requirements: Statutory requirements as laid down in the Indian Electricity Rules 1956 or by any other statutory body applicable to such structures shall be satisfied/ observed.

6.6.0. Ground Clearance: The minimum ground clearance from the lowest conductor shall be considered as per the specific technical requirement. The provisions of 150 mm have to be made for considering the ground undulations, errors in stringing and creep on conductor. For ACSR conductor stringing, necessary provision has to be given for creep compensation. The tenderer shall make necessary provision to cater for the above requirement. No creep compensation shall be provided in case of earth wire.

7.0. TOWER DESIGN:

7.1.0. The tenderer shall design the towers by using 3-D analysis. The tenderer shall also check the tower for 36% of full wind at minimum temperature in all. The purchaser will check the tower designs submitted by the contractor and if any modifications / changes are necessitated consequent to the checking, the same shall be carried out invariably by the contractor without additional cost to the purchaser to avoid delay in testing of the towers.

The purchaser reserves the right to adopt, designs approved for any other package of TANTRANSCO. The successful bidder should fabricate the towers accordingly and adopt the foundations as per the designs approved and communicated to them.

i) The load trees for towers angle towers in wind Zone-2 are to be worked out as per IS-802-Part-1/Section-I. In case of design of suspension type towers the following aspects shall be considered.

ii) While working out the load trees, full wind shall be considered on conductor, G.W

and on tower in reliability condition. In case of security condition, the tension considered shall be at 75% full wind acting on conductors, Ground wire shall be worked out according to the above tension.

iii) While designing suspension type towers in security condition, 75% of full wind acting on tower as well as on healthy conductors, Ground wires shall be considered in IS-802.

7.1.1.0. If there is any deviation between the stipulation of this specification and IS: 802-Part-I/Section-1 the stipulations laid down in this specification, shall prevail.

7.1.1.1 Suitable single circuit towers/gantry for EHT crossing arrangement (if required) has to be designed by the tenderer and got approved by the Purchaser. The procedures given here under for the design of towers are based on probabilistic approach.

For 400 kV line covered in this specification, the relevant parameters for design of towers are as follows:

a) Reliability level for 400 KV Double circuit line -1 (Return period 50 years).

b)Terrain category – 2

c) Design wind pressure = 48.30 kg/sqm. for wind zone-5

d) Towers in wind zone edition) – 5 of IS 802 (latest)

e) The minimum height of the bottom conductor from ground level shall be equal to sum of max sag + minimum ground clearance + sag error.

7.1.1.2. SPECIAL TOWERS REQUIREMENT:

In case of necessity of providing special towers, the same shall be designed as per the specifications contained herein.

The design parameters shall be as per the latest code IS:802 for special towers and CBIP manual on Design of towers for long span river crossing. Publication No 290.

GENERAL:

Special towers are to be used for major river crossings requiring very long spans. These towers including their foundations, soil testing, tower erection and stringing shall form part of the bidders scope. The bidder shall submit the most economical design for such towers including their foundations.

Anchoring of Major river crossing towers, shall be with 'D' type towers. The requirement of anchor towers shall be deemed to have been included in the scope of work.

All the requirements as meant for standard towers shall apply for such special towers except those noted in the following subsequent clauses.

SHIELDING ANGLE:

The shielding angle shall not be greater than 10°.

CLEARANCES:

The minimum clearance of lowest point of power conductor from the highest floor level in navigable rivers for crossing towers shall be obtained from the navigation authority as well as from the purchaser.

The minimum electrical clearances between live parts and tower body and cross arm member shall be the same as for normal towers.

STUB LOCATIONS:

The approximate height of foundation, on which stubs for river crossing towers are to be set, over the highest flood level of the river shall be fixed only after purchaser's approval.

ANGLE OF DEVIATION:

The minimum angle of deviation to be considered for special towers is 4° and all live material clearances are to be computed considering double suspension insulator strings.

7.1.1.3. STATUTORY REQUIREMENTS :

Statutory requirements as laid down in the Indian Electricity Rules 1956 or by any other statutory body applicable to such structures shall be satisfied/ observed.

7.2.0. WIND LOAD ON TOWER :

Wind Zone : 5 - Basic wind speed = 50 m/ sec

Wind load on towers shall be worked out as per IS-802 Part-1/Sec-I/1995 in case of QB,QC & QD towers. In case of QA type tower, 75% wind acting on tower, as well as conductor OPGW and G.W shall be considered in security condition.

7.3.0. SAG TENSION CALCULATION :

A1) Full design wind pressure on conductor / ground wires at every day temperature.

A2) Thirty six (36) per cent full design wind pressure on conductor / ground wires at minimum temperature.

A3) Seventy Five (75%) per cent full design wind pressure on conductor / ground wires at every day temperature.

7.3.1. CLIMATIC LOADS:

Climatic loads are related to Reliability Requirements:

These are random loads imposed on tower, conductor, insulator strings and ground wires due to action of wind on transmission line and do not act continuously. Climatic loads shall be determined under either of the following climatic conditions, whichever is more stringent:

i) Every day temperature and design wind pressure.

ii) 32 degrees and 75% of full wind in case of DA/DAS towers.

iii) Minimum temperature with 0.36 times design wind pressure.

7.3.2. FAILURE CONTAINMENT LOADS: As per IS-802-Part-1 /Sect-I

7.3.3. ANTICASCADING LOADS : As per IS-802, Part-1/Sect-I

7.3.4. TORSIONAL AND LONGITUDINAL LOADS : As per IS-802/Part-1 /Sect-I

7.3.5 SAFETY REQUIREMENTS (CONSTRUCTION AND MAINTENANCE): As per IS-802 / Part-1/Sect-I

7.3.6. SPAN : (For 400 kV MC line)

a) Normal span

The normal ruling span of the line shall be 400 m for 400 kV MC. towers.

b) Wind span

The wind span is the sum of the two half spans adjacent to the support under consideration. For Normal Horizontal span this equals to Normal ruling span. For 400 kV Multi Circuit lines covered in this specification, the wind span shall be considered as 400 m.

c) Weight span

The weight span is the horizontal distance between the lowest points of the conductors on the two spans adjacent to the tower. For design of structures, the span limits given in Chapter-IV shall prevail:

7.3.7. COMPUTATIONS OF LOADS: Shall be as per IS-802/Part-1/Sect-1

7.3.8 ANTI CASCADING CHECKS:

All angle towers shall be checked for the following any cascading conditions without any over load factors with all conductors and ground wires intact only on one side of the tower.

a) Transverse loads: These shall be taken as under no wind condition at every day temperature.

b) Vertical loads: The vertical loads shall be the sum of weight of conductor / ground wires intact only on one side of tower weight of insulator strings and accessories and set weight of tower.

c) Longitudinal loads: The longitudinal loads shall be the pull of conductor ground wires at every day temperature and no wind applied simultaneously at all points on one side with zero degree line deviation.

7.3.9.TENSION LIMITS :

Conductor / ground wires tension at every day temperature and without external load, should not exceed the following percentage of the ultimate tensile strength of the conductor:

Initial unloaded tension	35 per cent
Final unloaded tension for conductor	22 per cent
Final unloaded tension for ground wire	20 per cent

Provided that the ultimate tension under everyday temperature and 100% design wind pressure or minimum temperature and 36% design wind pressure does not exceed 70 per cent of the ultimate tensile strength of the conductor / ground wire.

7.3.10. All the towers shall be checked to withstand wind loading due to narrow wind front diagonally at 45° and 60°. On tower with velocity of 260 KM / hours considering nil wind conductors, ground wires & insulator strings and taking 32 Deg. C and nil wind tension to be maintained on conductors ground wires.

Composition of loads shall be as indicated below:

i) Transverse wind on longitudinal face

ii) Longitudinal wind on transverse face

iii) Diagonal wind at 45 Deg. & 60 Deg.

iv) Vertical loads will retain, as in case of intact (healthy) conditions.

7.3.11. BROKEN WIRE CONDITIONS :

The following broken wire conditions shall be assumed in the design of towers:

S. No.	Type of Tower	Broken wire conditions to be adopted
	Multi Circuit Towers	
1.	Suspension tower	Any one phase or one ground wire broken whichever is more stringent for a particular member
2.	Small & Medium angle tower	Any two phases broken on the same side and same span or anyone phase and one ground wire broken on the same side and same span whichever combination is more stringent for a particular member.
3.	Large angle Tension towers / Dead end towers	Any three phases broken on the same side and the same span or any two phases and one ground wire broken on the same side and same span, whichever combination constitutes the most stringent condition for a particular member.

7.4.0. STRENGTH FACTORS RELATED TO QUALITY :

The design of tower shall be carried out in accordance with the provisions covered in IS: 802 (Part-1/Section-2). However, to account for the reduction in strength due to dimensional tolerance of the structural sections, yield strength of steel used the following strength factors shall be considered.

i) If steel with minimum guaranteed yield strength is used for fabrication of tower, the estimated loads shall be increased by a factor of 1.02, to account for dimensional tolerances.

ii) If steel of minimum guaranteed yield strength is not used for fabrication of tower, the estimated loads shall be increased by a factor of 1.05, in addition to that mentioned (i) above.

7.5.0. TOWER STEEL SECTIONS :

Steel section in conformity to IS: 808 are to be used in towers, extensions and stub setting templates shall be of tested quality conforming to IS: 2062. No individual members shall be longer than 7000 mm. Use of high tensile steel as per IS: 8500 is permitted for fabrication of towers.

The steel strength as per any other International Standards, if used shall be of equal or superior quality with corresponding Indian Standards.

For designing of towers only rationalized steel sections shall be used. During execution of the project, if any particular section is not available, the same shall be substituted by higher section

at no extra cost to the purchaser. However, design approved for such substitution shall be obtained from the purchaser.

7.6.0. THICKNESS OF MEMBERS:

The minimum thickness of angle section used in the design of towers, unless otherwise specified elsewhere in this specification, shall be kept not less than the following values:

a) Main corner leg members including the ground wire peak, lower and upper members of cross areas — 6 mm

b) For all other members — 5 mm

7.6.1. ALLOWABLE STRESS :

Structural steel angle section manufactured according to the latest IS: 808 and tested according to the latest edition of IS: 2062 or any other equivalent or superior International Standards will be used in the fabrication of the towers having its yield strength not less than 250 N/sq.mm. and where the yield strength required is 340N/Sq.mm high tensile steel (Fe 490 high tensile and Fe 540-High tensile grade) according to IS: 8500 shall be used.

7.6.2. AXIAL STRESS IN TENSION :

The estimated tensile stress on the net effective area in various members shall not exceed 250 N/sq.mm for mild steel or the specified yield stress of the High tensile steel sections if proposed to be used in the fabrication of towers as per stress value of high tensile steel according to IS:8500 or any other equivalent to International Standards.

7.6.3. AXIAL STRESS IN COMPRESSION :

The estimated compressive stress in various members shall not exceed the value given by the formulae specified in clause 5.2 of IS.802 (Part-1) Section (2) latest revision.

7.**6.4. STRESSES IN BOLTS AS PER IS-802/PART-1/SECTION-2**

7.6.5. **SLENDERNESS RATIO AS PER IS-802/PART-1/SECTION-2**

7.7. QUANTITIES AND WEIGHTS :

7.7.1. The quantities stated in the schedule are provisional. The rates, terms and conditions quoted in the bid shall be valid throughout the period of the contract and any period extended.

7.7.2**.** After the award of contract, the contractor shall submit for Purchaser's approval, the detailed design calculations, drawings for each type of tower, extension and stub template etc. The weights of towers shall be calculated by using the standard sectional weights of steel structural of the sizes indicated in the approved fabrication drawings and bill of materials, without taking into consideration the reduction in weight due to drilling of bolt holes, skew cuts, chamfering, etc. or increase in weight due to galvanization but taking into consideration the weight of bolts, nuts, washers, hangers, D-shackles, 'U' bolts, strain plates etc.

In case, the weight of the tower, finally approved and accepted by the purchaser on the basis of designs and drawings so submitted and the tests successfully carried out is more than the guaranteed weight, no extra payment shall be made to the contractor on this account. If, however, the weight of the finally approved and

adopted tower is less than guaranteed weight, the weight as per the finally approved design shall be adopted.

7.7.3. The contractor, while designing towers, shall use only such sizes of steel structural, which are easily procurable. If for any reason, the sections approved are not easily procurable, it is the contractor's responsibility to procure the alternative sizes, which are satisfactory from the point of design, fabrication, and galvanization and supply the same at no additional cost to the purchaser.

7.8. ERECTION STRESSES:

Where erection stresses combined with other possible co-existent stresses could produce a working stress in any member appreciably above the permissible stress, such additional strengthening of the member shall be effected or such other provision made as is necessary for bearing the working stress within the permissible limit.

7.9. CLEARANCES:

7.9.1. GROUND CLEARANCE :

The minimum ground clearance from the lowest conductor shall be considered as given in Chapter-IV.

7.9.2. The following provisions are made for considering the ground undulations, errors in stringing and creep on conductor:

i) 150 mm towards ground undulation and errors in stringing.

ii) Temperature compensation by increasing the stringing tension by reducing the stringing temperature by 26° C.

The tenderer shall make necessary provision to cater for the above requirement. No creep compensation shall be provided in case of ground wire.

7.9.3. CLEARANCES OF LIVE PARTS TO TOWER MEMBERS :

The minimum clearances between the live parts, tower and cross-arm members have been given in Chapter - IV. Whenever necessary the jumper loops at tension towers may be provided with counter weights with the approval of the purchaser with suitable weights to reduce the angles of swing and provide necessary air clearances under wind conditions. Pilot suspension strings to restrict the jumper swings can be used on QD / DD type towers. For the purpose of computing the clearances, the dimension of insulator strings as given in Chapter V and drawings enclosed to Volume-II of this specification may be assumed together with standard arcing horns. The design of the towers shall be such that it would satisfy all the above conditions when clearances are measured from any live point of the strings.

7.9.4. The clearances of all the cross-arms for specified swing angles of the insulator strings shall also be checked for suspension/tension insulator strings.

7.9.4.1. MIDSPAN CLEARANCE :

The minimum vertical mid span clearance between ground wire and the nearest power conductor shall not be less than the value specified in Chapter-IV. The minimum vertical

mid span clearance shall mean the vertical clearance between ground wire and the nearest conductor under all temperature conditions and still air in the normal ruling span. The ground wire sag shall be not more than 90 per cent of the corresponding sag of power conductor under still air conditions for the entire specified temperature range.

The successful tenderer in consultation with the Purchaser / insulator and insulator hardware suppliers shall verify the string length and ensure that the specified clearances and other relevant requirements are fully met and submit the final clearance diagrams based on the exact lengths of insulator strings for approval of the purchaser.

7.9.4.2. NUMBER OF PARTS:

Tower members shall be so fabricated with least number of parts to be bolted together easily at site, which offers best facilities for transport, erection and maintenance. In designing towers for a minimum number of parts, the contractor shall not, however, employ parts of such dimensions will prove difficult to handle. The length of the longest piece shall not exceed 7 m.

7.9.5. INSULATOR STRINGS AND EARTHWIRE CLAMP ATTACHMENTS:

a) For the attachment of 'I' type suspension insulator strings a suitable swinging hanger on the tower shall be provided so as to obtain requisite clearance under extreme swinging conditions and free swinging of the string. The hanger shall be designed to withstand highest possible load, which may be imposed on it.

b) Earth wire suspension clamps shall be supplied as per the reference drawing enclosed in Vol-II of the specification. Earth wire peaks/cross arms are to be suitably designed to accommodate the shackle of the suspension clamp.

At tension towers strain plates of suitable dimensions on the bottom of the each cross-arm tip and at the top of earth wire peak, should be provided for taking the D-shackles 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 bidder for purchaser's approval before starting the mass fabrication.

7.9.6. GROUNDING OF TOWERS:

a) Grounding of towers shall be done in accordance with IS: 5613 (Part 2/Section2).

b) The angle of shielding is defined as the angle formed by the line joining the centre lines of the ground wire and power conductor/outer power conductor, in still air, at tower, to the vertical line through the centre line of the ground wire. The angle of shielding to be maintained for the design of transmission lines under the project has been specified in Chapter - IV. The drop of 150 mm on account of ground wire suspension assembly shall be considered while calculating the minimum angle of shielding.

c) Two 17.5 mm dia holes shall be drilled about 50 mm apart on all stubs such that the lower hole is about 350 mm above the ground level, clear of the concrete muffing, for connecting the earth strip.

The tenderer shall include the rate for the supply of grounding materials complete with galvanized mild steel strip, necessary bolts, nuts and washers required for connecting the strip to pipe and the tower.

Counterpoise earths, where necessary, shall be provided by the contractor in accordance with IS.5613 (Part-2/Section-2).

7.9.7. STEP BOLTS & LADDERS :

a) Each tower shall be provided with step bolts on one of legs which shall conform to IS: 5613 Part/Sec-1 of not less than 16mm diameter and 175mm long, spaced not more than 450 mm apart and extending from about 3.5 meters above the ground level to the top of the tower. Bolt holes shall be provided below 3.5 m level and step bolts will not be filled but the same will be handed over to the Purchaser. Each step bolts shall be provided with two nuts on one end to fasten the bolt securely to the tower and button head at the other end to prevent the feet from lisping away. The step bolts shall be capable of withstanding a vertical load not less than 1.5 KN.

b) All normal towers with all extensions shall be provided with step bolts. For special towers & river crossing towers, if the height of superstructure exceeds 75 metres, a ladder along with protection rings of approved design shall be provided in continuation of the step-bolts on the longitudinal face of the tower from 75 metres above ground level to the top of the structure. Suitable platforms using flats and chequered plates not less than 6 mm thick along with suitable railing for access from step-bolts to the ladder and from the ladder to each cross-arm and the ground wire support shall also be provided.

7.9.8. NUMBER, DANGER AND PHASE PLATES :

Bidder shall supply number plates, danger plates, and phase plates for all towers as shown in drawing enclosed in Vol-ll of the specification.

Danger plates shall conform to IS: 2551. The number and phase plates shall conform to IS: 5613 (Part 2/Section-1).

7.9.9. ANTI-CLIMBING DEVICE :

a) Towers shall be fitted with anti-climbing devices, which shall be as per drawing enclosed in Vol - ll of the specification and conform to IS:5613 (Part 2/Section-1). Anti-climbing devices shall be installed on the tower at the height duly approved by the Purchaser.

b) Necessary holes shall be provided on the tower members for installation of the ant-climbing device.

C) The tenderer shall quote for anti climbing device inclusive of structural and barbed wire.

7.9.10. BIRD GUARDS:

The bird guards for suspension towers shall be made of galvanized iron sheet and shall be as per drawing enclosed in Vol. ll of the specification and shall conform to IS: 5613 (Part- 2 / Section -1).

7.9.11. AVIATION REQUIREMENTS:

7.9.11.1. The height of the towers above 45 m shall over the galvanized surface in contrasting bands of orange or red and white as per site requirement and with the approval of the Owner. The band shall be horizontal. The width of the colour band shall be as per the relevant aviation regulation clauses, prevalent at the time of execution of the project. Aviation requirements shall be as per IS: 5613 (Part-3 / Section-1) - Annexure- B shall be in the scope of Contractor.

a) Surface Preparation:

The etching of galvanized surface of erected tower members with suitable etching or wash primer is to be done as per IS: 1477 to enhance the adhesion of subsequently applied paint coating. After etching of galvanized surface of tower one coat of zinc primer is to be applied.

b) Painting of Towers:

Two coats of international orange or red and white paint at alternate interval (bands) as explained above is to be applied. The painting of towers shall generally confirm to relevant provisions in IS: 1477 (Part 1 & 2). The paints to be used for painting shall be in accordance with IS: 2074 with latest Amendments.

c) Line/Span Markers:

Sphere type span marker of 600mm diameter shall be provided on the earth wire/OPGW. The sphere shall be divided into two parts and one half shall be painted in orange and one half in white. These markers shall be suspended from earth wire at interval of approx. 200 M. The design of the markers and their fixing arrangement should be such that they can withstand the wind pressure and shall not induce excessive amount of vibration strain on earth wire. The Contractor along with Bid shall submit detail of this arrangement.

d) Night Markers (Obstruction lights)

The scope of night markers covers the design manufacture, testing at manufactures works, if any supply, delivery erection testing and commissioning of medium intensity low intensity lights along with storage battery and solar panel control panel cables clamps other accessories etc., as per the provision of IS –5613(Part -II /section –I)latest amendments regarding night and day visual aids for denoting transmission line structure as per the requirement of directorate of flight safely. The details of each component of medium intensity, low intensity lights & associated accessories to be provided on the towers shall be as per the technical specifications given in the preceding clauses and IS/ICAO, International Standards recommended practices. One set of Aviation Lights shall consists of one medium intensity light & two/four (as applicable) low intensity lights along with all accessories such as solar panel, control panel, batteries, cables etc.

Medium Intensity Light.

Medium Intensity light shall be provided on the top of each tower. The medium light should have a night time intensity as per ICAO requirements in international Standards Recommended Practices. The light on top of the structure should flash at the rate of 20 sequences per minute. The effective intensity during night time for the medium flashing light shall be 1600 CD. The Line shall conform to ICAO equipments requirement /BS 3224A and shall have whether production conforming to IP-55.

The above lights conforming to ICAO Specification flashing red lights shall be DC operated thro a suitably sized maintenance free battery bank at the operating voltage 12 V /24V DC. The burning life of the lamps shall be maximum possible in view of the maintenance hazards of HT. Live but in no case it should be less than 15000 burning hours. In case of failure of the lamp before 15000 burning hours the same shall have to be replaced by the contractor free of cost. The light shall be equipped with radio separation facilities conforming to BS 800.In order to avoid any interference signals of PLCC etc.,

Low intensity lights

Two /four (as applicable) no of low intensity lights are required to be put on each of the towers .Placement drawings for the same shall be submitted by the bidder/ contractor. The light shall be stationary lamp with minimum effective intensity of 10 CD of red light. The lamp shall conform to the ICAO requirement /relevant BS and shall have weather protection of minimum IP-55 class.

Two/Four Nos. LI lamp required for each tower shall be operated through a Suitable size common battery bank solar panel as per the requirement of operating voltage and load current of the type of lamps being offered.

The burning life of the lamps shall be maximum possible in view of the maintenance hazard of HT live line , but in case it should be less than 15,000 burning hours. In case of failure of the lamp before 15000 hrs the same shall have to be replaced by the contractor free of cost even if the pendency of contract expires. Performance certificate of the lamps to be offered shall be furnished by the contractor.

The low intensity lamp shall not generate any R.F which can interfere with the PLCC signals.

Storage Battery.

Storage Battery required for the above purpose shall be sealed maintenance free, and suitable for mounting on the top of the transmission line towers. Contractors shall offer the most optimum capacity of the Battery Bank at 120 hour discharge rate (considering 80% percentage usage) matching with the load requirement of the type of lamps being offered including any power loss in the associated cables. The battery sizing shall conform to JISC 8707/relevant Indian Standard or any other internationally recognized standard. The battery shall be hermetically sealed explosion proof and self – resealing type and free from orientation constraints. The working temperature ranges shall be minimum 0 degree centigrade and maximum 50 degree centigrade. Performance certificate of the offered batteries shall be submitted by the Contractor.

Battery Box

The battery box suitable for mounting on 400 kV Power transmission tower shall be robust construction suitable to accommodate desired number of SOLAR BATERIES with proper clearance between the batteries. The sides and the top of the battery box shall be made from MS sheets not less than 14 SWG thickness duly mounted on MS angle frame. The bottom of the battery box shall have suitably designed MS structure to freely hold the total weight of the batteries. The batteries should be placed on insulated base with proper drainage holes. Lifting lugs shall be provided. Dust and vermin proof lockable doors shall be provided for safety and easy access to the batteries for the maintenance. The battery box should incorporate the design for proper ventilation system in order to prevent a gas concentration inside the box. The ventilation opening shall be protected against rain/splash water and dust. The inside of the battery box shall be lined with insulating polyurethane plating and the exterior painted with weather proof polyurethane paint. The cable entry into the battery box shall be through suitable cable glands.

Solar modules.

Solar module required for the system shall be suitable for mounting on the transmission line towers and shall be designed for high performance, maximum reliability and minimum maintenance and shall be installed below bottom cross arms levels. The solar modules shall be IP.55 grade protection class. These should be highly resistant to water, abrasion, nail, impact and other environmental factors. These should be placed on the tower at a most optimum angle so as to homes the maximum solar energy and facilitate self cleaning and shall conform to relevant Indian / International Standards.

Module mounting frames shall be weather proof suitable for mounting on tall towers. Details of mounting frames shall be furnished by the Contractor., Junction box shall be provided with weather proof hinged lid with provision for cable glands entry and protections grade of class IP.55.

The Contractor shall submit the basis of selecting the numbers of solar modules.

The Provision for design, supply and erection of mounting arrangements for photovoltaic modules on the transmission towers in a suitable manner to homes maximum solar energy shall be in the scope of the Contractor.

Provisions for design, supply & erection of resting platform for the erection of battery bank in a closed enclosure with safety arrangements on the transmission towers shall also be in the scope of the contractor the design and load consideration for safety of towers due to additional plate form shall be kept in view while designing , selecting the above.

Control Panels

Control panels shall consist of solar charge controller, flasher unit, sensor, isolator, MCB, Voltmeter, Ammeter and other control gears. Panels enclosure shall be fabricated out of 14

SWG CRCA sheet and thoroughly treated and painted. Suitable neoprene rubber gasket and pad locking device shall be provided and the protection class shall be of IP-55 class.

The Solar charge controller shall be most efficient and preferably fully solid state. It shall be provided with protection to load against increase in temperature. Surge, automatic low voltage and automatic disconnection and reconnection during high inrush current and normalcy respectively.

The flash regulator shall be provided for regulating light flashing. The same shall be completely solid state and provided with flash rate set points. The protection against overload current shall also be provided.

Necessary sensor/timer shall be provided in the system to "switch on" the light automatically in the evening and poor visibility period and switch off the same during day time and normal visibility period.

Cables, Cable Glands, Conduits and Accessories.

The cable to be supplied and erected shall be of multi strands copper conductor, weather proof, PVC insulated PVC sheathed, armoured 1.1 KV grade. The same shall conform to IS: 1554. All the cable accessories such as glands etc. shall be in the scope of supply and erection of the Contractor. Supply and erection of all the PVC conduits and accessories shall be in the scope of the contract. All the conduit and accessories shall be as per the relevant ISS or ISI brand. The inter-connection cable / conduit will be clamped in a secured manner with the tower members and any interconnection should be made only inside the environmentally protected junction box. The cost of all the above mentioned items shall deemed to be included in the unit rate/KM

Earthing :

All the installations on the tower shall be securely and properly earthed with the tower body by using flexible copper braided wire. Cost of earthing material shall deemed to be included in the unit rate.

8.0 DESIGN OF FOUNDATION:

8.1. SCOPE:

This section covers the design requirements of plain cement concrete and reinforced cement concrete foundations of self supporting galvanized lattice towers for 400 kV MC Transmission Line under the scope of this tender.

The bidder shall furnish the complete detailed design and drawings including bar bending schedule for foundations for all types of MC towers and towers with required extensions.

The bidder shall also furnish with his offer the sample design calculations, drawings and bar bending schedules for each type of foundation which he proposes to use for the proposed transmission lines.

The design of foundation shall be developed as per soil properties given in the Chapter-ll A of the specification.

The payment for different items of foundation work viz excavation, concrete and

reinforcement, shall be restricted to guaranteed volumes or actual as per approved foundation designs whichever is less as per unit rates & guaranteed volumes quoted in the schedules.

8.2. CLASSIFICATION OF SOILS :

8.2.1. Classification of soils for which foundations are to be designed shall be in accordance with latest edition of IS:5613 (part - 2 / section - 2) and IS:1498 and latest CBIP manual. The foundations shall generally be designed for following types of soils:

a) Dry fissured rock (DFR):

DFR shall be that where fissured rock encountered from top level onwards will be treated as DFR. In these the boulder should be more than 200mm and the boulders percentage should be more than 85% in total excavation volume.

b) Partially dry fissured rock:

This foundation may be adopted where the normal dry soil is encountered for more than 1.5 M from ground level and balance is dry fissured rock. The boulder should be more than, 85% in total excavation volume.

c) Wet foundation:

Wet foundation shall be that where sub-soil water rises in the foundation pit up to 1.5 m below ground level, or where there is water over the ground for long period but does not penetrate beyond 1.0 m below ground such as paddy fields.

d) Partially submerged foundation:

Partially submerged foundation shall be that where sub-soil water rises in the foundation pit up to 0.75 m below ground level.

e) Fully submerged foundation:

Fully submerged foundation shall be that where sub-soil water rises in the foundation pit within 0.75 m below ground level.

f) Partially Black Cotton:

This foundation may be adopted where the Black Cotton soil is encountered from 0.3 m to 1.5 m and balance may be normal soil with wet condition.

g) Mixed dry fissured rock:

This foundation may be adopted where the Black Cotton soil is encountered from 0.3 m to 1.5 m and balance is DFR soil as mentioned for dry fissured rock foundation.

h) Black Cotton Soils :

This type of foundation can be used at locations when soil is clay type, not necessarily black in color, which shrinks when dry, swells, when wet, resulting in differential movement extending to a maximum depth of about 3.5 m below ground level and the soil strata at 3.5m depth will have poor bearing pressure.

This type of foundation classification will be given by Chief Engineer/ Transmission or his authorized officer after excavation of the pits. This type classification will be given duly following the necessary investigation.

Hard rock:

The locations where chiselling, drilling and blasting are required sheet rock for excavation, hard rock type foundations are to be used. The rock portion thickness should be at least 3.0 m. For these foundations, rock anchoring is to be provided to resist uplift forces.

Sandy soil:

To be used for locations where cohesion less pure sand or sand with clay content less than 10% met in dry condition.

The special foundations like pile foundations if required shall also be designed by the contractor based on detailed soil investigation and the design, working drawing of these foundations got approved during execution stage and adopted.

Where soil is of composite in nature classification of foundation shall be according to type of soil predominant in the footing. In addition to the above, depending on the site conditions more variations of foundations may be introduced suitable for intermediate conditions under the above classifications to effect more economy.

NOTE:- In all the cases, the water level shall be measured with respect to the tower centre line.

8.3 Though the relevant characteristics of the various types of soils are given above, it shall be the responsibility of the contractor to obtain approval of the purchaser for the departures necessitated in these design data, should he find it necessary based on the site conditions, results of trial pits etc

8.4. FORCES FOR DESIGN OF FOUNDATION :

8.4.1. The following forces/loads transmitted to foundation by superstructure due to the action of wind, conductor tension, acting thereon shall be considered in the design of foundation.

Maximum tension/uplift force.

Maximum compression force/down thrust.

Maximum horizontal shears / side thrusts in longitudinal and transverse directions.

Additional forces due to eccentricities in the foundation system (if any).

8.5 PARTIAL SAFETY FACTORS ON LOADS:

8.5.1. For the design of foundation under most critical loading, the partial factor of safety on loads shall be as under:

Towers up to angle of deviation of 0° -15°: 1.10

Towers with angle of deviation above 15° : 1.20

8.6. STABILITY OF FOUNDATION :

8.6.1. The foundation shall be designed to withstand the most critical combinations of forces for the forces specified in clause 8.4.1 multiplied by relevant partial factor of safety. The stability of foundation, in general, shall be checked for the following aspects:

STABILITY AGAINST UPLIFT
STABILITY AGAINST COMPRESSION LOADS.
STABILITY AGAINST SIDE THRUST
STABILITY AGAINST OVERTURNING
STABILITY AGAINST SLIDING

8.7. **STRUCTURAL DESIGN OF FOUNDATION**:

Isolated identical footings shall be provided for each leg of the tower.

Depending on soil conditions and loading, the foundation of tower shall be one of the following type:

PYRAMID TYPE ISOLATED FOOTING
SLAB TYPE R.C.C. ISOLATED FOOTING
WELL FOUNDATION
UNDER CUT TYPE ISOLATED FOOTING (FOR DFR, PDFR, MDFR ONLY)
ROCK ANCHOR TYPE (FOR HARD ROCK ONLY)
R.C.C PILE FOUNDATION – cast in site or pre cast pile foundation

The choice of type of footing between pyramid type and slab type R.C.C shall be decided based on techno-economical considerations. Slab type R.C.C isolated footings shall be provided at locations where from techno-economical considerations, pyramid types of foundations are not acceptable.

All foundations shall be designed so as to satisfy and meet the following requirements:

The chimney of the foundation shall be at least the 300 MM square providing a minimum clear concrete cover of not less than 100 MM over any part of the stub angle in case of NDS, DFR, PDFR and Hard Rock foundations and at least 450 MM square with minimum clear concrete cover of not less than 150MM over any part of the stub angle in case of wet, partially submerged, MDFR, B.C., PBC and fully submerged foundations.

The chimney top shall extend 250 mm (Minimum) above ground level and coping shall be up to 50 mm below the joint between the bottom bracing and the leg members.

In all foundations, a lean concrete sub-base having a thickness of 100 mm and of size equal to the concrete pyramid base / R.C.C. shall be provided under structural concrete. The lean concrete shall be of grade M-10 (1:3:6) conforming to IS: 456 . The lean concrete sub-base provided under the footings shall not be considered in the structural calculations.

The embedded end of the stub angle shall have a 150 mm thick clear concrete cover up to the top of the lean concrete sub-base in the case of NDS, DFR, PDFR and Hard Rock foundations and a 200 mm thick clear concrete cover in the case of wet, partially submerged MDFR, BC, PBC and fully submerged foundations.

The minimum length of stub encased in concrete below the ground level shall not be

less than 1.5 m. However, the stub shall extend up to the bottom of foundation having a clear concrete cover as specified in para (d) above.

The depth of foundation below ground level shall not be more than 3.0 m.

The joints between the tower stubs and the super structure bracing members shall be at least 300 mm above ground level.

h) The centroidal axis of the stub shall coincide with the axis of the chimney and pass through the centre of the footing base. The design of the foundation shall take into account the additional forces resulting from eccentricity introduced due to non-compliance of above requirements.

i) The chimney shall be designed as a composite member for combined action of axial forces and bending moment. The maximum compression/tension force along with both the horizontal shears viz. longitudinal and transverse shall be considered in the design of chimney. The adequacy of chimney section shall be checked as per above and necessary reinforcement in chimney shall be provided as per design requirements. The design shall be carried out in accordance with IS: 456 as limit state method of design. However, 12mm diameter bar or 0.15% of cross sectional area of chimney whichever is more shall be provided.

j) Wherever reinforcement is provided in foundations, the clear concrete cover to reinforcement shall not be less than 50 MM.

k) The base slab of all foundations shall be poured against undisturbed soil if the development of the uplift frustum angle is to be considered. The uplift angle of compacted backfill shall be considered as zero.

8.7.5. The pyramid type of isolated foundations shall also satisfy and meet the following requirements.

The slope of concrete pyramid shall be limited to 45° with respect to vertical.

The minimum thickness of the concrete pyramid base slab shall be 100 CM in case of NDS, PDFR, DFR and Hard Rock foundations.

The portion of stub and the angle cleats in the pyramid portion only shall be capable of developing the required bond strength corresponding to the uplift load.

8.7.6.The slab type isolated R.C.C. foundations shall also satisfy and meet the following requirements:

The structural design of foundations shall be strictly in accordance with IS: 456, SP-16, CBIP manual and other relevant I.S. codes.

The design of R.C.C. foundations shall be carried out by limit state method in accordance with IS: 456 SP-16 and CBIP manual using partial safety factors as given in the clause 8.5.1

The minimum thickness of footing slab for foundations shall not be less than 250 MM in case of NDS, PDFR, DFR and Hard Rock locations and 300 MM in case of BC, PBC, MDFR, PS, FS and wet locations.

The minimum thickness of footing slab at the edges shall not be less than 150 mm.

In case of stepped foundations, the reinforcement at top face of each step shall be separately provided. The reinforcement from one step to another step at top face of the footings shall not be permitted.

In the design of footing slabs, actual soil pressure under the footing shall be considered to calculate the maximum moments and shears at various sections. The critical sections for moments and shears shall be as specified in **IS: 456.** The reinforcement in the footings shall be accordingly calculated and provided.

ROCK ANCHOR TYPE FOUNDATION

In case of rock foundations, the holes in the rock shall be made in an approved manner so as to eliminate the possibility of cracking of rock. The concrete block shall be secured in the rock with the help of adequate number of anchor bolts of appropriate diameter grouted with a cement mortar containing suitable non-shrinkage admixture.

Under-reamed pile foundations may have to be provided in case of black cotton soil if found necessary. The design of under-reamed pile foundation shall be in accordance with IS: 2911 (Part-Ill).

RCC pile foundation for slush/loose/clay soil – cast in site or pre cast piles with pole cap shall be provided.

9.0. FABRICATION:

9.1.0. The fabrication of towers shall be in accordance with the provisions made in the following sub-clauses.

9.1.1. Except where, hereinafter modified, details of fabrication shall conform to the relevant clauses of IS: 802 (Part-ll).

The contractor during fabrication of tower members shall ensure that mild steel and high tensile steel do not get mixed up during fabrication and as such identification mark shall be embossed on each and every H.T. steel section at the time of shearing of members. The tenderer in his tender shall clearly bring out the means adopted to identify the mild steel and high tensile steel sections during fabrication.

All parts of the towers shall be cut to correct lengths and fabricated in accordance with the shop drawings approved by the purchaser. Welding of two or more pieces to obtain the length of member specified will not be allowed. Members shall be straight to the permissible tolerances or better when required to ensure proper fit before being laid off or worked and after galvanizing.

Normally butt splices shall be used. The components constituting the joint shall have a total strength greater than the heavier of the members connected. Lap splices may be used for connecting members of unequal sizes. The inside angle of lap splice shall be ground at the heel to fit the fillet of the outside angle. All splices shall develop full strength of the members connected through bolts. Butt as well as lap splices shall be made above and as close to the main panel points as possible.

9.1.5. Joints shall be so designed and detailed as to avoid eccentricity as far as possible. However, where the connections are such that the elimination of gusset plates would

result into eccentric joints gusset plates and spacer plates may be used in conformity with modern practices. The thickness of gusset plates shall not be less than 6mm. Where a gusset plate is required to transmit stress, its thickness shall not be less than the thickness of the thickest connected bracing members.

The use of fillers in the connections shall be avoided as far as possible. The diagonal web members in tension may be connected entirely to the gusset plate where necessary to avoid the use of fillers. Each diagonal shall be in one piece without splices or centre gusset, and it shall be connected at the point of intersection by one or more bolts.

The tower members shall be accurately fabricated to bolt together easily at site without any undue strain on them or the bolts.

No angle member shall have the two leg flanges brought together by closing the angle.

All parts of the towers shall be accessible for inspection and cleaning. Drain holes shall be provided at all points where pockets or depressions are likely to hold water.

All similar parts shall be made strictly interchangeable. No rough edges shall be permitted anywhere throughout the work.

9.2.0. **OPERATION IN FABRICATION**:

9.2.1. STRAIGHTENING:

Straightening shall be so done that it does not injure the material. Hammering shall not be permitted for straightening/or flattening of members. Sharp bends shall be a cause for rejection.

9.2.2. CUTTING:

The cut surfaces shall be clean, smooth, reasonably square and free from any distortion.

9.2.3. BENDING:

Mild steel angle sections up to 75x75 mm (thickness up to and including 6 mm) shall be sent be bent cold up to and including bend angles of 10 deg. Mild steel angle sections above 75x75 mm (thickness up to and including 6 mm) and up to and including 100x100 mm (thickness up to 8 mm) may also be bent cold up to bend angles of 5 deg. All other angle sections and bend angles not covered above shall be bent hot. All plates up to 12 mm thickness shall be cold worked up to a maximum bend angle of 15 deg. Hot bending shall be employed for greater bend angles and thicker plates. All hot bent material shall be air-cooled. The bends shall be of even profile and free from any surface damages. Bends on all high tensile steel sections shall be done hot.

9.2.4. HOLING:

Holes in the members shall either be drilled or punched to jig and shall not be formed by flame cutting process. All burrs left by punching or drilling shall be completely removed. Punching may be adopted for M.S. sections with thickness up to 16 mm. For

thicker sections, drilling shall be done. The holes near the bend line of a bent member on both sides of bend line should be punched/drilled after bending and relative positions of those holes shall be maintained with the use of proper templates/jigs and fixtures. The limit of punching for H.T. steel section may be indicated in the bid.

9.3.0. FASTENERS: BOLTS. NUTS AND WASHERS :

All bolts & nuts shall conform to IS: 6639, and IS: 12427 or and hexagonal nut. The heads being forged out of the solid, truly concentric, and square with the shank, which must be perfectly straight. Ultimate stresses in the bolts shall be as given in Table-I and clause 5.4.1 of IS: 802 (Part -1 / section - 2)

Fully threaded bolts shall not be used. The length of bolts shall be such that the threaded portion will not extend into the plane of contact of the member.

9.3.3. All bolts shall be threaded to take the full depth of the nut and threaded for enough to permit firm gripping of the members, but not further. It shall be ensured that the threaded portion of each bolt protrudes not less than 3 mm and not more than 8 mm when tightened. All nuts shall fit and tight to the point where the shank of the bolt connect to the thread.

9.3.4. Flat and tapered washers shall be provided wherever necessary. Spring washers designated as B-16, IS-3063 Electro galvanized/hot dip galvanized shall be provided for insertion under all nuts. These washers shall be of steel and electro-galvanized, conforming to IS: 1573- or hot dip galvanized as per IS: 2629 and positive lock type and 3.5 mm in thickness for 16 mm dia bolt and 4 mm for 20 mm dia bolt and 4.5 mm for 24 mm bolt as per IS: 3063- 1972.

9.3.5. The bidder shall furnish bolt schedules giving thickness of members connected, the nut and the washer and the length of shank and the threaded portion of bolts and sizes of holes and other special details of this nature.

9.3.6. To obviate bending stress in bolts or to reduce to minimum, no bolt shall connect aggregate thickness of more than (3) times the bolt diameter and also the number of members carrying stresses to be connected by a single bolt shall not generally exceed three (excluding gusset and packing).

The bolt positions in assembled towers shall be as per **IS:** 5613 (Part - 3 / section-2). Bolts at the joints shall be so staggered that nuts may be tightened with spanners without fouling.

SPACING OF BOLTS AND EDGE DISTANCE:

a) The minimum spacing of bolts and edge distances shall be as given below:

Bolt Diameter (mm)	Hole Diameter (mm)	Minimum bolt pacing	Minimum bolt centre to rolled or sawn edge	Distance hole centre to sheared Cut edge
16	17.5	40	20	23
20	21.5	48	25	28
24	25.5	60	33	38

Technical data for all the structural steel proposed for tower members and bolts.
Detailed design calculations including stress tables, member & bolt sizes, foundation loads etc. for tangent tower(s).
Drawings and /or catalogues of bidder's equipment.
Outline drawings of foundations of each type which are proposed with typical calculations.
Final conductor and shield wire sag/tension charts.
Full description of the proposed method of tension stringing.

9.4 The tenderers shall furnish the following designs and drawings after award of contract for 400 kV MC line.

Fully dimensioned drawing for each standard type of tower complete with cross arms showing sizes of all steel sections, fittings, bolts; attachments etc. and clearance diagrams, Dimensioned drawings for extensions with sizes of steel sections employed.
Dimensioned drawings for stub.
Dimensioned drawings for stub setting templates.
Dimensioned drawings for anti-climbing device.
Loading diagram for all towers under different working conditions.
Stress diagrams for all towers inclusive of 3-metre, 6-metre, 9-metre and 12-metre tower extensions and cross-arms.
Tabulation of stresses under different design assumptions, permissible Stresses for various members employed in the towers, extensions, and cross arms complete with the following information:
Member reference for identification on stress-diagrams. Individual loads, due to transverse, longitudinal, vertical, and torsional load, etc. under normal and broken wire conditions.
Measured unsupported lengths. Effective unsupported lengths. Appropriate radii of gyration. Sizes of members proposed.
Slenderness ratios.
Permissible crippling stresses.
Gross areas of sections.
Permissible crippling loads.
Number and size of bolts provided. Nett areas of sections.
Permissible tensile loads.
Aggregate cross sectional areas of bolt. Shearing stress on bolts.
Aggregate bearing areas of bolts. Bearing stress on bolts calculated weight of each member.
Dimensional drawings for foundations for each type of standard tower, and tower with 3-metre, 6-metre, 9-metre, 18-metre and 25-metre extensions with detailed design computation for resisting uplift, down thrust and side thrust shall be furnished. Drawings shall show all details of keying rods, cleat angles, etc. to be provided for concrete foundations.

For foundations of each type of towers, the drawings shall furnish the following information:

Dimensions of excavation per leg.

Volume of excavation

Volume of Concrete.

Reinforcement steel.

The capacity charts for all types of towers to be used for smaller angles and longer spans shall be furnished after award of contract.

9.5 Award of contract: The contractor shall submit detailed design of tower foundation and tower with extensions, along with stress diagram/computer output together with sample calculations etc., within one month from the date of agreement.

9.6. The design and drawings as covered in clause 9.4 above shall be approved/ commented by the owner. If the designs /drawings are commented by the owner, the contractor shall submit revised designs/drawings duly incorporating all comments for approval.

9.7 The contractor shall furnish to the purchaser for approval of all drawings, bills of materials, bolt and washer schedules, schedule for tower testing etc,. These shall include, but shall not be limited to the following:

a) Design calculations and drawings: All design drawings and calculations.

b) Shop Drawing: Shop drawings shall list in a space above the title, the part number and required quantity of each member detailed on the drawing. Members may be detailed separately or in place in any assembly.

c) Erection Drawings: Erection drawings shall be furnished for each type of tower and extension & shall show assembly diagram of structures clearly indicating the position of each member and the quantity and size of bolts for each joint.

d) Bill of Materials*:* A complete bill of material in a floppy as format required by purchaser for each type of tower shall be submitted with the erection drawings indicating each part number, required quantities for one tower section of member length, calculated weight and relevant design drawing reference.

e) Bolts, Nuts and Washer Schedule: Bolts, nuts and washers schedules shall list the number of bolts and washers required per tower along with the sizes and lengths of bolts and number, type and size of washers. The shank length and length of threaded portion of various types of bolts shall be indicated in drawing/ table.

9.8 <u>TESTING OF TOWERS:</u>

9.8.1 All standard tests, including quality control tests in accordance with relevant Indian Standards shall be carried out.

9.8.2 A galvanized tower of each type complete with 9M extension shall be subject to design and destruction tests by first applying tests load equivalent to the specified

ultimate tower loading and applied in a manner approved by the purchaser. The tower shall withstand these tests without showing any sign of failure or permanent distortion in any part. Thereafter the tower shall be subjected to destruction by increasing the loads further in an approved manner till it fails. The tower shall be tested for all the conditions considered for the design of tower. The successful bidder shall submit to the purchaser, for approval, the detailed program and proposal for testing the towers showing the methods of carrying out the tests and manner of applying the loads. After the purchaser has approved the test procedures and program the contractor will intimate the purchaser about carrying out of the test at least 15 days in advance of the scheduled date of tests during which the purchaser will arrange to depute the representatives to be present at the time of carrying out of the tests. Six copies of the test reports shall be submitted.

The testing shall be conducted in approved test pads in presence of the TNRDC/TANTRANSCO representative. The contractor shall submit one set of shop drawings along with the bill of materials at the time of prototype tower testing for checking the tower material. Further at the time of submitting test report, the contractor has to submit the final tracings of shop drawings and Bill of Materials for purchaser's reference and record.

9.8.3. In case of premature failure the tower shall be retested and steel already used in the earlier test shall not be used again. However, in case of minor failures, the contractor can replace the members with higher section and carry out the testing. The contractor shall provide facilities to the purchaser or their representatives for inspection of materials during manufacturing stage and also during testing of the same.

9.8.4 In case of any premature failure even during waiting period, the tower is to be retested with rectified members. However, if the failures are major in nature and considerable portion of tower is to be re-erected, in such cases all the tests which has been carried out earlier to be re-conducted again to the entire satisfaction of purchaser.

9.8.5. No part of any tower subject to test shall be allowed to be used on the line. The scrap value of the tower material, which will be retained by the successful bidder may be taken into consideration while working out the unit rate/Km.

9.8.6. The contractor shall ensure that the specification of materials and workmanship of all towers actually supplied conform strictly to the towers which have successfully undergone the tests. In case any deviation is detected the contractor shall replace such defective towers free of cost to the purchaser. All expenditure incurred in erection, to and fro transportation; any other expenditure or losses incurred by the purchaser on this account shall be fully borne by the successful bidder. No extension in delivery time shall be allowed on this account.

The purchaser, however, reserves the right to waive off the testing of the towers, provided the successful bidder had earlier successfully tested, erected and commissioned same towers and

certificate for such tests carried out earlier are furnished duly certified by that purchaser and are found acceptable.

9.8.7. Each type of tower to be tested shall be a full scale prototype black/galvanized tower and shall be erected vertically on rigid foundation and the stub protruding above ground level as provided in the design drawing between ground level and concrete level. This portion of the stub shall be kept un-braced while testing. The tower erected on test bed shall not be out of plumb by more than 1 in 360.

9.8.8. 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 tower up to the maximum anticipated loads to be applied during testing.

The sequence of testing shall be at the discretion of the purchaser.

9.8.10. The purchaser may decide to carry out the tensile test, bend test etc. as per relevant IS on few members of the test tower after completion of the test. The decision of the purchaser's representative regarding which member and number of members to be tested is final and binding. The successful bidder shall make suitable arrangement for the same.

9.8.11. Prefix "T" shall be marked on all members of test tower in addition to the mark no. already provided.

9.9. CALIBRATION OF MEASURING INSTRUMENTS:

All measuring instruments shall be calibrated at least 20% above the maximum anticipated load to be applied. Loads shall be corrected with the help of calibration curves. Strain gauge (Transformer Type) shall be placed on selected members of tower as chosen by Purchaser to record the maximum force experienced by the members in the critical load condition.

9.10. TESTS:

The procedure for conducting the tower test shall be as specified in IS: 802 (Part - 3) (latest edition)

9.10.1. BOLT SLIP TEST :

The test loads shall be gradually applied up to the design loads according to rigging diagram, kept constant for two (2) minutes at the design loads and then released gradually. The initial and final readings on the scales before application and after the release of loads respectively shall be taken with the help of theodolite and the bolt slip shall be determined from the readings so obtained.

9.10.2. NORMAL LOAD/BROKEN WIRE LOAD TESTS:

All the loads shall be applied gradually upto the ultimate design loads in the following steps and shall be released in a similar manner:

25 per cent

50 per cent

75 per cent
90 per cent
95 per cent &
100 per cent

Under normal and broken wire load tests, the tower shall be kept under observation for any sign of failure for two minutes (excluding the time for adjustment of loads) for all intermediate steps of loading up to and including 95% of ultimate design loads.

For normal as well as broken wire tests, the tower shall be kept under observation for five minutes with 100% ultimate design load applied to it.

While the loading operations are in progress, the tower shall be constantly watched, and if it shows any tendency of failure anywhere, the loading shall be immediately stopped, released and then the entire tower shall be inspected. The re-loading shall be started only after corrective measures are taken.

The deflection of the tower shall be recorded at each intermediate and final stage of normal load/broken-wire load test by means of a theodolite and graduated scales fitted on the tower. The structures shall be considered to be satisfactory if it is able to support the specific ultimate load for (5) minutes with no visible deformation after unloading (such as bowing, buckling) and no breakage of elements of constituent parts. Ovalization of holes and permanent deformation of bolts shall be considered as failure.

9.10.3. Destruction Tests*:* If desired by the purchaser, all types of towers shall be tested to destruction. The test shall be carried out under normal condition. All the provisions as stated in clause 9.10.2 shall be applicable to destruction test. However, the loads shall be increased in steps of 5% after the ultimate design loads have been reached.

