TENDER DOCUMENT

(e-Procurement)

Tender No: IISc/Tender-ELE-05/2024-25

For

Design, Supply, Installation of 12.5 MVA Power Transformer and associated works in 66 KV Main Receiving Station (MRS) at IISc, Bangalore

Office of the Project Engineer cum Estate officer

Centre for Campus Management and Development Indian Institute of Science

Indian Institute of Science Bangalore – 560012

080-2293-2202/2008

Website :https://iisc.ac.in/all-tenders/

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1. **Tender Notification**

Tender No: IISc/Tender-ELE-05/2024-25

Name of work	"Design, Supply, Installation of 12.5 MVA Power Transformer and associated works in 66 KV main receiving station (MRS) at IISc, Bangalore"
Estimated Value of work	Rs. 3,95,67,380/-
Period of Work Completion	10 Months
Name of the Client	Indian Institute of Science, Bangalore
Address of the Client	The Registrar Indian Institute of Science Bangalore – 560 012 Tel No. 080-2293 2008/2202 e-mail: office.ccmd@iisc.ac.in
Submission of Tender Document	e-procurement portal- https://eprocure.gov.in/eprocure/app Helpline no: 0120-4001005
Earnest Money to be deposited with the Tender	**Rs.5,93,510.70** (1.5% of the Estimated Cost)
Last date and Time for online submission (uploading) of tender	09.01.2025 at 1530Hrs
Date and Time of opening of Tender (Technical Bid)	10.01.2025 at 1530Hrs
Date and Time of opening of Tender (Financial Bid)	Shall be intimated to technically qualified bidders thro' CPP portal.
Pre-bid meeting Date, Time & Venue	27.12.2024 at 1200Hrs Pre bid meeting will be held on Teams App. The web link will be forwarded to the intending bidders. They are requested to send the request to the email id: office.ccmd@iisc.ac.in Queries can be mailed in prior to the same mail.

2.Notice Inviting Tender

The Registrar, Indian Institute of Science invites tenders in two bids (Technical and Financial) system from eligible Bidders, for **"Design, Supply, Installation of 12.5 MVA Power Transformer and associated works in 66 KV main receiving station (MRS) at IISc, Bangalore"**

Bidders shall not be under a declaration of ineligibility for corrupt and fraudulent practices issued by the Government of India or any State Government of Union of India. (Authorized signatory should provide an undertaking). Tenders from Joint ventures are not acceptable.

2.1 All Bidders shall provide the required information accurately and enough as per details in Section 4:Eligibility Criteria

2.2 The Tenderer shall upload the valid copies of the documents as mentioned in the Chapter-4 (Eligibility criteria) in technical bid**, failing which the tender will be rejected**. If necessary, bidder shall produce all the original documents for verification.

2.3 The work shall be carried out as per the directions of the Project Engineer cum Estate Officer.

2.4 Blacklisted contractors inState / Central Govt. Departments / BBMP / PSU/ Central PSUs/ Autonomous bodies / Institutions are not eligible to quote, if found such tenders will be rejected.

2.5 The successful Bidder shall execute an Agreement within 10 days from the date of Receipt of intimation from this office, The Tender Document will form the part and parcel of the agreement, failing which the tender will deem to be get cancelled.

2.6 The material shall be got approved by the Project Engineer cum Estate Officer, IISc before execution of the work.

2.7 Further details of the work can be obtained from this office.

2.8 The rates quoted should reflect all taxes. The bid evaluation will be done inclusive of all Taxes / Cess. / Royalty etc. The statutory levies as per Govt. guidelines will be deducted. The IISc reserves the right to accept / reject any or all the tenders without assigning any reasons.

2.9 The work shall be commenced with all manpower, material, machinery & requisite resources within 10 days from the date of workorder, failing which it would be presumed that the successful tenderer is not interested in the work and action will be taken to get the work executed through alternate agency at the risk and cost of the former Tenderer.

2.10 Conditional tenders will not be accepted and is liable for rejection.

2.11 Bidders who meet the specified minimum qualifying criteria, shall be eligible.

2.12 Even though the Bidders meet the eligibility criteria mentioned in Section-4 they are subject to be disqualified if they have:

- Made misleading or false representations 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 completed the contract, inordinate delays in completion, litigation history, or financial failures etc.

2.15 Site visit:

The Bidder at his own responsibility is encouraged to visit and examine the Site of Works and its surroundings and obtain all information that may be necessary for preparing the Tender and entering into a contract for the Works. The cost of visiting the Site shall be at the Bidder's own expense.