9.10.4. Material Test*:* In case of failure of towers after retest, coupons shall be cut from test tower members and tested in a laboratory to ascertain conformity of the material to the governing standard.

9.11. RE TEST:

In the event of premature failure of tower, the part that has failed may be replaced by another with a greater mechanical strength. The modified structure shall be required to pass the test for the specified ultimate load values (100% step).

9.12. PACKING:

The material shall be boxed or bundled for transport in the following manner:

9.12.1. Angles shall be packed in bundles securely wrapped four times around at each end and at every meter with No.9 gauge galvanized steel wire with ends twisted tightly. Gross weight of any bundle shall not exceed approximately 450 kg.

9.12.2. Cleat angles, brackets, filled plates and similar small loose pieces shall be nested and bolted together in multiples, and securely wired together through boles, wrapped round at least four times with no.9 gauge galvanized steel wire

and ends twisted tightly. Gross weight of each bundle shall not exceed approximately 70 kg,

9.12.3. The correct number of bolts, nuts and washers to be packed in heavy gunny bags accurately tagged in accordance with the contents and a number of bags packed in a solid box of 22mm thick lumber with panelled ends to be securely nailed and further reinforced with 22mm x No. 18 gauge ironbound stretched entirely around the buttons with ends overlapping at least 150 mm Gross weight of each box shall not exceed 70 kg.

All packing shall be subject to the approval of the purchaser, or his appointed representatives.

The packing shall be carried out with caution to protect the material from moisture, salt or any impurities, which may cause rust or harmful effects.

The packages shall be new and sufficiently sturdy in construction to withstand normal service incident to shipping and field handling.

9.13. MARKING OF PACKINGS:

Each bundle or package shall have the following marks:

The contract/purchase order no. and date, the name or designation of the consignee (to be furnished by the purchaser).

9.14. Ultimate destination (as required by the purchaser).

Detailed despatch instruction shall be asked for by the contractor from the purchaser at least 4 weeks ahead of the scheduled date of dispatch. The contractor shall give the updating statement of towers member wise to arrive the complete towers received in full shape from time to time with despatches.

The relevant software programme to update the dispatches to monitor the material supply position from time to time shall be furnished. All packages shall be marked with the standard packing mark as desired by the purchaser.

9.15. PLACE OF MANUFACTURE AND MANPOWER:

9.15.1. The tenderer must have established steel fabrication facilities in his works or at the works of his Associates. The galvanizing bath plant & equipment available for fabrication, testing facilities available in their works and other institution, which they intend to make use of, shall be stated in the schedules and shall not be changed without the approval of the purchaser. The tenderer shall also submit the details of manpower available with his Organization indicating clearly the number of personnel engaged in the design, fabrication of supporting structures and for erection/ construction of the transmission lines. The tenderer shall give a brief profile of the organization (s).

9.16.GUARANTEED TECHNICAL PARTICULARS:

9.16.1. The tenderer shall fill in the guaranteed technical particulars in the schedule (s) in Chapter-VII of this specification and submit the same with tender.

9.17. SCHEDULE OF REQUIREMENTS AND DESIRED DELIVERIES :

The schedule of requirements (tentative) and desired deliveries is given in Volume-I of this specification.

9.18. PERFORMANCE SCHEDULE:

The tenderer shall furnish the details of his performance in respect of the major works carried out by him involving supplies of materials for and / or erection of such EHV lines preferably 400 KV lines which are in service, at least for the last five years.

9.19.QUALITY ASSURANCE PLAN:

The contractor shall submit the quality assurance plan and shall get it approved by the purchaser. If desired by the purchaser, he shall give access to all the documents and materials to satisfy the purchaser that the quality assurance plan is being properly followed.

9.21. SCHEDULE OF DEVIATION / VARIATIONS:

If the tenderer has any exception to any of the clause laid down in this specification, these should be clearly stated in the schedule of deviations / variations (technical or commercial) otherwise it shall be presumed that the tenderer agrees to the provision /s of this specification and same shall be included in the purchase order and the contract in case of successful tenderers.

9.22 INSULATION RESISTANCE TEST

This test may be carried out with the help of a 10 OR 12 KV megger preferably power driven to ascertain the insulation condition of the line. In case 5 KV megger is used for insulation resistance measurement it shall be ensured that the induced voltage (CVT reading) is LESS than the instrument withstanding capacity otherwise it is likely that the instrument may be damaged.

This Test is to be carried out First prior to the continuity test.

9.23 MEASUREMENT OF INSULATION RESISTANCE

One of the most common devices used for testing electrical insulation is the Megger Insulation Tester.

The DC test voltage is generated by a permanent magnet generator. This generator is turned either by hand or by an electrical mortar. In case a slip clutch maintains the generator speed .A constant voltage is important when the insulation under test has a high capacitance. Common generator output voltage are 500,1000,2500 and 5000 volts. Many Megger have a “guard” terminal as well as “line’ and “earth”. The guard terminal is useful shall one wish to exclude part of the insulation under test from the measurements. this is possible since current flowing to the generator via the guard circuit does not pass through the deflection coil.

Another use of the guard circuit is to shield the “line” lead between the megger and the apparatus under test. This prevents leakage to ground from the “line” lead which would invalidate the Megger reading.

Insulation resistance is the ratio V_{DC} /I_{DC}.V_{DC} is applied across two conductors separately by the insulation under test.

I_{DC} is the current flowing through /over the insulation. For a healthy and clean insulation the megger reading is in mega-Ohms to infinity. For dirty in, insulation and defective ,moist insulation the megger shows a very low insulation resistance value. Megger test gives clear indication about the health, cleanliness and dryness of the line/equipments insulation % Kv megger of 10KV megger of 12KV megger may be used for the transmission line keeping all safety requirements permits to work clearance from statutory bodies and other conditions. Prevailing at the substation where charging of the line is being coordinated.

CONDUCTOR CONTIUNITY TEST

The objective of this is to verify that each conductor of the overhead line properly connected electrically (the value of electrical resistance of line does not vary abnormally from that of a continuous conductor of the same size and length). The electrical resistance of the conductor shall be measured with a whetstone bridge or other suitable instrument if available taking the safely aspects of equipment as well as testing Engineer.

A simple methods of continuity test is illustrated below:

One the insulation test is completed and the results confirms no short circuit carry the following:

SENDING END	RECEIVING END	RESULTS (OHMS)
CLOSE R-Ph GS	MEGGER R-Ph	ZERO/LOW
OPEN Y –Ph GS	MEGGER Y-Ph	HIGH
OPEN B–Ph GS	MEGGER B-Ph	HIGH
OPEN R –Ph GS	MEGGER R-Ph	HIGH
CLOSE Y-Ph GS	MEGGER Y-Ph	ZERO/LOW
OPEN B –Ph GS	MEGGER B-Ph	HIGH
OPEN R –Ph GS	MEGGER R-Ph	HIGH
OPEN Y –Ph GS	MEGGER Y-Ph	HIGH
CLOSE B-Ph GS	MEGGER B-Ph	ZERO/LOW

(ALL GS OPEN CONDITION)

SENDING END	RECEIVING END MEGGER BETWEEN	RESULT (OHMS)
CONNECT R & Y PHASE	R PHASE & Y PH	ZERO OR LOW
B- PHASE & ALL GS OPEN	Y PHASE & B PH	HIGH
	B PHASE & R PH	HIGH
CONNECT R & B PHASE	R PHASE & Y PH	HIGH
Y- PHASE & ALL GS OPEN	Y PHASE & B PH	HIGH
	B PHASE & R PH	ZERO OR LOW
CONNECT Y & B PHASE	R PHASE & Y PH	HIGH
R- PHASE & ALL GS OPEN	Y PHASE & B PH	ZERO OR LOW

	B PHASE & R PH	HIGH

GS means GROUND SWITCH

If the above test results are OK it confirms the continuity of the line.

The continuity test of the line with proper phase indication or phase marking can be checked by continuity test as described below.

PHASE SEQUENCE

Once the line is charges from one end without closing the breaker at the other end the phase sequence is to be checked from the CVT output by the help of phase sequence meter. In case there feeders available phase sequence is to be RECHECKED by the measurement of secondary voltage of both the feeders (New line & available charged line)

Let the secondary voltage of CVT 110 volts) Ph to Ph for both the circuit. In case of correct Phase sequence the voltage reading shall be as follows.

NEW CIRCUIT	OLD CIRCUIT	VOLTAGE
R-Phase	R-Phase	0
R-Phase	Y- Phase	110
R-Phase	B-Phase	110
Y- Phase	R-Phase	110
Y- Phase	Y- Phase	0
Y- Phase	B-Phase	110
B-Phase	R-Phase	110
B-Phase	Y- Phase	110
B-Phase	B-Phase	0

In case the results are not matching the phase sequence in to be rechecked and reconfirmed before closing the breaker.

ENERGIZATION

Execution of the energization is simply the last event in the switching sequence switching of the close control button for the relevant circuit breaker.

OBSERVATION AND DURATION

Visual and audible inspection (look and listen) of the relevant equipment and reading of permanent instrumentation will be made.

The system shall be charged at least for 8 hours. During this time continuous monitoring and inspection will be maintained in control room auxiliary systems areas and switch yards.

This will include frequent schedule inspection of all equipment and reading of all permanent instruments and records, and surge arrester counters especially system parameters as per standard procedures adopted by TANTRANSCO.

PASSING CRITERIA

Neither insulation breakdown nor protective system action must occur. No irregular equipment behaviour noise vibration high temperature is permitted.

Corona discharges may not be “unreasonable’. Local discharge that may be attributable to sharp points shall be carefully located and recorded. After termination of the energization the equipments shall be closely inspected and the points rounded or covered.

No unscheduled changes of system or of equipment are permitted during the 8 hours energized condition.

DOCUMENTATION

Switching and operational activities will be recorded in regular manner in the operators log. Likewise all readings of permanent instruments. Copies of the log, notes on specials observations from inspection and other measurements will constitute the test records

VOLUME-1I
Chapter-II A

DETAILED AND CHECK SURVEY:

SCOPE:

i) Design, Manufacture, Supply, Erection, Testing and Commissioning of **400 KV Towers** with **Twin Moose conductors** for deviation of the existing overhead towers for formation of Northern Port Access Road (NPAR) section –I of Chennai Peripheral Ring Road(CPRR).

1.1. Detailed and Check Survey

The Contractor shall perform detailed survey with preparation of route map and profile ploting and check survey to locate and peg marks the tower positions on ground conforming to the survey/profiles charts. In the process it is necessary to have the pit centres marked according to the excavation making charts. The levels, up or down, of each pit centre with respect to the centre of the tower location shall be noted and recorded for determining the amount of benching or earthwork required to meet design requirements of the foundation.

If the levels of the pit centres were in sharp contrast with the level of the tower centre (say beyond a slope of 1:4), suitable 'leg extensions' may be deployed as required.

1.2. Right-of-Way, Cutting/Trimming of Trees etc.

Any lopping or trimming of tree branches obstructing the line of sight during detailed survey shall be the responsibility of the contractor. Clearing of obstructions falling in the right-of-way as per IS:5613 (Part 3, Section 2) and lopping or trimming of the portion of the trees falling within the minimum electrical clearance zone shall be the responsibility of the contractor.

The purchaser shall not be responsible for arranging access roads/right-of-way for transport of man and material for doing survey from roadside to work sites enroute route alignment. If the contractor has to adopt any such arrangements, he may do so with the consent of the property owners and any compensation in that respect will be his responsibility. The contractor shall take reasonable steps for preventing damage to crops during detailed survey.

1.3. Soil Resistivity:

Soil resistivity along the alignment, shall preferably be measured in dry weather by the four electrodes method keeping interelectrode spacing of 50 meters. For calculating soil resistivity, formula 2 TT ar (where a = 50 meters, r = megger reading in ohms, TT = 3.14) shall be adopted. Measurements shall be made at every 2 to 3 km along the route. In case soil characteristics change within 2 to 3 km. The value shall also be measured at intermediate locations. The megger reading and soil characteristics shall also be indicated in the soil resistivity results.

1.4. Soil Investigation and Classification of soils:

General:

The scope of work includes detailed soil investigation at tower locations for railway crossings, major road crossing. Power line crossings and wherever soil strata differs from normal locations. The soil investigation activities shall be completed much before the commencement of main erection activities. Soil investigation need not be carried out in all the locations of the line.

1.4.1. Soil Investigation At Normal Locations:

One borehole of 150mm dia. shall be drilled at the centre point of the tower. Standard penetration Test (S.P.T.) shall be carried out at 1.50 m interval or change of strata up to the required depth of 2½ times below the depth of foundation below existing surface elevation or refusal whichever occurs earlier (By refusal it shall mean that a standard penetration blow count 'N' of 100 is recorded for 30 cm penetration). Bore details and water table up to required depth below existing surface elevation or refusal whichever occurs earlier shall be furnished in the report.

1.4.2. Preparation of Test Reports:

The investigation report snail contain the following test results:

Grain size analysis.

Nomenclature of soil.

Atterbergs limit (Liquid and plastic limit only).

Tri axial shear test results containing information about angle of internal friction and cohesion.

S.P.T. results containing information about natural moisture content, specific gravity and bulk unit weight.

Consolidation test.

Unconfined compression test.

Unconsolidated undrained test.

Presence of carbonates, sulphates, nitrates and organic matters and any other chemicals harmful to the concrete foundation obtained from chemical test on soil sample.

For rocky, soil core recovery and crushing strength of the rock shall be furnished.

The above test results shall be summarized strata-wise as well as in a combined tabular form with all relevant graph, charts, tables, diagrams and photographs, if any, shall be furnished in the test reports.

The test report shall include bore logs. Bore logs of each borehole shall clearly identify the stratification and type of soil stratum with depth up to the refusal. The locations of water table shall be identified on the bore log. The value of SPT at depth where conducted and various laboratory tests conducted from samples collected at various depths shall be clearly shown against the particular stratum.

The report should contain specific recommendation for the type of foundation. In case the soil parameters obtained from the soil investigation report for a particular

tower locations, differ from the ones considered during design, a fresh design will be developed by the Purchaser.

1.4.3. Procedure for Geotechnical Investigation:

A detailed note on procedure for Geotechnical Investigation is enclosed at Appendix - A.

1.9. Tower schedule :

1.9.1. A tower schedule shall be prepared for planning of tower and line materials. The proforma shall be made on a convenient sheet size of 280x508mm. Tower schedule shall further be checked by means of the tower capacity charts approved by the purchaser. If the limits are exceeded anywhere, the spotting should be relocated by trials.

Along with the tower schedules, a line schedule should also be prepared which should cover in detail the total quantity of all line materials required and the quantity in which these are required at various points on the line.

In addition to furnishing finalized copy of route alignment, plan and elevation profiles, sag template, diagonal profiles tower capacity chart etc, a reproducible copy each of these documents shall also be furnished.

** ** **

APPENDIX-A

1.0. Detailed Procedure for Geotechnical Investigations:

1.1 GENERAL:

Purchaser requires performing detailed geotechnical investigation at specified number of tower locations to provide sufficiently accurate information, both general and specific about the substrata profile and relevant soil and rock parameters at site on the basis of which the foundation of transmission line towers can be classified and designed rationally. The length of land use category, EHT line crossing details encountered en-route the transmission line are given in the route details of the specification.

SCOPE:

1.2.1 The scope involves soil sampling and tests, the details of which vary according to tower locations in order to verify the bearing capacity, uplift resistance and settlement constraints, as described hereafter. Detailed soil investigation shall be carried out at all important locations such as crossing of railway lines, national highways, power lines and location identified by the Purchaser. The contractor shall bore trial holes or excavate a test pit to at least 3.5 metre depth or more depending upon the design depth of foundation proposed in the bid and furnish bore log by data including depth of the ground water with table. Based on the soil parameters, contractor shall recommend the foundation type suitable for tower locations as qualified herein and as approved by the Purchaser. The Purchaser may modify the field exploration procedure both prior to and during the exploration process based on the actual findings.

1.2.2 This specification cover the technical requirements for a detailed geotechnical investigation and submission of a detailed Geotechnical Report. The work shall include mobilization of all necessary tools, survey instruments and equipment and provision of necessary engineering supervision and technical personnel, skilled and unskilled labour, etc., as required to carry out the entire field investigation as well as laboratory tests, analysis and interpretation of data collected and preparation of the Geotechnical report. Contractor shall also collect data regarding variation of subsoil water table along the proposed line route.

1.2.3 Contractor shall make his own arrangements to establish the coordinate system required to position boreholes, tests pits and other field test locations as per the drawings / sketches approved by Purchaser. Contractor shall determine the reduced levels (R.L.S) at these locations with respect to benchmarks used in the detailed survey. Two reference lines shall be established based on survey data/details.

1.2.4 The field and laboratory data/test results shall be recorded on the proforma recommended in relevant Indian Standards on weekly basis verified by

the Purchaser. Contractor shall submit to Purchaser two copies of field bore logs and all the field records soon after the completion of each borehole/test.

Whenever Contractor is unable to extract undisturbed samples, it shall immediately inform the Purchaser for his verification and concurrence. 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.

Contractor shall carry out all work expressed and implied in Clause 1.2 of IS specification in accordance with overall requirements of the specification.

1.3 General Requirements :

Wherever possible, contractor shall obtain information and review existing local knowledge of neighboring streams, water resources abandoned underground works, nearby quarries, unlined wells, excavations records of test pits, boreholes, recent landfills, landslides etc. types of foundations adopted and the behavior of existing structures, particularly those similar to the present project. Study of the general topography of the surrounding areas will often help in the delineation of different soil types.

1.4 Codes and Standards for Geotechnical Investigations:

All standards, specifications and codes of practice referred to herein including JIS shall be the latest editions including all amendments and revisions. In case of conflict between the present specifications and those referred to herein, the former shall prevail.

All work shall be carried out in accordance with the following Indian Standards and Codes:

Indian Standards (IS)	Title	International and Internationally Recognised Standard/Code.
IS: 1080	Codes of Practice for Design for construction of Simple Spread Foundations.	
IS : 1498	Classification and identification of soils for General Engineering Purposes.	**ASTM D 2487 ASTM D 2488**
IS: 1888	Method of load tests on soils	
IS : 1892	Code of Practice for Subsurface Investigation for foundation.	
IS: 1904	Code of Practice for Design and Construction of Foundation in Soils General Requirements	
IS: 2131	Method of Standard Penetration Test for Soil	**ASTM D 1586**
IS: 2132	Code of Practice for Thin Walled tube Sampling of Soils	**ASTM D 1587**
IS: 2720	Method of test for Soils (Relevant Parts)	**ASTM D 420**
IS: 2809	Glossary of Terms and Symbols relating to soil dynamics	**ASTM D 653**

IS: 2810	Glossary of terms and symbols relating to soil dynamics	
IS: 3025	Methods of Sampling and Testing (Physical and Chemical) for Water used in Industry.	
IS: 4078	Code of Practice for Indexing and Storage of Drill Cores.	
IS: 4434	Code of Practice for in-situ Vane Shear Test for soils	**ASTM D 2573 ASTM D 4648**
IS: 4453	Code of Practice for Exploration by Pits, Trenches, Drifts and Shafts	
IS: 4464	Code of Practice for Presentation of Drilling Information and Core Description in Foundation Investigation	
IS: 4968 (Part.II)	Method for Subsurface Sounding for Soils, Dynamic Method Using Cone and Bentonite Slurry.	
IS: 5313	Guide for Core Drilling Observation	
IS: 6403	Code of Practice for Determination of Allowable Bearing Pressure on Shallow Foundation	**ASTM D 194**
IS: 6926	Code of Practice for Diamond Core Drilling for Site Investigation for River Valley Projects.	
IS: 6935	Method of Determination of Water Level in a Bore Hole.	
IS: 7422	Symbols and Abbreviations for Use in Geological Maps, Sections and Subsurface Exploratory Logs (Relevant parts),	
IS: 1449 (Part-1)	Code of Practice for Calculation of settlements of foundations (Shallow Foundations subjected to Symmetrical Vertical Loads).	
IS:8764	Method of Determination of Point Load Strength Index of Rocks	
IS: 9143	Method of Determination of Unconfined Compressive Strength of Rock Materials	ASTM D 2938
IS :9179	Method of Preparation of Rock Specimen for Laboratory Testing	ASTM D 4543
IS :9259	Specification for Liquid Limit Apparatus	**ASTM D 4318**
IS : 9640	Specification for Spilt Spoon Sampler	**ASTM D 1586**
IS : 10050	Method of Determination of Slake Durability Index of Rocks	**ASTM D 4644**
IS: 11315	Description of Discontinuities in Rock Mass - Core Recovery and Rock Quality	
	CBI&P Manual on Transmission Line Towers -Chapter 10: Foundation	

1.5. Field investigation for Soils:

1.5.1. Boring Requirement and Boring:

1.5.1.1. Requirements:

One borehole shall be made in the centre point of tower to obtain information about the subsoil profile, its nature and strength and to collect soil samples for strata identification and for conducting laboratory tests. The minimum diameter, of the borehole shall be 150 mm and boring shall be carried out in accordance with the provisions of IS: 1892 and IS specification.

All boreholes shall be 7m deep or 2½ times the depth of foundation as approved by Purchaser for normal soil conditions. If a strata is encountered where the standard penetration test records N values greater than 100, with characteristics of rock, the borehole shall be advanced by coring at least 3 m further in normal locations with prior approval of the Purchaser. When the boreholes are to be terminated in soil strata, an additional Standard Penetration Test shall be carried out at the termination depth. No extra payment shall be made for carrying out Standard Penetration Test.

Casing pipe shall be used when collapse of a borehole wall is probable. The bottom of the casing pipe shall at all times be above the test or sampling level but not more than 15 cm above the borehole bottom. In case of cohesion less soils, the advancement of the casing pipe shall be such that it does not disturb the soil to be tested or samples. The casing shall preferably advanced by slowly rotating the casing pipe and not by driving.

In-situ tests shall be conducted and undisturbed samples shall be obtained in the boreholes at intervals specified hereafter. Representative disturbed samples shall be preserved for conducting various identification tests in the laboratory. Water table in the borehole shall be carefully recorded and reported following IS: 6935. No water or drilling mud shall be used while boring above ground water table. For cohesion less soil below water table, the water level in the borehole shall at all times be maintained slightly above the water table.

The borehole shall be cleaned using suitable tools to the depth of testing or sampling, ensuring least or minimum disturbance of the soil at the bottom of the borehole. The process of jetting through an open tube sampler shall not be permitted. In cohesive soils, the borehole may be cleaned by using a bailer with a tap valve. Gentle circulation of drilling fluid shall be done when rotary mud circulation boring is adopted.

On completion of drilling, Contractor shall backfill all boreholes as directed by the purchaser.

1.5.1.2. Auger boring and shell and auger boring shall be adopted depending on soil condition and water table.

1.5.2 Standard Penetration Test (SPT):

This test shall be conducted in all types of soil deposits encountered within a borehole of 150mm dia and be carried at interval of 1.5 m or change of strata up to the required depth 2½ times the depth of foundation below existing surface elevation or refusal whichever occurs earlier to find the variation in the soil stratification by correlating with the number of blows required for unit penetration of a standard penetrometer. Structure

sensitive engineering properties of cohesive soils and silts such as strength and compressibility shall not be inferred based on SPT values.

The spacing between the levels of standard penetration testing and next undisturbed sampling shall not be less than 10 m Equipment accessories and procedures for conducting the test and for collection of the samples shall conform to IS: 2131. All disturbed and undisturbed samples collected in the field shall be classified at site as per IS: 1498.

1.5.2.3 The test shall be discontinued when the blow count equal to 100 is recorded for 30 cm penetration. At the level, where the test is discontinued, the number of blows and the corresponding penetration shall be reported. Sufficient quantity of disturbed soil samples shall be collected from the split spoon sampler for identification and laboratory testing. The sample shall be visually classified and recorded at the site as well as properly preserved without loss of moisture content and labelled.

1.5.3. **Ground Water**:

The elevation of ground water table in boreholes shall be determined as per IS: 6935 and the instructions of the Purchaser. If any variation of the ground water level is observed in any specific boreholes, the water level in these boreholes shall be recorded during the course of the field investigation. Levels in nearby wells, streams etc., if any, shall also be noted.

1.6. Field Investigation for Rock:

1.6.1. Rock Drilling:

If, during the investigations, large hard fragments or natural rock beds are encountered, work shall proceed with core drilling methods. The equipment and procedures for this operation shall conform to IS: 1892. The starting depth of drilling in rock shall be certified by the Purchaser. At the end of the investigation, the hole drilled in rock shall be backfilled with grout consisting of 1 part cement and 3 parts sand by weight. Attempt shall be made to recover cores of 1.5 m in length. Tungsten carbide (TC) bits shall normally be used. Change over to a diamond bit shall require the specific written approval of the Purchaser.

No drilling shall exceed 1.5 m in depth. If the core recovery is less than 80% in any run, the length of the subsequent run shall be reduced to 0.75m. During drilling operations, all the observations and other details on return water, rate of penetration, etc., shall be observed recorded and reported as per IS: 5313.

1.6.2. Core Sampling:

The boxes for core samples shall be made from seasoned timber or any other durable material and shall be indexed on top of the lid according to IS: 4078. The cores shall be numbered serially and arranged in the boxes in a sequential order. The description of the core samples shall be recorded as instructed in IS: 4464. Where no core is recovered, it shall be recorded as specified in the standard. Continuous record of core recovery and rock quality designation (RQDD) are to be mentioned in the bore log in accordance with IS: 11315 (Part-ll).

1.7. Laboratory Testing:

1.7.1. Essential Requirements:

Depending on the types of substrata encountered, appropriate laboratory tests shall be conducted on soil and rock samples collected in the field in an approved laboratory. Calibration of all the instruments and their accessories shall be done carefully and precisely in an approved laboratory. Laboratory tests shall be carried out concurrently with the field investigation, as initial laboratory test results could be useful in planning the later stage fieldwork. A schedule of laboratory tests shall be established by contractor to the satisfaction of the purchaser within one week of completion of the first borehole.

1.7.2 Tests:

Tests, as indicated in these specifications and as may be required by the purchaser, shall be conducted. These tests shall include but may not be limited to the following.

a) Tests of disturbed samples: Visual and engineering classification/Nomenclature of soil, Sieve analysis and hydrometric analysis, Liquid, plastic and shrinkage limits / Alter bergs limit, Specific gravity, Swell pressure and the free swell index determination, Proctor compaction test

b) Tests of undisturbed samples: Bulk density and moisture content, Relative density for sand); Unconfined compression test; Box shear test (for sand); Triaxial shear tests including angle of internal friction and Cohesion (depending on the type of soil and field condition on Undisturbed or removed samples)

   (i) Unconsolidated un-drained (ii) Consolidated drained test- Consolidation

c) Tests on rock samples: Visual and engineering classification Nomenclature. Moisture content, porosity and density. Specific gravity; Hardness; Slake durability; Unconfined compression test (both saturated and at in situ water Content); Point load strength index; Deformability test (both saturated and dry samples);

d) Chemical analysis of sub soil water

1.7.3. Salient Test Requirement:

Triaxial shear tests shall be conducted on undisturbed soil samples saturated by the application of backpressure. Only if the water table is at sufficient depth so that chances of its rising to the base of footing are small or nil, the triaxial tests shall be carried out on a set of three test specimens from one sample at cell pressures equal to 100, 200 and 300 kPa respectively or as required depending on the soil conditions.

Direct shear test shall be conducted on undisturbed soil samples. The three normal vertical stresses for each test shall be 100, 200 and 300kPa or as required for the soil conditions;

Consolidation tests shall have loading stages of 10, 25, 50, 75, 100, 200, 400 and 144 kPa. Rebound curve shall be recorded for all samples by unloading the specimen at its in-situ stress. Additional rebound curves shall also be recorded wherever desired by the purchaser.

Chemical analysis of subsoil shall include determination of pH value, carbonate, sulphate (both SO3 and SO4), chloride and nitrate contents, organic matter, salinity and any other chemicals which may be harmful to the foundation material. Their contents in the soil shall be indicated as percentage (%).

Chemical analysis of subsoil water samples shall include the determination of properties such as colour, odour, turbidity, pH value and specific conductivity, the last two at 25° C and chemical contents such as carbonates, sulphates (both SO3 and SO4), chlorides, nitrates, organic matter and any other chemical harmful to the foundation material. The chemical contents shall be indicated as parts per million (ppm) based on weight.

1.8. Geotechnical investigation Report:

1.8.1 General

a) Contractor shall submit a format draft report for review by the purchaser containing geological information of the region, procedures adopted for geotechnical investigation, field observations, summarized test data, conclusions and recommendations. The report shall also include detailed bore logs, sub-soil sections, field test results, laboratory observations and test results both in tabular as well as graphical form, practical and theoretical considerations for the interpretation of test results, supporting calculations for the conclusions drawn, etc.

b) Purchaser shall review the draft report and the contractor shall make available the Geotechnical engineer for discussions to finalize this report. Contractor shall incorporate in the report the agreed modifications and resubmit the revised report for approval.

c) The detailed final report based on field observations, in-situ and laboratory tests shall encompass theoretical as well as practical considerations for foundations for different types of towers as discussed in the specification.

1-8.2. Data to be Furnished:

1.8.2.1. The report shall also include the following:

A plot plan / location plan drawn to scale and dimensioned with reference to the established grid lines showing the locations and reduced levels of all boreholes, trial pits sites where static cone penetration and dynamic cone penetrations tests, etc. carried out.

A true cross section of all individual boreholes and test pits with reduced levels and coordinates showing the classification and thickness of individual stratum, position of ground water table, various in-situ tests conducted, samples collected at different depths and the rock stratum, if encountered;

Plot of Standard Penetration Test (uncorrected and corrected N values) with depth for each test site.

Results of all laboratory tests summarized according to enclosed Table for each sample as well as for each layer, along with all the relevant charts, tables,

graphs, figures, supporting calculations conclusions and photographs of representative rock cores.

For all tri-axial shear tests, stress Vs strain diagrams as well as Mohr's circle envelopes shall be furnished. If back pressure is applied for saturation, the magnitude of the same shall be indicated. The value of modulus of elasticity (E) shall be furnished for all tests along with relevant calculations;

For all consolidation tests, the following curves shall be furnished:

i. e Vs log p:

ii. e Vs p;

iii. Compression Vs log t or Vs /1

Depending upon the shape of the plot, for proper determination of coefficient of consolidation.

The point showing the initial condition (eo, Po) of the soil shall be marked on the curves.

g) The procedure adopted for calculating the compression index from the field curve and settlement of soil strata shall be clearly specified. The time required for 50% and 90% primary consolidation along with secondary settlements, if significant, shall also be calculated.

1.8.3. Recommendations:

Recommendations shall be provided for specified tower location and other tower locations in general duly considering soil type and tower spotting data. The recommendations shall provide all design parameters and considerations required for proper selection, dimensioning and future performance of tower foundations, as discussed in part but not limited to the specifications foundations and the following:

The subsurface material must provide safe bearing capacity and uplift resistance by incorporating appropriate safety factors or other equivalent stipulations specified in the specification ail the while experiencing small deformations throughout thereby avoiding rupture under ultimate loads:

Movement of the foundation, including short and long term components under transient and permanent loading, shall be strictly controlled with regard to settlement, uplift, lateral translation and rotation;

Co-efficient of permeability of various sub soil and rock strata based on in - situ permeability tests.

Core resistance, frictional resistance, total resistance, relation between core resistance Standard Penetration Test N value, and settlement analysis for different sizes of foundation based on static cone penetration test.

e) For shallow foundation the following shall be indicated with comprehensive supporting calculations.

i) Net safe allowable bearing pressure for isolated square, footing size 3.0 and 4.0m and sizes determined during designing at three different founding depths of 2, 3m and 4m below

ground level considering both shear failure and settlement criteria, giving reasons for type of shear failure adopted in the calculation.

ii) Net safe allowable bearing pressure for raft foundations of widths greater than 5m or as determined during designing at 2.0, 3.0 and 4.0 m below ground level considering both shear failure and settlement criteria.

iii). Rate and magnitude of settlement expected of the structure.

iv) Net safe bearing capacity for foundation sizes mentioned in para (i) above, modulus of subgrade reaction modulus of elasticity from plate load test results alongwith time settlement curves and load settlement curve in both natural and log graph, variation of Modulus of subgrade reaction with size shape and depth of foundation.

The stable slopes for shallow and deep excavations, active and passive earth pressure at rest and angle of repose for sandy soils shall be furnished. The loading of the foundation shall not compromise the stability of the surrounding subsurface materials and the stability of the foundation shall be ensured against sliding or overturning.

Depending on the subsurface material, water table level and tower type, recommendation for either reinforced concrete isolated pad and chimney or special foundations shall be made at various locations.

h) Net safe allowable bearing pressure and uplift resistance shall be provided for the various sizes of isolated square footings founded at various depths below ground level considering both shear failure and movement criteria; rate and magnitude of movement expected of the tower (settlement, uplift, rotation) shall also be given.

i) Where the subsoil water and soil properties are found to be chemically aggressive. Contractor shall take suitable precautions during construction including any protective coating to be applied on the foundations; susceptibility of soil to termite action and remedial measures for the same shall be dealt with.

j) Suitability of locally available soils at site for filling, backfilling and adequate compaction shall be investigated.

k) If expansive soil such as black cotton soil is encountered recommendation of removal or retaining of the same shall be given in the latter case, detailed specifications of special requirements shall also be given;

I) Susceptibility of subsoil strata to liquefaction in case of earthquake and remedial measures, if required, shall be considered.

m) Any other information of special significance such as dewatering schemes, etc., which may have a bearing on the design and construction shall be provided.

n) Recommendations for additional soil investigations, beyond the scope of the present work, shall be given if Contractor considers such investigations necessary.

1.8.4. Hydrological Conditions:

The maximum elevation of ground water table, amplitudes of its fluctuations and data on water aggressivity with regard to foundation structure materials shall be reported. While preparing ground water characteristics the following parameters should be specified for each aquifer.

a) bicarbonate alkalinity - mg - eq / (degr)

b) PH value.

c) Content of aggressive carbon dioxide, mg/l;

d) Content of magnesia salts, mg/l, recalculated in terms of ions Mg2.

e) Content of ammonia salts, mg/l, recalculated in terms of ions NH

f) Content of caustic alkalis, mg/l, recalculated in terms of ions Na and K.

g) Contents of chlorides, mg/l, recalculated in terms of ions Cl.

h) Contents of sulphates, mg/l, recalculated in terms of ions SO2.

i) Aggregate content of chlorides, sulphates, nitrates, carbonates and other salts, mg/l.

1.9. Schedule of Quantities for Geotechnical investigation including Laboratory Testing:

The terms of work are based on unit rate. It will be understood that the Bidder has fully studied the specification prior to bidding. All the quantities given in the specification are tentative and subject to change. Payment shall be made at quoted rates for actual quantities of work executed as approved by the Purchaser.

The provisional number of testing locations are to be ascertained in consultation with the Engineer in-charge of the project.

TABLE

SUMMARY OF RESULTS OF LABORATORY TESTS ON SOIL AND WATER SAMPLES:

1	Bore hole test pit. No.
2	Depth (m)
3	Type of sample
4	Density (kg/m3)
	a) Bulk b) Dry
5	Water content (%)
6	Particle size (%)
	a) Gravel b) Sand c) Silt d) Clay
7	Consistency properties
	a. LL
	b. PL
	c. PI
	d. L1
8	d. Soil
	e .Classification-IS
	f. Description
	g. Specific gravity

9	Strength test
	a) Type
	b) C (Cohesion)
	c) Ø (angle of internal friction)
	friction)
10	Consolidation test
	a. eo
	b. *Pc*
	c. Cc
	d. Ap
	e. mv
	f. Cv
11	Shrinkage limit (%)
12	Swell test
	a) S.Pr
	b) FS
13	Relative Density (%)
14	Remarks
	Notations:

I) For type of sample

DB Disturbed bulk soil sample

DP Disturbed SPT soil sample

DS Disturbed samples from cutting edge of undisturbed soil sample RM Remoulded soil sample

UB Undisturbed block soil sample

US Undisturbed soil sample by sampler

W Water sample

II) For Strength Test

SCPT Static Cone Penetration Test

UCC Unconfined Compression Test

VST Vane Shear Test

Tuu Unconsolidated Undrained Triaxial Test

Note: Replace T by D for Direct Shear Test

Ted Consolidated Drained Triaxial Test

III) For others

LL	Liquid Limit (%)
PL	Plastic Limit (%)
PI	Plasticity index (%)
LI	Liquidity index (%)
C	Cohesion (kPa)
Ø	Angle of Internal Friction (degrees)
S.Pr.	Swelling Pressure (kPa)

eo	Initial Void Ratio
Po	Reconsolidation Pressure (kPa)
Co	Compression index
ΔP	Change in Pressure (kPa)
mv	Coefficient of Volume Compressibility (m^2kN)
Cv	Coefficient of Consolidation (m/hr)

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ERECTION, TESTING AND COMMISSIONING
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VOLUME - II

CHAPTER — II B

ERECTION. TESTING AND COMMISSIONING

10. SCOPE:

This chapter covers erection and commissioning of the transmission lines enumerated in volume-II, “TECHNICAL SPECIFICATION", handling, transportation and distribution of all line materials to the respective work sites at his own cost.

The erection work shall also include the cost of labour, all tools and plants including tension stringing equipment and all other incidental expenses in connection with the erection, testing and commissioning of the line.

VARIATION IN QUANTITIES:

The contractor shall furnish estimated quantities for all items of contract, covered in the schedules for completing erection of 400 kV Multi circuit line in full shape within 15 days of completion of detailed survey.

The rates indicated in the schedule shall hold good up to 25% variation in Scheduled quantity. When quantity exceeds the Scheduled quantity the contractor shall bring the fact to the notice of the Chief Engineer/Civil/Transmission well in advance & obtain approval before commencing the execution of such excess quantity. The rates payable for such extra quantities beyond 25% of the Scheduled quantities shall be either accepted rate or estimated rate considered at the time of awarding the contract +/- the overall tender percentage over the estimated rate whichever is less.

2.0. SPECIFIC TECHNICAL REQUIREMENTS:

2.1. TRANSMISSION LINE ROUTE:

Before proceeding with tower foundation works the Contractor shall obtain clearance from the Purchaser for proceeding with foundation works of respective tower locations, duly furnishing the details of profiles, details of benching, revetments, hillside extensions along with necessary estimates.

The specific technical requirements for erection, testing and commissioning of the line and the particulars of the line etc. are specified in Chapter-IV of this specification.

2.2. STANDARDS:

Except where otherwise specified or implied, the erection, testing and Commissioning shall conform to the provisions of IS: 5613 (Part 3, Section - 2).

The Indian Standard Specifications mentioned below, JIS or equivalent International Standards shall be applicable to the materials and processes used in executing the work.

2.3. COMMUNICATION AND TRANSPORT:

(I)	IS: 383-Part-1	Course and fine aggregates from Natural sources for concrete. Earthwork.
(ii)	IS:456	Code of practice for plain and reinforced concrete.
(iii)	IS:2502	Code of practice for bending and fixing of bars for concrete reinforcement.
(iv)	IS:3043	Code of practice for earthing.
(v)	IS:3764	Safety code for excavation work.
(vi)	IS:4081	Safety code for blasting and related drilling operation.
(vii)	IS:4091	Code of practice for design and construction of foundations for Transmission line towers and poles.
(viii)		IE RULES 1956 and other applicable regulations.
(ix)	CBI&P Publication No.268,290	Transmission line manual
	SP-16	Foundations Reference Manual

2.3.1. The information about the existing communication and transport facilities may be verified from the concerned authorities before submitting the bid by the bidder.

2.4. MATERIAL HANDLING AND ACCOUNTING:

The bidder is responsible for transportation of the material from their designated storage yards to the work spot and storage of the material etc. Complaint of damages during transportation shall be made by the contractor to the insurance underwriters within the stipulated period. In case of loss/damage of the material, the contractor shall be responsible for making good the shortages/damages within the period specified by the purchaser. Any demurrage and wharf age incurred on the material due to contractor's carelessness shall be to his account.

The contractor shall be responsible for safe transportation of all line materials to the work sites. He shall be responsible for proper distribution of the conductor and earth wire drums so that the wastage of materials is kept to a minimum.

No separate charges shall be paid for head loading of materials, tools and tackles. The tenderers shall inspect the line route before submitting their tenders.

2.5. ERECTION LOSSES:

2.5.1. The contractor shall make every effort to minimize the breakages, losses and wharf ages of line materials during erection and all the losses are in contractors account and no extra amount will be paid.

* In case of conductor, Optical fibre GW and Earth wire the quantity required for sag, jumpering, damages, losses and wastage, cut lengths from conductor drums are in the contractors account and no extra amount will be paid.

** The contractor shall not be required to return to the owner empty conductor, earth wire drums and shall dispose off the same at bidder's cost.

2.6. GENERAL STORAGE OF MATERIAL:

The contractor shall procure the Cement and store in suitable weather proof, properly ventilated buildings with dry floors so as to prevent deterioration. The cement shall be "ordinary Portland" of standard make conforming to the IS.

The contractor shall stack the fabricated steel members in separate piles member-wise and tower wise. These shall be stacked clear off the ground with their heels upward in order to avoid entrapping of water between the angle-sections. The reinforcement bars shall also be stored in separate piles in a suitable manner to minimize corrosion. Other line material shall be stacked properly with a view of easy handling, issue, accounting minimum exposure to inclement weather etc.

The contractor shall store the aggregates on hard smooth and clean surfaces so that there is no possibility of inclusion of any foreign materials. Aggregates of different grades shall be stored in piles, which shall be spaced well apart to prevent their intermixing.

2.7 RIGHT-OF-WAY, CUTTING OF TREES ETC.

2.7.1. The Purchaser will arrange the right-of-way along the transmission line route including the expenditure required for crop compensation & tree compensation. Any avoidable or deliberate damage done to standing crop or private property by the contractor's labourers shall be the contractor's responsibility and the contractor shall pay compensation directly to the concerned party.

2.7.2. The Purchaser will arrange compensation for any damage to the crops to the extent of land required for laying of foundations for that location. Any extra land required by the contractor temporarily for dumping of the construction material and consequent damage to crops, etc. shall be the responsibility of the contractor.

2.7.3 The purchaser shall not be responsible for arranging access roads / right-of-way for transport of material from roadside to work sites. If the contractor has to adopt any such arrangements, he may do so with the consent of the property owners and any compensation in that respect will be his responsibility. The contractor shall take all reasonable steps for preventing damage to crops during execution of the contract work.

2.7.4 Clearing of obstruction falling in the right of way as per IS: 5613 (Part-3, Section-2)-1985 and lopping and trimming of the portion of the trees falling within the minimum electrical clearance zone and any lopping or trimming of the branches obstructing the line of sight during the detailed or check survey shall be the responsibility of the Contractor.

2.7.5 Payment of Yield Compensation towards tree/crop clearance shall be made by the Contractor, which will be reimbursed by the TNRDC later based on the prevailing rates fixed by the Agriculture/ Revenue department, Govt. of Tamil Nadu. Tree/crop clearance shall be done after getting approval from the TNRDC/TANTRANSCO's Engineer.

2.7.6 It is the responsibility of the Contractor to produce the authenticated records as per the MED – Volume I for getting reimbursement of tree/crop yield compensation from TNRDC.

2.7.7 Erection of additional tower/angle towers or change in type of tower for any deviation of route due to court case or any other reason beyond the control of the will be reimbursed at actual based on rates quoted.

2.8. ROADS. RIVER. KHUD/NALLAH, POWER AND TELECOMMUNICATION LINE AND RAILWAY CROSSING:

2.8.1 The crossings of roads, river, khuds / nallahs, power & communication lines, and railway tracks falling in the line route shall be carried out with the types of structures and at angles shall be indicated in profile sheets to be submitted for approval, ensuring that the minimum clearances at maximum temperature in still wind condition, after taking the effect of conductor creep and slack caused by the broken conductor in the adjoining span are not less than the relevant clearances specified in this specification.

2.8.2 The crossings of railway tracks, telecommunication lines and erection of lines in the vicinity of Aerodromes shall in addition meet the requirements of the regulations / code listed below: -

Regulation for Power line crossing of Railway tracks issued by the Ministry of Railways.

Code of practice for crossings between power and telecommunication lines issued by P&T Department.

Requirements for routing of overhead lines in the vicinity of Aerodromes laid down by the Director, General of Civil Aviation, Govt. of India.

2.9 CROSSING OF PUBLIC UTILITIES:

2.9.1. The contractor shall be responsible for giving requisite notice to the appropriate authorities and intimate that the date and time when he proposes to carry out erection of the conductors and ground wires across power lines or telecommunication lines, public roads, waterway, Railway etc. The lowering of conductor and / or ground wires of the existing power lines and its restringing and taking all necessary precautions to avoid damage to the existing lines will be the responsibility of the contractor. Any guying, temporary reinforcement required for the existing structures will also be the responsibility of the contractor.

2.9.2 Where other authorities or public undertakings affected, deem it necessary for the protection of their employees property, public or for the assistance of traffic to provide flagmen or watchmen, the cost of such provision shall be borne by the contractor.

2.9.3 Where it is necessary to provide scaffolding over roads, power lines or telecommunication lines, this shall be carried out by the Contractor at such times as may be convenient to the requisite authority and such work shall be deemed to be covered in the rates. The contractor to ensure safety of the public shall provide Flagmen and approved types of danger or warning notices. The time taken to affect the crossing shall be kept to the minimum.

2.10. ERECTION TOOLS AND PLANTS:

2.10.1. The contractor shall provide at his own expenses all necessary erection tools and plants such as surveying instruments, tackles, spanners, wrenches, pumps, timbering, scaffoldings, jacks, winches, ropes and all construction machinery such as tractors, bulldozers, hydraulic compressors and dies, dynamometers, come-along clamps, tension stringing equipment, camping requisites etc.

2.11. EXECUTION OF WORKS:

2.11.1 The erection activities shall be started only after the contractor receives profile and the tower schedule approved by the purchaser.

2.11.2 The contractor shall be responsible for correct setting out of towers as per the finally approved profile sheets and tower schedules. If towers, after erection, are found to be out of approved alignment, the contractor shall dismantle and re-erect them correctly at his own cost without extension in time.

2.12. ELECTRIC POWER FOR CONSTRUCTION PURPOSES:

The contractor shall make all necessary arrangements and provide all necessary electric power for construction purposes at his own cost. In case the power is available with the purchaser, the same shall be supplied at the prevailing tariff rates.

2.13. EXCAVATION:

2.13.1. This section covers technical specification for excavation for foundation work of transmission line towers. This shall include all works involved in excavation, dressing of soil, shoring for foundation work and carting for good quality earth, if required for back filling. Boring and sub-surface data regarding nature of soil, sub-soil water etc. shown on drawings or otherwise furnished to the contractor shall be taken as guidance only, and variations there from shall not affect the terms of the contract. The contractor must satisfy himself of the character and volume of all the works under this item and expected surface, subsurface, and/or sub-soil to be encountered. He must also satisfy himself about general conditions of transmission line route and ascertain the existing and future obstructions likely to come up during the execution of the contract to carry out the work under this scope.

2.13.2. The contractor shall control the grading in the vicinity of all excavations so that the surface of the ground shall be properly stopped or dyked to prevent surface water from running into the excavated areas during construction.

2.13.3 Excavations shall include the removal of all materials required to execute the work properly and shall be made with sufficient clearance to permit the placing, inspection, setting of forms and completion of all works for which the excavation has been made.

2.13.4 Sides of excavations shall be vertical and the base shall be horizontal. If the foundation dimensions are exceeded then the contractor shall install the next larger foundation at no additional cost to the purchaser. Boulders that protrude into the

excavation but do not interfere with the accurate and safe placement of the foundation may be left undisturbed. The concrete base slabs of the foundations shall be poured against undisturbed soil. The use of formwork for the base slab shall only be permitted where the angle of repose is zero.

2.13.5 When machines are used for excavation the last 300mm before reaching the required level shall be excavated by hand or by such equipment that will leave the soil at the required final level, in its natural condition.

2.13.6 Suitability for bearing of the bottom of excavations shall be determined by the contractor and shall be approved by purchaser.

2.13.7 The bottom of excavations shall be trimmed to the required levels and when carried below such levels due to contractor's fault, the excess depth shall be filled to the required level at the contractors cost. The fill material shall be concrete not leaner than M-10 (1:3:6) or richer as directed by the purchaser in each individual case.

2.13.8 If the contractor is directed by the purchaser to excavate to a lower level than that indicated in the drawings due to site conditions, such additional excavation, additional length of stub and/or additional chimney reinforcement shall be paid for at the applicable unit rate.

2.13.9 Excavated material shall be placed beyond 1.5 m from the edge of the pit or half the depth of the pit whichever is more or further away if directed by the purchaser.

2.13.10 Excavation shall not be carried below the foundation level of adjacent structures unless required precautions have been taken. Excavation clearance will not be allowed for any type of foundation. The width of excavation should match to the base width of structural concrete for any type of foundation.

2.13.11 The contractor shall be responsible for assumptions and conclusions regarding the nature of materials to be excavated and the difficulty of making and maintaining the required excavations and performing the work required as shown on the drawing and in accordance with these specifications. Cofferdams, sheeting, shoring, bracing, draining, dewatering etc. shall be furnished and installed as required. The contractor shall be held responsible for any damage to any part of the work and property caused by collapse of sides of excavation. Material may be salvaged if it can be done with safety for the work and structures, as approved by the purchaser and no extra claim shall be entertained for materials not salvaged or any other damage to contractor's property as a result of the collapse. He shall not be entitled to any claim for re doing the excavation as a result of the same.

2.13.12 Excavation for foundations where specified shall be carried at least 100 mm below the bottom of structural concrete and then be brought to the required level of placing lean concrete of M-10.

2.13.13 <u>SHORING AND SHUTTERING:</u>

Shoring and shuttering shall be done keeping in view the requirements given in IS: 3764 (LATEST). For excavations to be made in sandy soils or water bearing strata or in any

other type of soil where there is every likelihood of pits collapsing shoring and strutting made out of timber planks or steel frames of adequate strength as per requirements shall necessarily be provided.

Where excavation requires bracing, sheeting or shoring etc. the contractor shall submit to the purchaser the design and drawings showing arrangement and details of proposed installation for examination and approval, and shall not proceed until he has received approval from the purchaser.

2.13.14. For purposes of excavation of earthwork, the term 'soil' shall apply to all kinds of soil containing any percentage of small boulders, murrum etc. and hard rock.

2.13.15. EXCAVATION BELOW WATER TABLE:

Wherever water table is met with during the excavation, the contractor shall immediately report the fact to the purchaser who shall arrange to record the exact level of the water table. The decision of the purchaser in the matter shall be final.

The contractor shall dewater and maintain the water table below bottom of the excavated level during excavation, concreting and back fillings.

The guidelines for de-watering during construction specified in IS: 9759 (latest) shall be followed. Dewatering shall be carried out either manually or by mechanical pumps or power driven pumps to facilitate excavation and casting of foundation. The pumps shall be suitable for handling muddy water. The pits shall be kept dewatered until 24 hours after the concreting the foundations.

2.14.0. EXCAVATION FOR DRAINAGE AND LINE CLEARANCE (Excluding tower foundations):

2.14.1 This item covers excavation for levelling around the individual tower foundations, drainage, line clearance etc. but excludes the excavation for tower foundations. The excavation shall be carried out as per clause 2.13 above and as described herein.

2.14.2 The excavations for tower sites, drainage and line clearance shall be made to the approved dimensions and shall be finished according to the specified lines and grades. Where the purchaser considers it necessary, adequate drainage shall be provided around tower foundations. Except as otherwise in this specification, excavated materials shall be used for grading as directed, around the site from where the materials are excavated. The requirement of excavation for tower sites, drainage and line clearance and the amount of excavation required at a location shall be optional with the purchaser.