2.16 The Tender document can be downloaded from e-procurement website: https://eprocure.gov.in/eprocure/app. It may be noted that all subsequent notifications,

changes and amendments on the project/document would be posted only on the same website. The bidders are advised to visit e-procurement portal and get familiarized with the procedure for submission of the tenders.

2.17 **Content of Tender documents**

The bidders should go through the Tender Document and submit online response through e-procurement portal only.

2.18 Amendment of Tender documents

Before the deadline for submission of tenders, the IISc may modify the tender documents by issuing corrigendum / addendum.

Such corrigendum/ addendum thus issued shall be part of the tender documents and shall be published online in e-Procurement portal.

Prospective Bidders will be given reasonable time for submitting the bid by taking the corrigendum/ addendum into account.

2.19 Documents comprising the Tender

The Technical Bid submitted by the Bidder shall contain the documents as follows:

a) Earnest Money Deposit paid in the specified form as mentioned in the e-Procurement platform.

b) Qualification Information as per formats to comply the task created in the e-Procurement Portal under General Terms and Conditions and Technical parameters and Documents required from Bidder.

c) Any other documents / materials required to be completed and submitted by Bidders in accordance with these instructions. The required documents shall be filled in without exception.

The bidder shall submit the hard copies of the documents / credentials which are uploaded in the tender portal. The documents shall reach the designated office within 3 days from the tender opening date.

The Financial bid shall be submitted by the bidder through e-procurement portal only and no hardcopy of financial bid should be attached or disclosed.

The contract shall be for category of works / whole works based on the priced Bill of Quantities submitted by the Bidder.

All prevailing duties, taxes, and other levies like CESS/Royalty payable by the contractor under the contract, or for any other cause, shall be included in the rates, prices and total Tender Price submitted by the Bidder.

2.20 Tender validity

Tenders shall remain valid for a period not less than **180 days** after the deadline date for tender submission. A tender valid for a shorter period shall be rejected by the IISc as non-responsive.

In exceptional circumstances, prior to expiry of the original time limit, the IISc. May request that the Bidders may extend the period of validity for a specified additional period. The request and the Bidders' responses shall be made in writing or by email. A Bidder may refuse the request without forfeiting his earnest money deposit. A Bidder agreeing to the request will not be required or permitted to modify his tender but will be required to extend the validity of his earnest money deposit for a period of the extension, and in compliance with Clause 2.18 and 2.22 in all respects.

2.21 Earnest money deposit:

The Bidder shall furnish, as part of his tender, earnest money deposit (EMD). The Bidder has to pay the Earnest Money Deposit (EMD) in the form of Demand draft drawn on "The Registrar, IISc" payable at "Bangalore".

The bidder has to scan the demand draft and submit it with Technical Bid Documents for our reference. The original DDs has to be submitted along with the hard copies of all the documents in a sealed cover as a pre-qualification bid (Technical bid) which were uploaded through e-procurement portal.

The EMD amount will have to be submitted by the bidder taking into account the following conditions:

a) The entire amount must be paid in a single transaction.
b) The earnest money deposit of unsuccessful Bidders will be returned after awarding the contract to the successful bidder.

The earnest money deposit may be forfeited:
a) If the Bidder withdraws the tender after tender opening during the period of tender validity,
b) If the Bidder fails within the specified time limit to
i) Sign the Agreement; or
ii) Furnish the required Security deposit

2.22 Provisions for Micro and Small Enterprises (MSE):

The MSE registered bidder should upload the registration certificate in the CPP portal along with the technical bid documents. The MSE registration to specify manufacturing / service of the tender item(s).

Policy is meant for procurement of only goods produced and services rendered by MSEs. However, traders are excluded from the purview of Public Procurement Policy.

Participating Micro and Small Enterprises quoting price within price band of L1+15%, will qualify to supply a portion of requirement by bringing down price to L1 price in a situation where L1 price is from someone other than a Micro and Small Enterprises.

2.23 Format and signing of Tender

Successful Bidder shall sign all the pages of the tender document as a token of acceptance of all the terms and conditions of the contract.

2.24 Submission of Tenders

Tenders must be submitted on-line in the e-Procurement portal by the Bidder before the notified date and time.

2.25 Deadline for submission of the Tenders

The Bidder shall submit a set of hard copies of all the documents in a sealed cover to IISc required as a pre-qualification bid (Technical bid) which were uploaded through e-procurement portal. In the event of any discrepancy between them, the original uploaded document in e-procurement shall govern.

The IISc may extend the deadline for submission of tenders by issuing an amendment, in which case all rights and obligations of the IISc and the Bidders previously subject to the original deadline will then be subject to the new deadline.

2.26 Late Tenders

In e-procurement system, Bidder shall not be able to submit the bid after the bid submission time and date as the icon or the task in the e-procurement portal will not be available. IISc will not be liable (or) responsible for any delay due to unavailability of the portal and the Internet link.

2.27 Modification and Withdrawal of Tenders

Bidder has all the time to modify and correct or upload any relevant document in the portal till last date and time for Bid submission, as published in the e-procurement portal.

The Bidder may withdraw his tender before the notified last date and time of tender submission. No Tender may be modified after the deadline for submission of Tenders.

Withdrawal or modification of a Tender between the deadline for submission of Tenders and the expiration of the original period of Tender validity specified in Clause 2.21 above may result in the forfeiture of the earnest money deposit.

2.28 **Tender Opening:**

The IISc will open all the Tenders received through' online mode, in the presence of the Bidders or their representatives who choose to attend on the specified date, time and place specified. In the event of the specified date of Tender opening being declared a holiday for the IISc. The Tenders will be opened at the appointed time and location on the next working day.

The IISc will evaluate and determine whether each tender meets the minimum qualification eligibility criteria.

Bidder to submit all the Original Documents, which are submitted in e-procurement portal, to the IISc for verification at the time of opening of Tender. The IISc will record the Tender opening.

2.29 Process to be confidential.

Information relating to the examination, clarification, evaluation, and comparison of Tenders and recommendations for the award of a contract shall not be disclosed to Bidders or any other persons not officially concerned with such process until the award to the successful Bidder has been announced.

2.30 Clarification of Tenders

To assist in the examination, evaluation, the IISc may, at his discretion, ask any Bidder for clarification of his Tender. The request for clarification and the response shall be in writing or bye-mail along with the section number, page number and subject of clarification, but no change in the price or substance of the Tender shall be sought, offered, or permitted.

Subject to clause 2.29, no Bidder shall contact the IISc on any matter relating to its Tender from the time of the Tender opening to the time the contract is awarded. If the Bidder wishes to bring additional information to the notice of the IISc, he/she should do so in writing.

Any effort by the Bidder to influence the IISc in the Tender evaluation, or contract award decisions may result in the rejection of the Bidders' Tender.

2.31 **Examination of Tenders and determination of responsiveness**

Prior to the detailed evaluation of Tenders, the IISc will determine whether each Tender (a) meets the eligibility criteria (b) is accompanied by the required earnest money deposit and; (c) is substantially responsive to the requirements of the Tender documents.

A substantially responsive Tender is one which conforms to all the terms, conditions, and specifications of the Tender documents, without material deviation or reservation. A material deviation or reservation is one (a) which affects in any substantial way the scope, quality, or performance of the Works; (b) which limits in any substantial way, inconsistent with the Tender documents, the IISc's rights or the Bidder's obligations under the Contract; or (c) whose rectification would affect unfairly the competitive position of other Bidders presenting substantially responsive Tenders.

If a Tender is not substantially responsive, it will be rejected by the IISc., and may not subsequently be made responsive by correction or withdrawal of the nonconforming deviation or reservation.

2.32 Correction of errors

No corrections to uploaded bid is permitted by the portal. Tenders determined to be substantially responsive will be checked by IISc.

2.33 **Evaluation and comparison of Tenders**

Opening of the Financial bid will be preceded by the evaluation of the Pre-qualification Offer (Technical bid), vis-a-vis the capability, capacity and credibility of the Bidder. Evaluation of the Prequalification Offer will be done by the Evaluation Committee constituted for the

purpose. After evaluation is completed, all the Bidders who are qualified will be notified and will be intimated at the time of opening of the Financial bid. Financial bid will be opened in the presence of those who choose to be present or even in the absence of any Bidder.

The IISc will evaluate and compare the Tenders asper comparative statement downloaded from e-procurement portal.

In evaluating the Tenders, the IISc. Will determine for each Tender the evaluated Tender Price by adjusting the Tender Price as follows:

a) Making any correction for errors and

b) Making appropriate adjustments to reflect discounts or other price modifications offered

The IISc reserves the right to accept or reject any variation, deviation, or alternative offer. Variations, deviations, and alternative offers and other factors which are in excess of the requirements of the Tender documents or otherwise result in unsolicited benefits for the IISc shall not be taken into account in Tender evaluation.

2.34 Negotiations

The Bidder though technically qualified and whose financial offer is the lowest, fails to convince the Tender Evaluation Committee of his capability, capacity, credibility, his offer may be reviewed, and the Bidder intimated accordingly. In such case, the Bidder, who has quoted the lowest price, may be considered and his price may be negotiated as advised by the tender committee.