2.14.3. Measurement for payment for Excavation for tower sites, line clearance and drainage shall be made to the most practicable lines and grades as approved by the purchaser. Payment for such excavations, including the associated grading shall be made at the unit rate/cum quoted in schedule of prices.

2.15. CLASSIFICATION OF SOIL FOR EXCAVATION AND FOUNDATIONS:

The materials to be excavated shall be classified in accordance with IS.5613 (Part-2/ Section-2) and IS: 1498 unless otherwise specified. Excavation rates for foundation pits shall be included in the rates quoted ie., unit rate/Km in the relevant schedule.

2.15.1. TYPE OF SOILS:

a) Normal Dry Soil (NDS).
b) Partially Dry Fissured Rock (PDFR)
c) Dry Fissured Rock (DFR)
d) Wet Soil (WS)
e) Partially Submerged Soil (PS)
f) Fully Submerged Soil (FS)
g) Partially Black Cotton Soil (PBC)
h) Mixed Dry Fissured Rock (MDFR)
i) Black Cotton Soil (BCS)
(j) Hard Rock (HR)
(k) Sandy soil (SS)

2.15.2. Where soils at tower locations are of composite nature, i.e., partly soil and partly hard rock, the payment for excavation shall be at the unit rate quoted in schedule of prices, the volumes of hard rock & soil excavations shall be within the volume of excavation. The decision of the purchaser shall be final and binding with reference to the classification of soils.

2.15.3. The cost of drilling and blasting if any required shall be included in the quoted rates for hard rock excavation. Blasting materials shall be arranged by the contractor, at his own cost and stored in an approved manner. For all types of soils other than hard rock, the excavation rate to be quoted shall include the cost of back filling with excavated soil/ borrowed soil.

Where rock is encountered, the holes for tower foundations shall preferably be machine drilled and the rock excavated manually or with chemical expanders. Where blasting is required it shall be done in accordance with the relevant Indian Standard and with utmost care to minimize the use of concrete for filing up the blasted areas. All necessary precautions for handling and use of the blasting materials shall be taken as per the requirements of the relevant safety code. Only the persons having certificate for blasting issued by the competent authority shall be deployed for carrying out the blasting.

In case unnecessarily large quantities are blasted resulting in the use of large volumes of additional concrete and the cost of any concrete in excess of that shall be borne by the contractor.

2.15.5 CONSTRUCTION OF FOUNDATIONS:

2.15.5.1 The type of foundations to be constructed at each tower site shall be based on the soil characteristics to be indicated in the route profile sheets and as determined by the contractor and approved by the Purchaser during the progress of the work. The Purchaser reserves the right to change the type of foundation at any location where conditions during the progress of work indicated the use of a different type of foundation.

2.15.5.2 The contractor shall furnish the foundations designed for the soil conditions encountered in the excavations. If the soil conditions vary significantly between different excavations on one tower then foundations of different classes may be installed. Each foundation shall have steel stub angle embedded in concrete. The foundations for each tower in a straight section of the line shall be placed so that the longitudinal axis of the tower cross arm will be in a plane perpendicular to the transverse of the line. Unless otherwise directed by the purchaser, the foundations for each angle tower shall be placed in a manner so that the tower cross arms lie in a plane bisecting the interior angle formed by the intersection of the transverses of adjacent sections of the line.

2.15.5.3 Foundations shall be constructed in accordance with the approved drawings.

2.15.5.4. When determining the classification of the foundation at site the following procedure shall be followed.

The initial excavation shall be done to the dimensions of the next smaller foundation classification to that determined by the soil investigation.

The base of the excavation shall be examined to determine the bearing capacity of the soil and the minimum foundation classification ascertained.

The walls of the excavation shall be examined to determine the soil classification, angle of repose, and a suitable foundation classification selected to meet the soils encountered.

The level of ground water, or the expected level of ground water during the rainy season or standing water over the site shall also be considered when determining the foundation classification.

2.16. SETTING OF STUBS:

2.16.1 The stubs shall be set correctly at the exact locations and alignment and precisely at correct levels. Stubs shall be set in the presence of authorized representative of the purchaser available at site, for which adequate advance intimation shall be given to the purchaser by the contractor. This shall not, however, absolve the contractor of his responsibility for correctness of stub setting and for the correct erection of towers.

2.16.2 The stubs shall be set with their tops 250mm (minimum) above ground level and coping shall be of 50mm above the chimney.

2.16.3 The embedded end of the stub angle shall have a 150mm thick clear concrete cover over the top of lean concrete sub-base in case of dry foundations and a 200mm thick clear cover in case of wet, PS, and FS foundations.

2.16.4 The minimum length of stub encased in concrete below the ground level shall not be less than 1.5m. However the stub shall extend up to the bottom of foundation having a clear concrete cover as specified in Para 2.16.3 above.

2.16.5 The depth of foundation below ground level shall be 3.5m. Except in hard rock foundation the cutting of stub length is not allowed in any circumstances.

2.16.6 In any case the foundation should be 3.5m for each leg in original soil irrespective of the level difference between any two legs. The level difference up to 1.5m should be covered with extended stub along with chimney in addition to the standard length. The extended stub and chimney details will be furnished by Purchaser at the time of execution.

2.16.7 The stubs shall be placed individually with the help of total station in hill location. Where template / full assembly could not be provided.

2.17. MEASUREMENT AND PAYMENT:

The unit prices quoted shall include the cost of necessary excavations, drilling and blasting, labour and material for all timbering, shoring and spreading and compacting the excess material evenly around the site. Unit rate quoted shall also include the cost of dewatering during excavation and as well as laying of foundations and nothing extra shall be paid on this account.

If during the progress of excavation or after the completion of excavation, any alterations in the dimensions of excavation actually made become necessary has to be carried out by the contractor. The contractor shall be responsible for all costs resulting from the remedial works required to correct errors caused by any improper methods of excavation etc.

2.18. EXCAVATION OF BORROWED EARTH FOR BACKFILL:

2.18.1 This item covers excavation of borrowed earth required for backfill at the borrow areas identified by the contractor and approved by the purchaser.

2.18.2 The contractor shall strip the borrow area of all unsuitable material as may be necessary to obtain the required quantities of borrowed materials. The surfaces of borrow areas shall be left in reasonably even condition.

2.19. MEASUREMENT:

No separate payment shall be made to contractor for borrowed earth.

2.20. BACKFILLING:

The contractor shall furnish all labour, equipment and materials required for complete performance of the work in accordance with the drawings as described herein.

After completion of foundation work and other construction below the elevation of the final grades and prior to backfilling, all forms, temporary shoring, timber etc. shall be removed and the excavation cleaned of all trash, debris and perishable material. Backfilling shall

begin only with the approval of the TNRDC/TANTRANSCO.

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. The backfill material shall be clean and free from vegetation, pieces of timber and other undesirable materials. Backfilling shall be done with inorganic materials, obtained from the excavation or borrow pits and subject to the approval of the purchaser.

Backfill shall not be dropped directly upon or against any foundation or facility where there is danger of displacement or damage.

Backfill shall be placed in horizontal layers not to exceed 200 mm in thickness. Each layer shall be compacted with proper moisture content and with required equipments. Trucks or heavy equipment for depositing or compacting backfill shall not be used within 1.75 m of foundation that may be damaged by their weight or operation. The methods of compaction has to be proposed by the bidder and the same shall be approved by the TNRDC/TANTRANSCO.

Pushing of earth for backfilling shall not be adopted under any circumstances.

After backfilling, 100 mm high earthen embankment (Bund) along the sides of excavation pits shall be made and sufficient water poured in the back filled pits so that standing water remains above the back-filled earth for at least 24 hours. All surplus soil including residual sand, stone and concrete lying around, if any, shall be stacked within the tower base.

While backfilling of foundations, the pad shall be covered with about 300 mm layer of fine material before any coarse material is deposited. Care shall be taken to avoid damage to the concrete during back filling and compaction of soil.

All top soil shall be placed at the surface in the case of towers located on cultivated land.

Black cotton soil is not allowed for back filling purpose.

Where excavated material is not considered to be suitable by the purchaser for use as back-fill, borrowed earth shall be used for back filling, for which the provision of clause 2.19 of this specification shall be applicable.

On completion of foundation work, the earth surrounding them shall be accurately finished to natural line and grade or as directed by the purchaser. Finished surface shall be free of irregularities and depressions and shall be within 50 mm of the specified level. The cost of backfilling inclusive of backfill with borrowed earth, if required and compaction is deemed to be included in the unit prices quoted for foundation.

2.21. FORM WORK:

This section covers technical requirements for furnishing and installation of formwork for construction of foundations. The contractor shall furnish the labour, equipment and materials required for complete performance of the work in accordance with the drawings and as described herein. The diameter of steel can be 8mm to 25mm depends on design requirement.

Formwork shall be as per IS: 45-1978 and shall be composed of steel and/or best quality shuttering wood of non-absorbent type timber. The timber shall be free from knots and shall be of medium grain as far as possible.

The formwork shall conform to the shape, lines and dimensions of the foundations as per the design drawings. All details of the formwork, placing, tying etc. shall be subject to the approval of the purchaser. The contractor shall submit the design and drawings showing details of the form construction to the purchaser for approval before commencement of actual work. The formwork shall be adequate to withstand the pressure of freshly placed concrete or other loads imposed, without failure, movement or deflection of the component parts. Formwork shall be sufficiently tight to prevent the loss of liquid from the concrete.

The inner surfaces of formwork coming in contact with concrete shall be smooth and free from projections. All rubbish particularly chipping, shavings, dust and traces of concrete, if any, shall be removed from the interior of the formwork before the concrete is placed. The surface in contact with the concrete shall be wetted and sprayed with fine sand or treated with an approved composition to prevent absorption of water from the concrete. Such composition shall be kept out of contact with reinforcement and shall be non-staining and non- injurious to concrete.

2.22. REINFORCEMENT:

2.22.1. SCOPE:

This section covers the technical requirements of supply and installation of reinforcement steel for foundation work of transmission line towers. The contractor shall furnish all labour, equipment and materials required for complete performance of the work in accordance with the drawings and as described herein. The steel bars used for reinforcement may be of 6mm to 25mm dia. as per the design requirement.

2.22.2. Reinforcement steel shall be clean and free from loose mill scales, dust, loose rust and coats of paints, oil, grease or other coatings, which may impair or reduce bond. It shall conform to the following IS Specification.

Mild steel and medium Tensile Steel deformed bars and hard drawn steel wire shall conform to latest edition of IS: 432 (Part-I).

High yield strength deformed bars conforming to latest editions of IS: 1139 and IS: 1786.

All steel reinforcements including and above 6mm diameter shall necessarily be of tested quality.

2.22.3. Reinforcement accessories shall be furnished by the contractor. Binding wire shall be annealed iron wire quality not less than No. 16 SWG (1.65 mm dia). Bar support, chairs and bolsters shall be sufficiently strong to support the steel properly. Chairs shall be provided as per requirement.

2.22.4. The bending and fixing of reinforcement bars for reinforced concrete work shall be in accordance with IS: 2502, SP-34 and IS: 456.

2.22.5. Reinforcements shall be installed as per the approved design and drawing. No payment shall be made separately for supply and installation of reinforcements, binding wire, chairs, spacers as the cost of these is deemed to be included in the unit rate quoted.

2.23. CONCRETE:

This section covers the technical requirements in respect of materials used in forming, mixing, placing, finishing, curing and testing of plain and reinforced concrete for foundation work for transmission line towers. The contractor shall furnish all labour, equipment and materials required for complete performance of the work in accordance with the drawings and as described herein.

STANDARDS:

The latest Indian Standard specifications mentioned below shall be applicable to the materials and processes used in the preparation of concrete.

IS: 456-2000 -- Code of practice for plain and reinforced concrete for general building construction.

IS: 269-1990 -- Specification for ordinary rapid hardening and low heat - Portland cement.

IS: 383-1991 -- Specification for coarse and fine aggregate from natural sources for concrete.

IV) IS: 5613 (Part-3)-- Code of practice for design installation (Section-2-1989) and maintenance of overhead power lines.

V) IS: 4091 -1979 -- Code of practice for design and Construction of foundations for transmission line towers and poles.

The provision of the latest revision of all the relevant standards shall be complied with unless permitted otherwise and any other Indian Standard Code shall form a part of this specification to the extent it has been referred to or applicable within this specification. This specification shall have precedence in case anything contrary to this is stated anywhere in the bidding document.

GENERAL REQUIREMENTS:

All materials, tests, mixing, placing, formwork, reinforcing and workmanship shall conform to IS:456-2000, CODE OF PRACTICE FOR PLAIN AND REINFORCED CONCRETE and other relevant Indian Standard codes.

2.23.5. MATERIALS:

2.23.5.1. CEMENT:

Cement used shall be **ordinary Portland cement** conforming to IS: 269. Cement that has set or partially set shall not be used.

2.23.5.2. AGGREGATES:

The aggregates shall conform to the provisions of IS: 383 specifications for Coarse & Fine Aggregates from Natural Sources for concrete.

I) COARSE AGGREGATES :

The maximum size of coarse aggregate shall be as follows:

Structural concrete for foundations Slab	:	20 mm
Chimney	:	20 mm
Lean concrete	:	20 mm

Grading of course aggregates for a particular size shall generally conform to IS: 383 and shall also be such as to procure a dense concrete of the specified proportions and/or strength and consistency that will work readily into position without segregation.

II) FINE AGGREGATES:

Fine aggregates shall be well graded within the limits by weight as specified in IS:383. Fineness modulus shall not vary by more than plus or minus 0.20 from that of the approved sample. Fineness modulus for sand shall not be less than 2.5.

2.23.5.3. WATER:

Water used for forming and curing the concrete shall be clean, fresh and free from injurious amounts of oil, acids, alkalis organic material or other deleterious matters in solution or in suspension in such amounts that may impair the strength or durability of the concrete. Potable water shall be generally satisfactory. Latest IS:3025 and IS:3550 may be followed for testing of water, if required, by the purchaser at his cost and the cost of water required for works is also in the scope of the contractor.

2.23.5.4. ADMIXTURES:

The use of admixtures in concrete for promoting workability, improving strength, entrained air or for any other purpose may be used only with the approval of the purchaser. Addition of admixture shall not reduce the specified strength of concrete in any case. The admixtures shall conform to IS: 9103. Admixtures shall be used, if necessary, only with the written permission of the purchaser.

2.23.6. GRADE OF CONCRETE:

Concrete shall be either ordinary or controlled and in grades designated as M-10 or M-15 or M-20 or M-25 or M-30 in accordance with IS: 456 - 2000 and these specifications.

2.23.7. ORDINARY CONCRETE:

Ordinary concrete is recommended only when accurate control is impracticable and not necessary. However, if the purchaser allows ordinary concrete, it shall be used only in the concrete of grade M-10.

If ordinary concrete made in accordance with the proportions given in IS: 456-2000 for a particular grade does not yield the specified strength and fails to satisfy the requirements of 'Acceptance Criteria' as specified in IS: 456-2000, the cement shall be increased as directed

by the purchaser to obtain a specified strength at no extra cost to the purchaser.

Ordinary concrete proportion for a given grade specified under relevant paragraph above shall not however, be classified as a higher grade on the ground that the test strengths were found higher than the minimum specified.

2.23.8. CONTROLLED CONCRETE:

2.23.8.1. Controlled concrete shall be used on all concrete works, except where specified otherwise. Controlled concrete for use in plain and reinforced concrete structures shall be in grade M-15, M-20,M-25 & M-30. Ready mix concrete shall be used for all the towers except the tower in hilly terrain or in accessible site as decided by the Board's Engineer at site. If the location of Ready mix plant is far from the site, suitable type retarder shall be added to the concrete.

The mix proportions for all grades of concrete shall be designed to obtain strengths corresponding to values specified hereinafter for respective grades of concrete. Preliminary tests as specified in the IS: 456 and required by the purchaser, shall be carried out sufficiently ahead of the actual commencement of the work with different grades of concrete made from representative samples of aggregates and cement expected to be used on the job to ascertain the ratios by weight of cement to total quantities of fine and coarse aggregate and the water cement ratio required to produce a concrete of specified strength and desired workability.

Mix design for all grades of controlled concrete shall be undertaken to investigate the grading of aggregates water cement ratio, workability and the quantity of cement required to give cubes the minimum strength specified in IS:456-2000 used as mentioned below:

The proportions at the mix shall be determined by weight. Adjustment of aggregate proportions due to moisture present in the aggregate shall be made :

Sl. No.	**Description Of work**	**Grade of CONC. M- 20**
i)	Preliminary Tests at 28 days	26.7 N/sq.mm
ii)	Work Tests at 7 days	13.5 N/sq.mm
iii)	Work Tests at 28 days	20.0 N/sq.mm

NOTE : I) Preliminary Tests:

A test conducted in laboratory on the trial mix of concrete produced in a laboratory with the object of:

Designing of a concrete mix before the actual concreting operation start.

Determining the adjustments required in the design mix when there is a change in the materials used during the execution of work.

Verifying the strength of the concrete mix.

II) Work Tests:

A test conducted in the field o in a laboratory on the specimen made on the works, out of the concrete being used on the works.

a) Design mix concrete shall be used on all concrete works, except where specified otherwise. Work shall not commence until the Purchaser has approved the control/design concrete mix. The contractor shall allow sufficient time for all the obligations and tests etc. to be carried out prior to approval.

2.23.9. CONCRETE MIX REQUIREMENTS:

2.23.9.1. The minimum quantity of cement content per cubic metre for each grade of concrete, notwithstanding the strength requirements specified in the specification, shall be as below:

M-10	220 Kg.
M-20	400 Kg.

2.23.9.2. Based on the contractor's mix design, if the actual requirement of cement for a grade of concrete is found to be more than those specified above, such excess quantity of cement shall be used for which no extra payment shall be made.

Concrete slump shall be kept as contractor's mix design.

The concrete shall be of such consistency as to give a slump of 75 to 100mm with a maximum water cement ratio of 0.50. Use of admixtures for increasing the workability and/or retarding the initial setting time of concrete may be used subject to approval by the purchaser.

2.23.9.5. The admixture content, batching method and time of adding to the mix shall be in accordance with the manufacturer's recommendations for compliance with these specifications.

2.23.10. CONCRETE MIX REVIEW:

2.23.10.1. The source and quality of concrete materials and concrete proportions proposed for the work shall be submitted to the purchaser for review before the concrete work is started. Complete certified reports prepared by an independent testing laboratory and covering the materials and proportions shall be submitted to the purchaser. Review of these reports will be for general acceptability only and continued compliance with all contract provisions only will be required. The purchaser shall have the option to witness the preparation of the trial mixes, testing etc.

2.23.10.2 Reports on admixture shall include the classification, brand, manufacturer and active chemical ingredient. All admixtures, conforming to relevant IS Codes, shall the purchaser approve the products of one manufacturer.

2.23.10.3. Reports on the fine aggregates shall include the sources, type, gradation, deleterious substance, soundness and the results of ail tests required to verify compliance IS: 383.

2.23.10.4. Reports on the coarse aggregates shall include the source, type, gradation, deleterious substances, soundness, abrasion loss and the results of all tests required to comply with IS: 383.

2.23.10.5. Using Concrete materials acceptable to the purchaser, a concrete mix with cement content & water cement ratio as specified above shall be designed and tested for each size and gradation of aggregates and for consistency intended for use on the work. Design quantities and test results of each mix shall be submitted for review. Acceptable mixes shall be subjected to field adjustments as necessary to meet the requirements of these specifications. Should the contractor wish to use alternative sources for sand and aggregate the additional design mixes must be supplied.

2.23.10.6. The report for each concrete mix submitted for review shall include the following information.

a) Slump on which the design is based.

b) Total litres of water per cubic meter.

(c) Water-cement ratio.

(d) Ratio of fine to coarse aggregates.

e) Weight (surface dry) of each aggregate per cubic meter.

f) Quantity of each admixture.

g) Air content, if any.

(h) Compressive strength based on 7 days and 28 day's compression test.

(i) Time of initial set.

(j) Time of final set.

(k) Weight of cement used in the mix.

2.23.10.7. Concrete test specimens shall be made, cured and tests in conformity with IS: 516. These tests shall be conducted at approved laboratory. Calibration certificates for the test equipment shall be available on demand. The mould and materials for cubes and cylinders shall be supplied by the contractor who shall also arrange to transport the cubes / cylinders to laboratory at his own cost. The cost of the testing shall also be borne by the contractor.

2.23.11. **CONCRETE MIXING :**

2.23.11.1. Concrete mixing shall conform to IS: 456. Concrete shall only be mixed in a mechanical mixer. Mixing by hand is specifically prohibited.

On sites where access is very difficult then "one bag" mixers capable of being dismantled and carried in shall be employed.

2.23.11.2. Ready mix concrete shall be used for all the tower foundations, except the tower on hilly terrain as decided by department Engineer at site.

2.23.11.3. The proportion of fine and coarse aggregates, with cement content & water cement ratio as specified above shall be determined by the mix design. The quantities of fine and course aggregates shall be determined by weight. The purchaser may allow the quantity of aggregates to be determined by equivalent volume basis after the relationship

between the weight and volume is well established by trial and the same will be verified frequently. The quantity of cement shall always be determined by weight. The water shall be measured accurately after giving proper allowance for surface water present in the aggregates for which regular check shall be made for bulking in the case of volume batching in accordance with IS: 2386 (Part-Ill).

2.23.11.4 All concrete shall be mixed until there is a uniform distribution of materials and shall be discharged completely before the mixer is recharged. Mixing shall be done in a mechanical mixer and the type and size shall be subjected to the approval of the purchaser. Mixers shall rotate at the speed recommended by the manufacturer. The water shall not be added to the mix until all the cement and aggregates constituting the batch are already in the drum and dry mixed for atleast one minute and thereafter mixing shall continue for atleast 2 minutes or atleast forty (40) revolutions. All concrete shall be discharged within 3 minutes after the introduction of mixing water to the cement and aggregates, unless otherwise specified by the purchaser.

2.23.11.5 Before beginning a run of concrete all partially set or hardened concrete and foreign material shall be removed from the inner surfaces of mixing and conveying equipment. The first batch of concrete, through a cleaned mixer, for use in the works, shall contain 10% additional cement at no extra cost to allow for loss in the drum. All conveyances, buggies and barrows shall be thoroughly cleaned at frequent intervals during the placing of concrete. Concrete shall be rapidly handled from the mixer to the place of final deposit and shall not be delivered by tube, chute or wheelbarrow with a free fall from the mixer of more than 1.0 m. Every possible precaution shall be taken of prevent separation or loss of the ingredients while transporting the concrete.

2.23.12. CONCRETE PLACEMENT:

The handling, depositing and compacting of concrete shall conform to these specifications, subject to adjustments by the purchaser for weather or placements conditions. During hot or cold weather, the concreting shall be done as per the procedure set out in IS: 7861 (Part-l and Part-ll).

Concrete shall not be placed until the formwork reinforcements and preparation of surfaces involved in casting are approved by the purchaser and shall be placed only in the presence of purchaser or his representative. Preferably concrete shall not be placed under water and all excavations prepared for concrete shall be maintained free of water until the concreting is completed 24 hours thereafter. All surfaces of foundations upon or against which concrete is placed shall be free from mud and loose earth.

Contractor shall keep an accurate record of the date on which the concrete is cast for each part of work and date on which the forms are removed.

Concrete shall be conveyed to the point of final deposit by methods that will prevent the separations or loss of the ingredients. Concrete shall be deposited in its final position without moving it laterally in the forms for a distance in excess of 1.5 meter.

Concrete shall be deposited in approximately horizontal layers to proper depth for

effecting compaction. However, the depth of a layer shall not exceed 500 mm. Each layer and the forms shall be filled at a rate of vertical rise of not less than 150 mm per hour. Construction joints shall be provided as necessary and as accepted by the purchaser to comply with these requirements.

Plastic concrete is defined as concrete that can be re-vibrated least to the extent that an immersion type vibrator stud will penetrate the concrete at least 25 mm by vibration action and its weight. Concrete which is no longer plastic but which must be covered by an additional lift shall be immediately chipped back to well consolidated concrete and flushed with mortar puddle.

The surface of hardened concrete upon which fresh concrete is to be placed shall be rough and clean and damp. Surface mortar shall be removed to expose the aggregate.The hardened surface shall be cleaned of all foreign substances (including curing compound), washed with clean water, and kept saturated during the 24 hours period preceding placement of fresh concrete. Coarse aggregates shall be omitted from the batches of concrete deposited on hardened concrete. This mortar puddle shall convert the hardened concrete to a depth of not less than 15mm at every point, To secure maximum density and eliminate formation of air pockets, the concrete shall be thoroughly vibrated and worked around all reinforcements, embedded facilities and into corners of forms during and immediately after placing. Unless other methods are authorized by the Purchaser, mechanical vibrators conforming to IS: 2505, IS:2506, IS:251 and IS:4656 shall be used for this purpose, the type and operation of which is subject to the approval of the purchaser.

The placing of concrete shall be in continuous operation with no interruption in each location. Concrete shall be handled from the place of mixing to the place of final deposit as rapidly as practicable by methods, which will prevent segregation.

Concrete shall normally be placed in continuous horizontal layers. Construction joints in foundations shall not permit. Concrete shall be compacted to the maximum practicable density during the placement and thoroughly worked around the reinforcement if any and around the embedded stubs and into the corners of the formwork, with vibrators or any other means approved by the purchaser.

Repairs of imperfection in concrete shall be completed within 24 hours after the removal of forms. Repair of concrete shall be performed only in the presence of the purchaser or his representative. All exposed corners shall be slightly rounded or chamfered. Concrete in the top of foundations shall be sloped to provide drainage away from stub angles.

2.23.13. **TEMPERATURE OF CONCRETE**:

2.23.13.1. In hot weather, the temperature of concrete when it is placed in the forms shall not be more than 38 deg. C. In extreme hot weather a suitable means shall be employed to lower the temperature of concrete: A list of acceptable methods are given below, Using cold mixing water Cooling coarse aggregate with cold water by sprinkling or inundation.

Insulating mixer drums or cooling with sprays or with wet burlap coverings.

Shading materials and facilities not otherwise protected from heat.

Working only at night. Use of ice for mixing water should be carefully controlled to ensure complete melting before mixing is completed.

In cold weather, the temperature of concrete when it is placed at or below freezing temperatures shall be maintained at least 4.5 deg. C. No frozen material or material containing ice shall be used. Depending upon the severity of weather, it is necessary to heat the mixing water or aggregate. Heating of mixing water shall be preferred. Very hot water shall not be allowed to touch the cement to avoid quick or flash setting. Hot water and coldest portion of aggregate shall be brought together in the mixer first.

Subject to the approval of purchaser, the aggregate shall be heated uniformly and carefully avoiding overheating and excessive drying. The average temperature of aggregate shall not exceed 65 deg C and the maximum temperature shall not exceed 100 deg. C.

STRIPPING TIME :

Under fair weather conditions with average daily temperature not less than 20° C. and when ordinary cement is used, forms may be struck after 24 hours of placing the concrete. In very cold temperatures, the forms shall be struck after 48 hours of the placing concrete.

2.23.14. PROTECTION OF CONCRETE :

In very cold weather the concrete shall be protected from freezing for atleast 48 hours of placement when the mean daily temperature is 4.5 deg. C. When the mean daily temperature in the vicinity of work site falls below 4.5 deg. C for more than one day, the concrete shall be maintained at a temperature not less than 10 deg C for at least 72 hours after it is placed. Concrete cured by water curing shall be protected at 10 deg C.

In hot weather, the curing shall be commenced even before stripping the form work by loosening the forms and allowing curing water to run down between the concrete forms.

Bitumen coating over the concrete surface immediately after removal of shutter, to protect the concrete against loss of moisture against setting, Chemical attack, corrosion etc shall be provided by the contractor. Specification for which shall be got approved by the contractor.

2.23.15. **CURING:**

2.23.15.1. The concrete after setting for 24 hours shall be cured by keeping the concrete wet continuously for a period of 1 day after laying. The pit may be backfilled with selected earth, sprinkled with necessary amount of water and well consolidated in layers not exceeding 200 mm after a minimum period of 24 hours and there after both the back filled earth and exposed chimney top shall be kept wet for the remainder of the prescribed time of 14 days. The uncovered concrete chimney above the backfilled earth shall be kept wet by providing empty gunny bags dipped in water fully wrapped around the concrete chimney for curing and ensuring that the bags kept wet by the frequent pouring of water on them.

For curing the foundations below ground level, after backfilling, 150mm high earthen embankment along the sides of excavation pits shall be made and sufficient water shall be poured in the backfilled pits so that standing water may remain above the backfilled

earth. Curing compound shall be applied to the concrete for effective curing to all foundation of towers. (Specn. shall be provided by the contractor for approval).

In high temperature and low humidity areas, more frequent sprinkling shall be done.

In cold weather at or below freezing temperature, concrete shall be insulated with layer of straw or similar material covered with a waterproof sheet material to help retention of the original heat of concrete plus heat of hydration.

Curing shall be carried out for longer periods to the satisfaction of purchaser, to ensure that the concrete attains the strength and quality.

2.23.16. SAMPLING AND TESTING:

Samples of concrete shall be taken at the direction of the purchaser in the field in accordance with IS: 1199 Methods of Sampling & Analysis of concrete*. The testing shall be carried out as per IS: 456-2000 and other relevant codes.

The samples shall be tested for strength and consistency at any approved laboratory in accordance with IS: 516. These tests shall be conducted at approved laboratory or at the contractor's premises under the supervision of the Purchaser's representative. Calibration certificates for the test equipment shall be available on demand. The mould and materials for cubes and cylinders shall be supplied by the contractor who shall also arrange to transport the cubes/cylinders to laboratory at his own cost. The cost of the testing shall also be borne by the contractor.

The number of samples to be taken for testing and verifying concrete strength shall be in accordance with IS: 456-2000 but shall be a minimum of four (4) cubes per foundation and as per the directions of purchaser.

Samples shall be cured under laboratory conditions except when in the opinion of the purchaser extreme weather conditions may prevail at which time the purchaser may require additional cubes cured under job conditions.

The contractor shall promptly furnish to the purchaser certified reports of all tests made by the testing laboratory.

If the strength of the cubes for any portion of the concrete work falls below the specified compressive strength, the criteria for acceptance of the portion of the work shall be as stipulated in IS: 456-2000.

If the concrete falls below the specified compressive strength then the contractor shall:

i) Analyse the actual loads on the foundation to determine its adequate strength. If acceptable, this shall require a payment to the purchaser for the reduced quality.

ii) Propose modifications to bring the strength of the foundation to a level acceptable to the purchaser. All modifications shall be at the contractor's expense.

iii) Break out and replace the foundation as per the purchasers instruction at the contractor's expense.

2.23.16.7. The purchaser shall also reserve the right to reject whole or any part of the work. In case of acceptance of such works, the standard deviations shall be worked out, and examined by the purchaser and if he is satisfied only then such works can be accepted at the

reduced rates. Furthermore, the purchaser shall have the right to order a change in the mix or the water cement ratio for the remaining portion of the foundations at no extra cost to the purchaser.

2.23.17. CONCRETEING OF FOUNDATION:

The contractor shall inform the purchaser or his authorized representative sufficiently in advance about the programme of concreting the location.

2.23.18. MEASUREMENT:

Concreting shall be as per approved design and drawing and the cost shall be included in the quoted unit rate/Cu.m.in the price schedule.

2.24. PROTECTION OF TOWER FOUNDATIONS:

The work shall include all necessary stone revetment, concreting and earth filling above ground level. Special measures for protection of foundations shall be taken in respect of locations close to nallah, riverbeds, etc. by providing suitable crate of galvanized wire netting and meshing packed with boulders. The top seal cover of the revetment work shall be done with M-10 concrete (1:3:6 nominal mix). The contractor shall furnish recommendations for providing protection at such locations.

Where the ground surface is irregular the foundation shall be finished off in a substantial and permanent way by forming a plinth by side cutting and building a suitable random stone revetment or in case of rock foundation by building up with concrete as desired by the purchaser. The number of retaining walls and breast walls en-route transmission line shall be intimated by the contractor for obtaining the decision of the purchaser before taking up erection.

2.24.3. MEASUREMENT:

2.24.3.1. The unit rate for revetment for protection of the tower foundation shall be quoted in the schedule of prices and constructed with the required height & bottom width, and shall include excavation, 100 mm thick M-10 concrete at bottom, RR in CM 1:6. Weep holes of size 100x100mm @ 2.0mm interval, dry stone packing of 300x300 mm size at mouth of weep hole, top seal cover with M-15 concrete 100 mm thick and raised pointing for outside of revetment with CM 1:4). M-10 concrete volumes will be added to the revetment volumes for payment purpose. Dry stone packing and weep holes volumes are neglected for payment purpose.

2.25. GROUNDING:

The installation of earthing sets shall be in accordance with relevant standard specifications. The galvanized steel pipe sets shall be installed in the ground near the towers and connected to the tower legs by means of galvanized steel flat as shown in Drawing enclosed. The grounding shall be effected by making about 300 mm dia and 3600 mm deep pit at a distance of not less than 3650 mm diagonally away from the stubs and filling in the pits with finely broken coke having grain sizes not more than 25 mm thick. Coke shall be maintained up to a distance of 150 mm from the centre of pipe on all sides. The top edge of the pipe shall be at least 600 mm below the ground level. The steel strip

shall be buried not less 450 mm deep from the ground level. Where tower foundation resistance exceeds the value specified in chapter-IV of this specification, the desired earthing resistance shall be obtained by installing additional pipe earthing sets. The distance between the electrodes in such cases shall preferably be not less than twice the length of electrode.

At locations, where it is not possible to obtain the desired foundation resistance by the means mentioned in clause 2.25.1, installation of counterpoise earthing shall be resorted to. Four galvanized steel stranded conductors shall be radiated from tower as shown in Drawing enclosed. The measured earthing resistance of tower shall not exceed 10 ohms in dry weather.

In case the measured resistance of the earthing arrangement described in 2.25.2 still exceeds the values, use of continuous counterpoise shall be made as per the arrangement shown in enclosed drawing.

Where a tower stands on rock, efforts shall be made to obtain a good ground by carrying a length of galvanized steel flat from the tower legs to earthing pipe driven in damp soil at the shortest possible distance from the tower. The connecting flat shall be buried in a grove cut in the rock surface and adequately protected from damage.

The contractor shall measure and record the resistance of each tower to earth after erection and before installing the earth wire and submit the same to the purchaser. He shall provide adequate notice to the purchaser so the purchaser can witness the measurements if he so wishes. The measurements shall be made during the dry season.

2.26. HANDLING AND TRANSPORTATION OF STEEL:

2.26.1. All galvanized tower steel, including stub angles, shall be handled and transported to work site by the contractor with care to avoid bending of members and damage to galvanized surfaces.

2.27. TOWER ERECTION :

Towers shall be erected member-by-member assembly or any other standard method without overstressing any member on foundations at least after 14 days of casting but a gap of 28 days shall be preferred. The tower shall be erected with the best workmanship.

The contractor shall be entirely responsible for correct erection for all towers as per the approved drawings and their correct setting on the alignment finally approved by the purchaser. The towers must be truly vertical after erection, the permitted tolerance in verticality being 1 in 360 of the tower height. No straining will be permitted to make the towers vertical.

A reasonable amount of drifting as permissible in IS: 5613 (Part 3, Section-2) - 1989 shall be allowed in assembling, but remaining for correction of mismatched holes due to shop errors will not be permitted. If any shop errors are discovered, the contractor shall notify the purchaser, who will decide whether the errors may be corrected in the field or members returned to tower fabricator for correction or replacement. All galvanized surfaces damaged as a result of correction shall be made good as directed by the purchaser.

2.27.4. The contractor at no additional cost to the purchaser shall correct all errors and omissions in erection of towers. Any tower damaged during erection due to incomplete bolting, improper guying or any other reasons, shall the purchaser direct repaired / replaced by the contractor,

2.27.5. **ASSEMBLY:**

The method followed for the erection of towers, shall ensure the points mentioned below:

Straining of the members shall not be permitted for bringing them into position. It may, however, be necessary to match hole positions at joints and to facilitate this, tommy bars not more than 450 mm long may be used.

Before starting erection of an upper section, the lower section shall be completely braced and all bolts provided in accordance with approved drawings.

All plan diagonals relevant to a section of tower shall be placed in position before assembly of upper section is taken up.

The bolt positions in assembled towers shall be as per IS: 5613 (Part-3, Section-2).

Tower shall be fitted with number plate, danger plate, phase plates, circuit plates and anti climbing device as described.

2.28. TIGHTENING AND PUNCHING OF BOTLS AND NUTS:

2.28.1. All nuts shall be tightened properly using correct size spanners. Before tightening, it will be ensured that filler washers and plates are placed in relevant gaps between members, bolts of proper size and length are inserted and one spring washer used under each nut, and in case of step bolts, spring washers have been placed under the outer nuts. The tightening shall progressively be carried out from the top downwards, care being taken that all bolts at every level are tightened simultaneously. The threads of bolts projecting outside of the nuts shall be punched at three positions on the diameter to ensure that the nuts are not loosened in course of time. If during tightened a nut is found to be slipping or running over the bolt threads, the bolt together with the nut shall be replaced.

2.28.2. All the bolts projected outside the nuts shall be welded with the nuts at two diametrically opposite places. The length of each welding shall be at least 10 mm. The welding shall be provided from ground level up to bottom cross arm level. After welding cold galvanized paint (zinc rich paint) having at least 90% (per cent) zinc content shall be applied to the welded portion. At least two coats of the paint shall be applied. The cost of welding including application of paint shall be deemed to be included in the unit rate/Km quoted. If the tack welding is not carried out at the time of tower erection itself Rs.2000/= per tower be deduced from the tower erection bill.

2.29. TOWER ACCESSORIES:

Each tower shall be fitted with number plate, danger plate, phase plates and circuit plates.

Anti-climbing device shall be provided on all towers.

Bird-guards shall be provided on suspension towers.

2-30. INSULATOR HOISTING :

The insulators shall be supplied by the Contractor. The numbers of insulator units, required

per string, are given in chapter-IV of this specification for suspension as well as tension strings. Single suspension insulator strings shall be used on tangent towers and double tension insulator strings on all tension towers.

Damaged insulators and fittings, if any, shall not be used in the assemblies. All insulators shall be cleaned in a manner that will not spoil, injure or scratch the surface of the insulator, but in no case shall any oils be used for the purpose. Before hoisting, the components of the insulator string shall be checked for any damage, crack and missing of security clips etc. Corona control rings in case of 400kV lines only shall be fitted in an approved manner. The yoke arrangements shall be horizontal for tension and longitudinal for suspension strings. Torque wrench shall be used for fixing different components, like suspension clamp for conductor and ground-wire, etc. whenever recommended by the manufacturer of the same. The contractor shall include in his erection costs for insulators for the 1R testing of each insulator unit. The insulator shall be tested with a suitable calibrated Megger as approved by the purchaser and any insulator that fails to achieve a 50 Mohm resistance shall not be used on line.

The installation of string assemblies shall also include the installation of armour rod sets at suspension locations.

The compression dead ends and jumper connection in tension assemblies shall be fixed to conductor in accordance with manufacturer's recommendations that shall be furnished to the contractor.

Sacks shall be wrapped over the cross arm members of towers to prevent damage to the galvanized surface during hoisting of string assemblies.

In case pilot insulator strings are proposed to be used, the angle of swing to be considered shall be a minimum of 15°.

The bidder is permitted to adopt separate cross arm for 'DDS' and or 'DD' type towers under dead end conditions provided adequate live metal clearance is available with at least 15° angle on both line side and slack span side, and also provided that all the specified conditions of the specifications are fulfilled.

In computing live metal clearances, the dimensions of single suspension and double tension string shall be taken as given in Annexure enclosed. The design of the towers shall be such that it should satisfy all the above conditions when clearances are measured from any live point on the insulator strings.

2..31. HANDLING OF CONDUCTOR AND GROUNDWIRE:

2.31.1. Before commencement of stringing, the contractor shall submit stringing charts for the conductor and earth wire for various temperatures corresponding to spans and equivalent spans. These charts shall be prepared on the basis of the data given in chapter-III of this specification and also on the data obtained from the detailed survey for the approval of the purchaser. The contractor shall provide a drum schedule, based upon the tower schedule and line profile, to show efficient use of the contractor for the purchaser's approval. Wherever possible 12 drums from the same lot shall be used in the

same position on each conductor pull.

2.31.2. The contractor shall be entirely responsible for any damage to the towers or conductors during stringing. While paving out the conductors, care shall be taken that the conductors do not touch and rub against the ground or objects that could cause scratches or damage to the strands. The conductor shall be run out of the drums from the top in order, to avoid damage due to chafing. Immediately after paving out, the conductor shall be raised at the supports to the levels of the clamp and placed into the running blocks. The groove of the running blocks shall be of such a design that the seat is semicircular and lager than the diameter of the conductor, ground wire and it does not slip over to rub against the sides. The grooves shall be lined with hard rubber or neoprene to avoid damage to conductor and shall be mounted on properly lubricated bearings.

2.31.3. The running blocks shall be suspended in a manner to suit the design of the cross-arm. All running blocks, especially those at the tensioning end shall be fitted on the cross arms with jute cloth wrapped over the steel work and under the slings to avoid damage to the slings as well as to the protective surface finish of the steel work. Normally, suspension towers shall not be used even for temporary termination. In case small or medium angle towers are used even for temporary terminations, these shall be well guyed and steps be taken by the contractor to avoid damage. Guying proposals along with necessary calculations shall be submitted, for approval by the contractor to the Purchaser. Proper "T & P" shall also be made available to the purchaser by the contractor for checking the tensions in the guy wires. The drums shall be provided with a suitable braking device to avoid damages, loose running out and kinking of the conductor. The conductor shall be continuously observed for loose or broken strands or any other damage. When approaching the end of drum length, at least three coils shall be left when the stringing operations are to be stopped. These coils are to be removed carefully, and if another length is required to be run out, a joint shall be made as per the recommendations of the conductor accessory manufacturers. The contractor shall use running out blocks suitable for joint protectors to ensure that the joints remain straight during tension stringing.

2.31.4. Repairs to conductors, if necessary, shall be carried out during the paving out operations, with repair sleeves. Repairing of conductor surface shall be done only in case of minor damage, scuff marks or not more than 2 broken strands in the outer layer etc. keeping in view both electrical and mechanical safe requirements. The final conductor surface shall be clean smooth and shall be without any projections, sharp points, cuts, abrasions etc. if the damage is greater than above or extends to the successive layers then a midspan joint shall be used.

2.31.5. The contractor shall take adequate steps to prevent clashing of sub-conductors from the process of paving out to the installations of the spacers/spacer dampers. Care shall be taken that both sub-conductor of a bundle are from the same conductor supplier and preferably from the same batch so that creep behavior of the sub-conductor remains identical. During sagging care shall be taken to eliminate differential sag in the sub-

conductor as far as possible. However, in no case sag mismatch shall be more than 25mm.

2.31.6 Conductor splices shall be so made that they do not crack or get damaged in the stringing operation. The contractor shall use only such equipment/methods during conductor stringing which ensures complete compliance in this regard.

2.31.7. Derricks and scaffolding shall be used where roads, rivers, channels, telecommunication or overhead power lines, railways lines, fences or walls have to be crossed during stringing operations. It shall be seen that normal services are not interrupted or damage caused to property. Shutdown shall be obtained when working at crossing of overhead power lines. The contractor shall be entirely responsible for the proper handling of the conductor, ground wire and accessories in the field.

2.31.8. Suitable guards/sheaves shall be used to protect the conductor from damage in places where it would otherwise be impossible to save the conductors from coming in contact with objects, which may injure the conductors. Guards shall consist of material over which the conductor may slide without injury and shall be subject to the approval of purchaser.

2.31.9. The sequence of paving out shall be from top downwards, i.e. the OPGW & ground wire shall be run out first, followed by the conductors in succession alternating across the tower between phases. Unbalance of loads on towers shall be avoided as far as possible.

2.31.10. The proposed 400 kV transmissions line may run parallel for certain distance with the existing 400 kV, 230 kV and 110 kV lines which may remain energized during the stringing period. As a result there is a possibility of dangerous voltage build-up due to electromagnetic and electrostatic coupling in the pulling wire conductors and ground wires. It shall be the contractor's responsibility to take adequate safety precautions to protect his employees and others from this potential danger. Running grounds and earthing of running blocks at each tower shall be installed as a minimum requirement.

The towers are not designed for one side stringing. Proper guying arrangement shall therefore be made by the contractor during stringing to avoid unbalanced loads on towers. All the expenditure on account of the above work is deemed to be included in the tender and no extra payment shall be made for the same. The sagging and landing of the conductor's phases and ground wires shall be done in pairs i.e. both top phases or both middle phases etc.

2.32. STRINGING OF CONDUCTOR AND GROUNDWIRE:

The paving out and tensioning of the conductor line shall be done by the control tension method. The equipment shall be capable of maintaining a continuous tension of not less than about 50 kN per bundle that shall be such the sag for each conductor is maintained about twenty per cent greater than the sags specified in the stringing sag table. The stringing equipment shall comprise a tensioner, puller, pilot line winder, conductor let-off reel stand, pulling rope take-up reel stand, pilot lines, triple sheave stringing blocks, running board, running grounds, space ring cart, conductor lifting hook, insulator lifter,

sagging winch, wire cutters, dynamometers etc. The capacity of the tension stringing equipment is as indicated in appendix-I.

Controlled-stringing method suitable for simultaneous stringing of the sub-conductors shall be used. Both the conductors making one phase bundle shall be pulled in and paid off simultaneously. Both the conductors of the bundle shall be of matched length. After being pulled, the conductor and earth wire shall not be allowed to hang in the stringing blocks for more 96 hrs. before being pulled to the specified sag.

2.33. JOINTING:

2.33.1. All the joints on the conductor and ground wire shall be of compression type, in accordance with the recommendations of the manufacturer for which all necessary tools and equipment like compressors, dies, etc. shall have to be arranged by the contractor. Each part of the joint shall be cleaned by wire brush to make it free of rust or dirt etc. and shall properly be greased with anti-corrosive compound, if required and as recommended by the supplier before the final compression is done with the compressors.

All joints or splices shall be made at least 75 metres away from the structures. No joints or splices shall be made in the span crossing over main roads, railways and rivers or in the span adjacent to a tension tower. No joints in the conductor or earth wire shall be permitted without the approval of the purchaser. Not more than one joint per sub-conductors shall be allowed in a span. The compression type fitting used shall be self-centring type or care shall be taken to mark the conductor to indicate when the fitting is sitting on the conductor properly. During compression or splicing operations the conductor shall be handled in such a manner as to prevent lateral or vertical bearing against the dies. After pressing the joint, the aluminium sleeve shall have all corners rounded, burrs and sharp edges removed and smoothened. The compression of the joints shall be as per the manufacturer's instructions.

During stringing of conductor, to avoid any damage to the joint, the contractor shall use a suitable protector with mid span compression joints in case joints are to be passed over pulley blocks/aerial rollers. The size of the groove of the pulley shall be such that the joint along with protector can be passed over it smoothly. The arrangement to be adopted shall be explained in the tenders.

2.34. **SAGGING OPERATION**:

The conductors shall be pulled up to the desired sag and left in running block for at least one hour after which the sag shall be re-checked and adjusted, if necessary, before transferring the conductors from the running blocks to the suspension clamps. The conductors shall be clamped within 36 hours of sagging in.

The sag will be checked in the first and the last span of the section in case of sections up to eight spans and in one intermediate span also for sections with more than eight spans. The sag shall also be checked when the conductors have been drawn up and transferred from running blocks to the insulator clamps.

The running blocks attached to the suspension string, when suspended from the

tower shall be so adjusted that the conductors on running blocks will be at the same height as the suspension clamp to which it is to be secured.

At sharp vertical downward angles, the sags and tensions shall be checked on both sides of the angles, the conductor and earth wire shall be checked on the running block for equality of tension on both sides. The suspension insulator assemblies shall normally assume vertical positions when the conductor is clamped.

Tensioning and sagging operations shall be carried out in calm whether when rapid changes in temperatures are not likely to occur. In areas where calm weather is not prevalent during working season, the contractor shall recommend the precautions to be taken during final tensioning and sagging of conductor.

2.35. **TENSIONING AND SAGGING OF CONDUCTORS AND GROUND WIRE**:

The tensioning and sagging shall be done in accordance with the approved stringing charts before the conductors and ground wire are finally attached to the towers through the ground wire clamps for the ground wire and insulator strings for the conductor. Dynamometers shall be employed for measuring tension in the conductor and ground wire. The dynamometers employed shall be periodically checked and calibrated with a standard dynamometer.

Provision for ground undulations, errors in stringing and compensation for creep in conductors. This shall be considered at the time of stringing of conductors.

No pre-stressing/over-tensioning of the ground wire shall be done.

The adjustment of sub-conductor's by means of sag adjustment devices provided in the insulator string shall invariably be not permitted at the time of stringing of the conductors. The sag adjustment plates shall be kept in fully open position at the time of stringing of the conductor.

The contractor shall terminate the line conductors and ground wires at the dead-end towers on each end of the line. Payment for stringing work shall be made for the actual route length of the line at the unit rates quoted for the stringing of conductors and ground wires in the Schedule of Prices.

2.36. CLIPPING IN :

Clipping of the conductors in position shall be done in accordance with the recommendations of the purchaser. Conductor shall be fitted with the armour rods at suspension point and with vibration dampers at suspension and tension points.

The jumpers at the section and angle towers shall be formed to parabolic shape to ensure maximum clearance requirements. Pilot suspension insulator string shall be used, where ever required. Fasteners in all fittings and accessories shall be secured in position. The security clip shall be properly opened and strung into position.

2.37. FIXING OF CONDUCTOR AND GROUNDWIRE ACCESSORIES:

2.37.1. Spacers, spacer dampers, vibration dampers and other conductor and ground wire accessories that will be supplied by the contractor shall be installed by the contractor as per the design requirements and respective manufacturer's instruction. Spacer and

vibration dampers/spacer dampers shall be fitted within 24 hrs. of the conductor clamping. While installing the conductor and ground wire accessories proper care shall be taken to ensure that the surfaces are clean and smooth and no damage shall occur to any part of the accessories.

The contractor shall ensure that drain holes, if provided, in the weights of the vibration dampers are open. The spacer/spacer dampers shall be installed at the intervals indicated by the purchaser. The contractor shall arrange the required number of spacer cars/cycles with meter counters suitable for installing spacer/spacer damper.

Rates for installing vibration dampers and spacers or spacer dampers & vibration dampers for earth wire & OPGW shall be included in the rates of stringing of conductor, earth wire, OPGW.

2.38. **REPLACEMENT** :

If any replacements are to be effected after stringing and tensioning or before handing over, leg members and bracings shall not be removed without reducing the tension on the tower with proper guying or releasing the conductor. If the replacement of cross arms becomes necessary after stringing, the conductor shall be suitably tied to the tower tension points or transferred to suitable roller pulleys at suspension points.

2.39. FINAL CHECKING, TESTING AND COMMISSIONING:

After completion of the works, final checking of the line shall be done by the contractor to ensure that all the foundation works, tower erection, and stringing have been done strictly according to the specifications and as approved by the purchaser. All the works shall be thoroughly inspected keeping in view of the following main points.

a) Sufficient backfilled earth is lying over each foundation pit and it is adequately compacted.

b) Concreted chimneys and their copings are in good finally shaped conditions.

c) All the tower members are correctly used, strictly according to final approved drawings and are free from any defect or damage whatsoever.

d) All bolts are properly tightened and punched/and half round welded (as specified).

e) The stringing of the conductors and ground wire has been done as per the approved sag and tension charts and desired clearances are clearly available.

f) All conductor and ground wire accessories are properly installed.

g) All other requirements to complete the work like fixing of danger plate, phase plates, number plate, circuit plates, anti-climbing device, bird guards etc. are properly installed.

h) Wherever required, it should be ensured that revetment is provided.

i) Two copies of the profile, route alignment and tower design, structural drawings, bill of material, shop drawings of all towers are to be modified "AS BUILT and submitted to the purchaser for reference and record.

j) The line insulation is tested by the contractor by providing his own equipment, labour etc. to the satisfaction of the purchaser.

k) The line is tested satisfactorily for commissioning purpose.