2.35 Award criteria

Subject to Clause 2.36, the IISc will award the Contract to the Bidder whose Tender has been determined to be substantially responsive to the Tender documents and who has offered the lowest evaluated Tender Price. After technical evaluation the technically qualified bidders will be considered for opening of the financial bids provided that such Bidder has been determined to be eligible in accordance with the provisions of this tender document and subsequent technical clarifications offered by the responsive bidders.

2.36 Right to accept any Tender and to reject any or all Tenders

Notwithstanding Clause 2.35, the IISc reserves the right to accept or reject any Tender, and to cancel the Tender process and reject all Tenders, at any time prior to the award of Contract, without thereby incurring any liability to the affected Bidder or Bidders or any obligation to inform the affected Bidder or Bidders of the grounds for the IISc's action.

2.37 Notification of award and signing of Agreement

The Bidder whose Tender has been accepted will be notified of the award by the IISc. Prior to expiration of the Tender validity period by e-mail or confirmed by letter. This letter (hereinafter and in the Conditions of Contract called the "Letter of Acceptance") will state the sum that the IISc. Will pay the Contractor in consideration of the execution, completion, and maintenance of the Works by the Contractor as prescribed by the Contract (hereinafter and in the Contract called the "Contract Price").

The Notification of award will constitute the formation of the Contract, subject only to the furnishing of a performance security in accordance with the provisions of clause 2.39

The Agreement will incorporate all agreements between the IISc and the successful Bidder /Bidders. It will be kept ready for signature of the successful Bidder in the office of IISc. Following the notification of award along with the Letter of intent. The successful Bidder will sign the Agreement and deliver it to the IISc.

Upon the furnishing by the successful Bidder of the Security deposit, the IISc will issue formal work order.

The successful bidder is required to sign an agreement for the due fulfilment of the contract and start the work immediately on of the acceptance of his tender. A draft of the Articles

of the Agreement is enclosed. The Earnest Money will be forfeited and at the absolute disposal of the Employer if the Contractor defaults from signing the Agreement of in starting the work.

2.38 Security deposit (SD)

Further percentage on the running bills and final bill in addition to Earnest Money Deposit shall be levied from the contractor. When the SD deducted from R.A Bills of the contractor **@ 6%** of the bill amount exceeds Rs.1.00 Lakh, the amount in excess of Rs. 1.00 Lakh may, at the request of the bidder, be released to him against the production of the bank guarantee issued from a Nationalized/Scheduled bank only for an equal amount in the prescribed form. The bank guarantee should be valid till the completion of the defect liability period.

If the security deposit is provided by the successful bidder in the form of a Bank Guarantee, it shall be issued either by a Nationalized/Scheduled bank.

Failure of the successful Bidder to comply with the requirements of clause 2.38 shall constitute sufficient grounds for cancellation of the award and forfeiture of the earnest money deposit.

2.39 Corrupt or Fraudulent practices

The IISc requires that the Bidders observe the highest standard of ethics during the procurement and execution of such contracts. In pursuance of this policy, IISc.

a) will reject a proposal for award if it determines that the Bidder recommended for award has engaged in corrupt or fraudulent practices in competing for the contract in question.

b) will declare a firm ineligible, either indefinitely or for a stated period of time, to be awarded a IISc contract if it at any time determines that the firm has engaged in corrupt or fraudulent practices in competing for, or in executing, a IISc contract.

2.40 Payment Terms

For Civil works: Monthly running account bills.

For Electrical works: 80% against the supply of material and 10% after installation and 10% after testing and commissioning, subject to the other provisions of the tender document.

2.41 Work done as a sub- contractor under a prime contractor will not be considered for qualification. **"Prime Contractor"** means a firm that performs a construction work itself and that the work is directly entrusted to the firm by the owner/ government/ local body/ quasi government/ Government undertaking bodies.

2.42 <u>Make in India</u>

Only "Class–I and Class-II local supplier will be eligible to bid notified vide (DPIIT) Notification No. P-45021/2/2017-PP (BE-II) dated 4th June 2020 amended from time to time.

3.Declaration of Tenderer

Name of Work: **"Design, Supply, Installation of 12.5 MVA Power Transformer and associated works in 66 KV main receiving station (MRS) at IISc, Bangalore"**

3.1 I/We, declare that specifications, plans, designs and conditions of contract on which the rates have been quoted are completely studied by me/us before submitting this tender.

3.2 I/We declare that I/We have inspected the work spot and have made myself/ourselves thoroughly conversant and satisfied as regards the field conditions prevalent there, regarding the materials, labour and the particulars of various leads with which the materials required to be brought for the work.

3.3 I/We, declare that the rates quoted for items of works for which now tenders are called for are inclusive of leads with which I/We propose to bring the materials. I/We will not have any claims for higher leads, and my/our quoted rates are with all leads and lifts etc.,

3.4 I/We, declare that the rates tendered by me/us for this work have not been witnessed by any other contractor/s who has/have tendered for this work.

3.5 I/We, declare that I/We, have understood all the conditions mentioned above and also the specifications stipulated in tender condition either by going through myself/ourselves or by getting translated into my/our own mother tongue.

4.**Eligibility Criteria**

Technical Criteria:

4.1–Any specialised firms company registered under KPWD /CPWD/ railways/ MES/ central PSUs/ or any Government department of **Class I with Super Grade Electrical License Contractor** or equivalent are eligible to apply.

4.2The Bidder should have Experience of similar nature of work having a successfully completed either of the following works:

(a) Three (03) completed works each costing not less than **40%** (forty percent) of the estimated cost i.e. **Rs.1,58,26,952.00**

(Or)

(b) Two (02) completed works each costing not less than **60%** (Sixty percent) of the estimated cost i.e. **Rs.2,37,40,428.00**

(Or)

(c) One (01) completed works each costing not less than **80%** (Eighty percent) of the estimated cost i.e. **Rs.3,16,53,904.00**

4.3 The works should have been completed of similar nature in last seven (7) consecutive years.

Note: The Experience certificate / work order should be in the same registered name as per Clause 4.1 and not as a joint venture.

Financial Criteria:

4.3The bidder should have registered for a minimum period of Ten years.

4.4The average annual financial gross turnover should be **30%** of estimated cost in that last five years.

4.5The minimum annual financial turnover for the two consecutive years should be **30%** of estimated cost.

4.6The bidder should have not incurred any loss in more than two years. The bidder should submit the **solvency certificate** from the bank for 30% of estimated cost. The Solvency should not be more than Six-month-Old ending last day of the month, previous to the month in which tender is invited.

4.7The average net worth of the bidder as of **2023-24** should be not less than 25% of estimated cost. Necessary certificate by the Charted Accountant shall be submitted.

4.8The bidder should have not been blacklisted by any State / Central Govt. Departments / BBMP / PSU/ Central PSUs/ Autonomous bodies / Institutions.

4.9The bidding capacity of the bidder should be 75% or more of the estimated cost.

The bidder should possess the bidding capacity as calculated by the following formula.

Available bid capacity = A x M x N -B, where

A = Maximum value of engineering (Civil/ Electrical/ Mechanical as relevant to work being procured)works executed in any one year during the last five years(updated at the current price level), taking into account the completed as well as works in progress.

M = Multiplier Factor (usually 1.5)

N = Number of years prescribed for completion of the work in question.

B = Value (updated at the current price level) of the existing commitments and ongoing works to be completed in the next 'N' years.

4.10 Information on works for which tenders have been submitted and ongoing works as on the date of this Tender.

(A) Existing commitments and on-going works:

Description ofwork	Place & State	Contract number & date	Name & address ofthe customer	Value of Contract in Lakhs	Stipulated period of completion	Value of work remaining to be completed in Lakhs	Anticipated date of completion
1	2	3	4	5	6	7	8

[Details to be furnished with necessary work order signed from concerned project in-charge not below the rank of Executive Engineer or Competent Authority. The Work order/Testimonials will be verified, if required]

(B) Works for which Tenderers already completed:

Description of work	Place & State	Name & address of the customer	Estimated value of work in lakhs	Stipulated period of completion	Date when decision is expected	Remark if any
1	2	3	4	5	6	7

4.11 Certificate from Charted Account stating turnover for the last five years is also to be uploaded.

Sl.No	Year	Turn over amount	Remark
1	2019-20		
2	2020-21		
3	2021-22		
4	2022-23		
5	2023-24		

Litigation and Arbitral Issues:

4.12 Net pending litigations should not be more than 50% of bidder's net worth. As a supporting document of undertaking letter to be submitted by Bidder. It must be certified by Authorized Legal person / lawyer.

4.13 No consistent history of court/arbitral award decisions against the bidder for the last five years. As supporting document of under letter to be submitted by Bidder. It must be confirmed by Authorized Legal person/ lawyer.

5.Special Conditions

5.1.1 Establishment of Labor Camp is strictly prohibited in the premises of Indian Institute of Science Campus. Essential labor for round the clock work at site will be allowed with prior permission of Project Engineer cum Estate Officer.

5.1.2 Any damage to the existing service lines during execution of work shall be got rectified by the bidder at his own cost and risk.

5.1.3 Debris shall be disposed-off to an undisputed place of Bangalore outskirts as per the direction of the Engineer-in-Charge, whenever required.