I) The right-of-way all along the route of line is clear of all obstructions and meets requirements of clause 5.3 of IS: 5613 (Part-3, Section-2) - 1989.

m) In addition to the tests stipulated in IS: 5613 (Part-3, Section-2) -1989 the tower foundation resistance at the locations decided by the purchaser shall be measured. All arrangements for testing shall be made by the contractor and the necessary labour, transport and equipment shall be provided by him.

n) Any defects found as a result of testing shall be rectified by the contractor forthwith to the satisfaction of the purchaser without any extra charges.

o) Before taking over of the line by the purchaser, the line shall be energized at full working voltage.

2.40. PAYMENTS:

The payment to the contractor for various items of works shall be based on the rates quoted in the schedule of prices for the respective works.

The purchaser shall entertain no claim for idle period resulting from any "force majeure" condition.

2.41. ERECTION EXPERIENCE AND FINANCIAL RESOURCES OF TENDERER:

2.41.1. The tenderer should have experience of erection and commissioning of 400 kV lines as per Section-ll of Volume-I. The bids received from the tenderers who do not fulfill these requirements shall not be considered. The tenderers shall submit details of the 400 kV lines of similar construction erected by them, which are in operation, in 'Performance Schedule', along with certificates from their customers in support of the satisfactory construction and operation of the lines. Information about financial resources of the tenderer shall also accompany the tender.

2.42. ERECTION SCHEDULE:

2.42.1. The tenderer shall submit erection schedules(s) covering all phases of work starting from the date of award of contract up to the commissioning of the transmission line, in the form of flow diagrams showing critical path construction schedule of all phases of work simultaneously or in the form of Bar Chart.

2.43. PROGRESS REPORT:

2.43.1. Progress reports of erection work in triplicate shall be submitted by the contractor as required by the Purchaser.

2.44 OPGW & APPROACH CABLE :

2.44.1 Installation of OPGW and laying of approach cable, testing and commissioning are dealt in Chapter-III Volume-II.

** ** **

APPENDIX - I
TENSION STRINGING EQUIPMENT

Equipment	Capacity****
Tensioner	4500 kg per sub-conductor in the bundle at medium gear speed when the final stringing is done with the tensioner.
Conductor let-off reel stand	450kg (approx.) and is related to the tail pull of the tensioner.
Puller	10000kg to 11000kg at the same speed as the tensioner.
Take-up reel stand	550kg (approx.) and is related to the tail pull requirement of the puller.
Stringing blocks	4500kg (working) for conductor sheave. 1100kg (working) for pulling line sheave.
Running board with swivels	11000kg (working) for the running board. 11000kg (working) for the pulling line swivels. 4500kg (working) for the conductor swivels.
Multiple strength pulling grips	4500kg (working)

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The capacity of any of the above mentioned equipment's is in-adequate for stringing Twin moose ACSR, suitable higher capacity equipment should be used for stringing Twin moose ACSR.

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VOLUME - II

CHAPTER – III

OPTICAL POWER GROUND WIRE (OPGW) DETAILED TECHNICAL SPECIFICATION

1.0 General:

The OPGW cable comprises a ground wire (containing aluminium and steel) with optical fibres in the core or first layer. The OPGW cable replaces the normal ground wires and therefore has to fulfil all the electrical and environmental requirements which affect the ground wire.

The fittings, accessories to be supplied shall be suitable for the OPGW type.

2.0 Optical Power Ground Wire (OPGW) Cable:

The OPGW cable construction shall comply with IEEE-P 1138 and IEC publication 1396. The OPGW structure shall be based on the following characteristics:

Electrical characteristics of the OPGW must be equal to or better when compared to the standard ground wire which will be replaced by the OPGW.

The electrical conductivity must be designed to withstand the specified short circuit currents.

The OPGW cable selected shall withstand the temperature increase caused by the maximum short circuit current. The Bidder shall describe the electrical parameters of the OPGW types which are proposed.

The mechanical structure of the OPGW shall be designed to withstand the wind and other environmental conditions in the routes which have been specified under clause 7.6**.** The location of the fibres inside the structure shall be such that the application of the OPGW in the specified routes is possible. The selected OPGW cable shall tolerate the normal installation procedures. The Bidder shall list the mechanical parameters of the OPGW and describe the cable structure, including how the fibres are located inside.

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

The cable construction shall conform to the applicable requirements of, applicable clauses of IEC 1089 related to stranded conductors and Table - 1. OPGW Mechanical and Electrical requirements**.** The OPGW cable should be with the latest technology using Aluminium clad stainless steel tube with plastic inner lining fibre unit with Aluminium clad steel wires, Aluminium alloy wires complete with accessories or Aluminium tube containing plastic tubes having optic fibres as the fibre unit with Aluminium clad steel wires , Aluminium alloy wires complete with accessories. The wires may be of multiple layers with a combination of various metallic wires within each layer. The direction of lay shall be reversed in successive layers. The finished wires shall contain no joints or splices.

1.0 Jacket Material

The jacket material shall withstand short term temperature rises up to 200°C associated with lightning strikes and system faults.

2.0 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.

3.0 Design

The OPGW conductors shall be designed to contain a reliable free space for the fibres (either stranded over a central element or single tube). The tube shall be metallic or plastic. The conductors shall be hermetically protected against water and hydrogen penetration.

The metallic wires have to give the OPGW conductivity to carry fault currents and the strength to withstand mechanical stresses. Aluminium, aluminium alloy, galvanized steel, aluminium clad steel wires or a combination of them shall be used.

The fibre tubes shall have a high crush resistance and minimal permanent or temporary deformation under mechanical pressure. The fittings must be designed to prevent these pressures. OPGW elongation under different stress situations likely during wind loads or during ground faults shall be considered.

4.0 Electrical and Mechanical Requirements

Table-1 provides OPGW Electrical and Mechanical Requirements for the minimum performance characteristics.

Table – 1

OPGW Electrical and Mechanical Requirements

1	Overall Diameter	≤ 16 mm
2	Minimum Breaking Load	≥ 50 KN
3	Unit Mass	< 500 kg/km
4	Max Sag at 0°C and No Wind	< 8.706m for 400m Span
5	Everyday Tension at 32°C, no wind	≤ 25% of UTS of OPGW
6	Max tension at 32°C, wind pressure 135 kg/m^2	≤ 2610 kg on full projected area, 400m span
7	D.C. Resistance at 20°C	<1.0 ohm/km
8	Short Circuit Current	≥ 6.32 kA for 1.0 second without exceeding the max. allowable temperature of OPGW for short circuit duration as specified by the bidder in Guaranteed Technical Particulars(GTP) .

All Dielectric Self- Supporting (ADSS) Cable:

ADSS cable shall be used for inter connecting OPGW cable with the terminal gantry at the substation/power house/office.

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

The ADSS cable shall be of all dielectric construction and designed to withstand the electromagnetic fields in the high voltage towers. The bidder shall list the electrical parameters of the ADSS cable types which are proposed. The bidder shall describe the design methods, including how the ADSS cable is located in the electromagnetic field in the tower. The location of the cable shall be selected by the contractor, based on electric field analysis, to permit adequate clearances from the conductors and minimize the effects of the electric field on the sheath.

The mechanical structure of the ADSS cable shall be designed to withstand the wind and other environmental conditions in the routes which have been specified in this document. The location of the fibres inside the structure shall be such that the application of the ADSS cable in the specified routes is possible. The ADSS cable selected shall tolerate the normal installation procedures. The bidder shall list the mechanical parameters of the ADSS cable and describe the cable structure, including how the fibres are located inside.

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

General:

The ADSS cable shall be of non-metallic aerial type designed for installation on power transmission lines. The cable shall be designed to withstand all prevailing environmental conditions including the effects of high electric and magnetic fields produced by the proximity of live power conductors.

Design:

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

The cable shall be designed with sufficient tensile strength to maintain clearance considerations and protect the optical fibres from external stresses and strains throughout the service life of 25 years. Consideration must be given to long term fatigue and creep. An anti-buckling strength member with similar expansion and contraction characteristics as the optical fibres shall be incorporated in the cable and this shall provide sufficient strength to withstand wind load and stringing over maximum span length. The central strength member shall be decoupled from the jacket material.

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

The cable shall be fully filled so as to prevent water condensation and electrical degradation within the sheath. The sheath of the cable shall be able to withstand solar ultra-violet radiation without significant degradation.

At maximum working tension the fibre shall not be subjected to a longitudinal strain greater than specified by the manufacturer and there shall be no detectable increase in fibre attenuation.

Jacket Construction

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

Jacket Material

The jacket material shall have an operating ambient temperature range of - 40^0C to+60^0 C

Electrical and Mechanical Requirements

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

Table 2.1

ADSS Electrical and Mechanical Requirements

i)	Overall Diameter	13.0 mm
ii)	Minimum bend radius	$\leq$ 285 mm during installation 200 mm installed
iii)	Weight	$\leq$ 160 kg/km.
iv)	Tensile strength	$\geq$ 16000 N during installation $\geq$ 12500 N long term (Installed)
v)	Allowable sag	$\leq$ 1.0 % of Maximum span length

Operating conditions

The ADSS cable including various clamps, terminals and accessories shall withstand aeolin vibrations and possible galloping and touching of the phase conductors. In order to reduce the possibility of mechanical failure, the erosion of the cable sheath due to " dry banding effect" shall be minimized.

Installation

Where ADSS cable is proposed as part of the survey and design , the Contractor shall determine if any additional work or strengthening of existing lines or towers is required, and if so, perform the necessary work at no additional cost or extension of project schedule.

Standard installation procedures and quality accessories such as Suspension clamp assembly, Dead end clamp assembly , Pipe Holding clamp assembly, Vibration dampers etc., shall be used. The details of the above materials and installation procedures shall be provided in advance and approval of the purchaser shall be obtained.

5.0 Fibre Types

Dual-Window Single Mode (DWSM) optical fibres of 12/24 Nos. shall be provided in the cable. DWSM requirements are defined in Table – 2.2.

Table – 2.2

DWSM Optical Fibre Characteristics

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

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

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

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

Fibre Parameters

6.1 Attenuation Variation

The attenuation coefficient for wavelengths between 1525 nm and 1575 nm shall not exceed the attenuation coefficient at 1550 nm by more than 0.01 dB/km. The attenuation coefficient between 1285 nm and 1330 nm shall not exceed the attenuation coefficient at 1310 nm by more than 0.01 dB/km. The attenuation of the fibre shall be distributed

uniformly throughout its length such that there are no point discontinuities in excess of 0.05 dB.

6.2 Fibre Colouring

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

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

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

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

Fibre Buffering and Protection

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

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

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

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

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

Technical Characteristics

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

6.5 Fiber Strain

The optical fiber cable must have a minimum strain margin of 0.5%.

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

7.0 Cable Materials

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

7.1 Filling Materials

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

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

The filling compound shall remain stable for ambient temperatures between -20°C and +80°C and shall not drip, flow or leak with age or at high temperatures during short duration lightning strikes and short circuit currents per EIA-455-81.

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

Outside Jacket Materials

The outer cable jacket 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 low density, medium density and high density polyethylene standards as defined in ASTM D1248.

7.3 Metallic Members

When the fibre optic cable design incorporates metallic elements in its construction, all metallic elements shall be electrically continuous.

7.4 Sheathing Removal

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

7.5 Marking, Packaging and Shipping:

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

(a) Cable Identification Markings

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

(b) Cable Length Markings

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

(c) Reel Markings

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

(d) Cable Drums

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

All wooden components shall be manufactured out of seasoned soft wood free from defects that may materially weaken the component parts of the drums. Preservative treatment for anti-termite/anti-fungus shall be applied to the entire drum with preservatives of a quality which is not harmful to the cable.

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

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

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

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

Manufacturer's name and address

Contract/Award letter number.

Type of the cable.

Gross weight of the cable and drum.

Weight of empty drum with lagging.
Net weight of the cable.
Length of the cable.
Drum and lot number.
Name and address of the consignee.
Month and year of manufacture

7.6 Environmental Requirements

The optical fibre cables, mounting hardware, splice boxes, and connectors must be suitable for operation in India in both outdoor and underground conditions where the following conditions prevail:

Outside temperature varies in the range of 0°C to 50°C.
The average annual rainfall is 100-140 mm.
The relative humidity varies between 10% and 100%.
The number of thunderstorm days is 65/year.
Moderately hot and humid tropical climate conducive to rust and fungus growth.

7.7 EHV TRANSMISSION LINE DETAILS:

(a) Ultimate Tensile Strength (UTS):

UTS of the optical fibre cable shall be designed to exceed 2.5 times the maximum working tension.

(b) Maximum Working Tension:

The maximum working tension shall be calculated for maximum allowable sag of 2% on nominal span lengths and under standard wind and ice conditions.

7.8 Installation Hardware:

Suspension Clamps:

Preformed armour grip suspension clamps shall be used. Aluminium alloy Armour rods shall be used. The suspension clamp shall be designed to carry minimum vertical load of 25 kN and shall have minimum slip strength of not less than 12 kN and not greater than 17 kN. The contractor shall supply all the components of the suspension clamp including shackles, nuts and bolts, etc. The total drop of the suspension assembly shall not exceed 150 mm.

TENSION CLAMPS:

The dead end clamps shall be of bolted type using armour rods and shall include all necessary hardware for attaching the assembly to tower strain plates**.** Dead end clamps shall allow the OPGW to be continuous through the clamp without cutting and splicing. The dead end clamp shall have a slip strength not less than 0.95 times the OPGW rated tensile strength.

The grounding wire shall be bolted directly to the suspension or dead end clamp. The grounding wire shall consist of a 1500 mm length of aluminium or aluminium alloy earth

wire with an equivalent size of the OPGW and a lug at each end. One lug shall be attached to the suspension or dead end clamp and the other lug with 16 mm diameter bolt shall be attached to the tower.

Structure Attachment Clamp assembly shall attach the OPGW to the structures. The clamp shall have two parallel grooves for the OPGW, one on either side of connecting bolt. The clamps shall be such that clamping characteristics do not change if only one OPGW is installed. The tower attachment plates shall locate the OPGW on the inside of the tower. It shall be attached directly to tower legs/ cross arm without drilling or any other modification to the tower.

The vibration damper shall have an aluminium clamp capable of supporting the damper during installation and maintain the damper in position without damaging or crushing the OPGW or causing fatigue under the clamp. Armour or patch rods shall be provided as necessary to reduce clamping stresses of the OPGW. The armour rod shall be made of aluminium alloy. The Vibration damper material shall be hot dip galvanized mild steel cast iron or shall be permanent mould cast zinc alloy.

In-Line Fibre Optic Splice Enclosures:

All in-line splices will be encased in In-Line Fibre Optic Splice Enclosures. Suitable splice enclosures shall be supplied to encase the optical cable splices in a protective, moisture and dust free environment. The splice enclosures shall be designed for the storage and protection of a minimum of 24 optical fibre splices and shall provide access through lockable doors. They shall be filled with suitable encapsulant that is easily removable should re-entry be required into the enclosures. In-line splice enclosures shall be suitable for outdoor use with OPGW cable. Splice enclosures shall be appropriate for mounting on EHV transmission towers above anti-climb guard levels at about 10 meters from ground level and shall accommodate pass-through splicing.

Multi-purpose Indoor Cable (MIC)

For purposes of this specification, Multi-purpose Indoor Cable (MIC) is defined as multi-fibre cable specifically intended to provide multiple connectorized inside plant jumpers within a single jacket. MIC cables shall be used to route between FODPs and equipment racks. The intent of providing MIC cable assemblies is to bundle multiple connectorized fibre jumpers into one cable sheath for protection, organization and identification of fibres routed between different locations within the inside plant. MIC cable assemblies shall be used whenever the FODP is not collocated (same rack) with the equipment.

Basic Construction

The MIC cable shall be of all di-electric construction. A central strength member is not required. The cable jacket shall be extruded over multiple buffer tubes. Each buffer tube shall contain only one fibre. There shall be no filling compounds or gels used.

MIC cabling routed outside of equipment enclosures shall meet or exceed all requirements for inside plant cabling.

Applicable US NEC Articles

Plenum cable:	Non-conductive fibre	NEC 770, UL 1581
Plenum cable:	Non-conductive Plenum	NEC 770, UL 910
Plenum cable:	Non-conductive Riser	NEC 770, UL 1666

Jacket construction

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

Buffer Tubes

MIC cable buffer tubes shall be constructed of materials similar in size and flexability as the tubes used in the fabrication of connectorized fibre jumpers. They shall loosely protect individual fibres while providing easy and safe handling of connectorized fibres. Each fibre shall be wrapped in Kevlar fabric for protection within the buffer tubes while allowing the fibre to move freely within the tube.

MIC cables shall contain atleast six(6) individually buffered fibres. Each buffer tube shall be permanently identifiable throughout its length with colour coding or marked at intervals not to exceed 0.5 metres.

Installed MIC cable assemblies shall be clearly labeled at both ends with identification traceable from each end of the cable to other end.

Optical Fibres

The optical fibres used in MIC cables shall be single-mode. The performance and physical characteristics shall be similar to the optical fibre characteristics specified in section 3.1.3.2. There shall be no splices allowed on a MIC cable assembly.

Optical Fibre Connectorization

The optical fibres used in MIC cables shall be pre-connectorized at each end as appropriate for the interface to the FODP or Equipment. Hybrid MIC cable assemblies with different type of connectors at each end, shall be allowed as required. However, all connectors at either end of the cable shall be of the same type of connector.

Approach Cables

An approach cable /lead is defined as the cable installed between the final splice box, forming the termination of the fibre cable in the

power line and the FDP installed within the terminal building, or the cable traversing a site and terminated in splice boxes located in separate buildings/ separate towers.

The approach cable shall contain fibres with identical optical characteristics as those in the outdoor cables and shall be entirely of non-metallic construction and shall be suitable for

direct burial in the ground and for installation within the cable ducts and on cable trays. The cable shall comprise a tensile strength member, fibre support/bedding structure, core wrap/bedding, armoring and overall impervious jacket.

No intermediate splices shall be permitted in any approach cable between its two termination points.

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

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

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

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

Cable existing from the ground or passing through floors shall be protected against mechanical damage for a distance of 450 mm above finished ground or floor level.

The fibre optic approach cable shall be provided with a minimum outer jacket thickness of 3mm and meeting the following requirements:

UV resistant

Anti-hygroscopic

Rodent proof

Fire retardant with any acid gas evolution

The requirements of the following US National Electric Code articles apply to all approach cable installations as shown in table below:

Inside Plant Cabling Construction Requirements

Plenum cable:	Non-conductive fibre	NEC 770, UL 1581
Plenum cable:	Non-conductive Plenum	NEC 770, UL 910
Plenum cable:	Non-conductive Riser	NEC 770, UL 1666

The approach cable shall be pulled in buried PVC ducts (to be provided by the Contractor). The PVC ducts shall be 76 mm in diameter and shall inter connect the final outdoor splice box and the FDP installed within the terminal building, or the cable traversing a site and terminated in splice boxes located in separate buildings/separate towers.

All required fittings, supports, accessories, fibre distribution frames, ducts, conduits and any other item not specifically mentioned herein, but required for laying and installation of approach /lead cable.

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 TANTRANSCO for review and approval 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 Employer for approval. All installation practices shall be field proven and ISO accredited.

All cable segments shall include service loops as specified in 2.2.5.1. 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 Employer 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, the complete span shall be replaced as mid-span joints are not acceptable.

The Contractor shall supply all tools and accessories required for installation. It shall be the Contractors responsibility to provide adequate communications among all crew members and support staff to ensure safe and successful installations.

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.

Outdoor Cable Service Loops: FODPs and 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.

Indoor Cable Service Loops: FODPs and in-line splice enclosures installations located indoors, shall provide at least three (3) meters of cable service loop. Service loops shall be neatly secured and stored, coiled such that the minimum recommended bend radius are maintained.

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.

Pigtail Service Loops: Connectorized pigtails spliced to bare fibres shall provide at lease 0.5 meter of service loop installed in the FODP fibre organizer and at least (1) meter of service loop to the couplings neatly stored behind the FODP coupling panels.

Fibre Service Loops: At least 0.5 meters 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.

Fibre Patch Cords: Shall be of sufficient length as to provide at least 0.5 meters of service loop when connected for their intended purpose.

MIC Cable Service Loops: MIC cable installed between FODPs and equipment racks, shall provide for at least 3 meters of service loop. For storage, the service loop may be equally divided at the FODP and the equipment rack ends.

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 pre-connectorized pigtails and to accommodate connectorized termination and coupling of the fibre optic cables. In-line fibre optic splices shall be encased in fibre optic splice enclosures. Optical fibre termination and splicing is specified as follows:

Fibre Optic Distribution Panels

At each location requiring the termination of at least one fibre within a cable, all fibres within that cable shall be connectorized and terminated in Fibre Optic Distribution Panels in a manner consistent with the following:

All fibre optic terminations shall be housed using FODPs provisioned with splice organizers and splice trays. All fibres within a cable shall be fusion spliced to

Preconnectorized pigtails and fitted to the “Back-side” of the provided fibre optic couplings.

FODPs provided for indoor use 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.

FODPs provided for outdoor installation shall encase the optical fibre splices, pigtails and terminations in a protective, water proof environment FODPs shall be designed for the storage and protection of a minimum of 24 optical fibre terminations and shall provide reentry access through lockable doors FODPs shall be suitable for outdoor use with each of the cable types provided under this contract and shall be appropriate for mounting on EHV transmission towers above anti-climb guard levels at about 10 meters from ground level.

All FODPs shall be of metal construction that is clean and smooth finished, treated to resist corrosion, shall accommodate the storage of a minimum of 3 meters of coiled fibre and shall allow both top or bottom entry for access to the splice trays Specific selection of the entry points shall be made at the time of installation. Ground lugs shall be provided on all FODPs and the Contractor shall ensure that all FODPs are properly grounded.

Optical Fibre Connectors:

Unless otherwise specified:

Dual-Window Single Mode optical fibres shall be connectorised with ST-PC type connectors.

Fibre optic couplings supplied with FODPs shall be appropriate for the fibre connectors to be supported. There shall be no adopters allowed.

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 within facilities or on tower structures. All optical fibre splicing shall comply with the following:

All fibre splices shall be accomplished through fusion splicing.

Each fibre splice shall be fitted with a splice protection sheath fitted over the final splice.

All splices and bare fibre shall be neatly installed in covered splice trays. No more than twelve (12) fibres shall be installed in each splice tray.

Attenuation of single mode fusion splices shall not average 0.05 dB and no single splice attenuation shall exceed 0.1 dB when measured 1550 nanometers.

For in-line 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.

Intra-Station Outside Plant Infrastructure Support:

At many sites, the outside cable plant shall require traversing the station from the tower structures to the facilities where the outside cable plant will be terminated (the main distribution frame). Often, the outside cable plant will be a hybrid of communications cabling (i.e., fibre optic cabling/approach cabling, microwave feed lines, coaxial cable for Power Line Carrier, signal distribution cabling and even instrumentation cabling). A network of cable trenches and/or ducts may exist at some sites but shall require expansion and / or new construction at most stations. It shall be a responsibility of the Contractor to cooperate fully with the Employer and all other on-going project contractors in the planning and efficient use of existing and new-construction infrastructure supporting intra-station communications cabling.

The Contractor shall provide the Employer with the details of all expected in station outside cable plant routing requirements within thirty (30) calendar days from site survey.

Approach cabling shall not be direct buried. It shall normally be routed through buried PVC multi-duct conduit (to be provided by the Contractor) unless a suitable alternative is approved by the Employer. Approach cabling approved for routing in cable trenches or in existing ducts shall be installed inside inner ducting and shall not be collocated with high voltage power cabling. New PVC conduit provided and installed by the contractor, shall be provisioned for sufficient multiple inner ducts as to provide for at least one maintenance duct to be left empty. PVC conduit chambered with multiple inner ducts as an integral part of its construction is recommended. Cable markers shall be provided and installed to mark the location and route of all buried ducts.

Approach cables exiting from the ground or passing through floors shall be protected against mechanical damage for a distance of 450 mm above finished ground or floor level.

Approach cables shall penetrate buildings through cable ducts. The cabling shall route within buildings in cable raceways or under raised floors. The contractor may utilize existing ducts, building penetrations, cable trays, racks, etc., where appropriate and approved by the employer. The cables shall be affixed to cable supports using approved ties, clips or cleats at regular intervals.

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

The contractor shall be responsible for new building penetrations required for approach cabling. Caution shall be taken to ensure existing equipment and site personnel are protected from dust and debris incident to the cable penetration work. Penetrations shall be neatly formed and sealed for protection from moisture, dust, wind and vermin intrusion.

All required fittings, supports, accessories, FODPs, ducts, inner ducts, conduits, risers and any item not specially mentioned but required for lay and installation of approach cables shall be supplied and installed by the contractor. It is the responsibility of the contractor to check safety of OPGW for flawless operation & communication.

8.0 Standards

The material shall conform to the following Indian/International Standards, which shall mean latest revisions, amendments/changes adopted and published unless otherwise specified herein.

In the event of the supply of material conforming to any standard other than standards listed below, the salient features of comparison shall be brought out and furnished along with the bid.

Indian / International Standards

Sl. No	INDIAN STANDARD	TITLE	INTERNATIONAL STANDARD
		The international Telecommunication Union (ITU-T) Recommendations	G.652, G.653
		International Electro-technical Commission (IEC) vocabulary	IEC:50-1975
		Optic Fibres, Part 1:General specification	IEC:793-1
		Optic Fibre Cables, Part 1: Generic Specification	IEC:794-1
		Aluminium Alloy Redraw rods	IEC:104-1987
		Aluminium-clad steel wires for electrical purposes	IEC:1232-1993
		Fibre Optic Test Procedure Series	EIA-TIA-445 (FOTPs)
	IS: 2121	Specification for Conductor and Earthwire Accessories for Overhead Power lines	
		IEEE Standard construction of composite Fibre Optic overhead Ground wire (OPGW) for use on electric utility power lines.	IEEE:1138-1994
	IS: 398	Stranded conductor for overhead lines	IEC:1089-1993
		Standard Colours for Colour Identification and Coding	IEEE: 359A
		Colour Coding for Fibre Optic Cables	IEEE: 598

5.3 INSPECTION AND TESTS:

5.3.1 Inspection

The Employer representative shall at all times be entitled to have access to the facilities and all places where systems, equipments, software, firmware, materials are being produced, tested, integrated. The material for final inspection shall be offered by the Contractor only under packed condition. The Employer shall select samples at random from the packed lot for carrying out acceptance tests.

The Contractor shall keep the Employer informed in advance of the time of starting and of the progress of manufacture of materials in its various stages so that arrangements could be made for inspection. Record of routine test reports shall be maintained by the Contractor at his works for periodic inspection by the Employer's representative. Certificate of manufacturing tests shall be maintained by the Contractor and be produced for verification as and when desired by the Employer. Materials shall not be shipped from its point of manufacture before it has been satisfactorily inspected and tested, unless the inspection is waived by the Employer in writing. In the latter case the materials shall be shipped only after all tests specified herein have been satisfactory completed. The

acceptance of any quantity of materials 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. The Contractor shall give the Employer/inspector twenty one (21) days written notice of any material being ready for testing. Such tests shall be borne by the Contractor except for the expenses of the Inspector. The Employer/Inspector, unless witnessing of the tests is waived, will attend such tests which notice is given to the Employer that the equipment is to be ready for test/inspection on a mutually agreed date, 21 or more days after notification. If the Employer / inspector fails to attend the tests, the Contractor may proceed with the test which shall be deemed to have been made in the Inspector's presence and he shall forthwith forward to the Inspector duly certified copies of tests in triplicate. The inspector shall, within twenty one (21) 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 make the modifications that may be necessary to meet the said objections. When the factory tests have been completed at the Contractor's or Subcontractor's works, the Employer/Inspector shall issue a certificate to this effect within twenty one (21) days after completion of tests but if the tests are not witnessed by Employer/ Inspector the certificate shall be issued within twenty one (21) days of receipt of the Contractor's Test Certificate by the Employer/Inspector The completion of these tests or the issue of the certificates shall not bind the Employer to accept the equipment should it, on further tests after installation, be found not to comply with the Contract. In all cases where the Contract provides for tests, whether at the premises or works of the Contractor or of any Subcontractor, the Contractor except where otherwise specified shall provide free of charge items such as labour, materials, electricity, fuel, water, stores, apparatus and instruments, as may be reasonably demanded by the Employer/Inspector or his authorised representative to carry out effectively such tests of the equipment in accordance with the Contract and shall provide facilities to the Employer/Inspector or to his authorised representative to accomplish testing. The inspection by the Employer and issue of Inspection Certificate thereon shall in no way limit the liabilities and responsibilities of the Contractor in respect of the agreed Quality Assurance Program forming a part of the Contract.

Material Inspection Clearance Certificate (MICC) shall be issued by the Employer after inspection of the equipment. The Employer may waive off the presence of Employer's Consulting Engineer. In that case tests will be carried out as per approved quality plan and the test certificate will be furnished by the Contractor for approval. MICC will be issued only after review and approval of the test reports.

5.3.2 General Conditions for Tests

Except where otherwise specified, the Contractor shall furnish labour and materials for tests, including testing facilities, power and instrumentation and replacement of damaged parts. The costs shall be borne by the Contractor and shall be deemed to be included in the contract price.

Testing charges for all the type tests shall be indicated separately for each item in the prescribed schedule of the bidding document. The Bidder shall indicate the laboratories in which they propose to conduct the type tests. They shall ensure that the tests can be completed in these laboratories within the time schedule guaranteed by them in the appropriate schedule of the bidding document. In case of failure in any type test the Contractor is either required to manufacture a new sample lot and repeat all type tests successfully or repeat that particular type tests at least three times successfully on the samples selected from the" already manufactured lot ,at his own expense. In case a fresh lot is manufactured for testing then the lot already manufactured shall be rejected.

The entire cost of testing for acceptance and routine tests and test during manufacture specified herein shall be treated as included in the quoted unit price of materials except for the expenses of inspector / Employer's representative.

The Contractor shall give the Employer 21 days written notice of any material being ready for testing. Fifteen days prior to the scheduled testing, the Employer shall provide written notice to the Contractor of any drawings, equipment, material, or workmanship which, in the Employer's opinion, are not compliant to the specification. The Contractor shall give due consideration to such objections, if valid, effecting the corrections as necessary or shall prove, in writing, that said modifications are unnecessary for contract compliance.

The Contractor shall submit a Test Schedule for the Employer's approval within two months after the Contract Award The Test Schedule specifies when the tests are to be carried out, and the approximate testing duration. The test periods shall also be indicated in the PERT chart or equivalent for the work.

The Contractor shall submit for the Employer's approval a Test Procedure Specification at least two months before each individual test will be performed. Fully approved test procedures shall be submitted to Employer at least 4 weeks prior to the commencement of testing. The Test Procedure Specification shall specify the detailed test in accordance with the requirements of this Specification. Detailed documentation (e.g. circuit diagrams) of the tested system equipment shall also be available to the Employer at the same time.

Acceptance or waiver of tests shall not relieve the Contractor from the responsibility to furnish material in accordance with the Specification.

The Employer or his authorized representative shall at all time have access to all places where materials or equipment are being prepared or manufactured under this Contract and shall have full facilities for unrestricted inspection of such materials or equipment.

The Contractor's Quality Assurance (QDA) procedures and organization shall be submitted to the Employer for approval.
All manufacturing facilities shall be ISO 9000 certified.
All tests shall be witnessed by the Employer and/or it's authorized representative (hereinafter referred to as the Employer) unless the Employer authorizes testing to proceed without witness. The Employer shall sign the test form indicating approval of successful tests. Un-witnessed testing authorization shall supersede the requirement for signed approval.
All test equipment and/or instruments shall bear calibration stickers indicating calibration occurred less than 12 months prior to the testing date.
The Contractor shall ensure that all testing will be performed by qualified testing personnel each with a minimum of 12 months experience performing such tests. Testing personnel names, qualifications, and the specific tests each will perform shall be included in the proposal.
The Employer reserves the right to require the Contractor to perform at the Employer's expense, any other reasonable test(s) at the Contractor's premises, on site, or elsewhere in addition to the aforementioned Type, Acceptance, Routine, or Manufacturing tests to assure Employer of specification compliance.
The Employer also reserves the right to require any retesting of previously approved tests at the Employer's expense, However if the retest(s) reveal noncompliance to the specification, the Contractor shall bear the expense for the retesting and remedial action.

5.3.3 Test Plans and Test Procedures

Test plans and test-procedures for both factory and site acceptance tests shall be provided by the Contractor. Test plans and test procedures shall ensure that each factory and field test is comprehensive and verify all the features of the equipment to be tested. Test plans and test procedures shall be modular to allow individual test segments to be repeated upon request.
Test plans and test procedures shall provide a two-step description of each factor and field test. A high-level functional summary of the methods used for verifying each feature of the hardware, software and firmware being tested shall be provided in the test plans, the step-by-step activities associated with each test shall be listed in the test procedures. All test plans and test procedures shall be submitted to the Employer for approval.
There shall be two types of factory and field test plans required and shall be submitted for Employer approval at least three months before the start of testing.

5.4 TESTING REQUIREMENTS

General Requirements

The terminology used with the tests described in this section is as follows:
a. Pre-Commissioning Period - The Phase 1 Site Acceptance Test (SAT) including Pre-

Commissioning tests.

b. Commissioning Period - The Phase 2 SAT

c. Guarantee Test - Guaranteed System Availability Test

5.4.1 Cable Tests

5.4.1.1 Test Classification

The Cable tests prior to despatch to sites shall consist of Type, Factory Acceptance, Routine tests, and Tests During Manufacture as defined below:

Type tests are those tests required to verify design, process of manufacture, and general equipment and material compliance with the specification. Type tests shall be performed on samples prior to the start of commercial production. All bidders shall submit, as part of their proposals, a Type testing schedule.

Factory Acceptance tests are tests to be performed on samples taken from each lot (or production run) offered for shipment to the Employer. The purpose is for approval of each individual lot.

Routine tests are random tests performed during the production phase.

Tests During Manufacture are those tests to be performed during the manufacturing process and end inspection to ensure the desired end product satisfies the specification.

The norms and procedure of sampling for these tests shall be as per the Quality Assurance Program to be mutually agreed to by the Contractor and Employer.

Specific standards for each test are identified in this Specification, Where a particular test is required. the norms and procedure for that test shall be as specified in the listed standard and the associated specific procedure where applicable.

For all type and acceptance tests the acceptance values shall be the values guaranteed by the Bidder in the guaranteed technical particulars schedule or the acceptance values specified in this specification, whichever is more stringent for that particular test.

5.4.1.2 Type Tests

"Type Tests" shall be defined as those tests which are to be carried out to prove the design, process of manufacture and general conformity of the materials to this Specification. The Type Tests to be performed shall comply with the following:

The Bidder along with his bid shall furnish type test certificates for the tests specified in this specification for all the equipment/ material offered by him.

Type Tests shall be performed for all equipment types for which certification is not provided as required in (a) above or if it is determined by Employer that the certification provided is not acceptable.

Type Tests shall be certified at or carried out at internationally reputed laboratories approved by the Employer.

The Contractor shall be required to submit the Schedule for performing type tests on equipment types for which previous certification is not available. Type tests shall he performed in the presence of the Employer representative.

Testing charges for all the type tests shall be indicated separately for each item in the prescribed schedule of the bidding document.

Bidder shall indicate the laboratories in which they propose to conduct the type tests.

They shall ensure that the tests can be completed in these laboratories within the time schedule guaranteed by them in the appropriate schedule of the bidding document.

In case of failure in any type test the supplier is either required to manufacture fresh sample lot and repeat all type tests successfully or repeat that particular type tests at least three times successfully on the samples 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.

Type tests shall be performed in accordance with ITU-T G.650, ITU-T G.653, IEC, EIA/TIA, IEEE, and other standards and descriptions as specified herein.

The list of type tests for FO cables (OPGW and ADSS) and their accessories are listed in Appendix FI (Type Testing Requirements).

Type test Samples

The Contractor shall supply material for sample selection only after Quality Assurance Plan approval by the Employer. The sample material shall be manufactured strictly in accordance with the approved Quality Assurance Plan.

The Contractor shall offer three drums (reels) of each type of fibre-optic cable. The Employer will choose which reel of each cable type to be used for the Type testing.

5.4.1.3 Factory Acceptance Tests

Factory tests shall be conducted on selected samples of OPGW cable to be supplied. Material shall not be shipped to the Employer until required factory tests are completed satisfactorily, all variances are resolved, full test documentation has been delivered to the Employer and the Employer has approved for shipment. Successful completion of the factory tests and the Employer approval to ship, shall in no way constitute final acceptance of the system or any portion thereof.

5.4.1.4 Routine Tests

Measure the optical loss of each fibre at 1550 nm. Measure the mode field diameter, the chromatic dispersion, core diameter and cladding diameter of each fibre.

Perform all acceptance tests on metallic wires.

5.4.1.5 Tests During Manufacture

Perform a chemical analysis of steel/aluminium alloy used for OPGW cable strands. Perform optical fibre tests mutually agreed to by the Contractor and the Employer in accordance with the Quality Assurance Program.

Receiving Inspection(RI)

Upon material receipt by The Employer, the Contractor shall perform witnessed acceptance tests to verify that optical specifications are satisfactory and that no damage

occurred during handling and shipment. Testing may be performed with either an OTDR or a light source and power meter.

Should evidence of specification non-compliance arise, it is incumbent on the Contractor to either prove compliance in writing or to replace all defective material.

5.4.1. 7 Site Acceptance Tests

The Site Acceptance Test (SAT) for the fibre optic cable is a part of the SAT discussed further in Section 5.4.2.4.1.

Prior to installation, every spooled fibre optic cable segment shall be tested for compliance with the Pre-shipment data previously received from the manufacturer. This requirement will preclude the installation of out of specification cable segments that may have been damaged during shipment.

During the installation, spliced cable segments shall be tested and documented. Upon completion of a continuous cable path (equipment to equipment locations) all fibres within the cable path shall be demonstrated for acceptance of the cable path. Fibre Optic cable field testing minimum requirements are provided in Table 5.6(a) through 5.6(c).

Table 5.6(a)

Fibre Optic Cable Pre-Installation Testing

Item:	Description:
I.	Physical Inspection of the cable assembly for damage
2	Optical fibre continuity end-to-end
3.	Per fibre OTDR

Table 5.6(b)

Fibre Optic Cable Splice Testing

Item	Description
1	Per splice attenuation
2	Per splice OTDR
3	Physical inspection of splice box/enclosure for proper fibre routing techniques
4	Physical inspection of sealing techniques, weather proofing etc.

Table 5-6(c)

Fibre Optic Cable Commissioning Testing

Item:	Description
1.	Fibre continuity and span attenuation between equipment end to end connectors at two ends for each fibre at 1310/1550 nm
2.	Bi-directional OTDR per fibre ,end to end
3.	Per fibre spectral analysis

4.	Raleigh scatter diagram
5.	Bit Error Count and BER record for 360 consecutive hours. Sampled at 30 min interval, at test data rate of 8.448 Mbits/s

5.5.1 **Site Acceptance Testing for Optical Fibre Cabling**

Prior to installation every spooled fibre optic cable segment shall be tested for compliance with the Pre-shipment data previously received from the manufacturer. This requirement will preclude the installation of out of specification cable segments that may have been damaged during shipment.

During the installation. spliced cable segments shall be tested and documented. Upon completion of a continuous cable path (equipment to equipment locations) all fibres within the cable path shall be demonstrated for acceptance of the cable path Fibre Optic cable field testing minimum requirements are provided in Table 5-8(i) through Table 5-8(iii):

Table-5-8(i)

Fibre 0ptic Cable Pre-Installation Testing

Item	Description
1.	Physical inspection of cable assembly for damage.
2.	Optical fibre continuity end-to-end.
3.	Per fibre OTDR.

Table-5-8(ii)

Fibre 0ptic Cable Splice Testing

Item	Description
1.	Per splice attenuation
2.	Per splice OTDR
3.	Physical inspection of splice box/enclosure for proper fibre routing techniques
4.	Physical inspection of sealing techniques, weatherproofing etc.

Table5-8(iii):

Fibre Optic Cable Commissioning Testing

Item	Description
1.	Fibre continuity and span attenuation between equipment end to end connectors at two ends for each fibre at 1310/1550 nm
2.	Bi-directional OTDR per fibre end to end
3.	Per fibre spectral analysis
4.	Rayleigh scatter diagram
5.	Bit Error Count and BER record for 360 consecutive hours, sampled at 30 min interval, at test data rate of 8.448 Mbit/s

5.5.2 Test Procedures

Test procedures for factory and field testing shall be submitted for Employer approval at least one month before each individual test. Fully approved test procedures shall be

submitted to the Employer at least two weeks prior to the commencement of testing. Testing shall not commence without approved test procedures. The Employer will only approve test procedures if they are inclusive and thoroughly test each component of the item both independently and collectively. At a minimum, test procedures shall include the items in Table 5-3.

All necessary maintenance and adjustments shall be carried out before the commencement of tests so that they can continue uninterrupted by routine operations.

The Contractor shall ensure that all testing will be performed by qualified testing personnel each personnel with a minimum of 12 months experience performing such tests. Testing personnel names, qualifications and the specific tests each will perform shall be included in the proposal.

Table 5-3

Test Procedure Requirements

1	Test Title and Revision Level, if applicable Test Title shall include Subsystem, End Item and Component as applicable
2	Function(s) to be tested
3	Purpose of each test segment
4	List of required test equipment
5	Description of any special test conditions or special conditions required. This includes complete descriptions, listings and user interface procedures for all special hardware and software tools and/or display formats to be used during the test.
6	Test setup including test configuration block diagrams and/or illustrations.
7	Test procedures to be followed
8	Required inputs and expected outputs for each test segment.
9	Acceptance criteria for each test segment.
10	Format of test reports.

Test Records

Complete and indexed records of all factory and site acceptance tests results shall be maintained by the Contractor in hardcopy and also on MS-DOS formatted 3 floppy disks. The records shall be keyed to the steps enumerated in the test procedures. The minimal items required in test records are described in Table 5-4

Table 5-4 Test Record Requirements

ITEM	DESCRIPTION
1.	Test Title and Revision Level, if applicable; contract references
2.	Date and time for test start and test completed
3.	Test title and reference to the appropriate section of the test procedures

4.	Description of any special test conditions or special actions taken (Includes test-case data).
5.	Test results for each test segment including an indication of Passed, Conditional Pass, Incomplete or Failed.
6.	Test procedure modifications made during testing.
7.	Variance Report(s) tracking information and copies (if variance(s) was detected).
8.	Contractor's test engineer(s) identification, signature and remarks
9.	Employer test witness(s) identification, signature and remarks
10.	List of all attachments
11.	Attachments (including system logs. printouts, variances, hard copies of visual test result displays. etc.)

Reports on commissioning of the fibre cables will be produced by the Employer. The Contractor shall cooperate with the Employer and furnish him with all data necessary to complete such reports.

Six (6) sets of all principle test records, test certificates and performance curves shall be supplied for all tests carried out in accordance as proof of compliance with the specifications and/or each & every specified test. These test certificates, Records and performance curves shall be supplied for all tests, whether or not they have been witnessed by the Employer within 30 calendar days of completion of tests. Information given on such test certificates and curves shall be sufficient to identify the material or equipment to which the certificates refer and shall also bear the Contractor's reference and heading.

5.5.3 Variance Procedures

This section describes the procedures and requirements for the reporting and disposition of variances.

5.5.4. Reporting Variances

A variance report shall be prepared by either TNEB or Contractor' s personnel each time a deviation from specification requirements is detected. The variance report shall include a complete description of the variance in accordance with Table 5-5 Report of Variance.

Table 5 -5

Report of Variance Requirements

Item	Description
1.	Variance Record Number (for summaries, logs and tracking)
2.	Date and Time Variance was detected
3.	Appropriate references to the test procedure(s) and/or applicable specification.
4.	A description of the test conditions at the time the variance was detected.
5.	Variance Impact Class as defined within this specification
6.	Contractor's test engineer(s) identification, signature and remarks
7.	Employer's test witness(s) identification(s), signature(s) and remarks
8.	List of all attachments
9.	Attachments
10.	Closeout Record as defined within this specification

Depending on its impact each variance shall be assigned to one of three classes by the Contractor with Employer having class assignment approval rights.

(a) Class 1 Testing will stop for immediate evaluation and correction by the Contractor.

(b) Class 2 Testing will continue and the variance will be corrected at the end of the current session or day.

(c) Class 3 Testing will continue and the variance will be corrected and tested at a mutually agreed upon time (e.g., at the end of the test or later in the test period prior to shipment)

5.5.5. Disposition of Variances

All actions taken to correct variances shall be documented by the Contractor. Sufficient information shall be provided to enable a Employer's representative to determine the need for retesting the function for testing interaction with any previously tested function and for updating appropriate documentation as a result of the corrective action. Variance corrections which would result in a change to an approved document must be approved by Employer prior to their implementation by the Contractor.

The variance report shall be completed and considered closed when Contractor and Employer's representatives acknowledge by signatures on the variance record, correction of the variance. Variance reports shall be available to Employer at all times and shall be submitted by the Contractor to Employer upon shipment of the equipment.

The Contractor shall maintain and periodically distribute (frequency of distribution based on testing activity) a variance summary that lists for each variance, the variance number, functional identification, class, and current status.

Phase 1 SAT

5.5.6. Installation Testing

The Phase 1 SAT consists of installation testing of the fibre optic cable and termination equipment. In the installation test report, the Contractor shall include a list of all hardware or components replaced or changed between the completion of factory tests and the start of field tests and show that documentation and spare parts have been updated.

5.6. DOCUMENTATION

5.6.1 General Documentation Requirements

All the documentation shall be provided in hard copy and also on CD in full compliance with the specifications. To ensure that the proposed telecommunications network conforms to the specific provisions and general intent of this Specification, the Contractor shall submit documentation describing the telecommunication network, systems, subsystems and equipment to The Employer for review and approval. The Employer shall have the right to require the Contractor to make any necessary documentation changes to achieve conformance with the Specification, at no additional cost to The Employer.

Documentation for the Contractor's standard hardware, software, and firmware shall be furnished to the Employer for review, but approval by the Employer will not be required. The Employer, however, reserves the right to determine that this standard hardware, software and firmware is in full conformance with the contract requirements and that the documentation contains sufficient information for the Employer to make this determination.

All standard hardware and software documentation shall be submitted to the Employer within 90 days after signing the contract. All documentation submitted to The Employer shall be in the English language only.

Any documentation prepared specifically for the Employer's communication equipment shall be submitted to the Employer for review and approval. Any purchasing, manufacturing, or programming implementation initiated prior to written approval The Employer of the relevant documents or drawings shall be performed at the Contractor' risk.

Documentation for equipment that is standard or has proprietary software/firmware shall meet the intent of the requirements defined herein. If during the training courses or while performing maintenance on such equipment during the warranty period, the Employer determines that additional information is required to perform the maintenance function, the Contractor and/or its subcontractors shall provide the specific supplemental information necessary to perform the maintenance function. This information shall be documented in a form suitable for incorporation into the appropriate maintenance document.

As detailed in subsequent sections the documentation shall include the following:

a. Detailed list of the deliverables
b. Description of the products
c. Technical particulars

d. Optical Signal Performance Calculations
e. Installation guides
F Maintenance manuals
g. Quality assurance manuals
h. Tests documentation

5.6.2 Test Documentation

The Contractor shall provide documentation for all factory and field tests. Section 5.3 & 5.4 describe the test documentation requirements. The test documentation shall include the following:

a. Test Procedure Document
b. Type test documents
c. Factory Acceptance Test Documents
d. Site Acceptance Test Documents
e. Availability Test Documents

Factory Acceptance Test results will be included in factory test data. Test results, for any un-witnessed equipment tests, shall be shipped along with the associated equipment.

5.6.3. Drawings

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, dimensions, material description, Bill of Materials, weight of each component, break-up for packing and shipment, shipping arrangement required, the dimensions required for installation and any other information specifically requested in the Specifications.

Each drawing submitted by the Contractor shall be clearly marked with the Employer name, the unit designation, the specification title, the specification number and the name of the Project. All titles, notes, markings and writings on the drawing shall be in English. All the dimensions should be to the scale and in metric units.

The drawings submitted by the Contractor shall be reviewed by the Employer as far as practicable within four (4) weeks and shall be

modified by the Contractor if any modifications and/or corrections are required by the Employer in compliance with the Specifications. The Contractor shall incorporate such modifications and/or corrections and submit the final drawings for approval. Any delays arising out of failure by the Contractor to rectify the drawings in good time shall not alter the contract completions date.

The drawings submitted for approval to the Employer shall be in quadruplicate One print of such drawings shall be returned to the Contractor by the Employer marked "approved/approved with corrections".

The Contractor shall thereupon furnish the Employer additional prints as stipulated in the Technical Specification along with one reproducible in original of the drawings after incorporating all corrections.

Further work by the Contractor shall be strictly in accordance with these drawings and no deviation shall be permitted without the written approval of the Employer.

All manufacturing and fabrication work in connection with the equipment/material 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/material conform to the provisions and intent of the Contract and such changes will again be subject to approval by the Employer. Approval of Contractor's drawing or work by the Employer shall not relieve the Contractor of any of his responsibilities and liabilities under the Contract.

5.6.4. Document Quantities

Summaries of the deliverable documentation requirements and the quantities of preliminary and final documents to be supplied, are provided below.

All final textual documentation shall be provided on electronic media in Word Perfect Version 6.1 or MS-Word Version 2.0 format unless another wordprocessing format, acceptable to the Employer, and already in use by the Contractor is proposed. All drawings shall be provided on electronic media in AutoCAD. Version 12 DXF Format, unless another CAD/Drawing program acceptable to The Employer and already in use by the Contractor, is proposed. Where an alternative format(s) is offered, the Contractor (at their cost) shall provide the Employer with the appropriate software, manuals and training.

TYPE TESTING REQUIREMENTS

Type Tests For Optical Fibres

The type tests listed below in table F-1.1 are applicable to all types of F .0. cables and shall be conducted on DWSM fibres. The tests specific to the cable type are listed in subsequent sections.

Table F-1.1:
Type Tests For Optical Fibers

S. No.	Test Name	Acceptance Criteria	Test procedure
(1)	Attenuation	Technical specification Part-II Section-II Table 2.2	EIA/TIA 455- 78A
(2)	Attenuation Variation with Wavelength	--DO-	EIA/TIA 455- 78A
(3)	Attenuation at Water Peak	3 dB/Km at1383 nm	EIA/TIA 455- 78A
(4)	Temp. Cycling (Temp dependence of Attenuation)	Technical specification Part-II Section-II Table 2.2	EIA/TIA 455- 3A. 2 cycles
(5)	Attenuation With Bending (Bend Performance)		EIA/TIA 455- 62A
(6)	Mode Field dia.		EIA/TIA 455-164A/167A/174
(7)	Chromatic Dispersion		EIA/TIA 455-168A/169A/175A

(8)	Mode field dia. Concentricity error		EIA/TIA 455

F –2 Type Tests For OPGW Cables

The type tests to be conducted on the OPGW cable are listed in table F-2.1: Type Tests for OPGW Cables. Unless specified otherwise in the technical specifications or the referenced standards, the optical attenuation of the specimen, measured during or after the test as applicable, shall not increase by more than 0.05 dB/Km.