5.1.4 Labor employed at the site will not be allowed to use cellphone while working at the site.

5.1.5 Supply of Electricity: - Electricity required for construction shall be arranged by the contractor himself. Electricity if supplied to the contractor by the Institute will be metered and amount will be recovered in the Bills as per actual at rates fixed by the Institute. Supply of electricity from the Institute is not mandatory. Non-supply of electricity by the Institute cannot be held as reason for shortfall in progress.

5.1.6 Water supply: The Contractor has to make his own arrangement for water supply. However, if water supply to the site at one convenient point is made available by the Institute, the charges for the consumption of water will be borne by the Contractor at 1.5 % of the value of the work.

5.2 Schedule of Quantities (Bill of Quantities) is attached herewith. It should, however, be clearly understood that these quantities are liable to alterations by omission, addition or variation, at the discretion of the Architects/Project Engineer Cum Estate Officer.

5.3 The drawings together with specifications and conditions of contract are enclosed. These should be studied carefully by the intending tenderers. In the absence of specifications for any item of work, material or ingredient in the specifications, CPWD/MoRTH specifications shall be followed and in the absence of specification for any item, materials are ingredient shall be fixed in all respects in accordance with the instructions and requirements of the Project Engineer Cum Estate Officer, the work will be the best of the kind.

5.4 The tenderer is expected to inspect the site and acquaint himself with the local conditions and will be deemed to have so done before submitting the tender.

5.5 The rates quoted shall be for finished work and shall include for all necessary incidental work. Sales or any other tax on materials in respect of this contract will be payable by the Contractor. The Contractors cannot presume any details regarding the contract.

5.6 It is entirely the responsibility of the Contractor to arrange for and provide all materials required for successful completion of the work except such special materials that may be supplied if any.

5.7 Tenders determined to be substantially responsive will be checked by IISc for any arithmetic errors. Errors will be corrected by the IISc as follows.

5.8 Where there is discrepancy between the rates in figures and in words, the lower of the two will be governed.

5.9 Where there is a discrepancy between the unit rate and the line-item total resulting from multiplying the unit rate by the quantity, the unit rate as quoted will be governed.

5.10 Where there is a discrepancy in entries of unit rate between the Original and Duplicate, the lower will govern.

5.11 The Contractor should make his own arrangements to cover the all-round construction area, by providing polyester net/polythene sheet/barricading to avoid inconvenience to other surrounding departments, as directed by the Project Engineer-cum-Estate Officer of the work.

5.12 The debris arise during the period of construction will have to be cleared then and there to keep the surroundings clean and tidy. Such debris shall, if not cleared, be cleared at contractor's risk and cost.

5.13 The contractor shall vacate the campus premises with all his men/ materials immediately after completion of the project.

6. Technical Specification

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6.	SCADA Architecture	1

6.1 Scope of Enquiry

1.0 This specification covers the design, engineering, procurement, manufacture, inspection and testing at the works of manufacturer and/or sub-vendor, packing for shipment, forwarding, including transit insurance, receipt at site, storage and handling at site, erection, testing, cleaning, start-up & commissioning and performance testing - all to the satisfaction of INSTITUTE and in accordance with these specifications and as per good engineering practices for **upgrdation of one (1) Transformer bay with 66/11kV 12.5MVA Transformer (T1) and associated works, 11kV Additional DG Panel, SCADA Upgradation include integration and all civil works releavant to this Bay at 66kV MRS, Indian Institute of Science**.

2.0 It is not the intent herein to specify completely all details of design and construction features of the equipment. However, the equipment shall conform in all respects to high standards of engineering, design and workmanship and be capable of performing in continuous operation in a manner acceptable to institute, who will interpret the meaning of drawings and specifications and shall have the power to reject any work which in his judgement is not in full accordance herewith.

3.0 Bidder shall quote for all the systems covered in this specification. If any item other than those specified is required for the proper operation of the system, the same shall be included in the offer.

6.2 Project Information

1.0	OWNER	**Indian Institute of Science (IISc), Bangalore**
2.0	CONSULTANT	**POET Consultants Pvt. Ltd., Bangalore**
3.0	PROJECT TITLE	Electrical system up-gradation at IISc campus
4.0	LOCATION	Bangalore, Karnataka
5.0	ELEVATION ABOVE MEAN SEA LEVEL	908 meter
6.0	NEAREST RAILWAY STATION	Bangalore City Railway Station / Yeshwanthpur Railway Station
7.0	NEAREST NATIONAL HIGHWAY	NH No.7
8.0	NEAREST AIRPORT	Kempegowda International Airport
9.0	ANNUAL AVE. AMBIENT TEMP.	
	a. Maximum	37.5^0 C
	b. Minimum	12^0 C
	c. Amb. Temp (For Equipment Design)	45^0 C
10.0	ANNUAL RAIN FALL	650-850 mm.
11.0	HUMIDITY (For Equipment Design)	Not more than 85% at maximum temperature
12.0	SEISMIC ZONE	Zone -II as per IS 1893
13.0	TROPICALIZATION	All equipment supplied against this specification shall be given tropical and fungicidal treatment in view of the climatic conditions prevailing at site. Tropical