Table F-2.1

Type tests for OPGW Cable

S. No.	Test Name	Test Description	Test procedure
(1)	Water Ingress Test	IEEE: 1138 Section 4.1.1.1	IEFE: 1138 Section 5.1.1.1 (IEC 794-1-E5/ EIA/TIA 455-82B)
(2)	Seepage of filling Compound	IEEE 1138 Section 4.1.1.2	IEEE 1138 Section 5.1.1.2 (EIA/TIA 455-82B)
(3)	Short Circuit Test	IEEE 1138 Section 4.1.1.3	IEEE 1138 Section 5.1.1.3
(4)	Aeolian Vibration Test	IEEE 1138 Section 4.1.1.4	IEEE 1138 Section 5.1.1.4
(5)	Galloping test	IEEE 1138 Section 4.1.1.5	IEEE 1138 Section 5.1.1.5
(6)	Cable Bend Test	Procedure. 2 in IEC:794-1-E11 Ref Para F-2.1	
(7)	Sheave Test	IEEE 1138 Section 4.1.1.6	IEEE 1138 Section 5.1.1.6
(8)	Crush Test	IEEE 1138 Section 4.1.1.7	IEEE 1138 Section 5. 1.1. 7 (IEC 794- 1 -E3/ EIA/TIA 455-25A)Ref Para F-2.2
(9)	Impact Test	IEEE 1138 Section 4.1.1.7	IEEE 1138 Section 5.1.1.7 (IEC 794-1-E4/ EIA/TIA. 455-41) Ref Para F-2.3
(10)	Creep Test	IEEE 1138 Section 4.1.1.8	IEEE 1138 Section 5.1.1.8
(11)	Fibre Strain Test	IEEE 1138 Section 4.1.1.9	IEEE 1138 Section 5.1.1. 9

(12)	Strain Margin Test	IEEE 1138 Section 4.1.1.10	IEEE 1138 Section 5.1.1.10
(13)	Stress strain Test	IEEE 1138 Section 4.1.1.11	IEEE 1138 Section 5.1.1.11
(14)	Cable Cut-off Wavelength Test	IEEE 1138 Section 4.1.1.12	IEEE 1138 Section 5.1.1.12

Table F-2.1

Type tests for OPGW Cable

S. No.	Test Name	Test Description	Test Procedure
(15)	Temperature Cycling Test	IEEE 1138 Section 4.1.1.13	IEEE 1138 Section 5.1.1.13
(16)	Corrosion (Salt spray) Test	EIA/TIA 455-16A	
(17)	Tensile Performance Test	IEC 794-1-E1/ EIA/TIA 455-33A. Ref Para F-2.4	
(18)	Fault Current/ lightening Test	IEEE Std. 4-1978 Para F-2.5	
(19)	DC Resistance Test	Para F-2.6	

F-2.1 Cable Bend Test

The short-term and long-term bend tests shall be conducted in accordance with Procedure 2 in IEC:794-1-E11 to determine the minimum acceptable radius of bending without any increase in attenuation or any other damage to the fibre optic cable core such as bird caging, deformation, kinking and crimping.

F-2.2 Crush Test

The crush test shall be carried out on a sample of approximately one (1) metre long in accordance with IEC:794-1-E3. A load equal to 1.3 times the weight of a 400-metre length of fibre optic cable shall be applied for a period of 10 minutes. A permanent or temporarily increase in optical attenuation value greater than 0.1 dB change in sample shall constitute failure. The load shall be further increased in small increments until the measured attenuation of the optical waveguide fibres increases and the failure load recorded along with results.

F -2.3 Impact Test

The impact test shall be carried out in accordance with IEC:794-1-E4. Five separate impacts of 0.1-0.3kgm shall be applied. The radius of the intermediate piece shall be the reel drum radius $\pm$ 10%. A permanent or temporary increase in optical attenuation value greater than 0.1 dB/km change in sample shall constitute failure.

F-2.4 Tensile Performance Test

The test shall be conducted on a sample of sufficient length in accordance with IEC:794-1-E1. There shall not be any change in attenuation up to 90% of RTS of fibre optic cable.

The load shall be increased at a steady rate up to rated tensile strength and held for one (1) minute. The fibre optic cable sample shall not fail during the period. The applied load shall then be increased until the failing load is reached and the value recorded.

F-2.5 Lightning Test

Tension equal to 20% of the OPGW RTS shall be applied to a sample with minimum length of 30 m of cabled fibres and two separate 4/10 micro second current impulses each having a peak value of 150 KA and a negative polarity shall be applied through a 1 cm gap.

The attenuation during the tests shall be continuously measured. After the tests the same shall be visually inspected. Any increase in optical waveguide fibres attenuation measured at 1550 nm shall constitute failure.

F-2.6 D.C. Resistance Test

On a fibre optic cable sample of minimum 1 metre length, two contact clamps shall be fixed with a predetermined bolt torque. The resistance shall be measured by a Kelvin double bridge by placing the clamps initially zero metre and subsequently one metre apart.

The tests shall be repeated at least five times and the average value recorded after correcting at 20°C.

As specified in section 5.5: factory Tests of Vol.IIA of technical specifications, the Factory acceptance tests shall be conducted on random sampling of fiber optic cable to be supplied for the present procurement, prior to any shipment.

F-9.1 FAT On Fiber Optic cables: Optical Acceptance Tests

The Optical acceptance tests listed in table F-9.1 below are applicable for all the two types of F.O. Cables viz. OPGW and ADSS. The listed tests follow testing requirements set forth in IEEE standards, 1222 and 1138 section 4.2.2.1 and section 5.1.2.1. The referenced sections specify the detailed test description. The acceptance norm shall be as specified in the above mentioned IEEE standards unless specified otherwise in the technical specifications.

Table F-9.1

FAT for F .0. Cables: Optical Acceptance Tests

S. No.	Test Name	Acceptance Norm	Fiber Optic Test Procedure
(1)	Attenuation Coefficient	Technical Specification Part II Section II	EIA/TIA 455- 78A/ 61
(2)	Attenuation Uniformity	Technical Specification Part II Section II	EIA/TI A 455-59

(3)	Chromatic Dispersion	Technical Specification Part II Section II	EIA/TIA 455-168A/169A/175A
(4)	Mode Field dia.		EIA/TIA 455-164A/167A/174
(5)	Concentricity Error		EIA/TIA 455-45B/176
(6)	Cladding dia.		EIA/TIA 455-45B/176
(7)	Cladding Non-circularity	≤ 2%	EIA/TIA 455-45B/176
(8)	Coating Dia.	Technical Specification Part II Section II	EIA/TIA 455-55B/173
(9)	Fiber Tensile Proof testing		EIA/TIA 455- 31 B

F-9.2 Factory Acceptance Test on OPGW

The factory acceptance tests for OPGW specified below, follow the requirements set forth in section 4.1.2 and section 5.1.2 0f IEEE standard 1138.

Appendix F

TYPE TESTING REQUIREMENTS

Table F-2.1

Type tests for OPGW Cable

S. No.	Test Name	Test Description	Test procedure
(3)	Short Circuit Test	IEEE 1138 Section 4.1.1.3	IEEE 1138 Section 5.1.1.3

Table F-2.1

Type tests for OPGW Cable

S. No.	Test Name	Test Description
(18)	Fault Current/ lightening Test	IEEE Std. 4-1978 Para F-2.5

F-2.5 Lightning Test

Tension equal to 20% of the OPGW RTS shall be applied to a sample with minimum length of 30 m of cabled fibres and two separate 4/10 micro second current impulses each having a peak value of 150 KA and a negative polarity shall be applied through a 1 cm gap.

The attenuation during the tests shall be continuously measured. After the tests the same shall be visually inspected. Any increase in optical waveguide fibres attenuation measured at 1550 nm shall constitute failure.

Any other tests as specified in latest amended IS/IEC.

** ** **

VOLUME – II
CHAPTER – IV
SPECIFIC TECHNICAL REQUIREMENTS

This chapter covers climatic conditions and technical requirement Relating to Towers, Conductor, Earth wire and Insulator technical Requirements.

1.0.CLIMATIC CONDITIONS:

i) Location: Detailed Engineering, Design, Manufacture, Supply, Erection, Testing and Commissioning of 400 kV DC in MC towers with Twin Moose conductors for formation of Northern Port Access Road (NPAR) Section-I of Chennai Peripheral Ring Road (CPRR).

ii) Maximum ambient temperature (degree C) : 50
iii) Minimum ambient air temperature (deg C) : 5
iv) Daily average ambient temperature (deg-C) : 32
v) Max. Relative humidity % : Range 10-100%
vi) Rainfall (max) mm : 120
vii) Rainy days in a year (days) : June to October
viii) Maximum wind velocity M / sec : Zone-2-39
ix) Average number of thunderstorm days per year:
x) Maximum altitude above MSL (Meter) :

2.0 System Particulars 400kV:

a) Line Voltage (kV) : 400
b) Highest System Voltage (kV) : 420
c) Number of circuits : 2
d) Frequency (Hz) : 50
e) Neutral : Effectively earthed
f) Number of sub conductors : 4
g) Bundle arrangement :Twin
h) Bundle spacing (mm) 450
i) Basic insulation level BIL (kV peak): 1550
j) Power frequency withstand voltage wet (kVrms) 680
k) Switching Surge withstand voltage wet (kV peak): 1050
l) Corona extinction voltage Dry condition (kV rms) : 320
m) Radio interference voltage at one MHz for Phase to earth voltage of 266 kV rms dry- (micro volts) 1000

n) Short circuit level (Ka) 40

o) Maximum temperatures (deg C)

Conductor 75

Earth wire 53

p) Power line crossing

i) Any other power lines (mm) 5490

ii) Telecommunications line (mm) 4570

iii) Railway line Above track (mm) 17900

Above crane (mm) 6000

Sl. No	Description	Conductor	Earthwire
1.	Nominal Voltage	kV	765
2.	Maximum System Voltage	kV	800
3.	BIL (Impulse)	kV (Peak)	2400
4.	Power frequency Withstand voltage (wet)	kV (rms)	830
5.	Switching surge withstand Voltage (wet)	kV (rms)	1550
6.	Minimum Corona extinction Voltage at 50 Hz AC System under dry condition	kV (rms) phase to earth	510 (Min)
7.	Radio interference Voltage at one MHz for phase to earth voltage of 510 kV under dry condition.	Micro Volts	1000 (Max)

ii) Major road As per IE Rules - 1956

Details of Line Materials

3.0 <u>TOWER PARTICULARS</u>:

a) Configuration (400 kV): DC vertical with 8000 min inter phase spacing

b) Spans

Tower type	**Normal span**	**Wind Span**		**Weight Span**			
400 MC Tower		Normal condition	Broken wire condition	Normal Condition Max(M)	Min(M)	Broken wire condition Max(M)	Min (M)
QA	400	400	240	600	200	360	100
QB	400	400	240	600	0	360	-200
QC	400	400	240	600	0	360	-200
QD	400	400	240	600	0	360	-300

c) Number of sub conductors per phase (400 kV) 4/6
d) Sub conductor spacing (mm) 457
e) Bundle arrangement (400 kV) Twin
f) Number of earth wires GSW -1 OPGW – 1
g) Shielding angle (deg) (400 kV) 20/10
h) Tower footing resistance (ohms) 10

i) Clearances(400 kV)

i) Minimum ground clearance from power conductor (mm) 8840
ii) Provision for survey and sag errors (mm) 150
iii) Minimum phase-to-phase distance (mm) 8000
iv) Maximum vertical midspan clearance between Power conductor and earth wire in still air (mm) 9000

j) Swing angles and minimum clearance from live to earthed metal

i) Suspension insulator string in still air and when Deflected up to 22 / 25 deg from the vertical (mm) for 400 kV line 3050
ii) Suspension insulator when deflected by wind Up to 44 deg for 400 kv line from the vertical (mm) 1860
iii) Jumpers in still air and when deflected upto 20 / 25 deg for 400 / 765 kv line from the vertical (mm) 3050
iv) Jumpers when deflected by wind upto 40 / 55 degree for 400 / 765 kV from the vertical (mm) 1860
v) Tension insulator string (mm) 400 kV 3050
vii) Design wind pressure (Kg/Sq.m.) for both 400 kV 71.46

STRUCTURAL STEEL PARTICULARS:

a) Details of structural steel

- Steel quality IS:2062 BS: 4360
- Minimum guaranteed yield Stress (kg / mm^2) MS / HT 2550 / 3600
- Maximum allowable stress (kg / mm^2)
- For tension members (on net area) MS/HT 2550 / 3600
- For compression members (on gross area) MS & HT as per IS: 802

b) Details of 16 mm dia bolts nuts

i) Shear stress on gross area of bolt shank of 5.6 grade (kg /mm^2) 3160
ii) Bearing stress on shank of grade 5.6 bolts (Kg/mm2)
MS 6322
HT 6322
iii) Tension on net area of the thread (kg / mm^2) 2590

FOUNDATION PARTICULARS:

Classification	Normal soil, Black cotton soil, Soft/Disintegrated Rock, Hard Rock and Sandy Soil
Water table	Dry, Wet, Partially submerged (PS) and Fully submerged (FS)
Partial Factors of Safety for foundation design. Towers up to an angle of 15 deg deviations Towers above an angle of 15 deg Deviations	 1.1 1.2
Grounding of towers Maximum tower footing resistance	10 Ohms
Maximum distance between Counterpoise wires	30 M

6.0. SAG - Tension details for wind zone – 5 (Values to be furnished by the bidder along with working sheet for each zone)

Temp deg. C	**Wind** (kg/M^2)	**Conductor**		**Earth wire**	
		Sag (M)	Tension (Kg)	Sag (M)	Tension (Kg) .
5					
32					
53					
75					

7.0. CONDUCTOR PARTICULARS:

7.1. "MOOSE" ACSR CONDUCTOR:

a) Type	Moose ACSR
b) No./Wire diameter (mm)	
Aluminum	54/3.53
Steel	7/3.53
c) Sectional Area of Aluminum (Sq.mm)	528.5
d) Total Sectional Area (Sq.mm)Composite	597.0
e) Overall diameter (mm)	31.77
f) Approximate weight (Kg./Km.)	2004
g) Calculated D.C resistance at 20° C	
maximum (Ohm / km)	0.05552
h) Ultimate tensile strength (KN.)	161.2
i) Final modulus of elasticity ($Kg./Cm^2$)	$0.704x10^{6}$
j) Coefficient of Linear expansion (per deg.C)	$19.3x10^{-6}$

EARTHWIRE PARTICULARS

8.1.0. 7/3.66 GSW Earth wire:

Type : GSW

No/Wire diameter (mm) : : 7/3.66 Steel

Total Sectional Area (Sq.mm) : 73.65

Overall diameter mm : 10.98

Approximate weight (Kg/Km) : 583

Calculated D.C. resistance at 20° C maximum (ohm / km) : 2.5

g) Ultimate tensile strength (KN) : 68.4

i) Final modulus of elasticity (Kg/Cm^2) : 1.933×10^6

Coefficient of Linear expansion (per deg.C) : 11.5×10^{-6}

INSULATOR STRING PARTICULARS:

Sl. No.	Particulars	Single Suspension and Pilot String	QUAD Tension String	Double suspension String	Single tension String
a)	No. of standard discs	1 x23	4x24	2x24	1 x 24
b)	Size of Porcelain disc Insulators (mm).	255x145	280x170	255x145	255x145
c)	E&M Strength each string (kN)	120	4 x 160	2x120	120
d)	Ball and socket designation (mm)	20	20	20	20
e)	Creepage distance of each Porcelain Insulator disc (mm)	315	330	315	315

VOLUME – II

CHAPTER - V

QUALIFICATION REQUIREMENT FOR SUPPLY OF LINE MATERIALS & DETAILED TECHNICAL SPECIFICATION

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CHAPTER -V

DETAILED TECHNICAL SPECIFICATIONS

Sl. No.	Description
	QUALIFICATION REQUIREMENT FOR SUPPLY OF LINE MATERIALS
PART - A	"MOOSE ACSR" CONDUCTOR
PART-B	GROUND WIRE 7/3.66 mm.
PART-C	ACCESSORIES AND HARDWARE FITTINGS FOR MOOSE ACSR, AND GROUND WIRE.
PART-D	DISC INSULATORS
PART-E	HARDWARE FITTINGS FOR INSULATORS
PART-F	GI BOLT AND NUTS

QUALIFICATION REQUIREMENT FOR PROCUREMENT & SUPPLY OF MATERIALS:

The bidder should have assured access to supply Moose ACSR, Earth wire, OPGW Insulators, Hardware fittings & Accessories for conductor and Earth wire, GI Bolt & nut, GI Anti theft Bolt & nut and washers etc. qualified manufacturers meeting the following minimum requirement and must demonstrate that based on known commitments they will be available for use in the proposed contract.

The qualified manufacturer should have designed, manufactured, type tested and supplied hardware fittings for 400 kV or above voltage transmission line at least 25% of the quantity of line materials (like Moose ACSR, Earth wire, OPGW Insulators, Hardware fittings & Accessories for conductor and Earth wire) required for transmission line, directly to Electricity Boards/Power utilities in India or to the Turnkey contractors who have executed the line to Electricity Boards/Power utilities in India in any one year during the last Ten years and at least 10% of the quantity required for the transmission line should have been in satisfactory operation for a minimum period of two years as on date of technical bid opening.

Further, qualified manufacturer should also have type tested Twin tension and suspension strings for 400 kV voltage rating in a period not later than 5 years as on date of technical bid opening i.e. at the time of sub vendor approval.

For spacer dampers for Twin bundle conductor and vibration dampers for earth wire, the experience should include at least the supply of 4000 Nos of spacer dampers for Twin bundle conductor and 100 Nos of vibration dampers for earth wire for 345/400 KV or above voltage transmission line and at least 10% of the quantity required for the transmission line should have been in satisfactory operation for a minimum period of two years as on date of bid opening. (For accessories for galvanized steel earth wire, the requirement of voltage level shall not be applicable).

In case of procurement of spacer damper for **Twin Moose ACSR** from those approved sub vendors having satisfactory operation period of more than 9 months and within 24 months for quad Spacer damper as on date of opening of technical bid then the sub vendor shall provide performance guarantee for 60 months from the date of energization instead of 36 months.

After award and at the time of execution of work in case of any sub vendor substituted for the originally proposed and approved sub vendor, the new sub vendor shall also satisfy the requirements specified and the approval obtained from the Board for the new sub vendor.

If the line materials are proposed for procurement from sub vendor companies approved earlier for similar 400 KV transmission line projects executed by TANTRANSCO ,furnishing of required documents for sub vendor approval for this project is not required, however prior intimation shall be given & acceptance to be obtained from TNRDC/TANTRANSCO before initiating the procurement process.

The successful bidders shall procure any individual item(s) from the manufacturer(s) meeting the above requirement after obtaining approval for the respective item(s). The list of sub vendors from whom the line materials proposed to be procured shall be furnished along with the tender.

The manufacturer(s) meeting the above requirement for any individual item or items shall be considered qualified for the respective item or items. The tenderer shall furnish the end user certificate of the qualified manufacturers to prove their experience in supply and satisfactory performance of materials. The tenderer shall furnish the type test certificates for all the materials conducted in a period not later than 5 years as on date of opening of technical bid or after opening of tender i.e. at the time of sub vendor approval from a reputed/approved laboratory(by Government /Power utility) for having conducted these tests as per relevant, latest IS.

VOLUME – II
CHAPTER-V
PART A
CONDUCTOR

1.0. SCOPE:

This specification covers the manufacture, testing at manufacturer's works and supply of MOOSE ACSR conductor as per technical details enclosed and these conductors are to be used as Power conductors on 400 kV Multi circuit Transmission lines, respectively.

2.0. STANDARD:

Except as modified by this specification, the ACSR conductor to be supplied shall conform to the latest edition with revision of the following Bureau of Indian Standards (IS) and British Standards (BS).

IS-209-Latest	Specification for Zinc
BS-215-1970	Aluminium conductors, steel reinforced
IS-398-Part-ll	Aluminium conductors, galvanized steel reinforced
IS-398-PartV	Aluminium conductors galvanized steel reinforced for Extra high. Voltage (400 kV and above)
IS-1778	Reels and drums for bare conductors (First Revision)
IS-1841	EC grade Aluminium rod produced by Rolling (Second Revision).
IS-2629	Recommended practice for hot dip galvanizing of Iron & Steel.
IS-2633	Methods of testing uniformity of Coating on Zinc Coated articles
IS-4826	Hot dipped Galvanised coating on round steel wires
IS-5484	EC grade Aluminium rod produced by continuous casting and rolling (Second revision).
IS-7623	Lithium base Grease for Industrial purposes (First Revision)
IS-8263	Method of Radio Interference tests on high voltage insulators.

DEVIATIONS IN SPECIFICATIONS:

All discrepancies and or deviations in specifications if any shall be brought out by the bidder and shall be detailed clause by clause in the deviation schedule.

Deviations brought out elsewhere or in any other format will not be considered by TNRDC/TANTRANSCO and are liable for being rejected. It shall also be brought out by TANTRANSCO in such an event that the bidder has conformed to the clauses in this specification scrupulously.

Deviations in specifications shall if possible be quoted with reference to standards. The bidder shall then furnish an authentic English Version of such standards.

However in an event where the Bidder offers ACSR conductor conforming to standards other than the above, then the salient points of comparison between the standards quoted herein shall be detailed in the Schedule enclosed to the Bid proposal sheets.

The material offered shall be of best quality and workmanship. The conductor

shall be suitable for being installed directly on suspension insulator strings or anchored through tension insulator strings at tower cross arms. They shall be suitable for climatic conditions listed in the specification. The steel cored aluminium conductor strands shall consist of hard drawn aluminium wire, manufactured from 99.60% pure electrolytic aluminium rods of E.C. grade. They shall be free from scratches, die marks and other surface imperfections.

The Aluminium rods used shall comply with IS 1841 as IS 5484. The mechanical and Electrical properties of Aluminium wire shall comply with the requirements as in Appendix-ll enclosed. They shall be reinforced with galvanized high tensile strength steel wire made from materials produced either by the acidic 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 and phosphorus exceeding 0.05% and the total sulphur and phosphorus shall not exceed 0.085%. The steel wire shall not be subject to any heat treatment after being galvanized. The zinc coating of the steel wires shall be smooth and of uniform thickness and shall conform to IS-209 and satisfy tests as per IS-2633. There shall be no bare spots owing to adherence of scales or other causes. The zinc used for galvanizing shall be electrolytic high-grade zinc not less than 99.95% shall conform to and satisfy all the requirements of IS 209.

Neutral grease shall be applied between the layers of wire using Lithium soap grease corresponding to Grade-ll of IS 7623.

The conductor shall conform to type tests and shall also be subjected to acceptance and routine tests as specified in the specification. The resistance of the individual aluminium wires shall be determined separately before stranding by means of tests on samples of wires to an accuracy of one part in a thousand. The test samples shall be of sufficient length to give the required accuracy.

Physical constants of Materials:

2.4.1. Physical constants of Hard drawn Aluminium :

Resistivity: The resistivity of Aluminium depends upon its purity and its physical condition. For the purpose of this specification the maximum value permitted is 0.28264 Ohm.sq.mm/m at 20° C and this value has been used for calculation of the maximum permissible value of resistance.

Density: At temperature of 20° C, the density of hard drawn Aluminium has been taken as 2.703 g / M^3.

Constant-Mass Temperature co-efficient of Resistance of hard drawn aluminium measured between two potential points rigidly fixed to the wire, the metal being allowed to expand freely, has been taken as 0.004 per degree Celsius.

Coefficient of Linear expansion: The Co-efficient of liner expansion of hard drawn aluminium at 0° C has been taken as 23.0 x 10 per deg.C. This value holds good for all practical purposes over the range of temperature from 0° C to highest safe operating temperature.

2.4.2. Physical constants of Galvanised ground wire;

Density: At temperature of 20° C the density of galvanized steel wire is to be taken as 7.80 g / cm^3.

Coefficient of linear expansion: In order to obtain uniformity in calculations a value of 11.5 x 10° C may be taken as the value for the co-efficient of Linear expansion of galvanized steel wires used for the cores of steel reinforced aluminium conductors.

2.4.3. Tolerance:

The following tolerance shall be permitted on standard diameter and on the resistance of aluminium wires.

Tolerance on standard : +/- 0.5% on the nominal dia

Diameter of Aluminium wire specified in Annexure-ll when corrected to standard weight and temperature. Negative tolerance on standard Wt/Km of conductor is not Permitted.

Galvanized Steel Wire : + 2% on the nominal dia. Specified in Appendix - II.

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.

SURFACE CONDITIONS:

The wires shall be smooth and free from inequalities, spills and splits. The surface conductor shall be free from points, sharp edges, abrasions or other departure from smoothness on uniformity of surface contour that would increase radio interferences and corona losses. When subjected to tension up to 50% of the ultimate strength of the conductor, the surface shall not depart from the cylindrical form on any part of the component, 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.

4.0. JOINTS IN WIRE AND CONDUCTORS:

Aluminium wires: No joint shall be permitted in the Aluminium wires in the outermost layer of the ACSR conductor. Joints in the individual aluminium wires in the inner layers are permitted, in addition to those made in the base rod or wire before final drawing, but no two such joints shall be less than 15 m apart in the complete stranded conductor. The cold pressure butt-welding shall make such joints. They are not required to fulfill the mechanical requirements for the un-joined wires.

Galvanized steel wires: There shall be no joints except those in the base rod or wire before final drawing, in steel wires forming the core of the steel-reinforced aluminium conductor.

Stranding: The wires used in construction of stranded conductor shall before stranding, satisfy all requirements of IS 398 with latest amendments.

For steel cored aluminium conductors, the lay ratio of the different layers shall be within the limits given under Appendix-I. For all constructions each alternate layer shall be stranded in opposite directions. The wires in each layer shall be evenly and closely stranded round the underlying wire or wires. The final layer of wires shall have a right hand lay.

5.0. PACKING AND MARKING:

The conductor shall be wound on non-returnable reels or drums conforming to IS. 1778 and its latest amendments with the following.

a) Trade name if any.
b) Name of the manufacture.
c) Size of conductor.
d) Length of conductor.
e) Gross weight of drum with protective lagging including conductor.
f) Weight of empty drum with protective lagging.
g) Net weight of conductor.
h) Arrow marking for unwinding.
i) Position of conductor end.

Only one conductor length shall be packed on each drum.

LENGTHS: The conductor shall be supplied in the standard lengths of 1.8 Km and above. Not less than 95% of the total quantity of the conductor shall be supplied in standard lengths. None of the pieces of the remaining 5% shall be less than half of the nominal lengths.

Within two weeks of the receipt of each consignment of raw materials viz. steel, electrolytic aluminium rods etc. at the manufacturer's work, the contractor shall furnish for approval of the owner raw material test certificate in triplicate. No manufacturer shall commence manufacturing the conductor ordered prior to the owner's approval of the test certificates for raw materials.

Test certificates shall cover all tests stipulated in the relevant ISS.

Test certificates in triplicate for tests on hard drawn aluminium wire employed in the manufacture of ACSR conductor shall be submitted. No dispatch shall be effected prior to the owner's written approval of the test certificates.

Type tests: Following tests shall constitute the Type tests. The Bidders shall furnish the type test certificates of recent origin from a reputed laboratory for having conducted these tests for the purchaser's scrutiny along with the bids.

i) Visual Examination
ii) Measurements of diameters of individual Aluminium and steel wires.
ii) Measurement of lay ratio of each layer
iii) Breaking load test
iv) Ductality test
v) Wrapping test
vi) Resistance test
vii) Galvanising test
viii) Load test composite conductor
ix) Surface condition test

x) Corona test
xi) Radio interference voltage test
xii) Torsion and elongation test on steel strands
xiii) Procedure qualification test on welded joints of Aluminium strands
xiv) Barrel Batter strength test

In addition to the above all the type tests shall be repeated for every 1000 km. of conductor of the same type and make ordered after the award of the Contract which will be witnessed by the purchaser's representative. The cost for repeating these type tests shall be indicated in the price schedule.

7.4. Acceptance tests:

The following shall constitute the Acceptance tests.

i) Visual examination and dimensional check on drums
ii) Measurements of diameters of individual aluminium and steel wires.
iii) Measurement of lay ratio of various layers
iv) Breaking load test on individual wires
v) Ductility test
vi) Wrapping test
vii) Resistance test
viii) Galvanising test
ix) Verification of length and weight of conductor
x) Torsion and elongation test on steel strands

The above acceptance tests shall be conducted in the presence of the owner's representative. Schedule of various type and routine tests to be carried out on conductors shall be submitted by the contractor for owner's approval. No change in the schedule of tests, unless desired by the owner shall be subsequently made by the contractor or his sub-contractor or the manufacturer without prior consent of the owner.

The owner may at any time call for any tests that are laid in the specification as optional tests. The contractor shall arrange to carry out such tests expeditiously and at his own cost. Test certificate for each optional tests shall be submitted to the owner for approval.

The contractor shall notify the owner atleast six weeks in advance, the time of manufacture, so that inspection of material manufacture and/or witnessing of tests can be arranged. Inspection shall also include method of packing and stacking of finished materials in the works.

7.5. Routine tests:

a) Check to ensure that the joints are as per specifications
b) Check that there are no cuts, fins etc., on the strands.
c) Check that drums are as per specifications
d) All acceptance tests shall be conducted by the manufacturer on all the coils to check the requirements, which are likely to vary during the manufacture.

7.6. Tests during manufacture:

a) Chemical analysis of zinc used for galvanising.

b) Chemical analysis of Aluminium used for making Aluminium strands.

c) Chemical analysis of steel used for making steel strands.

8.0. SAG AND TENSION CHARTS:

The contractor shall supply six copies of sag tension charts for the conductor supplied. The contractor shall also prepare and supply a sag template on celluloid, which shall be subject to approval by the owner at no extra cost to the owner.

9.0 GUARANTEED TECHNICAL PARTICULARS:

The bidder shall fill in guaranteed technical particulars in the proforma given in the Section Data Requirement Sheets.

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APPENDIX – I

CONDUCTOR DETAILS ACSR "MOOSE'

Stranding and wire diameter	54/3.53 mm Al + 7/3.53 mm steel
Aluminium	54/3.53 mm
Steel	7/3.53 mm
Overall diameter	31.77 mm
Calculated equivalent area of Aluminium	515.7 Sq.mm
Actual area of cross section	528.5 Sq.mm
Standard area and cross section a) Aluminium strand b) Steel strand c) Conductor	 9.787 Sq.mm 9.787 Sq.mm 597 Sq.mm
Approximate total weight	2004 kgs./km.
Guaranteed ultimate tensile strength of conductor	161.2 kN
Calculated DC resistance at 20° C	0.0552 Ohm/km
Lay lengths	
Steel layer	Max. Min.
Outer Steel layer in mm	18 16
Aluminium layers	Max. Min.
12 wire layers	14 12
18 wire layers	13 11
24 wire layer	12 10
Modules of elasticity of conductor(Alu.strand)	0.704×10^{6}
Co-efficient of linear expansion per degree C. (composite ACSR)	19.3×10^{-6}
Chemical composition	As per IS 4026 (Grade 2)

(A) CHEMICAL COMPOSITION OF HIGH CARBON STEEL

The chemical composition of high carbon steel used in the manufacture of steel wire of ACSR conductor is given below for guidance. (IS 398 Part -5)

Element	**Percentage composition**
Carbon	0.50 to 0.85
Manganese	0.50 to 1.10
Phosphorus	Not more than 0.035
Sulphur	Not more than 0.045
Silicon	0.10 to 0.35 (max)

(B) DESIGN PARTICULARS

Span a) Normal span : 400 Meter

Wind span, Wt. span: As per tower designs

Wind pressure on full projected area: 50 Kgs / Sq.mm. Temperature: Min 5°C, Max. 75°C, Every day 32° C

Factor of safety: The minimum factor of safety for conductor may be assumed as 2.0 based on their ultimate tensile strength at 32 Deg.C and maximum wind pressure expected in the region. In addition the conductor tension at 32 Deg.C without external load should not exceed the following percentages of the ultimate strength of the conductor. Initial unloaded tension: 35% Final unloaded Tension : 22%

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APPENDIX - II

DETAILS OF SOLID AND ALUMINIUM WIRES USED IN THE "MOOSE" ACSR CONDUCTOR:

Diameter	**Steel**	**Aluminium**
a) Standard	3.53 mm	3.53 mm
b) Maximum	3.60 mm	3.55 mm
c) Minimum	3.53 mm	3.51 mm
Sectional area	9.787 mm	9.787 mm
Weight	76.34 Kgs/Km.	26.45 Kgs/Km
Breaking load	12.22 KN (after stranding)	1.49 KN
	12.86 KN (before stranding)	1.57 KN
Minimum ultimate Tensile strength	134.0 Kg/Sq.mm	16.38 Kgs/Sq.mm

ZINC COATING:

a) No and duration of dips 3 (1 min. dip)

b) Minimum weight of coating 259 gm / Sq. Metre.

Resistance at 20° C: - When corrected to standard weight,

Maximum : 2.921 ohm/km.

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APPENDIX-III

TESTING FOR GALVANISING SAMPLING AND PREPARATION OF TEST PIECES:

Sampling:- The degree of sampling shall be as agreed to between the galvanizer and the owner.

Preparation of test pieces: The test sample length of the wire shall be cut from one of both ends of coil under test portion of wire which are obviously damaged shall not be used for sample. In case of stranded or armour wire or wire which has undergone any other similar process, care should be taken to avoid in preparing the sample. A sample of suitable length usually not less than 150 mm shall be from one or both of the selected coils.

NOTE: The test pieces shall be selected from the material galvanized but if the material is of inconvenient lengths, shorter pieces of the same section and of the same steel composition may be introduced as test pieces. All test pieces shall be treated in the same manner in the same bath and at the same line as the materials.

Cleaning of sample: The test piece can be cleaned with a volatile organic solvent such as either trichloroethylene, carbon tetra-chloride etc. then with alcohol and finally washed thoroughly with a suitable clean, volatile organic solvent which will not attack the zinc coating or leave a greasy or waxy deposit. Test pieces shall be brought to a temperature from 15 to 20° C prior to the beginning of the test.

Abnormal cases may arise when by reason of unusual surface conditions the copper sulphate solution will not act normally on the zinc coating; for example, the solution may have no apparent attach on all-or part of the surface or false deposits of copper may appear on the zinc coating. If there is any abnormality of performance of test pieces, they shall be discarded and new one selected. The new test pieces shall be cleaned in alcohol rinsed and wiped dry and then immersed for three minutes in a solution consisting of one part by volume of ammonium hydroxide (Sp.Gr.0.90) and nine parts of distilled water. The test piece may be so rubbed with cotton cloth during this immersion. After cleaning the test pieces shall be washed and wiped dry.

COPPER SULPHATE SOLUTION:

PREPARATION:

Dissolve about 36g. of commercial copper sulphate crystal in 100ml. of distilled water (See note).Heat the water to aid solution but if heated, the solution should be cooled before neutralising.

Neutralising the free sulphuric acid with solution by shaking with excess of copper carbonate (Chemically pure) or copper hydroxide (Chemically pure) (about one gram/litre of solution) and allow to stand for atleast 24 hours before filtering or decanting the solution.

c) The specific gravity of the test solution during the test shall be 1.186 at 18 + 2° C. Adjustment may be made by adding distilled water or solution of highest specific gravity.

NOTE: Chemically pure copper sulphate crystals are preferable to commercial grade although not necessary for this test.

Test pieces of wire shall be tested in a glass containing at least 50mm in inside diameter for 2.00 mm wire and smaller and at least 75 mm in inside diameter for wire longer in diameter than 2.00 mm. The container shall be filled with fresh test solution to a depth of at least 100mm. This quantity of solution shall be used for the simultaneous testing of one to seven test pieces. The solution shall be discharged after completion of the test and fresh solution used for any additional test.

TEMPERATURE OF THE SOLUTION: The temperature of the solution shall not vary outside the limits of 18 + 2° C either at the commencement of the test or through the duration of the test.

PROCEDURE: The cleaned test piece or pieces shall be subjected to as many one minute or half minute successive dips as prescribed in Appendix-ll in the copper sulphate solution kept at a temperature of 18 + 2 ° C. Half-minute dips shall be carried out after the completion of all the one-minute dips. If possible, immerse the test pieces completely taking cared that they do not touch each other. During the test neither the test pieces nor the solution shall be agitated. After each dip withdraw the test pieces, rinse immediately in clean running water (see note) and remove any black deposit by a fiber brush, taking care that all the holes and pockets are removed, wipe and dry the test pieces with a clean soft cloth and return immediately to solution.

Successive dips of one minute each shall be continued with washing and wiping of the test pieces after each dip, until the test pieces have withstood the required number of dips or until the end point has been reached.

NOTE: The rinse water shall be changed often enough preferably after each dip to ensure that it is reasonably free from copper sulphate, the temperature of the rise water should be 15 ° C to 20 ° C.

INTERPRETATION OF THE TEST:

The material passes this test if at the end of the specified number of dips, when the test piece is finally rinsed and wiped dry, it does not show any red deposit of copper upon the base metal. In case of wire any red deposit of copper within 25mm of the cut end of the sample shall not be interpreted as a failure of the sample.

A fine line appearance of copper on the top of screw threads or on sharp edges of articles or within 25mm. Of a cut portion of specimen, shall not be judged as a failure. Likewise, the failure of a coating at or adjacent to any cut or abrasion present on the original test shall not be considered as failure. Direction of false and point if it is possible to remove the bright copper deposit with an ink eraser or top speed the copper deposit with the edge of blunt tool as the back of a knife, blade and zinc

appears underneath the copper such an appearance of deposited copper shall be construed as false end point.

SUPPLEMENTARY TESTS*:* If at any time during the test there is any doubt as to the presence of exposed base metal as determined by visual inspection, test given under 5.20 may be used.

SUPPLEMENTARY TEST FOR ALL TYPES OF ZINC COATINGS:

MICROSCOPIC TEST*:* Section the test piece through the copper deposit amount and polish it metallagraphically. Etch the polished surface using an etching solution composed of 20 g of chromic acid, 1.5 g of sodium sulphate and 100 ml. of distilled water. After etching was the test piece under a microscope, using a magnification 100 diameters or greater if necessary look for the exposed base metal.

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VOLUME.II
CHAPTER –V
PART – B

GROUNDWIRE (7/3.66 mm)

SCOPE:

1.0. This 'Specification provides for the manufacture, testing before dispatch supply and delivery of 7/3.66 mm ground wire 1100 NEWTON/Sq.mm quality (grade 3 as per IS 12776) for the purpose of earthing and protection of power transmission lines as per the particulars given in Appendix-I attached. The ground wire shall consist of standard galvanized steel wires. The GSS wire is to be used for the overhead protection of 400 KV Double circuit. The GSS wire offered shall conform to type tests and shall also be subjected to routine and acceptance tests in accordance with the requirements stipulated in this specification.

2.0. STANDARDS:

The ground wire shall comply in all respects with the latest edition with revisions of the following Indian Standards (IS) and British Standard specifications.

IS 182-Latest	Specification for Galvanised line wire for telephone & telegraph purposes
IS 209	Zinc
IS 1521	Method of Tensile testing of steel wire.
IS 1755	Method of wrapping test of steel wires
IS 1778	Reels and drums for Bare conductors
IS 12776	Galvanised stay strand (Amendments 1 to 4)
IS 2629	Recommended practice for Hot dip galvanizing For Iron and steel.
IS 2633	(First Revision)-Methods of testing uniformity of Coating on Zinc coated articles.
IS 4826	(First Revision)-Hot dipped galvanized coatings on round steel wires (Amendment No.1)
IS 5714	Method of measurement of resistivity of metallic materials
IS 6594	Technical supply conditions For steel wire rope and strands.

No deviations shall be allowed with reference to standards and specifications.

DEVIATIONS IN SPECIFICATIONS:

All discrepancies and or deviations in specifications shall be brought out by the bidder and detailed clause by clause in the deviation schedule.

Deviations brought out elsewhere or in any other format will not be considered by the purchaser and are liable for being rejected. It shall also be by the purchaser in such an event that the bidder has conformed to the clauses in this

specification scrupulously.

Deviations in specifications shall if possible be quoted with reference to standards. The bidder shall then furnish an authentic English Version of such standards.

3.0. MATERIAL:

The materials offered shall be of best quality and workmanship. The steel wire (strands) shall be manufactured from steel produced by the suitable process. The steel wire shall not contain sulphur and phosphorous exceeding 0.040% each. The carbon content shall not exceed 0.55%. The quality of wire shall be such that when drawn to the size of wire specified and coated with zinc, the finished strand and the individual wires shall be of uniform quality and shall possess the properties and characteristics as specified hereto.

The steel wire shall be evenly and uniformly coated with Zinc complying with IS-209 Latest specification for Zinc (revised)-99.95% grade and zinc coating shall conform to heavy type coating as per IS-4826 including latest amendments, IS-2633 and IS-6745. The individual wires after galvanizing shall be smooth, free of inequalities, spills or splits before stranding.

The outer wires of strand shall have a right hand laky. The lay length shall be 12 to 18 times the strand diameter. The stranding shall be such that when an evenly distributed load is applied at the ends of a completed strand, each strand wire shall take an equal share of the pull. The completed strand when subjected to 50% of the ultimate tensile strength shall not depart from it's cylindrical form or cause relative displacement of strands of longitudinal displacement of strands.

4-0. SIZES AND CONSTRUCTION:

The sizes and physical properties of the ground wire shall be as given in Appendix-I. The lay of the strands shall be of lengths given in the appendices and the wires shall be so stranded together that when an evenly distributed pull is applied at the end of completed strands, each wire will take an equal share of the pull.

5.0. LENGTHS:

The ground wire may be supplied in the stranded length of 2 Km with a tolerance of +/- 5%. However, random lengths of ground wire up to a minimum of 5 (five) percent may be allowed. But no single length in respect of such random lengths shall be less than 50% of the standard length.

Joints are not permitted either in the individual strand wires or in the completed strand. The completed strand shall be circular, free of scales, irregularities, imperfections, flaws, splits and other defects. The zinc coating shall be smooth even and bright.

6.0. TESTS AND TEST CERTIFICATE:

The successful Bidder / Contractor / Manufacturer shall conduct the following tests and furnish test certificates thereof in six sets to the Purchaser for approval.

These tests shall be conducted on each and every coil in accordance with IS 12776-latest.

6.1. Tests on wires before stranding:

The type tests are to be conducted as per IS:12776 with latest amendments

6.2. Tests on completed strand

The type tests are to be conducted as per IS:12776 with latest amendments

The successful Bidder / Contractor on receipt of approval to the test certificates shall arrange for inspection and acceptance tests. The contractor shall give sufficient advance intimation of at least 15 days to enable the purchaser to depute his representatives for such inspection and acceptance test.

In addition to furnishing the type test certificates as per specification along with the Bids, the successful tenderer shall repeat all the type test on ground wire as per the relevant ISS after the placement of award on the same type and make of ground wire approved for construction of the line which will be witnessed by the purchaser's representative. The cost for repeating these type tests shall be indicated in the price schedule. No material shall be despatched without approval to the acceptance tests.

6.3 ACCEPTANCE TESTS:

The acceptance tests shall be conducted as per the scale of sampling specified in standard IS-12776.

Samples from each lot shall be tested for ascertaining the conformity to the requirements of this specification. The number of coils to be selected shall be in accordance with IS 12776. The lot shall be declared in conformity with the requirements of the following tests are satisfied. The length of the test sample shall be not less than 5 (five) meters.

Length and lay of joints.

Ductility test.

Tolerance on wire diameter as per Cl.6.1 above

Tensile and Elongation test as per Cl.6.2 above

Galvanizing test

Electrical Resistance as per BS 182-1972 & BS 5714-1979.

Tensile test as per IS 1521. The wire when tested at a stress less than 100 percent of the ultimate strength of the wire specified in the Appendix-I of the said IS shall not fail.

The above acceptance tests should be conducted in the presence of the Purchaser's representative. Three copies of manufacturer's test certificate shall be submitted by the contractor to the owner for approval immediately after such tests have been conducted on the G.S. strands and the wire.

The owner reserves the right to inspect the material at manufacturer's works before dispatch.

7.0. PACKING AND MARKING:

The ground wire shall be supplied in non-returnable reels or drums of non-perishable or treated wood conforming to IS:1778 specification for reels and drums for the same wires. Each coil shall be provided with a label fixed firmly on the inner part of the coil bearing the following information.

Trade mark, name if any.
Name of the manufacturer.
Type of wire-size and length of wire.
Net weight of the wire.
Tare weight and
No. of lengths on the reel or drum.

8.0. SAG AND TENSION CHARTS:

The successful tenderer shall submit seven copies of stringing charts for earth wire showing initial and final sags and tensions for various temperatures and spans. One set of chart shall be in ink or tracing cloth.

9.0. GUARANTEED TECHNICAL PARTICULARS:

The bidder shall fill in guaranteed technical particulars in the proforma given in the Chapter-VI, Data requirement sheets.

APPENDIX I

DETAILS OF GROUND WIRE

(1100 Newton / Sq.mm quality) grade 3 as per IS 12776 of latest

1.Stranding and wire diameter	7/3.66 mm
2.Grade	3
3.Tensile Designation (IS 2141)	1100
4.Tensile strength N/Sq.mm	1100
5.No. of strands	7(6/1)
6.Strand wire diameter	3.66 mm
7.Overall wire diameter	10.98 mm
8.Weight	583 Kgs/Km
9. Sinqle strand wire before strandinq:	
a. Diameter	3.66 mm
b. Tolerance	+ 0.06 mm (No negative tolerance)
c. Minimum Elongation	5 mm in 100 mm length
d. Minimum breaking strength	11.35 KN
e. Minimum ultimate tensile strength	1100 KN/Sq.mm
f. D.C. Resistance at 20 deg C	17.16 Ohms/KM
g. Sectional area	10.52 Sq.mm
10.Wire after stranding	
a. Length of lay Maximum	198 mm
Minimum	165 mm
b. Minimum breaking load	68.4 KN(min.)
c. Overall wire diameter	10.98 mm
d. Modulus of elasticity	1.933×10^{6} kg/Sq.cm
e. Coefficient of linear expansion	11.50×10^{-6} /deg. C
f. DC Resistance at 20 deg. C	2.5 Ohms/KM

11. <u>Zinc coating</u>

a) Number of one minute dips	: 3
b) Number of half minute dips	: 1
c) Zinc quality	: conforming to IS 209
d) Weight of zinc coating	: 275 gms/sq.m
e) Galvanising process	: Hot dip
f) Oiling	: Dipped in boiled linseed oil.

12. Percentage of carbon content in the steel wire: 0.55% Max
13. Percentage of Sulphur content in the steel wire: .04% Max
14. Percentage of phosphorous content in the steel wire: 0.04% Max

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VOLUME – II

CHAPTER-V

PART-C

ACCESSORIES / HARDWARE
FOR MOOSE ACSR CONDUCTOR AND
GROUND WIRE

1.0. Scope:

This specification provides for the manufacture, testing, inspection and testing before dispatch, supply and delivery of Power conductor Accessories Ground wire Accessories and Ground wire Hardware fittings required for 400 KV Double circuit/Multi Circuit transmission line.

2.0. Standards:

The fittings and accessories shall comply in all respects with the latest edition of relevant IS Specification or any other equivalent authoritative standard. Except as modified by this specification, the conductor accessories to be supplied shall conform to the latest addition with amendments and revisions thereof the following Bureau of Indian Standards (IS) & British Standards (BS) specifications.

IS 209	Zinc
B.S:970 – (Part.I)	General Instruction and testing procedures specific requirements for carbon Manganese alloy and stainless steels.
IS:1327	Method of determination of mass of tin coating on Tinplate (Second revision)
IS:1363	Hexagon head bolts, screws and nuts
IS:1363 (Part-I)	Hexagon head bolts (Second Revision with Amendment No.1)
IS: 1363 (Part-ll)	Hexagon head screws (Second Revision with Amendment No.1)
IS: 1363 (Part-lll)	Hexagon head screws (Second Revision with Amendment No.1)
IS: 1367	Technical supply conditions for threaded steel fasteners.
IS 1367(Part-l)	Technical supply conditions for threaded steel fasteners.
IS 1367(Part-ll)	Product grades and tolerance (Second Revision)
IS: 1367 (Part-lll)	Mechanical properties and test methods for bolts screws and studs with full lead ability (Second revision)
IS: 1573	Electroplated coatings of zinc on Iron & Steel (First revision)
IS: 2004	Carbon steel forgings for general engineering purposes (Second Revision.)
IS: 2121	Conductors and Earth wire accessories for overhead power lines
IS: 2121 (Part-I)	Armour rods, binding wires and tapes for conductors
IS: 2121(Part-ll)	Mid span joints and repair sleeves for conductors
IS: 2486	Insulator fittings for overhead power lines of 3.3 KV and above
IS: 2486 (Part-I)	General Requirements and tests (First Revision with

	Amendment No.1)
IS: 2486 (Part-ll)	Dimensional Requirements (First Revision)
IS: 2486 (Part-Ill)	Locking devices
IS: 2486 (Part-IV)	Tests for locking devices
IS: 2629	Recommended practice for hot dip galvanizing of Iron and Steel.
IS: 2633	Methods of testing uniformity of coating on Zinc coated articles (First Revision)
IS: 3138	Specification for Hexagonal Bolts and Nuts
IS: 4218	Specification for Metric Screw Threads
IS: 4826	Hot dipped galvanized coatings on round steel wires
IS: 5318	Specification for Hot dip galvanized coating on fasteners
IS: 6639	Hexagon bolts for steel structures (Amendments – 1 and 2)
IS: 8263	Method of radio interference tests on high voltage insulators
IS: 9708	Stockbridge vibration dampers for overhead power lines
IS: 10162	Spacers and spacer dampers for twin horizontal bundle conductors

DEVIATIONS IN SPECIFICATIONS:

All discrepancies and or deviations in specifications shall be brought out by the bidder and detailed clause by clause in the deviation schedule.

Deviations brought out elsewhere or in any other format will not be considered by the purchaser and are liable for being rejected. It shall also be by the purchaser in such an event that the bidder has conformed to the clauses in this specification scrupulously.

Deviations in specifications shall if possible be quoted with reference to standards. The bidder shall then furnish an authentic English Version of such standards.

Conductor and Ground wire accessories and hardware conforming to any other national or international standards are also acceptable. However in such an event, the salient points of comparison between the standards adopted and the standards quoted herein shall be detailed in deviations schedule in section BPS with an authentic English version of such standards.

3.0. Installation requirements :

The Conductor Accessories and Hardware shall be suitable for being installed directly in air along with the power and ground wire conductors of 400 Double Circuit/Multi circuit Transmission lines. They shall be therefore suitable for satisfactory operation under the tropical climatic conditions listed elsewhere in the specifications. The applicable design particulars of these lines are furnished in the Appendix enclosed.

4.0. Material:

The materials offered shall be complete in all respects and of best quality and workmanship. The materials in the manufacture of accessories

viz. malleable iron and forged steel depending on the type of application for which the accessories are used shall be corrosion resistant and machinable. The composition of aluminium alloys used shall be made available to the owner if required for verification.

5.0. General Requirements:

All parts of fittings shall be suitable for use in atmospheric condition indicated elsewhere in the specification inherently resistant to atmospheric corrosion or be suitably protected against corrosion both during storage and in service.

All ferrous metal parts except those made of stainless steel shall protected by hot dip galvanizing. Spring washers shall be electro galvanized.

All castings shall be free from blowholes and other casting defects such as cracks etc. The surface shall be as smooth as possible.

The tension joints shall be so designed that strength of complete joints shall not be less than 95% of the minimum breaking load of the conductor under tension.

In case of rods, wire or tape no joints shall be permitted except those in the base rod or wire before final drawings.

6.0.TYPES AND REQUIREMENT OF ACCESSORIES AND HARDWARE FITTINGS FOR ACSR MOOSE/ZEBRA CONDUCTOR AND GROUND WIRE:

6.1 REQUIREMENTS:

The accessories and Hardware fittings that are required shall be suitable for MOOSE ACSR conductor and Ground Wire.

6.2. ACCESSORIES FOR POWER CONDUCTOR (MOOSE ACSR):

i) Mid span compression joints
ii) Repair sleeves
i) Spacer dampers
vi) Tee connectors

6.3. ACCESSORIES FOR GROUND WIRE:

i) Mid span compression joints
ii) Flexible copper earth bonds, Vibration Dampers

6.4. HARDWARE FITTINGS FOR CONDUCTOR AND GROUND WIRE:

i) Suspension Fittings
ii) Tension Fittings

7.0. SPECIFICATION AND DRAWINGS :

A set of specification drawings in respect of all the accessories and hardware fittings listed above are attached herewith. These drawings are for information and guidance of the Bidder only. The drawings to be furnished by the Bidder shall be as per their own design and manufacture and shall be distinct and separate from these specification drawings.

8.0. TECHNICAL REQUIREMENTS:

The Technical requirements of the above individual accessories and hardware fittings are set out hereunder.

ACCESSORIES FOR CONDUCTOR:

8.1. MID SPAN COMPRESSION JOINTS FOR POWER CONDUCTOR:

i) This shall be suitable for jointing the two ends of the MOOSE ACSR power conductor. The joint shall have a conductivity of an equivalent length of the conductor. The joint shall not permit slipping of, damage to or failure of the complete conductor or any part thereof at a load of not less than 95% of the ultimate tensile strength of the conductor. The electrical resistance of the joint after installation shall not exceed 75% of the measured resistance of the equivalent length of the conductor.

ii) The components of the joint shall consist of steel and aluminium sleeves for joint compression of the steel core conductors and aluminium conductors respectively. The steel sleeve shall not crack or fail during compression. The steel sleeve shall be hot dip galvanized. The Aluminium sleeve shall be manufactured and extruded out of EC grade Aluminium with a purity of not less than 99.5%. Tapered Aluminium filler plugs shall be provided at the line of demarcation between compression and non-compression zones.

iii) The dimensions and dimensional tolerances of this mid span compression joint shall be as per Drawing enclosed.

8.2. REPAIR SLEEVES FOR POWER CONDUCTOR:

Repair sleeves to be used shall be for repairing the conductor when a few strands of the aluminium conductor in the outermost layer are damaged with scratches, kinks abrasions, nicks or cuts. They shall be of the compression type. The sleeve shall be manufactured and extruded out of EC grade Aluminium having a purity of 99.5%. The sleeve shall be in two halves with a seat provision for sliding of the keeper piece. The edges of the seat as well as of the keeper piece shall be so rounded that the conductor strands are not damaged during installation. The outer body of the sleeve shall be smooth even and with rounded off edges.

The compressed conductor with the repair sleeve shall not permit damage or failure of the conductor at a load of not less than 95% of the ultimate tensile strength of the conductor. The electrical resistance of the repaired portion of the conductor shall not exceed 75% of the measured resistance of an equivalent length of the conductor.

The dimensions and dimensional tolerances of the repair sleeves shall be as per Drawing enclosed.

8.3. SPACER DAMPER FOR QUAD BUNDLE CONDUCTOR:

Suitable spacer dampers for four bundle ACSR Moose conductor shall be offered. The spacer damper covered in this specification shall be designed to maintain the bundle spacing of 457 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.

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.

The design offered shall be presented as a system consisting of spacer dampers and their staggering scheme for spans ranging from 100m to 1100m. A Vibration performance test shall be carried out on an experimental test line. The systems tested should be those specified by the Supplier for the 800 kV line conditions. Only systems satisfying the performance criteria shall be submitted by Bidder along with Bid.

The test line selected for the performance evaluation shall have been designed for that purpose, be adequately exposed to wind and properly instrumented.

Sl. No.	Description	Technical particulars.
1	Configuration	Double circuit For ACSR Moose conductor bundle per phase and all three phases per circuit in near vertical configuration on both side of tower
2	Span length in metres	
	i) Ruling span	400 Meters
	ii) Maximum Span	1100 Meters
	iii) Minimum span	100 Meters
3	Tensile load in each sub-conductor	Sag Tension calculation shall be provided to the supplier for various wind temperature loading conditions for two ruling design spans.
4	Maximum permissible dynamic strains	± 150 micro strains.

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.

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.

The spacer damper shall consist of a rigid central body called the frame linked to the conductor by four 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.

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.

Bolted type clamps shall allow installation without removal of the bo0lts or the clamps from clamp body. Locking mechan9ism shall be suitable to prevent bolt loosening. Clamp locking devices using small loose components shall not accepted. Nut cracker, hinged open or boltless type clamps are acceptable provided adequate grip can be maintai9ned on the conductor.

Bolts and nuts shall be of mild steel, stainless steel, or high strength steel in accordance with the design of the spacer damper.

Where elastomer surfaced clamps are used, the elastomer elements shall be firmly fixed to the clamp. The insert should be forged from aluminium alloy of type 6061 or equivalent aluminium alloy having minimum tensile strength of 25 kG/mm^2 . 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.

If clamps involving preformed rods are used, these rods shall be designed for specific conductor size. They shall be made of high strength aluminium alloy of type 6061 or equivalent aluminium alloy having a minimum tensile strength of 35 kg/mm^2. 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 shoes sides are vertical and horizontal outer tangents to the conductor sections.

The spacer damper body shall be cast/forged from suitable high strength corrosion resistant aluminium alloy. The aluminium alloy shall be chosen in relation with the process used. However a combination of aluminium alloy and steel shall also be accepted.

The rubber components involved in the design such as damping elements shall be made with rubber compound selected specifically for that particular application. The Bidder shall submit a complete list of physical and mechanical properties of the elastomer used. This list shall make reference to all applicable ASTM standards.

The rubber components used shall have good resistance to the effects of temperature up to 95^{o}C and to ultraviolet radiation, ozone and other atmospheric contaminants. The rubber shall have good wear and fatigue resistance and shall be electrically semi conductive.

The spacer damper involving ferrous material shall not have magnetic power loss more than one watt at 600A, 50 Hz alternative current per sub-conductor. 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.

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.

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 four bundle conductors.

The staggering scheme shall be provided for spans ranging from 100m to1100m. The number of spacer dampers for a nominal ruling span of 400 m shall not be less than six. No. of sub-span shall be greater than 70m and no end sub-span shall be longer than 40m.

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 speed upto 60m/hr.

The Bidder shall furnish all the relevant technical documents in support of the saggering scheme recommended for the spacer damper.

8.4. T-CONNECTOR

T-Connector of compression type shall be used for jumper connection at transposition tower. It shall be manufactured out of 99.50% pure aluminium and shall be strong enough to withstand normal working loads. The T-Connector shall have a resistivity across jumper less than 75% resistivity of equivalent length of conductor. The T-Connector shall not permit slipping off, damage to or failure of complete conductor. The welded portions shall be designed for 30 kN axial tensile load. Leg sleeve of T-Connector should be kept at an angle or 15 deg.C from vertical and horizontal plane of the conductor in order to minimize jumper pull at the welded portion.

TECHNICAL PARTICULARS OF T-CONNECTOR

Sl. No.	Description	Unit	Particulars/Value
1	Material		Aluminium of purity 99.50%
2	Dimensions of Aluminium Sleeve before compression		
	i) Inside Diameter	mm	34±0.5
	ii) Outside Diameter	mm	54±1.0
	iii) Length	mm	400±5
	i) Before fatigue test	kN	2.5
	ii) After fatigue test	kN	2
3	Dimensions of Aluminium Sleeve after compression		
	i) Outside Dimension (Corner to Corner)	mm	53±0.5
	ii) Outside Dimension (Face to Face)	mm	46±0.5
4	Axial tensile strength of welded portion of T-Connector	kN	30
5	Maximum resistance of the compressed unit expressed as percentage of the resistance of equivalent length of bare conductor.	%	75
8	Minimum corona extinction voltage kV (rms) under dry condition	kV	320
9	Radio Interference voltage at 1 MHz for phase to earth voltage of 305 kV (rms) Microvolts under dry condition	µV	Below 1000

ACCESSORIES FOR EARTHWIRE:

8.5. MID SPAN COMPRESSION JOINT FOR GROUND WIRE:

i) The mid span compression joint for Ground wire conductor is to be used for jointing of two lengths of galvanized steel stranded (GSS) earth wire of size 7/3.66 mm and of 10-kgs/sq.mm tensile strength.

ii) The joint sleeve shall be made of high strength Mild steel tubes with Aluminium sleeves and shall be easily compressible with a 100 tonne capacity hydraulic compressor. The Mils Steel shall conform to IS 226 grade or equivalent thereof and other relevant standards. The Brinnel Hardness number of Mild steel shall not exceed 200. The clamp shall not permit slipping of damage to or failure of the complete earth wire or any part thereof at a load of not less than 95% of the ultimate tensile strength of the earth wire. The joint shall have conductivity more than the conductivity more than the conductivity of an equivalent length of earth wire. The dimensions of the joint shall be as per the following table:

Dimensions before compression			**Dimensions after compression**	
Inner dia. (mm)	Outer dia. (mm)	length (mm)	Corner to corner Width (mm)	Face to face width (mm)
11.5+/-0.5	21+/-1.0	230	20.2+/-0.5	17.5+/-0.5

8.6. FLEXIBLE COPPER EARTH BOND FOR GROUNDWIRE:

The flexible copper-earthing bond shall be made of tinned flexible copper cable of size 37/7/0.417 with 9.81 mm dia and copper area equivalent to 34 Sq.mm. The tinning shall be as per relevant Indian Standard. The length of copper cable shall be as per relevant Indian Standard. The length of copper cable shall not be less than 500 mm. Dia 40 mm 10 hs HRH M.S. bolt hot dip galvanized with nut and lock washer.

8.7. VIBRATION DAMPER FOR GROUND WIRE:

i) Vibration dampers of stock bridge 4R type be used at all suspension and tension points on each overhead ground wire lin each span to damp out the vibrations of the ground wire to the specified level as stated hereinafter.

ii) The clamp of the vibration damper shall be made of aluminium alloy. It shall be capable of supporting the damper during installation and prevent damage or chafing of the earth wire during erection or continued operation. The clamp shall have sufficient grip to maintain the damper in position on the earth wire without damaging the strands or causing premature fatigue of the earth wire under the clamp. The groove of the clamp body and clamp cap shaii be smooth, free of projections, grit or other materials, which could cause damage to the earth wire when the clamp is installed.

iii) The messenger cable of the vibration damper shall be made of high strength steel with a minimum strength of 135 Kg./Sq.mm and performed in order to prevent subsequent drop of weights in service. The number of strands in the messenger cable shall be 19. Clamping, bolts shall be provided with self-locking nuts designed to prevent corrosion of the threads or loosening during service. The messenger cable shall be suitably and effectively sealed to prevent corrosion.

iv) 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 form defects such as cracks shrinkage, inclusions and blown holes etc. The inside and outside surfaces of the damper masses shall be smooth.

v) The vibration damper shall be capable of being installed and removed from an energized line by means of hot line techniques. In addition, the clamp shall be capable of being removed and reinstalled on the earth wire at the design torque without shearing or damaging of bolt and nuts or cap screws.

vi) The vibration analysis of the system with and without damper, dynamic characteristic of the damper shall have to be submitted by Bidder along with the bid. The vibration analysis and damping design shall be suitable to the 400 KV system now offered for construction.

vii)The Bidder shall recommend the number of vibration dampers of the type offered by them and their points of fixation for spans of 250 Meters to 1000 Meters at an interval of 50 Meters.

HARDWARE FITTINGS FOR CONDUCTOR:

8.8. TECHNICAL PARTICULARS OF MID-SPAN COMPRESSION JOINT ACSR MOOSE :

Sl. No.	Description	Unit	Particulars/Value	
			Aluminum Sleeve	Steel Sleeve
1	Material of joint		Aluminium of purity 99.5%	Mild steel (Fe-410, IS:2062)
2	Range of Hardness of the steel sleeve (Brinnel Hardness)	BHN	From 100 to 200	
3	Weight of Zinc coating for steel sleeve	Gm/m^2	610	
4	Dimension of Sleeve before compression			
	i) Inside Diameter	mm	34±0.5	11.10±0.2
	ii) Outside Diameter	mm	54±1.0	21±0.5
	iii)Length	mm	735±5	230±5
5	Dimension of Sleeve after compression			
	i) Outside Dimension (Corner to corner)	mm	53±0.5	20.20±0.5
	ii) Outside Dimension (Face to face)	mm	46±0.5	17.5±0.5
	iii)Length	mm	785 (approx)	286 (approx)
6	Slip strength	kN	153.20	
7	Maximum resistance of the compressed unit expressed as percentage of the resistance of equivalent length of bare	%	75	

	conductor.		
8	Minimum Corona Extinction voltage kV (rms) under dry condition	kV	320
9	Maximum Radio Interference Voltage at 1 MHz for phase to earth voltage of 305 kV (rms) under dry condition	Micro Volts	1000

8.9. TECHNICAL PARTICULARS OF REPAIR SLEEVES FOR ACSR MOOSE

Sl. No.	Description	Unit	Particulars/Value
1	Material of joint		Aluminium of minimum purity 99.5%
2	**Dimension of Sleeve before compression**		
	i) Inside Diameter	Mm	34±0.5
	ii) Outside Diameter	Mm	54±1.0
	iii)Length	Mm	300±5
3	**Dimension of Sleeve after compression**		
	i) Outside Dimension (Corner to corner)	Mm	53±0.5
	ii) Outside Dimension (Face to face)	Mm	46±0.5
	iii)Length	Mm	330 (approx)
4	Slip strength	kN	153.20
5	Minimum Corona Extinction voltage kV (rms) under dry condition	kV	320
6	Maximum Radio Interference Voltage at 1 MHz for phase to earth voltage of 305 kV (rms) under dry condition	Micro Volts	1000

8.10. TECHNICAL PARTICULARS FOR RIGID SPACER FOR QUAD BUNDLE CONDUCTOR

Sl.No.	Description	Unit	Particulars/Value		
1	Material of				
	a) Clamp		Al. Alloy IS:4600 or Equivalent		
	b) Body		Galvanized steel/Al. Alloy 4600 or Equivalent.		
2	Elastomer (if used)				
	a) Shore hardness		65 - 80		
	b) Temperature range for which designed	^{o}C	Upto 95 ^{o}C		
3	Minimum ultimate tensile strength of spacer				
	a) Compressive load	kN	14		
	b) Tensile load	kN	7.0		
4	Slipping strength of spacer clamp				
	a) Before vibration test	kN	Clamp type	Longitudinal load	Max. Slip permitted (mm)
			Metal-Metal Bolted	6.5	1
			Rubber	2.5	2.5

			loaded		
			Preformed rods	2.5	12
5	Maximum magnetic power loss of at sub-conductor current of 600 Amp, 50Hz. AC	Watts	Below 1 watt		
6	Minimum corona extinction voltage kV (rms) under dry condition	kV	320		
7	Radio Interference voltage at 1 MHz for phase to earth voltage of 305 kV (rms) Microvolts under dry condition	µV	Below 1000		

8.11. TECHNICAL PARTICULARS FOR SPACER DAMPER FOR QUAD BUNDLE CONDUCTOR

Sl. No.	Description	Unit	Particulars/Value		
1	Type of clamp		Bolted/Nut cracker/Hinged open/Boltless/Preformed rods.		
2	Type of damping element		Spring/Elastomer/EPDM		
3	Material of				
	a) Clamp		Al. Alloy IS:4600 or Equivalent		
	b) Body		Galvanized steel/Al. Alloy 4600 or Equivalent.		
4	Elastomer (if used)				
	a) Shore hardness		50 - 80		
	b) Temperature range for which designed	^oC	Upto 95 ^oC		
5	Minimum ultimate tensile strength of spacer				
	a) Compressive load	kN	14		
	b) Tensile load	kN	7.0		
6	Slipping strength of spacer clamp				
	a) Before vibration test	kN	Clamp type	Longitudinal load	Max. Slip permitted (mm)
			Metal-Metal Bolted	6.5	1
			Rubber loaded	2.5	2.5
			Preformed rods	2.5	12
	b) After vibration test	kN	80% of the above values		
7	Maximum magnetic power loss of at sub-conductor current of	Watt	Below 1 watt		

	600 Amp, 50Hz. AC		
8	Minimum corona extinction voltage kV (rms) under dry condition	kV	320
9	Radio Interference voltage at 1 MHz for phase to earth voltage of 305 kV (rms) Microvolts under dry condition	µV	Below 1000

HARDWARE FITTINGS FOR EARTHWIRE:

8.10. SUSPENSION HARDWADRE FITTINGS FOR GROUND WIRE:

i) These are to be used for suspending the ground wire conductor at all tangent/suspension towers and shall be suitable for supporting the G.S.S. earth wire of size 7/3.66 mm.

ii) The suspension clamps shall conform to IS 2486-1971 and shall adequate area of support for the earth wire. The groove of the clamp shall be smooth, finished in an uniform circular or oval shape and shall slope downwards in a smooth curve to avoid edge support and hence to reduce the intensity of bending moment on the earth wire.

iii) There shall be no sharp points in the clamps coming in contact with earth wire. There shall not be any displacement in the configuration of the earth wire strands nor shall these be unduly stressed in final assembly.

iv) The clamping piece and the clamp body shall be clamped by at least two 'IT bolts of size not less than 10 mm. With 3 mm. Thick lock washers on each of its limbs. Suspension clamp shall be provided with inverted type of 'U[1] bolts. One limb of the 'IT bolt shall be long enough to accommodate the lug of the flexible copper band.

v) The suspension clamp shall be of the 'Trunnion' type or envelope type.

vi) The complete assembly of the suspension clamp shall be guaranteed for slip strength and Mechanical test as per clause 5.4.1 & 5.5.1 of ISS 2486 part-l 1971.

8.11. TENSION HARDWARES FITTINGS FOR GROUND WIRE:

i) These tension hardware are to be used at all tension towers for anchoring the 7/3.66 mm. galvanized steel earth wire (ground wire). The hardware assembly shall comprise of compression type of tension clamp and two 'D' shackles. The tension clamp is to be attached to the horizontal strain plate of the tower body by means of a 'D' shackle.

ii) These clamps shall give adequate area of support without any slip to the ground wire under normal working tension and vibration conditions.

iii) The complete tension hardware assembly shall be so designed as to avoid undue bending in any part of the clamp and shall not produce any hindrance to the movements of the clamp in horizontal and vertical direction.

iv) The slip strength of tension clamp assembly shall not be less than 95% of the ultimate strength of the ground wire. The ultimate strength of the clamp and Individual components shall not be less than that of ground wire.

9.0. MATERIAL DESIGN AND WORKMANSHIP:

9.1. GENERAL:

i) All the equipments shall be of the latest design and shall conform to the best modern engineering practice adopted in the field of extra high voltage engineering. The bidder shall offer only such equipment as are guaranteed for satisfactory and suitable performance of 400 kV transmission lines with bundled conductors.

ii) The design, manufacturing process and quality control of all the materials shall be such as to give maximum factor of safety, maximum possible working load, highest mobility, elimination of sharp edges and corners to limit corona and radio interference best resistance to corrosion and a good finish.

9.2. GALVANISING:

All ferrous parts including steel components, bolts, nuts and washers etc. shall be hot dip galvanized after all machining has been completed. Nuts may, however be tapped (threaded) after galvanizing. Spring washers shall be electro galvanized. 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 and shall satisfy the tests mentioned in IS: 2633. Bolts and nuts and washers shall withstand four dips while spring washers shall withstand three dips. Other galvanized materials shall be guaranteed to withstand at least six dips each lasting one minute under the standard piece test for galvanizing.

The Zinc coating shall be perfectly adherent, of uniform thickness, smooth), reasonably bright, continuous and free from all 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.

9.3. CASTINGS:

i) All ferrous and aluminium alloy castings, shall be free of all internal defects, shrinkages, inclusions, blow holes, cracks etc.

ii) All castings shall be smoothly and evenly finished by machining, buffing etc., so as to eliminate sharp ends, edges, abrasions and projections. No surface area of the accessories and hard wares in contact with the conductors h any manner either during erection or during continuous operation. The surface in contact with the conductor shall not cause any abnormal electrical or mechanic? I stresses during normal working and operating conditions.

9.4. CURRENT CARRYING PARTS :

i) All current carrying parts shall be so designed and manufactured that the contact resistance is reduced to a minimum.

ii) The design of metal parts and their mating surfaces in contact with power conductors shall be such as to prevent corrosion of the contact surface and to maintain good electrical contact under all operating conditions.

9.5. METAL PARTS OF GROUND WIRE HARDWARE:

i) The suspension clamp shall be of malleable cast iron or forged steel or of aluminium alloy. The tension clamp shall be made of Forged steel/Mild stee! conforming to IS: 2486 or of a grade or equivalent thereof with Aluminium Sleeves.

ii) 'D" shackles, clevis 'U' bolts, cotter pins and other components shall be manufactured from drop forged steel conforming to IS: 2004 1978 or equivalent thereof.

iii) Bolts, nuts and washers shall be as per IS: 1367 and shall be of reputed makes such as GKW, TATA brands etc.

iv) All split pins shall be of stainless steel

9.6. INTER CHANGBABILITY:

All components of like design shall be interchangeable.

9.7. COMPRESSION MARKINGS:

Die compression areas shall be clearly marked on components, which are to be pressure compressed such as Mid-span compression joints and tension hard wares. The marking shall be an etched inscription with the words 'COMPRESS FIRST' on components, which are meant for continuous die compression. Where components are designed for intermittent die compressions, the compression and non-compression zones shall bear etched inscription such as "COMPRESSION ZONE" and "NON - COMPRESSION ZONE" distinctly with etched arrow signs indicating the direction of compression and knurled marks showing the end of the Zones.

All inscriptions etched on metal shall be distinct, legible and shall not wear out in the course of normal handling.

10.0. BID DRAWINGS:

The bidder shall furnish along with the bid the dimensional drawings of all accessories and hard wares.

These drawings shall include the following information.

a) Dimensions.
b) Tolerances on dimensions.
c) Material designation used for different components with reference to standards.
d) Fabrication details such as welds, finishes and coatings.
e) Catalogue or part numbers for each component and the total assembly with bill of materials.
f) Identification marking.

g) Weight of individual components and total assembled weight.

The assembly drawings shall include the following: -

Brief installation instructions.

Design installation torque for the bolt or cap screw.

Withstand torque that can be applied to the bolt or cap screw without failure of components or parts thereof.

Compression die number with recommended compression pressure.

Relevant technical details of significance.

11.0. TESTS:

All tests shall be conducted in accordance with I.S. 2121-1962 and IS 2486. Tests are divided groups viz. type tests, sample tests and routine tests. Details of tests have been given under the respective fittings.

11.1. TYPE TESTS:

Type tests are normally made once and unless otherwise agreed test certificates giving the results of the appropriate type tests made on knot less than three fittings identical in all essential details with those to be supplied are regarded as evidence of compliance. All the type test certificates of recent origin conducted in a reputed laboratory shall be furnished along with the Bid.

In addition to the above all the type tests as per the relevant ISS shall be repeated after the award of the contract on the same type and make of hardware/accessory offered for construction. The cost for repeating these type tests shall be indicated in the price schedule.

11.2. SAMPLE TEST:

Sample tests are not applicable when the order is for less than one hundred identical fittings. The number of samples shall be the nearest whole number to one half of one percent of the batch offered for inspection. If these samples meet the test requirements, the batch is deemed to comply with the standard. In the event of a sample not meeting the requirement, twice the original No. of new samples shall be tested. If all these new samples meet the test requirement, the batch is deemed to comply with the standard but if any fails to do so, the batch is deemed not to comply with the standard.

11.3. ROUTINE TEST:

Those shall be applied to every fitting unless mentioned otherwise to check with the requirements that are likely to vary during production.

11.4. STAGE TESTS:

Stage tests during manufacture shall mean those tests required to be carried out during the process of manufacture to ensure quality control such that the end product is of the designed quality conforming to the intent of this specification.

11.5. ACCEPTANCE TESTS:

Acceptance tests shall mean those tests, which are required to be carried out on samples taken from each lot offered for pre-despatch inspection for purposes of acceptance of that lot.

11.6. NORMS, PROCEDURES FOR SAMPLING AND TEST VALUES:

All the norms and procedures for sampling and values for all the tests shall be the values guaranteed by the Bidder in the guaranteed technical particulars or the acceptance value specified in the relevant standard whichever is more stringent for that particular test.

11.7. TYPE TESTS:

The following shall constitute the type tests. The Bidder shall furnish type test certificates for all these tests as per the relevant ISS of recent origin along with the offer.

These are in addition to the visual inspection and verification of dimensions, which are common.

a) Mid span compression joint for Conductor and Ground Wire:

Slip strength test
Electrical resistance test
Heating cycle test
Corona extinction voltage test
Radio Interference Voltage
Failing load test
Galvanizing test

Note: Tests at (iii), (iv) and (v) are not applicable for mid span Compression joint for ground wire conductor.

b) **Flexible copper Bond:**

I) Slip strength test

c) **Armour rods:**

i) Tensile strength test
ii) Corona test
ii) Radio Interference voltage test
iv) Slip strength test
v) Electrical resistance test
vi) Bend test
vii) Resilient test

d) Vibration damper for conductor and ground wire :

I) Dynamic characteristics
II) Vibration analysis
III) Clamp slip test
IV) Fatigue test

V) Magnetic power loss test
VI) Corona extinction voltage test
VII) Radio interference voltage test
VIII) Galvanising test
IX) Determination of weight of Zinc coating
X) Torque test
XI) Resonance frequency test
XII) Mass pull off test
XIII) Damping efficiency test

Note*:* Tests at (v), (vi) & (vii) above are not applicable to Vibration dampers for earth wire conductor.

Spacers I Spacer dampers for power conductor:

i) Vibration test
ii) Clamp slip test
iii) Movement test
iv) Magnetic power loss test
v) Short circuit test
vi) Corona extinction voltage test
vii) Radio interference test
viii) Decrement test (for spacer-damper only)
ix) Galvanizing test
x) Resilience test
xi) Clamp bolt torque test
xii) Assembly torque test
xiii) Tensile load test
xiv) Compression and pull off test

f) Suspension clamp for earth wire

i) Slip strength test
ii) Mechanical test
iii) Galvanizing test

g) Tension clamp for earthwire :

i) Slip strength test
ii) Minimum failing load test
iii) Galvanizing test

h) P.G.Clamps:

i) Failing load test
ii) Electrical resistance test

11.8.0. Acceptance Tests:

Following Acceptance tests shall be conducted as per the relevant ISS and any other relevant standards in the presence of the Purchaser's representative.

a)Mid span compression joints and repair sleeves :

i) Visual examination
ii) Dimensional verification
iii) Failing load test
iv) Galvanizing test
v) Hardness test

b)Vibration dampers:

I) Visual examination.
i) Verification of dimensions
ii) Resonance frequency test.
iii) Fatigue test
iv) Mass pull off test
v) Galvanising / electroplating test
vi) Strength of the Messenger cable

P.G.Clamps: As per the relevant ISS

Spacer / Spacer damper for power conductor:

i) Visual examination
ii) Dimensional verification
iii) Galvanising test
iv) Movement test (Except for spacers of jumpers)
v) Compressive and tensile test
vi) Clamp bolt torque test
vii) Assembly torque test
viii) Hardness test for neoprene (if applicable)
iX) UTS of retaining rod (if applicable)

e) Flexible copper earth bond:

i) Visual examination
ii) Dimensional verification
iii) Slip strength test

f) Armour rods:

i) Visual examination
ii) Dimensional verification
iii) Tensile strength test
iv) Electrical resistance test
v) Slip strength test

g) Suspension Hardware for Ground wire:

i) Visual examination

ii) Dimensional verification

iii) Mechanical tests

h) Tension Hardware for Ground wire:

11.9. Routine tests :

All the routine tests shall be conducted as per the relevant latest edition of ISS.

11.10. Test Reports:

Copies of test reports shall be furnished in 4 copies to the purchaser within one month of award of the contract. One copy will be returned duly certified by the Purchaser to the contractor within three weeks there afterwards and on receipt of the same shall commence with the commercial production of the concerned material.

Four copies of the acceptance test reports shall be furnished to the Purchaser. One copy will be returned, duly certified by the Purchaser and only thereafter shall the materials be dispatched.

All records of routine test reports shall be maintained by the Contractor at his works for periodic inspection by the Purchaser.

The Contractor shall maintain all test reports of tests conducted during manufacture. These shall be produced for verification as and when requested by the Purchaser.

12.0. SUBMISSION OF DRAWINGS:

Drawings equivalent to the number of consignees plus six extra for each item have to be submitted for approval before commencement of supply. Supplies shall not be commenced before approval of drawing. Non-submission of drawing / receipt of approval shall not be linked with delivery schedule. Delivery schedule should be adhered to.

The drawing shall be complete in all respects. Detailed dimensions shall be furnished in each of the drawings. Full specification of the equipment such as material weight, tensile strength, tolerance, chemical composition etc. shall be incorporated in each drawing.

Any defects noticed in the manufacture of the equipment during inspection or after receipt at destination have to be promptly set right by the contractor free of all cost to the owner.

13.0. INSPECTION:

The owner's representative shall have access to the manufacturer's works for purposes of inspection during the manufacture of the equipment and the manufacturer shall provide all facilities for unrestricted inspection of the contractor's works, raw materials, manufacture of all the accessories and for conducting necessary tests as detailed herein.

The successful Bidder / Contractor shall keep the purchaser informed in advance of the time of starting and of the progress of manufacture of accessories in its various stages so that arrangements could be made for inspection.

No material shall be dispatched from their point of manufacture unless the material has been satisfactorily inspected and tested.

The acceptance of any quantity of accessories shall in no way relieve the successful Bidder/Contractor of his responsibility for meeting all the requirements of this specification, and shall not prevent subsequent rejection, if such accessories or hard wares are later found to be defective.

14.0. PACKING:

All accessories and Hardware shall be supplied in strong wooden case all packages shall be marked on the sides as follows: -

Name and designation of the consignee.

Ultimate destination as required by the owner.

Trade name if any.

Name of the manufacturer

Any other information required

i) The gross weight of the packing shall not normally exceed 200 Kg to avoid handling problems.

ii) Suitable cushioning, protective padding, or spacer shall be provided to prevent damage to or deformation of the hard wares during transit and handling.

iii) All identical items shall be dispatched to destination duly assembled and packed. 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 taken to prevent their transit loss.

iv) Each component part shall be legibly and indelibly marked with the trademark of the manufacturer and year of manufacture.

v) All packing cases shall be marked legibly and correctly so as to ensure their safe arrival at their destination and to avoid the possibility of goods being lost or wrongly dispatched on account of faulty or illegible markings. Each wooden case/crate shall have all the markings stenciled on it in indelible ink.

VOLUME - II
CHAPTER-V
PART – D
DISC INSULATORS

1.0. SCOPE:

This specification covers the manufacture, testing at manufacturer's works before dispatch, supply and delivery of 90, 120, and 160 KN E.M.S. Antifog & Normal insulators for 400 kV over-head power lines.

Insulators suitable for 400 kV transmission lines shall be offered. These shall be suitable for being installed directly in air suspended on the tower cross arms or anchored to the power cross arms of 400 kV Multi circuit line on suspension and tension towers. The insulators offered shall be any of the following types.

1. Porcelain disc insulators-cap and pin, ball and socket type.

The description of the above types of insulators have been given in the specification.

2.0. STANDARDS:

The insulators offered shall conform to the following standards as applicable to the appropriate insulators.

1	IEC 120-Latest	Dimensions of ball and socket couplings of string insulator units.
2	IS: 137	Specification for Ceramic Material or glass for overhead lines with a nominal voltage greater than 1000 V.
3	IS: 209	Zinc
4	IEC-305	Characteristics of string insulators
5	IS: 372(2)	
6	IEC: 373	Parts 1 & 2 locking devices for ball and socket couplings of string insulator units.
7	IEC: 383	Tests on insulators and ceramic material or glass for over-head lines with a nominal voltage greater than 1000 volts.
8	IS: 385	Specification for phosphor Bronz Rods and Bars, sheet and strip and wire
9	IS 406	Method of Chemical Analysis of slab zinc
10	IEC 433	Characteristics of string insulator units of long-rod type
11	IEC 575	Thermal Mechanical Endurance tests and Mechanical Endurance tests and Mechanical performance tests in string Insulator units.
12	IEC 672	Specification for Ceramic and Glass Insulating materials. Part.I Definitions and classifications Part.II Methods and test Part.III Individual Materials
13	IS 731	Specification for porcelain insulators for over head lines (3.3

		KV) and above.
14	IS 814	Phosphor Bronze sheet, strip and foil
15	IS 1570	Specification for wrought steel for General Engineering purpose
16	IS 1573	Electroplated coatings of zinc on iron and steel
17	IS 2070	Method of Impulse testing
18	IS 2107	Specification for White Heart Malleable Iron castings
19	IS 2108	Specification for Black Heart Malleable Iron Castings
20	IS 2486	Parts 1,2,3 & 4 specifications for insulator fittings for over head power lines with nominal voltage greater than 1000 volts
21	IS 2629	Recommended practice for hot dip galvanizing of Iron and Steel
22	IS 3188	Dimensions for disc insulators
23	IS 6603	Stainless steel bars and flats (Amendments 1 to 4)
24	IS 7811	Phosphor bronze rods and bars
25	IS 7814	Phosphor rods and bars
26	IS 8263	Method of radio interference tests on HV insulators
27	IS 8269	Method of switching impulse Test on HV insulators

DEVIATIONS IN SPECIFICATIONS:

All discrepancies and or deviations in specifications shall be brought out by the bidder and detailed clause by clause in the deviation schedule. Deviations brought out elsewhere or in any other format will not be considered by the purchaser and are liable for being rejected. It shall also be by the purchaser in such an event that the bidder has conformed to the clauses in this specification scrupulously.

Deviations in specifications shall if possible be quoted with reference to standards. The bidder shall then furnish an authentic English Version of such standards.

However, if the bidder offers insulators conforming to standards other than the above, then the salient points of comparison between the standard adopted and the standards quoted herein shall be detailed in deviation schedule with an authenticated English version of such standards referred to.

DISC INSULATORS:

Type and rating: The disc insulators shall be of the cap and pinball and socket type. They shall be Normal/anti fog type of electro porcelain. For 400/230 kV line the ratings shall be 90, 120 kN, and 160 kN for discs in suspension and tension respectively. The suspension string includes the 'I' string configuration.

Insulator shell material:

3.2.1. Porcelain: The porcelain used in the manufacture of shells shall be ivory white, nonporous, of high dielectric, mechanical and thermal strength free from internal stresses, blisters, laminations, voids, foreign matter, imperfections of other defects which might render it in any was unsuitable for insulator shells. Porcelain shall remain unaffected by climatic conditions, ozone, acids, alkalis, zinc

or dust. The manufacturing shall be by the wet process and impervious character obtained by thorough verification.

3.2.2 Surfaces to come in contact with cement shall be made rough by sand glazing. All other exposed surfaces shall be glazed with ceramic materials having the same temperature coefficient of expansion as that of the insulator shell. The thickness of the glaze shall be uniform throughout and the colour of the glaze shall be brown. The glaze shall have a visible luster, smooth on surface and be subject to satisfactory performance under extreme tropical climatic weather conditions and prevent ageing of the porcelain. The glaze shall remain under compression on the porcelain body throughout the working temperature range.

3.3. Metal parts:

3.3.1. Cap and Ball pins:

Ball pins shall be made with drop forged steel and caps with malleable cast iron. They shall be in one single piece and duly hot dip galvanized. They shall not contain parts or pieces joined together, welded shrink fitted or by any other process from more than one piece of material. The pins shall be of high tensile steel, drop forged and heat-treated. The caps shall be cast with good quality black heart malleable, cast iron and annealed. Galvanizing shall be by the hot dip galvanizing process with a heavy coating of zinc of very high purity. The Bidder shall specify the grade, composition and mechanical properties of steel used for caps and pins.

3.3.2. Security clips:

The security clips shall be made of phosphor bronze or of stainless steel.

3.3.3. Zinc Sleeves:

For Anti-fog type disc insulators, Zinc sleeves shall be provided on the shank of the ball pins. The zinc to be used for making sleeve shall be 99.99% pure or as per latest acceptable standards. The Zinc sleeves shall be fixed at the top position of the neck of the shank of the ball pin. The length of the shank of the ball pin shall be suitably chosen to ensure easy fixing into the socket to the next disc insulator. The zinc sleeve shall cover the top neck portion of the shank of the ball pin to a minimum extent of 20 mm and embedded into the cemented portion up to an extent 10 mm.

The thickness of the sleeve shall be 5mm. The Zinc sleeve shall be clamped and fused together with the pin without forming any gap between the sleeve and the pin. Any gap will cause corona discharge due to the moisture and the insulators with this defect will be rejected outright.

3.4. FILLER MATERIAL:

Cement to be used, as filler material shall be quick setting, fast curing Portland cement. It shall not cause fracture by expansion or loosening by contraction.

Cement shall not react chemically with metal parts in contact with it and it's thickness shall be as small and as uniform as possible.

MATERIAL DESIGN AND WORKMANSHIP:

GENERAL:

I) All raw materials to be used in the manufacture of these insulators shall be subject to strict raw material quality control and to stage testing quality control during manufacturing stage to ensure the quality of the final end product. Manufacturing shall conform to the best engineering practices adopted in the field of extra high voltage transmission. Bidders shall therefore offer insulators as are guaranteed by them for satisfactory performance on 400 KV transmission lines.

II) The design, manufacturing process and material control at various stages be such as to give maximum working load, highest mobility, be resistance to corrosion, good finish, elimination of sharp edges and corners to limit corona and radio interference voltages.

4.2. INSULATOR SHELL:

The design of the insulator shells shall be such that stresses due to expansion and contraction in any part of the insulator shall not lead to deterioration. Shells with cracks shall be eliminated by temperature cycle test followed by mallet test. Shells shall be dried under controlled conditions of humidity and temperature.

4.3. METAL PARTS:

i) The pin and cap shall be designed to transmit the mechanical stresses to the shell by compression and develop uniform mechanical strength in the insulator. The cap shall be circular with the inner and outer surfaces concentric and of such design that it will not yield or distort under loaded conditions. The head portion of the pinball shall be suitably designed so that when the insulator is under tension, the stresses are uniformly distributed over the pinhole portion of the shell. The pin ball shall move freely in the cap socket but without any danger of accidental decoupling either during assembly of a string or during erection of a string or when a string is placed in position

ii) Metal caps shall be free from cracks, seams, shrinks air holes, blowholes and rough edges. All metal surfaces shall be perfectly smooth with no projecting part or irregularities, which may cause corona. All load bearing surfaces shall be smooth and uniform so as to distribute the loading stresses uniformly. Pins shall not show any microscopically visible cracks, inclusions and voids.

4.4. GALVANISING:

All ferrous parts shall be hot dip galvanized in accordance with the latest edition of IS: 2629. The zinc to be used for galvanizing 99.5 as per IS: 209. The zinc coating shall be uniform, smoothly adherent, reasonably bright, continuous and

free from impurities such as flux, ash, rust, stains, bulky white deposits and blisters. 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 design dimension requirements.

4.5. CEMENTING:

The insulator design shall be such that the insulating medium (porcelain) shall not directly engage with hard metal. The surfaces of porcelain and metal in contact with cement shall be coated with resilient paint to offset the effect of difference in thermal expansions of these materials.

4.6. SECURITY CLIPS (LOCKING DEVICES):

The security clips to be used as a locking device for ball and socket coupling shall be 'R' shaped hump type to provide for positive locking of the coupling as per IS: 2486 (Part-IV)/IEC-372. The legs of the security clips shall allow for spreading after installation to prevent complete withdrawal from the socket. The locking device shall be resilient, corrosion resistant and of suitable mechanical strength. There shall be no possibility of the locking device to be displaced or be capable of rotation when placed in position and under no circumstances shall it allow separation of insulator units and fittings. 'W' type security clips are also acceptable. The hole for the security clip shall be countersunk and the clip shall be of such design that the eye of the clip may be engaged by a hot line clip puller to provide for disengagement under energized conditions. The force required for pulling the clip into it's unlocked position shall not be less than 50 N (5 Kgs.) or more than 500 N (50 Kgs.)

4.7. BALL AND SOCKET DESIGNATION:

The dimensions of the ball and sockets of both 120 KN and 160 KN discs shall be 20 mm. Designation in accordance with the standard dimensions given in IS: 2486-Part II/IEC 120.

4.8. **DIMENSIONS OF INSULATOR DISCS** :

Nomenclature	90 KN	120 kN	160 kN
a) Diameter of disc: in mm	255	255	280
b)Spacing between the Discs in mm	145	145	170
c) Creepage distance in mm Dimensional tolerances shall be as per relevant standards.	315	315	330

4.9. INTER CHANGEABILITY:

The insulators inclusive of the ball and socket fitting shall be of standard design suitable for use with hardware fittings of any make conforming to relevant Indian/ International Standards.

4.10. CORONA AND RIV PERFORMANCE:

All surfaces shall be even, smooth, without cuts, abrasions or projections. No part shall be subjected to excessive localized pressure. The metal parts and porcelain shall not produce any noise generating coronal under all operating conditions.

4.11. SUITABILITY FOR LIVE LINE MAINTENANCE :

The insulators shall be suitable for use with hot line or live line maintenance techniques so that usual hot line operations can be carried out ease, speed and safety. Bidders shall indicate the methods generally adopted in routine hot and cold line maintenance of EHV lines for similar insulators supplied by them. Bidders shall also indicate the recommended periodicity of such maintenance.

4.12. FREE FROM DEFECTS:

Insulators shall have none of the following defects:

i) Ball pin shake

ii) Cementing defects near the pin like small blowholes, small hair cracks, lumps, etc.

iii) Sand fall defects on the surface of the insulator.

INSULATOR STRINGS:

TYPE AND RATING:

The Insulator strings shall be formed with standard discs described in clause below for use on a 3 phase, 400 V, 50, Hz effectively earthed system in a moderately polluted atmosphere. For 400 kV line the suspension insulator strings (with 'I' string) for use with suspension/tangent towers are to be formed with discs of 120 KN EMS rating while Tension insulator strings for use with Anchor/Tension towers are to formed with discs of 160 KN EMS rating.

5.2. STRING SIZE:

The size of the disc insulator, the number to be used in different types of strings, their electro-mechanical strength and minimum nominal creepage distance shall be as follows:

i) **For 400 kV line:**

Sl. No.	Type of string	Size of disc insulator mm	Minimum creepage distance of each disc (mm)	No. of discs	Electro-Mechanical strength of Insulator string KN
a)	Single suspension (Including for Pilot)	255x145	315	23	120 (11500 Kg.)
b)	Double suspension	255x145	315	2x23	2x120 (2x11500 kg.)
c)	Quadruple tension	280x170	330	4x24	4x160 (4x16500 kg.)
d)	Single tension	255x145	315	24	160 (16500 Kg.)

5.3. String characteristics:

For 400 kV line, the characteristics of the complete string shall be as follows:

S. No	Description	Suspension	Tension
I	Lightning Impulse withstand Voltage (dry) KV peak	1600	1700
II	Switching Surge withstand voltage (dry & wet) KV peak	1050	1050
III	Power frequency withstand voltage (wet) KV - rms	680	680
IV	Corona extinction voltage KV-rms	320	320
V	Max. RIV for complete string including Grading/corona rings, arcing horns, clamps etc. at 305 KV (rms) MV	1000	1000
VI	Mechanical failing load KN	1x120	2x160
VII	No deformation load Kgf	9200	26400
VIII	Max. voltage across any disc	9%	10%
IX	Length of string	As per drawing	As per drawing

6.0. ATMOSPHERIC CONDITIONS:

The materials offered shall be suitable for operation in tropical climate and will be subject to the full rays of the sun and inclement weather and should be able to withstand wide range of temperature variations. The humidity may be as high as 100% during rainy season and as low as 10% during the dry season.

7.0. MARKINGS:

Each insulator shall be legibly and indelibly marked to show the following: -

Name and trade mark of the manufacturer,

Month and year of manufacture,

Minimum failing load in Kg.

Country of manufacture and

IS I Certification marks.

Markings in case of porcelain shall be printed and shall be applied before firings.

8.0. TESTING OF INSULATORS:

Tests: The following type, acceptance and routine tests shall be carried out on the insulator string and disc insulators in accordance with IS: 731/IEC 383.

8.1. Type Tests: These shall mean those tests which are to be carried out to prove conformity with the specification. These are intended to prove the general qualities and design of a given type of insulator. The Bidders shall enclose the Type test certificates of recent origin for having carried out the type tests.

In addition to the above all the type tests on both 120 KN, 160 KN insulators of the same type and make as that is offered of construction shall be repeated after the award of the contract which will be witnessed by the purchaser's representative. Further, type tests (all mechanical and electrical tests) on the entire string both suspension and tension with all necessary insulators, hardware etc. of the same make and type approved for construction shall also be conducted which will also be witnessed by the purchaser's representative. The cost for repeating these type tests shall be indicated in the price schedule.

Acceptance Tests*:* Tests carried out on samples taken from the lot for purpose of acceptance of the lot.

Routine Tests*:* Tests carried out on each insulator to check requirements which are likely to vary during production.

Stage Tests during manufacture: Tests which are to be carried out during the process of manufacture and end inspection by the bidder to ensure the desired quality of the end product to be supplied.

Test values: These are values guaranteed by the bidder in the guaranteed technical particulars or the acceptance values specified in the relevant standard whichever is more stringent.

Test procedures and sampling norms: The general conditions for high voltage tests, mounting procedures, samples to be tested shall be as per relevant IS. All the tests shall be carried out in the presence of the purchaser's engineers.

Details of tests to be conducted.

The standards and norms to which the tests are to be conducted are as follows.

8.7. TYPE TESTS (IS: 731):

a)Visual examination.

b)Verification of dimensions.

c)Visible discharge tests.

d)Impulse voltage withstand test.

e)Wet power frequency voltage withstand test.

f)Temperature cycle test.

g)Electromechanical failing load test (for string insulator units, type – B only)
h) Mechanical failing load test (for string insulator units of type-A and those of type-B to which 'g' is not applicable).
i) 24 Hrs. mechanical strength test
j) Puncture test
k) Porosity test
l) Galvanising test
m) Radio interference test..
n) Residual strength test
o) Steep wave front test
p) Impact test .

8.8. **Acceptance Tests***:*

a) Verification of dimensions (IS 731)
b) Temperature cycle test (IS 731)
c) 24 Hrs. mechanical strength test (IS 731)
d) Electro mechanical failing load test (IS 731)
e) Mechanical failing load test (IS 731) (for string insulator units type-A and for rigid insulators only).
f) Puncture test(IS731)
g) Porosity test(IS731)
h) Galvanising test (IS 731)
i) Tests on locking device for ball socket compling (IEC 372(2)
J) Thermal shock test (IEC 383-1976 for glass insulators)
k) Polarised light inspection (do-)

8.9. Routine tests:

a) Visual examination (IS 731)
b)Mechanical routine test (IS 731)
c)Electrical routine test (IS 731)
d)Thermal shock routine test (for glass insulators IEC-383)

Tests on components during manufacture*:*

Chemical analysis of Zinc used for galvanizing.
Chemical analysis, mechanical and metallographic tests and magnetic particle inspection for malleable castings.
Chemical analysis, hardness tests and magnetic particle inspection and forgings.
Hydraulic Internal Pressure tests on disc Insulators shells
Auto Clave test on cement

8.11. Additional Tests: The purchaser reserves the right to direct the supplier to carry out any other tests of reasonable nature.
The successful bidder/contractor shall arrange to coordinate testing.

All the type tests and acceptance tests specified shall be carried out in the presence of purchaser's representatives. Four copies of type test reports shall be sent to the purchaser for approval. Only after approval the production of insulator shall start.
Similarly four copies of acceptance tests shall be furnished to the purchaser. The dispatches shall start only after the test certificates are returned duly certified by the purchaser.
All records of routine tests reports and stage test reports shall be maintained by the supplier for periodic inspection of the engineers. If two or more insulators or metal parts fail to comply with the above tests, or if any failure occurs on retesting as described above, the complete lot shall be withdrawn for further examination by the manufacturer after which the lot or any part thereof may be submitted for retests. The number then selected shall be three times the first quantity chosen for tests. This retesting shall comprise the tests which may be considered to have influenced the results of the original tests. If any failure occurs, the lot shall be rejected.
No part of the lot withdrawn as described above shall constitute part of any other test submitted for the first time.

8.12. Inspection:

The Engineer of the Purchaser shall at all times be entitled to have access to the works and to all places of manufacture where insulators are manufactured and the successful Bidder/Contractor shall afford all facilities to them for unrestricted inspection of the works. Inspection of materials, inspection of manufacturing process of insulators and for conducting necessary tests as specified herein.
The successful Bidder / Contractor shall keep the Purchaser informed in advance of the time of starting and of the progress of manufacture of the insulators in their various stages so that arrangements could be made for inspection.
No insulator shall be despatched from works, until and unless inspected and cleared for dispatch by the Purchaser.

8.13. Testing charges, Test time and Testing of complete strings with fittings:

The entire cost of type tests, acceptance tests, routine tests and stage tests during manufacture specified herein shall be included in the quoted unit price of the insulators quoted by the Bidder. There shall be no separate rates or charges quoted for conducting any of these tests.
The Bidder shall indicate the name of the laboratories in which it is proposed to conduct the type, acceptance and routine tests and shall ensure that tests in these laboratories are concluded within the commencement of the scheduled delivery date.

For type tests involving tests on a complete insulator string with hardware fittings, the purchaser will advise the supplier/contractor of the hardware fittings to supply the necessary fittings to the place of the test.

In the case of failure of the complete string in any type tests, the manufacturer whose product has failed in the tests, shall get the tests repeated at his cost. In case of any dispute, assessment of the purchaser as to the items that has caused the failure in any of the type tests shall be final and binding.

9.0. PACKING:

This clause shall be read in conjunction with clause 8.00 above.

All insulators shall be packed in suitable sizes of strong wooden cases / crates. The gross weight of the packing shall not normally exceed 100-150 Kg for easy handling.

Security clips and split pins if found necessary shall be packed separately and suitable measures taken to prevent its loss.

All packing cases shall be marked legibly and correctly so as to ensure its safe arrival at their destination and to avoid the possibility of the goods being lost or wrongfully dispatched on account of faulty packing or due to faulty or illegible markings. Each case/crate shall have all the marking stenciled on it in indelible ink.

10.0 DRAWINGS AND GUARANTEED TECHNICAL PARTICULARS:

Dimensioned drawings of the disc insulators shall be furnished for approval. The guaranteed technical particulars shall be furnished as per the proforma enclosed to Data requirement sheets.

The Bidder shall also furnish along with the bid the outline drawing (3 copies) of each insulator unit including cross sectional view of the shell. The drawing shall include the following information.

I) Shell diameter and unit spacing with manufacturing tolerances.
II) Minimum Creepage distance with positive tolerance.
III) Unit mechanical and electrical characteristic as also for the
IV) Complete string-suspension and tension.
V) Size and weight of ball and socket part.
VI) Weight of unit insulator disc./long rod units.
VII) Materials for the disc cap and pin.
VIII) Manufacturers catalogue number.
IX) Eccentricity of the Disc.
a) Axial run out
b) Radial run out

** ** **

VOLUME-II

CHAPTER-V

PART - E

TECHNICAL SPECIFICATION FOR INSULATOR HARDWARE FITTINGS(FOR400 kV)

SCOPE:

This specification covers design, manufacture, testing at manufacturer's works before despatch, supply and delivery porcelain insulator hardware for 400 KV overhead power lines. The hardware fitting should conform to the enclosed drawing. The technical specifications contained herein are for the guidance of the tenderers. Any deviations from the owner's specification will be considered on their relative merits in respect of performance, efficiency, durability and overall economy consistent with the requirements herein after.