		protection shall conform to BS CP -1014-1963, Protection of Electrical Power Equipment against climatic conditions.
14.0	PLANT MAIN EARTH GRID	50x10 mm GS Flat
15.0	AUXILIARY POWER SUPPLY	
	a.MV AC Power Supply	415V, 3-phase, 4-wire, 50 Hz effectively earthed system with voltage variation of +/- 10%, frequency variation of +/- 5%, or combined variation of voltage and frequency up to +/- 10%.
	b. Lighting Fixtures, spring charging motors and Space Heaters	240V, 1-phase, 2-wire, 50Hz, AC
	c. Control Supply	110V AC / 110V DC as applicable
16.0	AUXILIARY SUPPLY VOLTAGE VARIATION	
	a. AC Supply	Voltage Variation: +/- 10%
		Frequency Variation +/- 5%
		Combined Voltage and Frequency Variation: +/- 10%
	b. DC Supply	Voltage Variation : + 10% to – 15%
		All devices and equipment shall be suitable for continuous operation over the entire range of voltage and frequency indicated above, without any change in their performance.

6.3 Specific Technical Requirement (Electrical)

1.0 INTRODUCTION

1.1 The Indian Institute of Science (IISc), Bangalore is a 105 years old establishment and is a premier institute for advanced scientific and technological research and education in India.

1.2 IISc, Bangalore has got a very old electrical system and has planned to upgrade the same and increase its capacity.

1.3 At present, the power supply to the facility is fed by 1 Nos of 5MVA & 2 Nos of 12.5MVA 66/11kV transformers.

1.4 Transformer - 1 Bay of 5MVA is to be upgraded to 12.5 MVA Transformer.

1.5 As part of this project, 66kV Substation equipments will have to be procured under this scope of work and erected and commissioned.

1.6 In addition, New 11kV DG Panels need to be added with existing DG Panels at 11kV Control Room and DG Room in Main Receiving Substation.

2.0 SCOPE OF WORK

2.1 The following is the scope of supply, unloading and storage at site, erection, testing and commissioning for the project:

Sl. No.	Item Description	Quantity
	66kV Switchyard	
1	66kV SF_6 Circuit Breaker	1 Set
2	66kV Isolators with two earth switch	1 Set
3	66 kV CT	3 Nos

Sl. No.	Item Description	Quantity
4	66kV CT Junction Box	1 Nos
5	60kV Lightning Arrestors	3 Nos
6	Switchyard Miscellaneous accessories such as Bus bars, clamps, Connectors and any hardware required for Switchyard	1 Lot (Refer BOQ)
7	11kV Earthed Grade (E), Aluminium conductor, XLPE insulated, multi core, armoured Cable	1 Lot (Refer BOQ)
8	1100V Grade Power and Control cables	1 Lot (Refer BOQ)
9	Cabling accessories such as Cable trays, Steel for erection of cable trays, Glands, Cable Lugs, and any other hardware required for Cabling	1 Lot (Refer BOQ)
10	Switchyard Earthing system including necessary hardware	1 Lot (Refer BOQ)
	Oil Filled Transformer	
11	**66/11.6kV, 12.5MVA ONAN Cooled** Power Transformer with vector group **Dyn11, Z= 8.05%**	1 No
12	OLTC and OLTC Remote Control Panel for the above Transformer	1 No
13	First fill of oil along with 2 Drums (400 litre) extra oil in sealed non returnable containers.	1 Lot
14	Nitrogen Injection Fire Protection System (NIFPS) suitable for the above transformer	1 Set
15	10 litre of paint (finish shade) in non returnable containers for site touch-up after erection.	1 Lot
16	Oil filtration at the time of installation, testing and commissioning of transformer	1 Lot
17	Main and OLTC Tank Oil Samples Testing at CPRI	4 Nos
	Control Room Equipment	
18	66kV Control & Relay Panel for T1 include BCU as a loose item	1 No
19	New Bay TR#1 - SCADA integration with Existing	1 Lot.
	11kV Panels (Control Room)	
20	Existing Transformer #1 Incomer Cable box Modification	1 Lot.
21	New 11kV DG Incomer Feeder to be added with existing 11kV Panels include Power and control Cables	1 No
22	Additional Interlock system to be added between DG and Transformer Incomers	1 Lot.
	11kV Panels (DG Room)	
23	New 11kV DG Outgoing Feeder to be added with existing 11kV DG PCC Panels include Power and control Cables	1 No
	Power and Control Cables Installation	
24	Power and control cable relavant to the New Transformer #1, CRP, RTCC, New DG Incomer, Existing 11kV Transformer Incomer TR#1	(Refer BOQ)
	EARTHING	
25	75 x 12 mm GI strip for switchyard buried earth grid.	(Refer BOQ)
26	75 x 10 mm GI strip for substation riser to equipment and structural earthing.	(Refer BOQ)