STANDARDS:

Except as modified by this specification the insulator and conductor hard wares to be supplied shall conform to the latest edition with revisions of the following Bureau of Indian Standards (IS) & British Standards specifications (BS).

IS 209 Zinc (Third Revision)

IS 731 Porcelain insulators for overhead power lines with a nominal voltage greater than 1000 volts (second revision with amendments 1 to 5)

IS 1570 Schedules for wrought steels for general engineering purposes (Amendment No.1 and 3)

IS 1570 (Part I) Steel specified by tensile and/or yield properties (first Revision) with amendment No.1)

IS -1573 Electroplated coatings of zinc on iron and steel (First revision)

IS 2002 Steel plates for pressure vessels for intermediate and high temperature.

IS 2004 Carbon steel forging for general engineering purposes (2nd revision)

IS 2121 Conductors and Earthwire accessories for overhead power lines.

IS 2121 (Part -1) Armour rods, binding wires and tapes for conductors

IS 2486	Insulator fittings for overhead power lines of 33 KV and above.
IS 2486 (Part I)	General requirements and tests (First revision with Amendment)
IS 2486 (Part II)	Dimensional requirements (First revision)
IS 2486 (Part III)	Locking Devices
IS 2486 (Part IV)	Tests for locking devices
IS 2633	Methods for testing uniformity of coating on
IS 3138	zinc coated articles (First revision)
BS 3288(Part I)	Hexagonal bolts and nuts (M 42 to m 150)
BS 3288 (Part II)	Performance and general requirements
IS 4172	Dimensions Dimensions for heads of bolts and screws
IS 4206	Dimensions for nominal lengths thread lengths for bolts, screws and studs (with Amendment No.1)
IS 4218	ISO metric screw threads
IS 4218 (Part I)	Basic and design profiles (first Revision) (with Amendment No.1)
IS 4218 (Part II)	Diameter pitch combinations (First Revision) (With amendment No.1)
IS 4218 (Part III)	Basic and design profiles (First Revision)
IS 4218 (Part IV)	Tolerancing system (First Revision)
IS 4218 (Part V)	Tolerances (First Revision)
IS 4218 (Part VI)	Limits of sizes for commercial bolts and nuts (First Revision) With amendment No.1)
IS 4759	Hot dip zinc coating on structural steel and other allied products (Second revision)
IS 6603	Stainless Steel, bars and flats (amendments 1 to 4)

IS 6745	Methods for determination of weight of zinc coating on zinc coated iron and steel articles (with amendment No.1)
IS 8263	Methods for radio interference tests on high voltage insulators.

2.2. Hardware and fittings thereof conforming to any other National or International Standards are also acceptable. However in such an event the salient points of comparison between the standards adopted and the standards quoted herein shall be detailed in the deviation schedule in section-BPS with an authentic English version of such standards referred to.

3.0. **DEVIATIONS IN SPECIFICATIONS:**

All discrepancies and or deviations in specifications shall be brought out by the bidder and detailed clause by clause in the deviation schedule.

Deviations brought out elsewhere or in any other format will not be considered by the purchaser and are liable for being rejected. It shall also be by the purchaser in such an event that the bidder has conformed to the clauses in this specification scrupulously.

Deviations in specifications shall if possible be quoted with reference to standards. The bidder shall then furnish an authentic English Version of such standards.

4.0.TYPE OF HARDWARE FITTINGS, DRAWINGS AND COMPONENTS THEREOF:

4.1. The types of hardware and fittings thereof required shall be of the following types as indicated in the Bid proposal sheets.

(i) Single suspension string hardware with cushion grip clamps
(ii) Double suspension string hardware with cushion grip clamps
(iii) Single tension hardware
(iv) Double tension hardware
(v) Pilot string hardware with envelope type clamp,
(vi) Double tension hardware with vernier adjustment plate,
(vii) Balancing weights for Pilot insulator strings (200 Kgs)

4.2. DRAWINGS: Typical drawings of the said types of hardware fittings shall be submitted along with the bids.

4.3. COMPONENTS:

Each of the above hardware fittings shall be supplied in all respects and shall include the following components / parts.

Standard Anchor Shackle of 22 mm dia. for the suspension string suitable for attachment to the 'U' hanger supplied along with the tower. The attachment shall be such that the plane of the 'U' hanger is transverse to the run of the conductor.

"D" Shackle suitable for attachment of the tension string to the strain plate

on the tower cross arm. The strain plate to be supplied along with the towers will have a minimum thickness of 16 mm with a vertical hole of 32 mm diameter.

Suitable Arcing horns with grading rings or corona control rings on the line side and with other fittings to go along with the suspension and tension strings, as per specification stipulated herein.

Suitable yoke plates for single/double suspension and single/double tension strings for twin bundle conductor arrangement to comply with specifications stipulated herein.

All other fittings as are necessary to make a complete set of clamps for the insulator strings such Eye link, Ball clevis, socket clevis, Eye clevis, Clevis and chain link etc.

DESIGN DETAILS AND WORKMANSHIP:

GENERAL DESIGN :

(i) The general design of the hardware fittings shall be such as to ensure uniformity, high strength, freedom from corona formation, and high resistance to corrosion.

(ii) All hooks, eyes and such other fittings for attachment of the insulators to the tower and clamp assembly for clamping the line conductor to the insulator string shall be so designed so as to reduce to a minimum, if not eliminate completely and damage to the conductor, insulator or the fittings as such on account of fatigue caused by conductor vibration.

(iii) All exposed surfaces shall be finalised smoothly and evenly without any burrs, kinks or scratches so as to avoid local corona formation or discharges likely to cause interference with telecommunication signals of any kind.

(iv) All current carrying parts shall be designed to have a minimum contact resistance and there shall be adequate bearing area between the fittings and the conductors. Point and line contacts shall be totally avoided.

5.2. LENGTHS OF INSULATOR STRINGS (400 kv line):

(i) Suspension string:

The total free swinging length of the single suspension string measured from the point of attachment with the tower 'U' hanger to the centre of the conductor shall be as per the drawing attached.

(ii) Tension string:

The total length of the double tension string measured from the point of attachment to the tower cross arm to that point of compression dead attachment where the conductor jumpers leave the projecting lug shall be as per the drawing attached.

5.3. INTER CHANGEABILITY:

All hardware fittings together with ball and socket fittings shall be of standard design such that all like parts are interchangeable with each other.

5.4. CORONA AND RIV PERFORMANCE:

All exposed surfaces shall be clean, smooth without cuts, abrasions or projections. No part of any hardware shall be subjected to excessive localised pressure. The hardware surfaces shall not produce any noise-generating corona under normal operating conditions. All sharp edges around corners shall be rounded off evenly and smoothly. The bidder shall guarantee the hardware and fittings for satisfactory corona and RIV performance.

5.5. MAINTENANCE:

The hardware fittings shall be suitable for deployment with hotline maintenance techniques so that routine hot line maintenance can be carried out with ease, speed and safety. The bidder shall clearly state in the offer, the suitability of the hardware and fittings for use with hot line maintenance.

5.6. BALL AND SOCKET DESIGNATION:

The dimensions of the ball and socket shall be as per the relevant IS Codes.

5.7. SECURITY CLIPS AND SPLIT PINS:

(i) Security clips for use with ball and socket coupling shall be R shaped hump type and shall provide positive locking of the coupling as per IS 2486 (Part IV) /IEC :372. The legs of the security clips shall be suitable for being spread after assembly to prevent complete withdrawal from the socket. The locking device shall be resilient, corrosion resistant and of suitable mechanical strength. There shall be no risk of the locking device being displaced accidentally or being rotated when in position. Under no circumstances shall be locking device allow for separation of the fittings.

(ii) The hole for the Security clip shall counter sunk and the clip should be of such design that the eye of the clip may be engaged by a hot line clip puller to provide for disengagement under energized conditions. The force required to pull the clip into the unlocked position shall not be less 50 N (5 kg.) or more than 500 N (50 kg.)

(iii) Split pins of hump type shall be used with bolts.

(iv) Security clips and split pins shall be manufactured out of stainless steel as per IS 6603 – (Latest).

5.8. ARCING HORNS:

(i) The Arcing Horns shall be suitably designed for being attached to the hardware fittings. They shall not be attached to the insulator balls and caps. The arcing horns shall be provided with two bolts for fitment and shall be of the rod type with a forged ball.

(ii) The details of the arcing horns to be supplied for the tower side and line side shall be as under:

Tower side Arcing Horns: These shall be provided on the string hardware fittings.

Line side Arcing Horns: These shall be provided on the line side of all string hardware fittings. Corona control rings to be provided shall serve the purpose of arcing horns as well.

(iii) Arcing horns shall be made of mild steel rod, ball ended and duly hot dip galvanised. The total effective arcing distance shall be 3050mm under nominal dimensions of insulators.

5.9. YOKE PLATES :

The strength of the yoke plate shall be adequate to withstand the designed load. The plates shall be triangular or rectangular in shape as may be necessary. All the corners and edges shall be rounded off with radii of at least 3 mm. Yoke plate shall have holes for fixing corona rings and with holes in the centre for supporting stringing blocks. Yoke plates shall be of high tensile mild steel and hot dip galvanised.

5.10. CORONA CONTROL AND GRADING RINGS:

(i) Corona control and grading rings shall be provided with all string hardware fittings and shall be of such design and shape that they will reduce the voltage across the insulator units adjacent to the conductor for each insulator string to a value which will prevent visual corona from forming on the metal parts of the insulators and shall minimise radio interference voltage on the complete insulator string assemblies. The design shall be such as to limit the maximum voltage at the line side to 9%.

(ii) Corona control and grading rings shall be made of high strength heat treated aluminium alloy tube of suitable size with a minimum wall thickness of 2.5 mm. The brackets shall not be welded to the pipe but shall be fixed by means of bolts and nuts on a small attachment or a plate/flat welded to the pipe. The welded position of the corona control ring shall be ground before buffing. The brackets may be made of either high strength aluminium alloy or hot dip galvanised mild steel.

(iii) The corona control rings should have a brushed satin finish and not a bright glossy surface to pass electrical requirements for smoothness. No blemish should be seen or felt when rubbing a hand over the metal.

5**.11. SAG ADJUSTMENT DEVICE FOR DOUBE TENSION VERNIER TYPE**:

(i) The sag adjustment device to be provided with double tension hardware fittings shall be of three-plate type. The minimum ultimate tensile strength of the device shall be provided with safety locking arrangement. The design shall not be less than 165 KN. The device shall be provided with safety locking arrangements. Its design shall be such that sag adjustment should be possible with ease, speed and safety. They shall be made of high tensile mild steel hot dip galvanised plates.

(ii) The maximum length of the total sag adjustment device from the connecting part of rest of the hardware fitting shall be about 355 mm. The details of maximum and minimum adjustment possible and steps of adjustment shall be clearly indicated in the bid drawings. An adjustment of 150 mm of 175 mm shall be possible.

5.12. TURN BUCKLE:

i) The turn buckle to be provided with single tension fittings shall have a minimum ultimate tensile strength of 160 KN.

ii) The maximum length of the turn buckle from the connecting part of the rest of the hardware fitting shall be 520 mm.

iii) The details of the minimum and maximum adjustments possible shall be clearly indicated in the old drawings. An adjustment of 150 mm to 175 mm shall be possible.

5.13. SUSPENSION ASSEMBLY:

i) The suspension assembly 'I' string shall be suitable for QUAD ACSR MOOSE CONDUCTOR.

ii) It shall be designed to have maximum mobility in any direction and minimum moment of inertia so as to have minimum stress on the conductor oscillations.

iii) The outer sleeve of the clamp shall be made of pure aluminium EC grade and shall be extruded. The steel sleeve shall be of low carbon forged steel and hot dip galvanized.

5.14. BOLTS AND NUTS:

i) All bolts and nuts and screws shall be as per IS: 3118-1965 and IS: 4218-1967. All bolt heads and nuts shall be hexagonal and where required the nuts shall be locked in an approved manner. All bolts and nuts shall be hot dip galvanized including the threaded portion of the bolts.

ii) The make of the bots shall be specified in the bid drawing and they shall be preferably of either of GKW or TATA makes.

iii) All bolts carrying load shall be of high tensile tested qualify of standard make.

5-15. SOCKET AND BALL ENDED PARTS:

Socket and ball ended parts shall be made of drop forged steel as per IS 2004-1962 or equivalent. These parts shall be hot dip galvanized after proper machining.

5.16.. RATED STRENGTH:

The load carrying hardware should be capable of withstanding loads indicated in bid drawings without any visual deformation on removal of load.

5.17. WORKMANSHIP:

i) All fittings shall be of the latest design and shall confirm to the latest practices adopted in the field of extra high voltage engineering. The bidder shall offer only such components as are guaranteed for satisfactory and suitable performance on 400 KV transmission lines.

ii) The design, manufacturing process and quality control of all the materials shall be such as (a) to give good; finish of materials, elimination of sharp edges, corners (b) to limit corona and radio interference and (c) best resistance to corrosion.

iii) All ferrous parts including bolts, nuts and washers shall be hot dip galvanized after all machining has been completed. Nuts may be tapped (threaded) after galvanizing. All spring washers shall be electro galvanized. The bolt threads shall be undercut to take care of increase in diameter due to galvanizing. Galvanizing shall satisfy the tests mentioned in IS: 2633-1972. Bolts, nuts and washers shall withstand 4 (four) dips while washers 3 (three) dips. Other galvanized materials shall be guaranteed

to withstand at least 6 successive dips each lasting a minute under standard preece test for galvanizing.

iv) Ball fittings before; being galvanized shall be subject to die flashing on the shank and on the bearing surface of the ball, without reducing the dimensions below the design requirements.

v) Zinc coating shall be perfectly adherent, be uniform thickness, smooth, reasonably bright, continuous and free from perfections such as flux, ash, rust stains, bulky white deposit and blisters. The zinc used for galvanizing shall be of grade SN 99.5 in accordance with IS: 209-1966.

vi) Pin balls shall be checked with applicable 'GO[1] gauges in at least two directions, one of which shall be across the line of the die flashing and the other perpendicular to this line. 'NO-GO[1] gauges shall not pass in any direction.

vii) Forged 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 surface of the socket ends shall be concentric with the areas of the fittings and as per relevant Indian Standards. The areas of bearing surfaces of socket ends shall be coaxial with the areas of the fittings. There shall not be noticeable tilting of the bearing surfaces with the axis of fittings.

viii) Forged fittings shall be free from all internal defects like shrinkage, inclusions, blowholes, cracks etc.

ix) All current carrying parts shall be designed and manufactured so that contact resistance is reduced to minimum.

x) No materials shall have sharp ends or edges, abrasions or projections which would produce high electrical and mechanical stress in normal working and cause any damage to the conductor in any way during erection or during continuous operation. 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.

xi) All bolts and clamps shall have suitable and corona free locking arrangements to guard against loosening due to vibration.

xii) Welding of aluminium shall be by gas shielded tungsten arc or inert gas shielded metal arc process. Welds shall be clear, sound, smooth, and uniform without overlaps, properly fused and completely sealed. There shall be no cracks, voids, incomplete penetration, incomplete fusion under cuttings 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 practice.

6.0. ATMOSPHERIC CONDITIONS:

The materials offered shall be suitable for operation in tropical climate and will be subjected to the full rays of the sun and inclement weather and should be able to

withstand wide range of temperature variations. The humidity may be as high as 100% during rainy season and as low as 10% during the dry season. The prevailing weather conditions have been gives elsewhere in the specification. The fittings shall be inherently resistant to atmospheric corrosion or be suitable protected against corrosion both during storage and in service.

7.0. MECHANICAL LOADS:

The insulator strings shall be suitable for the minimum failing loads specified in Appendix-I. The load shall be applied axially to the insulating strings.

8.0. HARDWARE:

Each insulator string shall be supplied complete in all respects and shall include all fittings necessary for composing the insulator strings. T he insulator hardware should be suitable for use with ball and socket type disc insulators to be used in the string. It is the responsibility of the contractor to obtain the necessary details samples etc., of the disc insulator at his own cost.

The contractor shall be responsible for satisfying himself that the insulator fittings offered are complete and entirely suitable for the proposed attachments for the size of the conductor (MOOSE ACSR) specified for the Transmission line.

All bolts, nuts screw heads shall be of the whit worth standards thread. Bolt heads and nuts shall be hexagonal. Where required nuts shall be locked in an approved manner. The threads in nut and tapped holes shall be cut after galvanizing and shall be well lubricated or greased. All other threads shall be undercut to take care of increase in diameter due to galvanizing.

i) **For 400 kV line:**

TECHNICAL PARTICULARS FOR SUSPENSION HARDWARE FITTINGS					
Sl. No	Description	Unit	Particulars/Value		
			Double 'I' Suspension with		Single Suspension on Pilot fitting with
			AGS Clamp	Free centre clamp	Envelop clamp
1	Max. magnetic power loss of one suspension assembly at sub-conductor current of 600 Amps, 50Hz AC	Watt	4	4	8
2	Slipping strength of suspension assembly	KN	20-29	20-29	20-29
3	Particulars of Standard /AGS preformed amour rod set for suspension assembly.				
	a) No. of rods per set	No	12		NA
	b) Direction of lay		Right hand		NA
	c) Overall length after fitting the conductor	Mm	2235	2540	NA
	d) Diameter of each rod	mm	9.27		NA

	e) Tolerance in				
	i) Diameter of each rod	mm	±0.10		NA
	ii) Length of each rod	mm	±25		NA
	iii) Difference of length between the longest and shortest rod in a set	mm	±13		NA
	g) Type of Aluminium Alloy used for manufacture of PA rod set.		6061/65032		NA
	h) UTS of each rod	KG / mm (Min)	35		NA
4	a) Particulars of elastomer (for AGS clamp only)		Chloropene Neoprene	NA	NA
	b) Shore hardness of elastomer		65-80	NA	NA
	c) Temperature range for which elastomer is designed.	^{o}C	Upto 95^{o}C	NA	NA
	d) Moulded on insert		Yes	NA	NA
5	Mechanical strength of Suspension fitting excluding suspension clamp	kN	240	240	120
6	Mechanical strength of suspension clamp		70	70	70
7	Purity of Zinc used for galvanizing	%	As per IS:209/IS 13229		
8	Min. No. dips in standard preece test the ferrous parts can withstand.	No.	a) Fasteners : 4 dips of 1 Min b) Spring washers: 3 dips of 1 Min c) All other: 6 dips of 1 Min		

TECHNICAL PARTICULARS FOR TENSION HARDWARE FITTING

Sl. No.	Description	Unit	Particulars/Value	
			Single tension	Quad tension
1	Mechanical strength of tension fittings (excluding dead end clamps)	kN	120	640
2	Type of dead end assembly		Compression	
3	Compression pressure	MT	100	
4	Maximum electrical resistance of dead end assembly as a percentage of equivalent length of Conductor		75	
5	Slip strength of dead end assembly	kN	153.2	
6	Purity of Zinc used for galvanizing	%	As per IS:209/IS:13229	
7	Min. No. of dips in standard preece test the ferrous parts can withstand	No	Fasteners : 4 dips of 1 min Spring washers: 3 dips of 1 min All others: 6 dips of 1 min	

9.0. TESTS:

Following shall constitute the tests to be conducted. The tests shall be conducted as per the relevant IS. These are apart from the visual examination and dimensional verification, which are common tests.

Insulator hardware: IS: 2486 Part-I

I. Type tests:

a) Slip strength test for clamps (where armour rods are used. The test will be conducted with the armour rods installed on the conductor). Clause 5.4.

b) Mechanical tests for clamps Clause 5.5.

c) Electrical resistance test (for tension clamp only) Clause 5.6.

d) Heating cycle test (for tension clamp only) Clause 5.7.

e) Verification of dimensions test Clause 5.8.

f) Galvanizing test IS: 2633 &

g) Mechanical test for the complete String fittings IS: 6745

A double tension / suspension assembly consisting of respective string fittings but excluding clamps shall be mounted in a tensile testing machine.

The assembly then shall be subjected to a tensile load by increasing the load from 0 to 80% of the rated strength of the fittings in a time not exceeding two minutes this load shall be maintained on the assembly for one minute after which the assembly shall be unloaded and dismantled with hand or small hand tools and the string fittings shall be inspected for visual deformation. Should the bolts used in the assembly indicate a mid-point deflection of more than one millimetre with respect to there ends or any difficulty be experienced in dismantling and reassembling the string fittings with hand or small hand tools and / or if there is any visual deformation caused by the application of the above load, the string fittings which exhibit deformation shall be deemed to have failed in this test, if the string fittings can be re-assembled, the assembly shall be again mounted in the testing machine and loaded up to full value of the rated strength in a time; not exceeding two minutes. The load on the assembly shall be continued to be raised up to 110% of the rated strength or **till** breakage occurs whichever is lower. The string fittings shall be deemed to have passed this test if the breakage occurs at a load not lower than their rated strength. The behaviour of the string fittings at loads above their rated strength shall be for the sake of information only.

h) Magnetic power loss test for the suspension clamps:

The test may be conducted on an actual conductor fitted with armour rods of suitable length by differential power loss method making use of low p.f. Wattmeter, current transformer without phase shift and fixed gain differential amplifier. In this method a wheat stone bridge is formed by the conductor and two equal resistances included in the circuit. By using a slider contact on the conductor, the power loss in both the

arms of the conductor can be made equal. Thus initially the bridge is balanced. Introduction of the clamp shifts the balance and the shift is proportional to the power loss introduced by the clamp.

The balance circuit shall be cross-checked by loading a known resistance through a CT in one of the arms.

The test shall be carried out on individual clamp and average values on 3 clamps shall be recorded.

The test shall be conducted at 200, 400, 600 and 144 amps. In the case of each clamp the power loss of each clamp at 600 amps shall be recorded and the power loss of any clamp shall not be more than 13 W. A graph shall be drawn based on the average value of each clamp at 200, 400, 600 and 144 amps. The value of 600 amps taken from the graph shall not exceed 12 watts.

Note: The clamp under test shall consist of components including the bolts up to and excluding yoke plate.

II) Grading / Corona Rings: Type test IS: 2121

a	Mechanical test	The fittings should be rigidly supported. A Load of 150 Kg should be applied and maintained for one minute in the plane of the fittings. The fittings should not fail.
b	Electrical test	The electrical control fitting should be designed to ensure that when incorporated in the insulator set, the specified electrical performance of the set is achieved. There should be no visible discharge at the specified test voltage when tested with complete string.

III)	Test on locking devices for ball and socket couplings of string insulator units	IS: 2486 (P – IV)
	Visual examination test	Clause 3.1
	Verification of dimensions test	Clause 3.2
	Verification of resistance to bending	Clause 3.3
	'R' clips	Clause 3.3.1
	'W' clips	Clause 3.3.2
	Hardness test	Clause 3.4
	Operation test	Clause 3.5
	'R' clips	Clause 3.5.1
	'W' clips	Clause 3.5.2
	Test for resistance to corrosion	Clause 3.6

IV) Complete Insulator Strings IS: 731:

i) TYPE TEST:

a)	Visual discharge test	Clause 10.2.
b]	Lightning impulse voltage dry withstand test	Clause 10.3.
c)	Wet power frequency Voltage withstand test	Clause 10.4.
d]	RIV test	IS: 8263
e]	Switching surge wet withstand test.	IS;8269/ C - 506
f]	Voltage distribution test	

The power frequency voltage distribution across the various discs in the insulators string consisting of 23 discs shall be measured using 25mm diameter spheres with 1; mm gap between them. The flashover voltage of this gap, say 'Vs' is pre-determined. The terminals of the sphere gap shall be connected to the metal fittings of a disc insulator in the string and the voltage across the entire insulator string shall be raised gradually until a flashover takes places across the sphere gap. The procedure shall be repeated with the sphere gap connected across all the discs in the string successively. The values of the voltages E1, E2, E3, En, across the entire string when the sphere gap is connected successively across the 1, 2, 3, nth disc, shall be noted. The voltage W across the nth disc as a percentage of the voltage across the string is given by the relation: Vn = (Vs/En) x 100 percent Max. potential across any disc of the string shall not exceed 9% of the voltage applied across the string. The total of the voltage distribution of all discs so computed shall be within 95% and 105%. If not, the test shall be repeated. The proportionate correction shall be made on the value so as to give a total of 100% distribution.

In addition to above, voltage across the max. stressed insulators so tested above, shall be re-checked by applying 242 +/- 5% KV across the entire string and varying the sphere gap distance to determine percentage voltage distribution.

g) Time load test:

The insulator string shall first be subjected to 5 minute power frequency routine test. After successful completion of this test, the insulator string shall be mounted vertically / horizontally and subjected to a load equal to *66%* of the specified mechanical strength for a duration of 24 Hrs.

After the completion of above period in the string is found to be intact on visual examination, it shall again be subjected to 5 minutes power frequency routine test. The string shall be deemed to have passed the time load test if it successfully withstands 5 minute power frequency routine test.

h) Mechanical strength test:

A double tension / suspension insulator string consisting of the required number of discs and simulated string fittings essential to assemble the strings for; the test shall be mounted in the tensile testing machine.

The string shall then be subjected to a tensile load by increasing the load from 0 to 80% of the E&M strength in a time not exceeding two minutes. This load shall be maintained on the string one minute after which the string shall be unloaded and dismantled with hand or small hand tools and the string components shall be inspected for visual deformation. Should any difficulty be experienced in dismantling and re-assembling the string with hand or small hand tools and / or if there is any visual deformation caused by the application of the above load, the string shall be deemed to have failed in this test.

If the string can be re-assembled, it shall be again mounted in the testing machine and loaded up to full value of its E&M strength in a time not exceeding two minutes. The load on the string shall be continued to be raised up to 110% of E&M value or till breakage occurs whichever is lower. The string; shall be deemed to have passed the test if the breakage across at a load not lower than the E&M strength. The behaviour of the string at loads above E&M strength shall be for sake for information only.

i) Dynamic test:

Complete string is to be subjected to Aeolian vibrations by suitable arrangement, while keeping the tension at every day stress (e.d.s.). The string is proposed to vibrate at frequency and double amplitude as mutually agreed between purchasers and supplied for 10 million cycles. After 5 million cycles, the string shall be rotated 90 degrees in horizontal plane. For single suspension string, the e.d.s. will be 6600 Kg. (For this test instead of double tension, only single tension string will be used). After the completion of test, all discs shall be thoroughly checked for any damage, cracks, loosening of pins / caps. Thereafter, all the discs will be subjected to electrical routine test electromechanical test and porosity test. The string shall be deemed to have passed the dynamic test if it withstood these tests.

In addition to the above, all the type test on all the hard wares for insulators of the same type and make as that is approved to be used for construction of the line shall be repeated after the placement of award, which will be witnessed by the purchaser's representative. The cost for repeating these type tests shall be indicated in the price schedule.

V) Additional tests:

1) The following additional type tests relevant to 400KV Insulator fittings shall be conducted.

a] Visual discharge test (Clause 10.2 of IS: 731)
b] Radio Interference voltage test (IEC-437 or IS:8263)
c] Mechanical strength test for individual components of string insulator units as per IEC-372 (2) or as per ISS:2486, Part-4,.
d] Tests for forgings and fabricated components of hardware.
e] Chemical analysis of Zinc used for galvanizing as per IS: 209.
f] Tensile strength test for armour rod.
g] Corona test for Armour rods.
h) Radio interference test on Armour rods.
I] Slip strength test for Armour rods.

ACCEPTANCE TESTS:

The following shall constitute the Acceptance tests:

i) Clamps:

Verification of dimension
Ultimate strength test
Galvanising test
Electrical test
Heating cycle test

ii) Insulator string fittings:

Verification of dimension
Ultimate strength
Galvanising test.

3) ROUTINE TESTS:

The following shall constitute the Routine test

i) Clamps:

Visual examination
Mechanical routine test on conductor tension clamps

ii) Insulator string fittings:

Visual examination
Mechanical routine tests.

10.0. MARKING (HARDWARE):

The pins, caps, clamps, clips and bolts etc, shall have marked on them the following:
Name or trade mark of the manufacturer, and
Country of manufacturer.

11.0. PACKING:

All insulator hardware shall be packed in suitable crates or boxes with suitable steel bands so as to withstand rough handling and storage at destination. The following shaJI be marked on the crates:
Name of supplier, Destination and consignee, Purchase order number, Laden weight.

For packing hardware, wooden cases shall be employed. The packing shall be fait to withstand rough handling during transit and storage at destination. The leads and threads portions of pins and the fittings shall be properly protected against damage. The gross weight of the packing shall not normally exceed 50 Kg. Different fittings shall be packed in different cases and shall be completed with their minor accessories fitted in place. All nuts shall be hand tightened over the bolts and screwed up to the farthest point.

12.0. DRAWINGS:

The tenderer shall submit detailed drawings showing design and dimensions of the complete strings including arcing horns and corona rings and the design and dimensions of various parts. Full particulars of the conductor clamps shall be given and the nature of the material used for various parts shall be clearly specified either on the drawing or in a separate statement. Drawings equivalent to number of consignees plus six sets extra shall be submitted for approval.

We require the material to the supplied exactly as per Board's drawings and specifications. Hence the tenderers shall clearly indicate whether they are agreeable to supply the materials as per Board's drawings and specifications. It may be noted that the offers, which are not as per Board's drawings and specifications, are liable to be overlooked without further reference.

The list of tender drawings to be submitted is as follows: -

i) Dimensioned assembly drawings of the complete strings with all fittings.

ii) Separate detailed dimensioned drawing for all hardware fittings such as conductor tension clamps, hook, ball clevis, U-clevis, socket clevis, yokes etc.,

GURANTEED TECHNICAL PARTICULARS:

Full guaranteed particulars including dry and wet flashovers, puncture and impulse voltage, corona formation voltages, creepage distances, length, voltage distribution on strings etc., shall be given in the tender. The proforma for guaranteed technical particulars are given in Chapter-VI, the same shall be furnished along with the quotation.

VOLUME-II

CHAPTER-V

PART – F

TECHNICAL SPECIFICATION FOR TRANSMISSION TOWER BOLTS

1.0 SCOPE:

This specification covers design, manufacture, testing at manufacturer's works before despatch, supply and delivery of transmission tower bolts, nuts, step bolts, plain washers and spring washers for 400 KV overhead power lines.

2.0 STANDARDS:

Except as modified by this specification the transmission tower nuts, step bolts, plain washers and spring washers to be supplied shall conform to the latest edition with revisions of the following Bureau of Indian Standards (IS) & British Standards specifications.

IS 209 -	Zinc (Third Revision)
IS 10238	Specification for step bolts for steel structures
IS 12427	Specification for transmission tower bolts (with latest amendments)
IS 14394	Industrial fasteners-hexagon nuts of product grade C- Hot dip galvanized- Specification (size range M12 to M36).
IS 1363 (Part 3)	Hexagon head bolts, screws and nuts
ISO 4034:1986	of product grade C: Hexagon nuts (size range M5 to M64) (Third revision)
IS 1367(Part 1)	Technical supply Conditions for Threaded steel Fasteners: Part 1 Introduction and general information(second revision)
IS 1367(Part 2)	Technical supply Conditions for Threaded steel Fasteners: Part 2 Product grades and tolerances(second revision)
IS 1367(Part 3)	Fasteners- Threaded steel- Technical supply conditions: Part 3 Mechanical properties and test methods for bolts ,screws and studs with full loadability (third revision)
IS 1367(Part 6)	Technical supply Conditions for Threaded steel Fasteners: Part 6 Product grades and Tolerances (second revision)
IS 1367(Part 9/Sec 2)	Fasteners- Threaded steel- Technical supply

ISO 6157-3:1988	Conditions for threaded steel fasteners: Surface discontinuities, Section 2 Bolts, screws and studs for special applications (third revision)
IS 1367(Part 11)	Technical supply conditions for Threaded steel Fasteners- Electroplated coating on Threaded fasteners (second revision)
IS 1367(Part 13)	Technical supply conditions for Threaded steel Fasteners- Hot dip galvanized coatings on Threaded fasteners (second revision)
IS 1367(Part 17)	Fasteners- Threaded steel- Technical supply Conditions : Part 17 Inspection, sampling and acceptance procedure
IS 1367(Part 18)	Fasteners- Threaded steel- Technical supply conditions: Part 18- Packaging
IS 1368:	Dimensions of end of bolts and screws (Second revision)
IS 1369:	Dimensions of screw thread run- outs and Undercuts (Second revision)
IS:2016-	Specification for plain washers (First revision)
IS 2614-	Methods for sampling of fasteners (First revision)
IS 2633	Methods for testing uniformity of coating on zinc coated articles (Second revision)
IS 4218 (Part 1)- ISO 68-1:1998	ISO general purpose metric screw threads- Basic profile (Second revision)
(Part 2)-2001 ISO 261:1998	General plan (Second revision)
(Part 3) -1999 ISO 724:1993	Basic dimensions (Second revision)
(Part 4) -2001 ISO 262:1998	Seleted sizes for screws, bolts and nuts (Second revision)
(Part 5) -1979	Isometric screw threads- Tolerances (First revision)
IS 4218 (Part 6)-	Isometric screw threads-Part 6-Limits of sizes for commercial bolts and nuts(diameter range 1 to 52 mm)-First revision

IS 4759-	Hot dip zinc coating on structural steel and other allied products (Second revision)
IS 1570 (Part I)	Steel specified by tensile and/or yield properties (first Revision) with amendment No.1)
IS -1573	Electroplated coatings of zinc on iron and steel (First revision)
IS 2004	Carbon steel forging for general engineering purposes (2nd revision)
IS 6745	Methods for determination of weight of zinc coating on zinc coated iron and steel articles (with amendment No.1)

DEVIATIONS IN SPECIFICATIONS:

All discrepancies and or deviations in specifications shall be brought out by the bidder and detailed clause by clause in the deviation schedule.

Deviations brought out elsewhere or in any other format will not be considered by the purchaser and are liable for being rejected.

It shall also be by the purchaser in such an event that the bidder has conformed to the clauses in this specification scrupulously.

Deviations in specifications shall if possible be quoted with reference to standards. The bidder shall then furnish an authentic English Version of such standards.

INSPECTION :

The accredited representatives of the purchaser shall have access to the contractor's works at any time during working hours, for the purpose of inspecting the manufacture of the materials and for testing of the selected samples from the materials covered by this specification. The contractor or the sub-contractor shall provide facilities for the above.

Random samples of supplies as per IS 2614/1968 or the latest issue will be tested for quality, workmanship, mechanical strength and Galvanising and supply will rejected, if they fail in the tests. The samples will be subjected to tests as set out in IS 1367-1967 amended upto date.

4.0 Type Tests:

These shall mean those tests which are to be carried out to prove conformity with the specification. These are intended to prove the general qualities and design of a given type of insulator. The Bidders shall enclose the Type test certificates of recent origin (within 5 years on the date of opening of technical bid) from a reputed laboratory for having carried out the type tests.

In addition to furnishing the type test certificates as per specification along with the Bids, the successful tenderer shall repeat all the type test as per the relevant ISS after the placement of award on the same type and make approved for construction of the line which will be witnessed by the purchaser's representative. The cost for repeating these type tests shall be indicated in the price schedule. No material shall be despatched without approval to the acceptance tests.

4.1. The Hot Dip Galvanised Bolts and Nuts shall be subjected to the following Type Tests as set out in the latest issue of IS Specifications specified.

Tensile Test
Proofing load test
Wedge Loading Test
Surface Integrity Test
Vicker's Hardness Test
Head Soundness Test
Mass of Zinc coating Test
Preece Test for Hot Dip Galvanising
Percentage elongation Test
Cantilever Test/permanent Set
Impact Test.

Marking, Sampling, Inspection and Acceptance criteria shall be as stipulated in IS 12427 of latest issue.

The supplier should give the offer for inspection at least 15 days in advance of the actual date of despatch and should despatch only after getting despatch instructions.

4.**3 Acceptance Tests***:* Tests shall be carried out on samples taken from the lot for purpose of acceptance of the lot as per relevant IS. The Contractor shall maintain all test reports of tests conducted during manufacture. These shall be produced for verification as and when requested by the Purchaser.

GURANTEED TECHNICAL PARTICULARS:

The guaranteed technical particulars for the bolts and nuts in a tabular form (Schedule 19) shall be furnished in Chapter-VI along with the quotation.

VOLUME - II

CHAPTER -VI

GUARANTEED TECHNICAL PARTICULARS AND DATA REQUIREMENT SHEETS

SCHEDULE -1

Bidder's Name

Specification No:

1.0 400 KV TOWERS:

1.1. Name of manufacturers and country of origin

Steel (MS/HTS)

Bolts, nuts, step bolts and pack washers

Spring washers

Tower accessories

1.2. Name and address of

Tower Designer

Tower Fabricator

Galvanizer

1.3. Fabricated Tower-Guaranteed Tower Weight (Kgs)

Particulars shall be furnished in Schedu{£-G2

1.4 Sags & Tension

Conductor		Ground wire	
Tension (Kgs)	Sag (M)	Tension (Kgs)	Sag (m)
a) 32° C (Every day temp) and Nil wind			
32° C and Full wind			
32° C and 60% of Full wind			
75°C for conductor/53° C for ground wire and Nil Wind			
5° C (minimum temp) and 36% of Full Wind			

1.5 Standa to which conform

a) Mild steel

b) High tensile steel

c) Zinc

d) Bolts, nuts & Pack washers

e) Spring washers

f) Step bolts

g) Tower accessories

(List the accessories).

1.6 Minimum guaranteed yield stress (Kg/mm^2) corresponding angle sections

Mild steel

High tensile steel

1.7. Maximum allowable stress (Kg/ mm^2)

a) Tension Members (net area)

MS

HTS

b) Compression Members (gross area)

MS

HTS

1.8. Stress on area of class 4.6 & 5.6 Class Bolts and nuts

4.6

5.6

Shear stress on gross area (KG / cm^2)

Bearing stress on gross area (Kg /cm^2)

Bearing stress on Member (Kg/cm^2)

MS

HTS

d) Tension (Kg / cm^2)

1.9. Strut formulae adopted for determining Crippling stress in design.

1.10 Maximum slenderness ratio (KL/ r) Used in design

a) Leg member, ground wire Peak member, lower Member of cross-arms in Compression.

b) Other members carrying computed stress

Redundant members and Those carrying nominal Stress.

Maximum slenderness ratio (KL/r) of a member carrying axial tension only

Size and grade of bolts and corresponding limiting stress for steel section MS HTS

Step Bolt

Size dia (mm)

Overall length (mm)
Length of shank / Unthreaded
portion bolt (mm)
Vertical load with stand capacity
at 115 mm distance

1.14. Minimum thickness of
Leg member, ground wire peak
member, lower members
Other members
1.15 Clearances and tolerances
Minimum ground clearance under
maximum tern & Nil Wind (mm)
Provision for creep compensation
Provision for ground undulation
and sag error (mm)
1.16 Minimum live-metal clearance
Suspension string in still air &
when deflected upto 22° / 24 ° (mm)
Suspension string when deflected
due wind upto 44° / 48° (mm)
Jumper connection on tension tower
in still air & when deflected by
wind upto 20 vertical (mm^2)
Jumper connection on tension tower
when deflected by wind upto 40° from
vertical (mm)
Tension insulator string on tension tower
Jumper connection with pilot string
deflected by wind upto 15°
Minimum mid span clearance between
conductor & ground wire and corresponding
climatic condition
Angle of shield (degree)
Span limit of angle tower with 18m
and 25m body extension and corresponding
available ground clearance
1.20. Minimum clearance for crossing
Overhead power lines

Overhead telecon lines
Railway track
River crossing
Non navigable
Navigable

1.21.Galvanization

a) Method

b) Weight of Zinc [g/M^2]

Steel sections
Bolts and nuts
Spring washers
Pack washers

c) No. of dips of duration

1 Minute
½ Minute

d) Quantityof zinc & standard to which Conforming

1.22. Fabrication tolerances and standard to which conforming

a) Camber (straightness)

b) Allowable taper in Punched holes

c) Overall length of member

d) Consecutive holes

e) First hold and last hold

f) Specified hole diameter punched / drilled

g) Corner cut, notches, flange cut

1.23. Method of bending and bend angle for angle and plates

a) Angle section Up to 75 x 6 mm
Above 75 x 6 mm and up to 100x8 mm
Above 100x8 mm

b) Plates Thickness up to 12mm
Thickness greater than 12mm

1.24. Punching and]
drilling Maximum
thickness for Punching
Drilling
Edge security for rolled and sheared section and bolt

gauges for size of bolts used in fabricated tower
Tower accessories
a) Bird Guards
Governing standards
Bill of material

(Name the components, material
and indicate the quantity against
each)
Dimensioned drawing
enclosed: Yes/No
Galvanization method
and applicable standard
weight of zinc (gm / M^2) /
No. of dips of duration one
minute and half minute
b) **Anti Climbing device**
Governing standards
Bill of material
(Name the components, material and indicate the
quantity against each)
Dimensioned drawing
enclosed: Yes/No
Galvanization method
and applicable standard
weight of zinc (gm / M^2) /
No. of dips of duration one
minute and half minute
Barbed wire
Bolts & Nuts
Spring washers
Structural
c) Number plate / phase plate/
name plate / circuit plate/
danger plate
Governing standards
Bill of material
(Name the components, material and indicate the
quantity against each)
Materials & its thickness

Details of paint (Base coat,
Finish coat)
Dimensioned drawing
enclosed: Yes/No
d) Earthing Device
(i) Pipe Earth
Governing standards
Bill of material
(Name the components, material and indicate
the quantity against each)
Galvanization method and applicable standard
weight of zinc (gm / M^2) /
No. of dips of duration one
minute and half minute
Dimensioned drawing
enclosed: Yes / No

(ii) Counterpoise Earth

Governing standards
Bill of material
(Name the components, material and indicate the quantity against each)
- Galvanization method
and applicable standard
weight of zinc (gm / M^2) /
No. of dips of duration one minute and half minute Details of ground wire and governing standard to be used as counterpoise

1.27 Aviation signaling Devices/Visual Aids.

Governing standard
Bill of material
(Line markers / structure marking / medium flashing light / low intensity red Stationery light) (Name the components, material and indicate the quantity against each)
Candle Power of Medium Flashing Light
Candle power of low intensity Red Stationary Light
Source of power for night marking
Dimensioned drawings of various components enclosed: Yes/No
Details of structure marking (color code, base treatment, type of paint etc.

1.28. Details of packing

Structural Members
Bolts Nuts & Packing washer's
Tower Accessories
Spring washers

2.0 Stringing Procedure

The details of the stringing procedure

proposed the details and number of the tension stringing equipments and all other necessary tools and plants the bidder wishes to deploy for timely completion of the work	Yes/No

3.0 Cement Consumption for Different type of Concrete Mixture

a) For M20 concrete (1:1:5:3 nominal mix.) (Kg/m^3)
b) For M 15 concrete (1:2:4 nominal mix.) (Kg/m^3)
c) For M 10 concrete (1:3:6 nominal mix) (Kg/m^3)
d) For 1:5 random rubble stone masonry (Kg/m^3)

Date:

(Signature)
Place:
(Designation)

(Company seal)

SCHEDULE-2

Bidder's Name;

Specification No:.

GUARANTEED TECHNICAL PARTICULARS OF SUSPENSION HARDWARE FITTINGS

Sl. No.	Description	Unit	Value guaranteed by the bidder
1.0	Name of Manufacturer		
2.0.	Address of Manufacturer	KN	
3.0	Maximum magnetic power loss of suspension assembly at conductor current of 600 amperes		
4.0	Slipping strength of suspension Assembly (clamp torque Vs slip) Curve shall be enclosed)		
5.0	Particulars of 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

6.0 Particulars of Estomer (For AGS Clamp only)

7.0	Supplier of elastomer	**Yes/No**
8.0	Type of elastomer	**Yes/No**
	Shore hardness of elastomer	
	Temperature range for which elastomer is designed.	
	Moulded on inserts	
	UTS of hardware component indicated in the drawings enclosed with the Bid	
	Purity of Zinc used for Galvanizing	%

9.0. Min. no. of dips in standard preece test the ferrous parts can withstand

(Signature)

Date: Place:

(Designation)

(Company seal)

SCHEDULE – 3

Bidder's Name;

Specification No.

GUARANTEED TECHNICAL PARTICULARS OF SUSPENSION HARDWARE FITTINGS

Sl. No.	Description	Unit	Value guaranteed by the bidder
1.0.	Name of Manufacturer		
2.0.	Address of Manufacturer		
3.0	Electrical resistance of dead end assembly as a percentage of equivalent length of conductor	%	
4.0	Slip strength of dead end assembly	KN	
	UTS of hardware component indicated in the drawings enclosed with the Bid	Yes/No	
5.0	Purity of Zinc used for Galvanizing	%	
6.0	Min. no. of dips in standard preece test the ferrous parts can withstand.		

Date: (Signature)

Place:

(Designation) (Common seal)

SCHEDULE-4

Bidder's Name ;

Specification No.

GUARANTEED TECHNICAL PARTICULARS OF MID SPAN COMPRESSION JOINT FOR ACSR 'MOOSE' CONDUCTOR.

S.No.	Description	Unit	Value guaranteed by the bidder
1. 0.	Manufacturer's Name & Address		
			Yes/No
2.0.	Drawing enclosed		
3.0.	Suitable for conductor size	mm	
4.0.	Purity of aluminium used for aluminium sleeve		
5.0	Material for steel sleeve		
(i)	Type of material with chemical		
(ii)	Range of Hardness of material (Brinnel Hardness)		
(iii)	Weight of Zinc coating	gni /m	
6.0	Outside diameter of sleeve before compression		
Aluminium	(mm)		
Steel	(mm)		
7.0	Inside diameter of sleeve before compression		
Aluminium	(mm)		
Steel	(mm)		
8.0	Length of sleeve before compression		
Aluminium	(mm)		
Steel	(mm)		
		From	To

9.0 Dimensions of sleeve after compression

a) Aluminium

i) Corner to corner mm

ii) Surface to surface mm

b) Steel

i) Corner to corner mm

ii) Surface to surface mm

10.0. Length of sleeve after compression

Aluminium (mm) (Kg)

Steel (mm) (kg)

11.0 Weight of sleeve

Aluminium (Kg)

Steel (KN)

Total

12.0 Slip strength

13.0 Resistance of the compressed unit expressed, as percentage of the Resistance of equivalent length of bare conductor

14.0 Minimum Corona extinction voltage under dry condition (KV(rms)

15.0 Radio interference voltage at 1 MHZ for phase to earth voltage of 305 KLV under dry condition Micro-volts

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Date : (Signature)

Place:

(Common seal) Designation

Note: Tolerence, wherever applicable shallso be specified.
Also be specified.

SCHEDULE – 5

Bidder's Name ;

Specification No;

GUARANTEED TECHNICAL PARTICULARS OF REPAIR SLEEVE FOR ACSR 'MOOSE' CONDUCTOR.

SI.No.	Description	Unit	Value guaranteed by the bidder
1,0.	Manufacturer's Name & Address		
2.0.	Drawing enclosed		Yes/No
3.0.	Suitable for conductor size	(mm)	----------
4.0.	Purity of aluminium Inside	(mm)	
5.0	Diameter of sleeve before compression		
6.0	Outside dimensions of sleeve		
	a) Diameter before compression	(mm)	
	b) After compression	(mm)	
	i) Corner to corner	(mm)	
	ii) Surface to surface	(mm)	
7.0	Length of sleeve		
	a) Before compression	(mm)	
	b) After compression	(mm)	
8.0	Weight of sleeve	(Kg/rms)	
9.0	Minimum Corona extinction voltage under dry condition	(KV (rms)	
10.0	Radio interference voltaae at 1 MHZ for phase to earth voltage of 305 KV under dry condition	Microvolts	

Date : (Signature)

Place :

(Designation)(Common seal)

NOTE: Tolerances, wherever applicable, shall also be specified.

SCHEDULE - 6

Bidder's Name;

Specification No:.....

GUARANTEED TECHNICAL PARTICULARS OF MID SPAN COMPRESSION JOINT FOR GALVANISED STEEL EARTHWIRE

SI. No.	Description	Unit	Value guaranteed by the bidder
	Manufacturer's Name & Address		
	Drawing enclosed		Yes/No
	Material of Joint		
	(i) Type of material with chemical composition		
	(ii) Range of Hardness of the Steel sleeve (Brinnel hardness)		From to
4.	Inside diameter of sleeve before compression		
(i)	Steel sleeve	(mm)	
(ii)	Aluminium sleeve	(mm)	
(iii)	Aluminium sleeve	(mm)	
5.	**Outside dimensions of sleeve**		
i)	Steel sleeve	(mm)	
ii)	Aluminium sleeve	(mm)	
iii)	Aluminium filler sleeve	(mm)	
6.	**Outside dimensions of sleeve after compression**		
(a)	Steel sleeve		
i)	Corner to comer	(mm)	
ii)	Surface to surface	(mm)	
(b)	Aluminium cover		
i)	Corner to corner	(mm)	
ii)	Surface to surface	(mm)	
7.	Length of steel sleeve		
(a)	Before compression	(mm)	
(b)	After compression	(mm)	
8.	Length of Aluminium sleeve		
(a)	Before compression	(mm)	
(b)	After compression	(mm)	

9. Weight of sleeve

   a) Steel (Kg)

   b) Aluminium (Kg)

   c) Aluminium filter sleeve (Kg)

10. Slip strength (kN)

11. Resistance of the compressed unit expressed as a percentage of the Resistance of equivalent length of bare earth wire *(%)*

Date :
Place:

(Signature)

(Designation)

(Common seal)

NOTE: Tolerances, wherever applicable, shall also be specified.

SCHEDULE- 7

Bidder's Name;
Specification No:.....

GUARANTEED TECHNICAL PARTICULARS OF FLEXIBLE COPPER BOND

SI. No.	Description	Unit	Value guaranteed by the Bidder
01.	Manufacturer's Name and Address.		
02.	Drawing enclosed		**Yes/No**
03.	Stranding		
04.	Cross sectional area	**Sq.mm**	
05.	Minimum copper equivalent area	**Sq.mm.**	
06.	Length of copper cable	**mm.**	
07.	Material of lugs		
08.	Bolt Size		
	(i) Diameter	**mm.**	
	(ii) Length	**mm.**	
09.	Resistance	ohm	
10.	Total weight of flexible copper bond	**Kg.**	

Date: (Signature)
Place: (Designation)
(Common Seal)

Note: Tolerances, wherever applicable, shall also be specified.

SCHEDULE- 8

Bidder's Name;

Specification No: .....

GUARANTEED TECHNICAL PARTICULARS OF VIBRATION DAMPER FOR ACSR " MOOSE" CONDUCTOR.

Sl. No.	Description	Unit	Value guaranteed by the Bidder
01.	Manufacturer's Name and Address		
02.	Drawing enclosed		
	a) Design drawing		Yes/No
	b) Placement chart		Yes/No
03.	Suitable for conductor size	(mm)	
04.	Total weight of one damper	**(kg)**	RIGHT LEFT
05.	Diameter of each damper mass	(mm)	
06.	Length of each damper mass	(mm)	
07.	Weight of each damper mass	(kg)	
08.	Material of damper masses		
09.	Material of clamp		
10.	Material of the stranded messenger cable		
11.	Number of strands in stranded messenger cable		
12.	Lay ratio of stranded messenger cable		
13.	Minimum ultimate tensile strength of stranded messenger cable	(Kg/mm^2)	
14.	Slip strength of stranded messenger cable (mass pull off)	(KN)	

15.	Resonance frequencies		RIGHT	LEFT
	(a) First frequency	(Hz)		
	(b) Second frequency	(Hz)		
16.	Designed clamping torque	(Kg-m)		
17.	Slipping strength of damper clamp			
	(a) Before fatigue test	(kN)		
	(b) After fatigue test	(kN)		
18.	Magnetic power loss per vibration damper for 600 amps, 50 Hz Alternating Current	(watts)		
19.	Minimum corona Extinction voltage under dry condition	KV (rms)		
20.	Radio Interference Voltage at 1 MHz for phase to earth voltage of 305 kV (rms) under dry condition	Micro-volts		
21.	Percentage variation in reactance after fatigue test in comparison with that before fatigue test .	%		
22.	Percentage variation in power dissipation after fatigue test in comparison with that before fatigue test	%		

Date: (Signature)

Place: (Designation)

(Common Seal).

Note: Tolerances, wherever applicable, shall also be specified.

SCHEDULE – 9

Bidder's Name;

Specification No:.....

GUARANTEED TECHNICAL PARTICULARS OF VIBRATION DAMPER FOR GALVANISED STEEL EARTHWIRE

Sl. No.	Description	Unit	Value guaranteed by the Bidder
01.	Manufacturer's Name and Address		
02.	Drawing enclosed		
	(a) Design drawing		Yes/No
	(b) Placement chart		Yes/No
03.	Suitable for conductor size	(mm)	
04.	Total weight of one damper	(kg)	
05.	Diameter of each damper mass	(mm)	
06.	Length of each damper mass	(mm)	
07. 07	Weight of each damper mass	(mm)	
08	Material of damper masses		
09.	Material of clamp		
10.	Material of the stranded messenger cable		
11.	Number of strands in stranded messenger cable		
12.	Lay ratio of stranded messenger cable		
13.	Minimum ultimate tensile strength of stranded messenger cable	(Kg/mm^2)	
14.	Slip strength of stranded messenger cable (mass pull off)	(kN)	

15.	Resonance frequencies		RIGHT	LEFT
	a) First frequency	(Hz)		
	b) Second frequency	(Hz)		
16.	Designed clamping torque	(Kg-m)		
17.	Slipping strength of damper clamp			
	a) Before fatigue test	(kN)		
	b) After fatigue test	(kN)		
18.	Percentage variation in reactance after fatigue test in comparison with that before	± %		
19.	Percentage variation in power dissipation after fatigue test in comparison with that before fatigue test	±%		

Date:

Place: (Signature

(Designation)

(Common Seal)

Note: Tolerances, wherever applicable, shall also be specified.

SCHEDULE-10

Bidder's Name;

Specification No: .....

GUARANTEED TECHNICAL PARTICULARS OF BUNDLE SPACER FOR LINE FOR ACSR 'MOOSE' CONDUCTOR

Sl.No.	**Description**	**Unit**	**Value guaranteed by the Bidder**
01	Manufacturer's Name and Address		
02.	Drawing enclosed		
	(a) Design drawing		Yes/No
	(b) Placement chart		Yes/No
03.	Suitable for Earthwire size	(mm)	
04.	Material of component parts a) Insert b) Mainbody c) Retaining rods (if any)		
05.	Manufacturing process for a) Insert b) Mainbody c) Retaining rods (if any)		
06.	Retaining rods (if used) a) Type of alloy used b) Number of retaining rods used for each spacer c) Diameter d) Length e) Weight	(mm) (mm) **(kg)**	
07.	Elastomer a) Supplier b) Type c) Moulded on insert d) Shorehardness e) Thickness on insert f) Temp, range for which designed	(mm) (°C)	

08.	Minimum ultimate tensile strength of spacer (a) Compressive load (b) Tensile load	(kN) (kN)	
09.	Weight of spacer	(kg)	
10.	Designed clamping torque (if applicable)	(kg.m)	
11.	Slipping strength of spacer clamp (a) Before vibration test (b) After Vibration test	(kN) (kN)	
12.	Magnetic power loss per spacer for 600 Amps. 50 Hz Alternating Current	Watts	
13.	Electrical resistance of elastomer cushioned spacer (a) Maximum (b) Minimum	(ohm) (ohm)	
14.	Minimum corona extinction voltage (phase to earth) under Dry condition'	KV(rms)	
15.	Radio interference voltage at 1 MHz for phase to earth voltage of 305 kV under dry condition.	Microvolts	

Date: (Signature).

Place:

(Designation).

(Common Seal).

Note: Tolerances, wherever applicable, shall also be specified.

SCHEDULE - 11

Bidder's Name

Specification No: .....

GUARANTEED TECHNICAL PARTICULARS OF BUNDLE SPACER FOR JUMPER FOR ACSR MOOSE' CONDUCTOR

Sl. No.	Description	Unit	Value guaranteed by the Bidder
01.	Manufacturer's Name and Address		
02.	Drawing enclosed		
	a) Design drawing		Yes/No
	b) Placement chart		Yes/No
03.	Suitable for Conductor size	(mm)	
04.	Material of component parts (indicate i.e of alloy) a) Insert b) Main body		
05.	Manufacturing process for a) Insert b) Main body		
06.	Elastomer a) Contractor b) Type c) Moulded on insert d) Shore hardness e) Thickness on insert f) Temp, range for which designed	 (mm) (deg C)	

07.	Minimum ultimate tensile strength of spacer (a) Compressive load (b) Tensile load	(kN) (kN)	
08.	Weight of (a) Spacer for jumper	(kg)	
09.	Slipping strength of spacer clamp (a) Before vibration test (b) After vibration test	(kN) (kN)	
10.	Magnetic power loss per spacer for 600 Amps. 50 Hz Alternating Current	Watts	
11.	Electrical resistance of elastomer cushioned spacer		
12.	Minimum corona extinction voltage (phase to earth) under	KV (rms)	
13.	Radio interference voltage at 1 MHz for phase to earth voltage of 305 kV under dry condition.	Microvofts	

Date: (Signature)

Place: .

(Designation).

(Common Seal).

Note: Tolerances, wherever applicable, shall also be specified.

SCHEDULE- 12

Bidder's Name

Specification No: .....

GUARANTEED TECHNICAL PARTICULARS FOR SUSPENSION CLAMP FOR GALVANISED STEEL EARTHWIRE

Sl. No.	**Description**	**Unit**	**Value guaranteed by the Bidder**
01.	Manufacturer's Name		
02.	Drawing enclosed		
03.	Material a) Shackle b) Clamp Body & Keeper c) U-Bolt		
04.	Total drop (maximum)	(mm)	
05.	Weight	**(Kg)**	
06.	Breaking Strength (minimum)	**(Kgf)**	
07.	Slipping Strength	**(KN)**	
08.	Tightening Torque	(kg-m)	

Date: (Signature)

Place: (Designation)

(Common Seal).

Note : Tolerances, wherever applicable, shall also be specified.

SCHEDULE- 13

Bidder's Name;

Specification No: .....

GUARANTEED TECHNICAL PARTICULARS OF TENSION CLAMP FOR GALVANISED STEEL EARTH WIRE

Sl. No.	Description	Unit	Value guaranteed by the Bidder
01.	Manufacturer's Name		
02.	Drawing enclosed		Yes/No
03.	Material a) shackle **ii)** a) Compression clamp b) Hardness of the material (BHN)		
04.	Inside diameter of the sleeve before compression (i) Steel sleeve (ii) Aluminium sleeve (iii] Aluminium sleeve	**(mm)**	
05.	Outside dimensions of sleeve (a) Before compression i) Steel Sleeve ii) Aluminium sleeve iii) Aluminium filler sleeve	**(mm)** **(mm)**	
	(b) After compression		

	(I) Steel Sleeve (i) Corner to corner (ii) Surface to surface (II) Aluminium Sleeve (i) Corner to Corner (ii) Surface to surface	**(mm)** **(mm)** **(mm)** **(mm)** **(mm)** **(mm)**	
06.	Length of steel sleeve a) Before compression b) After compression	(mm) (mm)	
07.	Length of Aluminium sleeve a) Before Compression b) After compression	(mm) (mm)	
08.	Weight	(Kg)	
09.	Slip strength (minimum)	(kN)	
10.	Compression Pressure	(T)	
11.	Minimum Breaking strength of assembly (excluding clamp)	(kgf)	

Date: **(Signature)**

Place:

(Designation)

(Common Seal)

Note: Tolerances, wherever applicable, shall also be specified.

SCHEDULE-14

Bidder's Name;

Specification *No: .....*

GUARANTEED TECHNICAL PARTICULARS OF G.S.EARTHWIRE

SI. **No.**	Description	Unit	Particulars
01.	Name & Address of Manufacturer		
02.	Particulars of Raw Materials		
2.1.	Steel Wires/Rods a) Carbon b) Manganese c) Phosphorous d) Sulphur e) Silicon	 % % % % %	
2.2.	Zinc Minimum purity of Zinc	 %	
3.	STEEL STRANDS AFTER STRANDING		
3.1.	Diameter a) Nominal b) Maximum c) Minimum	 mm mm mm	
3.2.	Minimum breaking load of Strand	KN	

3.3.	Galvanising: a) Minimum weight of zinc coating per Sq.M. b) Minimum number of one minute dips that the galvanized strand can withstand in the standard preece test c) Minimum no. of twists in gauge length equal 100 times the dia. Of wire which the strand can withstand in the	Gm.	
4.0.	STRANDED EARTHWIRE		
4.1.	UTS of earthwire	KN	
4.2.	Lay length of outer steel layer	mm	
4.3.	DC resistance of earthwie at 20° C	Ohm/km	
4.4.	Standard length of earthwire	m	
4.5.	Tolerance on standard length	±m	
4.6.	Direction of lay of outer layer		
4.7.	Linear mass of earthwire a) Standard b) Minimum c) Maximum	Kg/km Kg/km Kg/km	
5.0.	Drum is as per specification		Yes/No.

Date: (Signature)

Place: .

(Designation).

(Common Seal).

Note: Tolerances, wherever applicable, shall also be specified.

SCHEDULE-15

Bidder's Name;

Specification No:... .....

GUARANTEED TECHNICAL PARTICULARS OF ACSR 'MOOSE' CONDUCTOR

SI. No.	Description	Unit	Particulars
01.	Name & Address of Manufacturer		
02.	PARTICULARS OF RAW MATERIALS		
2.1.	Aluminium a) Minimum Purity of aluminium b) Maximum Copper content	% % 	
2.2.	Steel Wires/Rods a) Carbon b) Manganese c) Phosphorous d) Sulphur e) Silicon	% % % % %	
2.3.	Zinc Minimum purity of Zinc	%	
03.	ALUMINIUM STRANDS AFTER STRANDING		
3.1.	Diameter a) Nominal b) Maximum c) Minimum	mm mm mm	
3.2.	Minimum breaking load of strand	KN	
3.3.	Maximum resistance of 1 m length of strand at 20° C	Ohm	
04.	STEEL STRANDS AFTER STRANDING		

4.1.	Diameter a) Nominal b) Maximum c) Minimum	mm mm mm	
4.2.	Minimum breaking load of strand	KN	
4.3.	Galvanising a) Minimum weight of zinc coating per sq.m. of uncoated wire surface. b) Minimum number of one minute dips that the galvanized strand can withstand in the standard preece test c) Minimum no. of twists in gauge length equal to100 times the dia. Of wire which the strand can withstand in	gm. Nos. Nos.	
5.0.	ACSR CONDUCTOR		
5.1.	UTS of conductor	KN	
5.2.	Lay ratio of conductor a) Outer steel layer b) 12 wire aluminium layer c) 18 wire aluminium layer d) 24 wire aluminium layer		
5.3.	DC resistance of conductor at 20° C.	Ohm/km	
5.4.	Minimum Corona Extinction voltage (line to ground) (a) Dry	KV (rms)	
5.5.	RIV at 1 MHz a) at 305 kV (rms) under dry conditions Microvolts		
5.6.	Standard length of conductor	M	

5.7	Maximum length of conductor that can be manufactured	M	
5.8.	Tolerance on standard length	%	
5.9.	Direction of lay of outer layer	NA	
5.10.	Linear mass of earth wire a) Standard b) Minimum c) Maximum	 Kg/km Kg/km Kg/km	
6.0.	Drum is as per specification.		Yes / No. I
7.0.	Material of Drum		Steel / Wood
8.0	No. of cold pressure butt welding equipments available at works	Nos.	

(Signature)

(Designation)
(Common Seal).
Note: Tolerances, wherever applicable, shall also be specified.

SCHEDULE – 16

GUARANTEED TECHNICAL PARTICULARS OF DISC INSULATOR UNITS

Sl. No	Description	Unit	90KN Standard Disc	120KN Standard Disc	160 KN Standard Disc
1	Name of the manufacturer				
2	Address of manufacturer				
3	Weight of Single Disc	Kg			
4	Size and Designation of pin ball shank	mm			
5	Diameter of disc	mm			
6	Tolerance on diameter	±mm			
7	Ball to ball spacing between disc	mm			
8	Tolerance on spacing	±mm			
9	Minimum nominal creepage distance of single disc	mm			
10	Tolerance on creepage distance	+mm			
11	Electromechanical strength of disc	KN			
12	Material of Shell (Porcelain /Toughened glass)				
13	Head thickness of shell with tolerance	mm			

14.	Power frequency flashover voltage of single disc (a) dry (b) wet	KV (rms) KV (rms)			
15.	Power frequency withstand voltage of single disc (a) dry (b) wet	KV (rms) KV (rms)			
16.	Power frequency puncture voltage of single disc	KV (rms)			
17.	Impulse flashover voltage of single disc (dry) a) Positive b) Negative	KV (peak) KV (peak)			
18.	Impulse withstand voltage of single disc (dry) (a) Positive (b) Negative	KV (peak) KV (peak)			
19.	Steepness of impulse voltage which the disc insulators can withstand in steep	KV/ microsec.			
20.	Visible discharge test of single disc (dry)	KV (rms)			
21.	Maximum RIV at 1 MHZ and 10kV AC (rms) voltage of single disc	Microvolts			
22.	Purity of zinc used for galvanizing				

23.	No. of dips in standard preece test a) Socket b) Ball pin				
24.	Axial and Radial run out (According to EC) a) As per pointer A b) As per pointer B	 mm mm			
25.	**Drawings enclosed**	**Yes / No**			

Date: (Signature).

Place:

(Designation).

(Common Seal).

Note: Tolerances, wherever applicable, shall also be specified.

SCHEDULE-17

Bidder's Name:

Specification No.

GUARANTEED TECHNICAL PARTICULARS OF INSULATOR STRINGS (WITH DISC INSULATORS) ALONGWITH HARDWARE FITTINGS FOR 400KV LINE

Sl. No.	Description	Unit	Single I /Dual I suspension (1x23)	Double tension (2x24)/ Quad Tension 4x24	Single I suspension Pilot (1x23)
01.	Power frequency withstand voltage of string with acring horns and corona control rings / grading rings under wet condition.	KV(rms)			
02.	Switching Surge Withstand Voltage (Wet) a) Positive b) Negative	KV (Peak) KV (Peak)			
03.	Impulse withstand voltage (dry) a) Positive b) Negative	kV (Peak) kV (Peak)			
04.	Impulse flashover voltage (dry) a) Positive b) Negative	KV (Peak) KV (Peak)			
05.	Minimum Corona extinction voltage under dry condition	KV (rms)			
06.	RIV at 1 MHZ when the string is energized at 305 kV (rms) under dry condition	Micro-volts			
07.	Mechanical Strength of complete insulator string alongwith hardware fittings	KN			
08.	Maximum voltage distribution across any disc of line to earth voltage	%			
09.	Dimensioned drawings of insulator strings enclosed	Yes / No			

Date:

Place: (Signature).

(Designation).

(Common Seal).

Note: Tolerances, wherever applicable, shall also be specified.

SCHEDULE OF GUARANTEED TECHNICAL PARTICULARS (GTP) FORMS

The following sets of GUARANTEED TECHNICAL PARTICULARS (GTP) FORMS are required to be filled up by the bidders to aid in the evaluation process. The response shall be brief and to the point and shall be supported by the printed product description and other literature.

7-1 GTP Form 1; GUARANTEED TECHNICAL PARTICULARS (GTP) Forms for Fibre Optic Cabling:

GTP Forms I-A (OPGW), and I-B (ADSS) shall be completed for each cable type to be supplied by the Bidder. The tables provide optical fibre mechanical, and physica1 parameters of the cables as well as information on spooling, packaging and installation. A form shall be completed for each type of cable and each cable configuration (12-fibre / 24-fibre).

GTP Forms I-C Fibre Optic Distribution Panels (FODP) shall be completed for each size and type of FODP proposed to be supplied by the Bidder. The table provides the mechanical and physical parameters of the FODP(s).

7-2 GTP Form 2; GUARANTEED TECHNICAL PARTICULARS (GTP) FORMS for Optical Fibre:

GTP Form 2-A (Dual-window Single Mode) shall be completed by the Bidder as applicable. The tables shall define the optical, physical and mechanical properties of the optical fibres to be provided. GTP Form 4; GUARANTEED TECHNICAL PARTICULARS (GTP) FORMS for

Inside Cable Plant:

GTP Form 4 shall be completed by the Bidder providing electrical, physical and mechanical details of the proposed Digital Distribution Frames, Main Distribution Frames and patching facilities as applicable to equipment to be supplied.

GTP Form 1-A

GUARANTEED TECHNICAL PARTICULARS for FIBRE OPTIC CABLING

OPTICAL GROUND WIRE (OPGW):

Manufacturer:

Part #:	**CABLE CONSTRUCTION**		
Seq.	Parameter:	Unit:	Particulars:
1.	No. of Fibres Dual Window Single-Mode:	Each	
2.	Fibre Manufacturer Dual Window Single-Mode:		
3.	Buffer Type:		
4.	Buffer Tube Diameter:	mm	
5.	Buffer Tube material		
6.	No. of Buffer Tubes:	Each	
7.	No. of Fibers per Tube:	Each	
8.	Identification/numbering of Individual tubes:		
9.	No. of empty tubes (If any):	each	
10.	Filling material:		
11.	Filling material compliant with Technical specifications?	Yes/No	
12.	Strength member(s):		
13.	Binding yarn/tape:		

14. Describe central core design

Date: Signature:

Place: Name:

Seal Designation:

GTP Form 1-A (Continued)

GUARANTEED TECHNICAL PARTICULARS FOR FIBRE OPTIC CABLING(OPGW):

Seq.	Parameter:	Unit:	Particulars:
15.	20 % Aluminum Clad steel wire Diameter: Number:	mm each	
16.	Aluminium alloy wires Diameter: Number:	mm each	
17.	Stainless steel/Aluminium tube Diameter:	mm	
18.	Approximate outside diameter:	mm	
19.	Cable Diameter: (nominal ± deviation)	mm	
20.	Cable cross-section area:	mm^2	
21.	Jacket thickness: nominal ± deviation):	mm	
22.	Jacket non-circularity:	%	
23.	Rip-cord provided?	Yes/No	
24.	Fully compliant with IEEE P1138:	Yes/No	

Mechanical Properties of Cable

25.	Max. breaking load/Ultimate Tensile strength(UTS)		
26.	Fibre strain Margin		
27.	Weight	Kg/Km.	
28.	Crush strength	Kg/m^2	
29.	Modulus of elasticity	KN/mm^2	

Date: Signature:

Place: Name:

Seal Designation:

GTP Form 1-A (Continued)

GUARANTEED TECHNICAL PARTICULARS For FIBRE OPTIC CABLING(OPGW):

Seq.	Parameter:	Unit:	Particulars:
30.	Minimum Bending Radius without Micro-bending:	mm	
31.	Maximum Bending Radius: Short Term: Long Term (Continuous):	mm	
32.	Tensile proof test (Screening) Level:	KN/mm^2	
33.	Maximum permissible tensile Stress:	KN/mm^2	
34.	Permissible CTS. tensile stress:		
35	Maximum sag at 0*C 400m span with no wind	mm	
36.	Everday tension at 32 ^{0} C, no Wind:	%of UTS	

Thermal Properties of Cable

38.	Coefficient of linear expansion:	per ^{0}C	
39.	Coefficient of expansion Cladding: Core:	per ^{0}C	
40.	Nominal operating temperature:		
41.	SC current transient peak temperature:		
42.	Maximum allowable temperature for lightening strike:		

Date: Signature:

Place: Name:

Seal: Designation:

GTP Form 1-A (Continued)

GUARANTEED TECHNICAL PARTICULARS FOR FIBRE OPTIC CABLING OPTICAL GROUND WIRE (OPGW):

CABLE SPOOL and DRUM			
Seq.	Parameter:	Unit:	Particulars:
43.	Available length per spool Maximum: Nominal:	Mtrs.	
44.	Size of drum:	Mtrs	
45.	Weight of empty drum:	Kg	
46.	Weight of drum with Cable :spooled	Kg.	
47.	Will drum length scheduling be practiced to match transmission line span lengths	Yes/No.	

Describe Drum materials

Describe cable end capping and protection against abrasion etc.,:

Date: Signature:

Place: Name:

Seal Designation:

GTP Form 1-A (continued)

GUARANTEED TECHNICAL PARTICULARS for FIBRE OPTIC CABLING (OPGW):

INSTALLATION			
Seq.	Parameter:	Unit:	Particulars:
50.	Splice Loss: Maximum: Average:	dB dB	
51.	Operating Temperature Range:	^{0} C	
52.	Rated lsoceraunic No.		
53.	Expected Cable Life:	Years	
54.	Installation rate per team:	km/day	
55.	No. of persons per team:		
56	Max. possible span for Specified operating Conditions:	m	
57.	Midspan sag at O°C with no wind loading:	mm	
58.	Midspan sag at max temp. and wind loading	mm	
59.	Cable swing angles: Worst Case: Every day:		

60. Describe Installation method(s):

Date: Signature:

Place: Name:

Seal Designation:

GTP Form 1-B

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

CABLE CONSTRUCTION			
Seq.	Parameter:	Unit:	Particulars:
1.	No. of Fibres Dual Window Single-Mode:	Each	
2.	Buffer Type:		
3.	Buffer Tube Diameter:	mm	
4.	Buffer Tube material		
5.	No. of Buffer Tubes:	each	
6.	No. of Fibers per Tube:	each	
7.	Identification/Numbering of Individual tubes:		
8.	No. of empty tubes(if anv):	Each	
9.	Filling material:		
10.	Filling material compliant with Technical specifications?	Yes/No	
11.	Strength member(s):		
12.	Binding yarn tape:		

13. Describe Central Core Design:

Date: Signature:

Place: Name:

Seal Designation:

GTP Form 1-B (Continued)

GUARANTEED TECHNICAL PARTICULARS for FIBRE OPTIC CABLING(ADSS)

CABLE CONSTRUCTION			
Seq.	Parameter:	Unit:	Particulars:
14.	Outside jacket coating (if any):		
15.	Jacket thickness:(nominal ± deviation):	mm	
16.	Jacket non-circularity:	%	
17.	Cable Diameter:(nominal ± deviation)	mm	
18.	Cable cross-section area:	mm^2	
19.	Rip-cord provided?	Yes/No	
20.	Fully Compliant with IEEE P1138:	Yes/No	

MECHANICAL PROPERTIES OF CABLE

21.	Max. breaking load/ Ultimate Tensile Strength(UTS)		
22.	Fibre strain margin:		
23.	Weight:	Kg/km	
24.	Crush strength:	Kg/m2	
25.	Modulus of elasticity:	KN/mm^2	
26.	Minimum Bending Radius: Short Term: Long Term (Continuous):	Mm	
27.	Tensile proof test (Screening) level:		
28.	Maximum permissible tensile stress:		
29.	Everyday tensile stress:		
30.	Torsion:	twist/ m	

GTP Form 1-B (Continued)

GUARANTEED TECHNICAL PARTICULARS for FIBRE OPTIC CABLING (ADSS)

CABLE SPOOL and DRUM			
Seq.	Parameter:	Unit:	Particulars:
31.	Available length per spool Maximum: Nominal:	Mtrs	
32.	Size of drum:	mtrs	
33.	Weight of empty drum:	kg	
34.	Weight of drum with cable: spooled	kg	
35.	Will length scheduling be Practiced to match Transmission line span Lengths?	Yes/No	

Describe Drum Materials:

37. Describe Cable end capping and protection against abrasion etc.,:

Date: Signature:

Place: Name:

Seal Designation:

GTP Form 1-B (continued)

GUARANTEED TECHNICAL PARTICULARS for FIBRE OPTIC CABLING (ADSS)

INSTALLATION			
Seq.	Parameter:	Unit:	Particulars:
38.	Splice Loss: Maximum: Average:	 dB dB	
39.	Operating Temperature Range:	^{0} C	
40.	Rated Isoceraunic No.		
41**.**	Expected Cable Life:	Years	
42.	Installation rate per team:	Km/day	
43.	No. of persons per team:		
44.	Max. possible span for Specified operating Conditions:	M	
45	Mid span sag at 0 ^{0} C with no wind loading	mm	
46	Mid span sag at maximum Temp. and wind loading	mm	
47	Cable swing angles: Worst case: Everyday:		

48. Describe Installation method(s):

Date: Signature

Place: Name

Seal Designation

GTP Form 1- C.

GUARANTEED TECHNICAL PARTICULARS for OPTICAL FIBRE DISTRIBUTION PANEL (FODP)

Manufacturer:

Model #:

Seq.	Parameter:	Unit:	Particulars:
1.	Dimensions H * W * D:	Cm	
2.	Weight:	Kg	
3.	Colour and Finish:		
4.	Cable Glanding:		
S.	Construction materials & Guage:		
6.	Locking arrangements:		
7.	Installation Clearances Front Access: Rear Access: Top* Bottom * Sides:	Cm	
8.	Total number of optical couplings:	Ea	
9.	Method(s) for mounting:		

Optical Fibre Cable Accommodations

10.	Cable Glanding:	
11.	Maximum number of cables that can be accommodated:	Each

Describe cable entries:

Date: Signature:

Place: Name :

Seal: Designation:

GTP Form 1- C (Continued)

GUARANTEED TECHNICAL PARTICULARS for OPTICAL FIBRE DISTRIBUTION PANEL (FODP)

Seq.	Parameter:	Unit:	Particulars:
Cable Termination Splice Accommodations:			
13.	Maximum number of splice trays:	Ea	
14.	Number of splices per tray:	Ea	

GTP Form 2-A

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

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

Date: Signature:
Place: Name:
Seal: Designation:

GTP Form 2-A (Continued)

GUARANTEED TECHNICAL PARTICULARS for OPTICAL FIBRE (DW-SM)

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

Date: Signature:

Place: Name: Seal:

Designation:

SCHEDULE- 19

Bidder's Name
Specification No:

GUARANTEED TECHNICAL PARTICULARS OF HOT DIP G.I BOLTS & NUTS

SI. No.	Description	Unit	Value guaranteed by the Bidder

Date: (Signature)
Place: (Designation)
(Common Seal)
Note: Tolerances, wherever applicable, shall also be specified.

GENERAL NOTES FOR FILLING THE PRICE SCHEDULE

1. The price quoted shall include cost of materials and works mentioned therein. The rates for all items shall be quoted without fail.
2. No separate price shall be quoted for testing and commissioning of the line.
3. No separate rates shall be quoted for the tools and plants required for the erection work. The successful bidder at his own cost shall arrange these.
4. The TNRDC reserves the right to place orders on one or more than one firm to meet the Completion requirements.
5. The General assembly drawings, BOM, shop floor drawings for towers and foundation drawings will be furnished to the successful tenderer for manufacturing the required number of towers, extensions and also to carry out the tower foundations. In case any other foundations required to be executed to suit the site conditions shall have to be designed by the successful tenderer and the detailed design along with the drawings submitted for approval before execution of works. Also transposition arrangements if any required, has to be designed by the successful tenderer and the detailed design along with the drawings submitted for approval before execution of works.
6. The price quoted shall be firm for the entire period of contract and any agreed extensions thereto. Variable prices if quoted will not be accepted and such bids will be SUMMARILY REJECTED. The price break up details shall be furnished for the supply of all materials including bought out items , so that any statutory variations within the delivery period may be borne by TNRDC. The benefit under CGST scheme if any shall be taken into account while quoting the rates. The bidders are requested to indicate in the offer the rate of GST. **The GST quoted will also be included for the purpose of evaluation.**

In case any bidder quotes as the rates is inclusive of GST or not mentioning about the GST, it will be construed that the rate quoted is inclusive of applicable GST and the rates will be back worked and the prevailing tax will be deducted from the running bills. The GST so deducted will be admitted and paid on production of documentary evidences as mentioned in the commercial specifications.

7. **Additional quantity:** Additional quantity when exceeds more than 25% of the scheduled quantity in any item due to various technical parameters, the tenderer should offer a rebate on the quoted rate in the tender itself for that exceeded quantity. The above rebate will not be considered for bid evaluation. The rates payable for such extra quantities beyond 25% of the scheduled quantities shall be at the rate after deducting the rebate.
8. Price details for all the items indicated in Price schedules and summary of schedule shall be furnished. Tender evaluation will be done for the total lump sum Contract value only including GST. The length of the line and alignment shown is based on the actual survey done. Based on the above, the quantities like number,

type of towers, weight, volume of excavation, concrete, hardware etc. worked out & indicated in the schedules. The General assembly drawings, BOM for towers and foundation drawings will be furnished to the successful tenderer. The actual quantities shall be based on the detailed check survey to be carried out. The tender scope shall include all the items essentially required for the Line commissioning whether mentioned in the schedules attached or not.

Payment will be made to the actual quantities executed as necessitated by the detailed check survey and as approved by the Engineer & based on the unit rate quoted and accepted in price schedules.

9. The rates and prices shall be written both in FIGURES and WORDS.

10. Where there is any discrepancy between the rates quoted in figures and words, the lower of the two shall be considered.

11. Various items of the SCHEDULE shall be read in conjunction with corresponding SECTIONS in the TECHNICAL SPECIFICATION.

12. Rates shall be inclusive of LEADS, LIFTS, Loading and Un-loading etc., and Complete.

13. **A soft copy of all the documents including price schedule with price breakup shall be enclosed in the form of CD or Pen-drive.**

14. The rates quoted shall hold good even if the shapes and sizes of members shown in bid drawings are modified while issuing the final construction drawings. No extra claims shall be entertained in this regard.

15. Abbreviations used for the unit of various items are as stated below:

MT	- Tonne - 1,000 kg.	;	kg	-	Kilogram
km	- Kilometre	;	Cum	-	Cubic metre
Sq m.	- Square metre	;	RM	-	Running metre
No.	- Number	;	Loc.	-	Location
Qty.	– Quantity				

16. The tenderer should specifically mention in the top of the outer cover the Specification No., name of work and due date of opening .

17. The tenderer should indicate the rates of cement per metric tonne, steel reinforcement bars per metric tonne and structural steel per metric tonne accounted for their tender offer in the foot note of the price schedule.

18. The rates quoted shall include for minor details of construction which are obviously and fairly intended and which may not have been referred to in this document but are essential for the satisfactory completion of work.

19. The bidder shall sign in all pages of the Tender Specification and price schedule along with the company seal.

20. The detailed profile shall be collected from the SE/GCC concerned.

SCHEDULE-B
DEVIATION FROM COMMERCIAL SPECIFICATION:
SPECIFICATION NO. T.

All deviations from the specification shall be filled in by the Tenderer, Clause by Clause, in the Schedule.

SECTION NO.	CLAUSE NO.	DEVIATION

The Tenderer hereby certifies that the above-mentioned are the only deviations from the Commercial Specification and the Tender conforms to the Specification in all other respects.

PLACE: SIGNATURE:

DATE: DESIGNATION:

COMPANY SEAL:

SCHEDULE – C

DEVIATION FROM TECHNICAL SPECIFICATION:

SPECIFICATION NO. T.

All deviations from the specification shall be filled in by the Tenderer, Clause by Clause, in the Schedule.

SECTION NO.	CLAUSE NO.	DEVIATION

The Tenderer hereby certifies that the above mentioned are the only deviations from the Technical Specification and the Tender conforms to the Specification in all other respects.

PLACE: SIGNATURE:

DATE: DESIGNATION:

COMPANY SEAL:

SCHEDULE – D

STATEMENT OF EXPERIENCE OF SIMILAR NATURE

YEAR	ORDER REFERENCE	NAME OF ORGANISATION FROM WHOM ORDER RECEIVED

PLACE: SIGNATURE:

DATE: DESIGNATION:

COMPANY SEAL:

TAMIL NADU ROAD DEVELOPMENT COMPANY LIMITED

SCHEDULE -E

DECLARATION FORM

To
The Chief General Manager,
Tamil Nadu Road Development Company Limited(TNRDC),
171,TNMB Builiding 2nd Floor,
South Kesavaperumalpuram,
Greenways Road,
RA puram, Chennai-600 028

Dear Sir,

Having examined the above specification together with the accompanying schedules etc., we hereby offer to manufacture, supply, erect, testing and commissioning of the equipments/materials covered in this specification at the rates entered in the attached schedule of prices.

2. We hereby guarantee the particulars entered in the schedules attached to the specification.

3. In accordance with security deposit clause, Section-V, of the specification we agree to furnish security to the extent of 5% of the total value of the contract.

4. In accordance with performance guarantee clause Section-V of the specification, we agree to furnish performance guarantee to the extent of 5% of the total value of the contract, till completion of the guarantee period.

5. Our company is not a potentially Sick Industrial Company or a Sick Industrial Company in terms of Section-23 or Section-15 of the Sick Industrial Companies (Special Provisions) Act, 1985.

Yours faithfully,

PLACE : SIGNATURE :

DATE : DESIGNATION :

COMPANY SEAL : COMPANY :

SCHEDULE - F

UNDERTAKING TOWARDS JURISDICTION FOR LEGAL PROCEEDINGS
(To be furnished in non-judicial stamp paper of value not less than Rs.80/-)

This undertaking executed at ……..on this. …… (Date). …… (Month) two thousand and five by M/s……

Registered under Companies Act, 1956 having its registered Office at…….. hereinafter called the contractor (which expression shall where the context so admits mean and include its successors in Office and in favour of Tamil Nadu Transmission Corporation Limited a body constituted under the Electricity (Supply) Act, 1948, (CA LIV of 1948) having its registered Office at No. 144, Anna Salai, NPKRR Maaligai, Chennai-600 002 herein after called the Purchaser (Which expression shall where the context so admits means and includes its successors in Office and assigns.

WHEREAS a contract for the work of……
……
…… has been awarded in favour of the Contractor under the Award Letter No…… dated…….

AND WHEREAS in accordance with terms of the above mentioned Acceptance Letter No, the Contractor has to furnish an undertaking to the effect that no suit or any proceedings in regard to any matter arising in any respect under this contract shall be instituted in any Court other than in the High Court, Madras or District Court at……or Sub-Court at …….. or at the District Munsiff Court at……as the case may be.

IN CONSIDERATION of the TANTRANSCO/TNRDC having agreed to accept the undertaking the contractor hereby undertakes that no suit or any proceedings in regard to any matter arising in respect of this contract shall be instituted in any Court, save in the High Court, Madras or District Court at ……or Sub-Court at…….. or at the District

Munsiff Court at..... ....as the case may be. It is agreed that no other Court shall have jurisdiction to entertain any suit of proceedings, even though, part of the cause of action might arise within their jurisdiction. In case any part of the cause of action might arise within the jurisdiction of any other Courts in Tamil Nadu and rest within the jurisdiction of Courts outside the State of Tamil Nadu, then it is agreed to between the parties that such suits on proceedings shall be instituted in a Court within the State of Tamil Nadu and no other Court outside the State of Tamil Nadu shall have jurisdiction.

IN WITNESS WHEREOF Thiru.....of M/s.....hereby put his hand and seal for due observance of the Undertaking in the presence of the following witness.

++

SIGNATURE:
DESIGNATION:
COMPANY SEAL:
DATE:

WITNESSES :
(Signature with Name & Address

1.

2.

TAMIL NADU ROAD DEVELOPMENT COMPANY LIMITED
CHENNAI – 600 028

◈◈◈◈

Design, Manufacture, Supply, Erection, Testing and Commissioning of **400 KV Towers** with **Twin Moose conductors** for deviation of the existing overhead towers for formation of Northern Port Access Road (NPAR) section –I of Chennai Peripheral Ring Road(CPRR)

VOLUME –III

(PRICE SCHEDULE)

Due date & Time for receipt of Tender : 15th March 2021 up to 15-00 Hrs
Due date & Time for opening of Tender : 15th March 2021 @ 15-30 Hrs

The Chief General Manager,
Tamil Nadu Road Development Company Limited(TNRDC),
South Kesavaperumalpuram, Greenways Road,
RA puram, Chennai-600 028

Design, Manufacture, Supply, Erection, Testing and Commissioning of 400 KV Towers with Twin Moose conductors for deviation of the existing overhead towers for formation of Northern Port Access Road (NPAR) section –I of Chennai Peripheral Ring Road(CPRR)

Sl. No	Description	Unit	Qty	Rate (Rs) exclusive of GST		Amount (Rs) exclusive of GST
				In Figures	In Words	
SCHEDULE-I						
1	Fabrication, galvanishing and supply of various type of normal, narrow base tower & extension tower parts, tower body/leg extension complete (excluding bolts, nuts and stubs)and including transport charge, hangers,d-shackles and all taxes etc complete as per standard specification					
a	GI Tower parts HT	MT	1217.51			
b	GI Tower parts MS	MT	383.03			
2	Fabrication, galvanishing and supply of stub HT & cleats for various type of normal, narrow base tower & tower extension complete (excluding bolts & nuts) and including transport charge and all taxes etc complete	MT	45.80			
3	Supply of Hot dipped hexaganal GI bolts&Nuts, including step bolts, packing washers and electro galvanished spring washers as per relevent latest IS including transport charge and all taxes etc complete as per standard specification.	MT	102.83			

Design, Manufacture, Supply, Erection, Testing and Commissioning of 400 KV Towers with Twin Moose conductors for deviation of the existing overhead towers for formation of Northern Port Access Road (NPAR) section –I of Chennai Peripheral Ring Road(CPRR)

Sl. No	Description	Unit	Qty	Rate (Rs) exclusive of GST		Amount (Rs) exclusive of GST
				In Figures	In Words	
4	Optic fibre ground wire with 24 fibres as per technical specification including cost of all required suitable tension clamp, suspension clamp, vibration dampers, joint/junction boxes for OPGW and all accessories including transport and all taxes etc, complete as per standard specification.	Kms	3.69			
5	Fibre Optic Approch cable with 24 fibres with suitable HDPE pipe including all accessories for laying, jointing, connection including transport and all taxes etc, complete as per standard specification.	Kms	1.00			
6	Design, manufacture and supply of following line materials as per IS and technical specification including transport and all taxes etc, complete.					
a	ACSR Twin Moose Conductor	Kms	81.28			
b	GS Earth wire 7/3.66mm size	Kms	3.39			
c	160 KN insulators suitable for Twin moose conductor	Nos.	576.00			
d	120 KN insulators suitable for Twin moose conductor	Nos.	144.00			

Design, Manufacture, Supply, Erection, Testing and Commissioning of 400 KV Towers with Twin Moose conductors for deviation of the existing overhead towers for formation of Northern Port Access Road (NPAR) section –I of Chennai Peripheral Ring Road(CPRR)

Sl. No	Description	Unit	Qty	Rate (Rs) exclusive of GST		Amount (Rs) exclusive of GST
				In Figures	In Words	
7	Supply of the following Hardware fittings as per standard specification					
a	Single I Suspension hardware fittings suitable for Twin moose ACSR 1x23, 120KN Disc insulator.	Sets	24.00			
b	Single "I " Suspension hardware fittings with counter weight 8 Nos 25KG/4 nos. 50kg each suitable for Twin Moose ACSR 1x23, 120 KN Disc insulator	Sets	144.00			
c	Double tension hard ware fitting suitable for ACSR twin moose	Sets	576.00			
8	Supply of the following Accessories for conductor &earth wire including transport charges and all taxes etc, complete as per standard specification.					
a	Mid span compression joint for ACSR Moose conductor	Sets	45.00			
b	Repair sleeve for ACSR Moose conductor	Nos.	27.00			
c	Bundle Spacer for ACSR Moose conductor	Sets	1360.00			

Design, Manufacture, Supply, Erection, Testing and Commissioning of 400 KV Towers with Twin Moose conductors for deviation of the existing overhead towers for formation of Northern Port Access Road (NPAR) section –I of Chennai Peripheral Ring Road(CPRR)

Sl. No	Description	Unit	Qty	Rate (Rs) exclusive of GST		Amount (Rs) exclusive of GST
				In Figures	In Words	
d	Rigid spacer for ACSR Moose conductor	Sets	432.00			
e	Vibration Damper for Twin ACSR Moose conductor	Sets	576.00			
f	Earth wire suspension clamp for 7/3.66mm EW.	Sets	2.00			
g	Earth wire tension clamp for 7/3.66mm EW.	Sets	24.00			
h	Flexible copper bonds for earth wire	Nos.	26.00			
i	Midspan compression joint for 7/3.66 mm Earth Wire	Sets	4.00			
j	Vibration damper for Earth wire 7/3.66mm	Sets	52.00			
9	Supply and fixing of following tower accessories including transport chargeand all taxes etc, complete as per standard specification.					

Design, Manufacture, Supply, Erection, Testing and Commissioning of 400 KV Towers with Twin Moose conductors for deviation of the existing overhead towers for formation of Northern Port Access Road (NPAR) section –I of Chennai Peripheral Ring Road(CPRR)

Sl. No	Description	Unit	Qty	Rate (Rs) exclusive of GST		Amount (Rs) exclusive of GST
				In Figures	In Words	
a	Number plate	Nos.	12.00			
b	Danger board	Nos.	12.00			
c	Phase Plate	Sets	12.00			
d	Circuit plate	Nos.	12.00			
e	Anti-Climbing devices	Nos.	12.00			
f	Name Plate Near road	Nos.	12.00			
10	Storage charges for storing all the materials as directed by the Engineer-in-charge		LS Prorata			
					Sub Total (Schedule-I)	

Design, Manufacture, Supply, Erection, Testing and Commissioning of 400 KV Towers with Twin Moose conductors for deviation of the existing overhead towers for formation of Northern Port Access Road (NPAR) section –I of Chennai Peripheral Ring Road(CPRR)

Sl. No	Description	Unit	Qty	Rate (Rs) exclusive of GST		Amount (Rs) exclusive of GST
				In Figures	In Words	
SCHEDULE-II						
1	Conducting preliminary survey and detailed survey with GPS, Total station & DGPS, plotting profile & tower spotting and submission of report, tower schedule, justification of angle points (25 copies)and profile in duplicate including cost of all materials, transporting, labour, leads, lifts etc., complete as directed by the department Engineer at site.	Kms	3.50			
2	Clearing heavy jungle for surveying including cost of all materials, leads, lifts etc., complete as directed by the Engineer-in-charge	M^2	9000.00			
3	Conducting Check survey in the already fixed route, fixing of tower locations and pit marking as directed by the Engineer-in-charge	Loc	12.00			
4	Forming approach road by filling with good quality earth / quarry rubbish over slushy soil including cost of materials , transport charges all labour lead and lift etc. complete as per standard specification.	M^3	2700.00			
5	Providing temporary foot bridge with casuarina props for carrying men and materials to the tower spot in all types of slushy soil / water logged area / marsh land including cost of materials , labour ,l ead & lift etc complete (Width of bridge - 2m) as directed by the Engineer-in-charge.	Rm	100.00			

Design, Manufacture, Supply, Erection, Testing and Commissioning of 400 KV Towers with Twin Moose conductors for deviation of the existing overhead towers for formation of Northern Port Access Road (NPAR) section –I of Chennai Peripheral Ring Road(CPRR)

Sl. No	Description	Unit	Qty	Rate (Rs) exclusive of GST		Amount (Rs) exclusive of GST
				In Figures	In Words	
6	Formation of working platform for each tower with good quality earth over slushy soil including cost of materials , transport charges all labour lead and lift etc. complete as per standard specification and as directed by the Engineer-in-charge	M^3	5000.00			
7	Excavation in all types of soil viz., sand, clay, gravel, Clayton, mud, slush other than rock for foundation of towers, columns, etc. as per the Drawing, including shoring, dewatering subsoil water/Rain water wherever required and disposing off surplus materials selected earth within the site (Maximum lead 100mtr) at locations as directed by the engineer-in-charge, levelling, dressing, and compaction of the earth, etc complete.					
a	Hard gravelly soil, black cotton soil, sand, red earth, shales, murram, stoney earth and earth mixed with small boulders.	M^3	14546.00			
b	Soft disintegrated rock, laterite, soft rock or kankar not requiring blasting (SDR)	M^3	8727.60			
c	Medium rock and dense medium rock (MR & DMR) not requiring blasting	M^3	5818.40			

Design, Manufacture, Supply, Erection, Testing and Commissioning of 400 KV Towers with Twin Moose conductors for deviation of the existing overhead towers for formation of Northern Port Access Road (NPAR) section –I of Chennai Peripheral Ring Road(CPRR)

Sl. No	Description	Unit	Qty	Rate (Rs) exclusive of GST		Amount (Rs) exclusive of GST
				In Figures	In Words	
8	Providing, mixing and laying plain cement M10 grade concrete with 40 mm ISS nominal size graded aggregates of approved quality as a levelling course under the column foundation, wall foundation, cable trenches, other trenches, raft foundations, pipe supports, plinth beam as floor sub base, etc. including ramming, levelling, curing etc. complete at any level (i.e. up to any depth or height from ground level). Please consider the cost of form work if required any. M10 concrete	M^3	1413.24			
9	Providing, mixing, Batching, Transporting through Transit Mixers, Pumping and laying Reinforced cement concrete M20 with 20 mm ISS HBG metal and downsized aggregate in all type of works such as foundation and superstructures, footings, pile caps, raft beams, columns, runners, coping beam, walls, etc. in any pattern & shapes all including making openings, leaving sleeves including vibrating, tamping, curing, etc. complete as per the drawing and specification:	M^3	6010.46			

Design, Manufacture, Supply, Erection, Testing and Commissioning of 400 KV Towers with Twin Moose conductors for deviation of the existing overhead towers for formation of Northern Port Access Road (NPAR) section –I of Chennai Peripheral Ring Road(CPRR)

Sl. No	Description	Unit	Qty	Rate (Rs) exclusive of GST		Amount (Rs) exclusive of GST
				In Figures	In Words	
10	Providing, cutting, bending, binding, laying, transporting and fixing in position at site up to any levels (depth & height) reinforcement bars for all concrete works including 16 gauge annealed M.S. wire, spacer blocks of C.M. 1:2 with embedded binding wire of suitable length, protective coat of neat cement slurry to be applied as per Engineer-in-charge etc. complete. Bar bending schedule to be prepared by contractor. Any variation in reinforcement will be adjusted as per B.B.S. (Bar bending schedule) subject to approval and joint record by Engineer-in-Charge.	MT	505.86			
11	Transport, installation of stub & cleats in position & alignment including cost of template assembly, prop setting arrangements transportation charges etc, complete as directed by the Engineer-in-charge	MT	45.80			
12	Transport & erection of various type of towers, tower extension (complete) including tack welding of bolts & nuts, supply of zinc rich primer, enamel paint and application of one coat of zinc rich primer and two coats of zinc rich enamel paint over the welded portion as per technical specification and as directed by the Engineer-in-charge	MT	1703.37			
13	Pipe type earthing as per standard specification and as directed by the Engineer-in-charge	No	12.00			

Design, Manufacture, Supply, Erection, Testing and Commissioning of 400 KV Towers with Twin Moose conductors for deviation of the existing overhead towers for formation of Northern Port Access Road (NPAR) section –I of Chennai Peripheral Ring Road(CPRR)

Sl. No	Description	Unit	Qty	Rate (Rs) exclusive of GST		Amount (Rs) exclusive of GST
				In Figures	In Words	
14	Counter poise type earthing as per standard specification as directed by the Engineer-in-charge	No	1.00			
15	Providing special earthing in Terminal tower as per standard specification by providing 150mm dia bore hole for a depth of 3.6m and placing of GI pipes 50mm dia C class 3m long into the bore including cost of 60mm dia collar placing over the tower leg as directed by dept engineer at site	No	1.00			
16	Labour charges for Transporting and hoisting of Antifog Single tension polymer insulators of 24 units under LC condition including cost of all labour, lead, lift etc. Complete as directed by the Engineer-in-charge	No	576.00			
17	Labour charges for Transporting and hoisting of Antifog Single tension polymer insulators of 23 units under LC condition including cost of all labour, lead, lift etc. Complete as directed by the Engineer-in-charge	No	144.00			
18	Installation of insulator strings complete with arcing horns & necessary hardware, stringing of Twin Moose conductor for four Circuit line (24- wire of Twin Moose) including fixing of conductor accessories, providing jumper etc. Complete for the line (Stringing of conductor is to be done using tension stringing equipment)	KM	3.35			

Design, Manufacture, Supply, Erection, Testing and Commissioning of 400 KV Towers with Twin Moose conductors for deviation of the existing overhead towers for formation of Northern Port Access Road (NPAR) section –I of Chennai Peripheral Ring Road(CPRR)

Sl. No	Description	Unit	Qty	Rate (Rs) exclusive of GST		Amount (Rs) exclusive of GST
				In Figures	In Words	
19	Installation & stringing of 1No. 7/3.66 mm earth wire including fixing of hardware fittings and accessories etc., complete for the line (Stringing of earth wire is to be done using tension stringing equipment)	KM	3.35			
20	Installation & stringing of 1No. OPGW including fixing of hardware fittings and accessories etc., complete for the line (Stringing of OPGW is to be done using tension stringing equipment)	KM	3.35			
21	Installation and laying of 1 No Fibre Optic approach cable with 24 fibres in suitable HDPE pipe including jointing ,connection with accessories etc complete	KM	1.00			
22	Arranging and availing shutdown on LT / HT lines for stringing operation including cost of all lead and lift etc. complete.	Nos	5.00			
23	Hire charges for engaging JCB for formation of road and levelling undulations for transport of Conductor drum etc. complete.	Hrs	40.00			
24	Providing well supported trussels up to 5m height for road crossing including cost of all materials labour, lead, lift etc complete as directed by the engineer at site.	Nos	4.00			
25	Back filling the area enclosed by revetment with good quality of gravel including cost and conveyance of gravel to worksite, all labour charges for filling in layers etc., complete as per standard specification	M^3	21668.30			

Design, Manufacture, Supply, Erection, Testing and Commissioning of 400 KV Towers with Twin Moose conductors for deviation of the existing overhead towers for formation of Northern Port Access Road (NPAR) section –I of Chennai Peripheral Ring Road(CPRR)

Sl. No	Description	Unit	Qty	Rate (Rs) exclusive of GST		Amount (Rs) exclusive of GST
				In Figures	In Words	
26	Labour charges for dismantling of existing tower including all labour, lift, etc complete and stacking the same at the place as directed by the Engineer-in-charge	MT	333.90			
27	Labour Charges for Dismantling of moose conductors 24 Nos under L.C condition and stacking the same at the place as directed by the Engineer-in-charge	Kms	3.10			
28	Labour charges for dismantling GI Earth wire - 1 No. under LC condition and stacking the same at the place as directed by the Engineer-in-charge	Kms	3.10			
29	Labour charges for dismantling OPGW - 1 No. under LC condition and stacking the same at the place as directed by the Engineer-in-charge	Kms	3.10			
30	Dismantling the insulator string including cost of labour for releasing, Tools and plants transporting charges from site etc complete for 23 units of 120 KN Disc Insulators and stacking the same at the place as directed by the Engineer-in-charge	Set	72.00			

Design, Manufacture, Supply, Erection, Testing and Commissioning of 400 KV Towers with Twin Moose conductors for deviation of the existing overhead towers for formation of Northern Port Access Road (NPAR) section –I of Chennai Peripheral Ring Road(CPRR)

Sl. No	Description	Unit	Qty	Rate (Rs) exclusive of GST		Amount (Rs) exclusive of GST
				In Figures	In Words	
31	Dismantling the insulator string including cost of labour for releasing, Tools and plants transporting charges from site etc complete for 24 units of 160 KN Disc Insulators and stacking the same at the place as directed by the Engineer-in-charge	Set	96.00			
	Sub Total (Schedule-I)					
	Grand Total exclusive of GST (Shedule - I + Schedule-II)					
	GST @ ___ %					
	Grand Total inclusive of GST					
(Rupees _____ only) **inclusive of GST**						