Sl. No.	Item Description	Quantity
27	50 x 8 mm Cu strip for Transformer neutral earthing.	(Refer BOQ)
28	25 x 6 mm GI Strip for fence earthing.	(Refer BOQ)
29	1C x 6 Sq.mm Cu Flexible Cable (Yellow/green) for DB's/Junction Box/Marshalling Kiosk	(Refer BOQ)
30	Auxiliary earth mat with Copper Mesh size of 150mm x 150mm for isolators (Overall-1200mm x 1200mm)	(Refer BOQ)
31	Treated Earth pits complete with 100 dia 13 thick Cast Iron Pipe 2.5m long with disconnecting links, chamber, inspection cover, civil works, etc., as per specifications and drawings.	(Refer BOQ)
32	Excavation in earth of dimension 300 x 600mm deep and back filling, compacting the earth as per specification and making good to original condition including asphalting / concreting (for buried earth grid)	(Refer BOQ)
	STEEL SUPPORTING STRUCTURE	
33	Steel supporting structure need to be replaced for all 66kV Switch yard equipments at Transformer Bay #1	(Refer Civil BOQ)
	Miscellaneous Items	
34	CO2 Fire Extinguishers - 4.5 kg	(Refer BOQ)
35	Fire bucket with sand	Refer BOQ)
36	Fire bucket Steel sand (For 3 buckets)	(Refer BOQ)
37	Rubber hand gloves,Branded, Class4	(Refer BOQ)
38	Shock treatment chart, duly framed	Refer BOQ)
39	Danger boards as per IS 2551 (150 x 150mm)	Refer BOQ)
40	First aid kits	(Refer BOQ)
41	Rubber Mats - 1500 mm (W) x 1000 mm (L) x 12 mm (T)	(Refer BOQ)
	Buy Back List	
42	66kV Three pole Double break Isolator with one hand operated Earth Switch-supply	1 No
43	66kV Class Triple pole Circuit Breaker	1 No
44	66kV, 3 Core CTs for metering and protection	3 No's
45	Outdoor Junction Box for CT	1 No
46	60kV, Station Class Lightning Arrestors	3 No's
47	5MVA, 66/11.6kV, Power Transformer, Z=7.04%, with OLTC +5% to -15%	1 No
48	Old GI Earthing strips from 66kV Yard	50 kgs

2.2 The highlighted equipments in dwg no : PCPL-2329-4-GA-002 will be replaced with new ones.

2.3 The work shall be carried out in accordance with drawings, specifications, installation notes, data sheets and price schedule enclosed with this document.

2.4 **The contractor shall be responsible for obtaining statutory clearances from the concerned authorities including approval of drawings and documents from KPTCL/BESCOM/CEIG/ CEA and to obtain the safety certificate for charging the**

switchyard. Statutory fees and processing fees shall be reimbursed by Institute on production of Receipts.

2.5 Reference drawings enclosed as Bid document are as given below:

Drawing No.	Rev No	Title
PCPL-2329-4-GA-001	P0	General arrangement-Existing 66kV Switchyard & Control Room Layout
PCPL-2329-4-SLD-001	P0	Main One Line Diagram - Existing
PCPL-2329-4-GA-002	P0	General arrangement – Proposed 12.5 MVA Power Transformer Bay-1
PCPL-2329-4-SLD-002	P0	Single Line Diagram - Proposed 12.5 MVA Power Transformer Bay-1
PCPL-2329-5-SK-001	P0	Existing - SAS panel
PCPL-2329-5-SK-002	P0	SCADA Architecture

3.0 GENERAL REQUIREMENT

3.1 In the event of conflict in details for any equipment / item / sub-system, etc., between data sheets, drawings, Section-6.4 to 6.18 & Section-7.0, the explanation furnished in this section i.e., **Section-6.3.1** shall be final and to be considered for bidding purposes.

3.2 The design, manufacture, testing and performance of all equipment shall comply in all respects with the requirements of the latest edition of the applicable standards and codes

3.3 66kV Switchyard

3.3.1 66kV Circuit Breaker

a) The Circuit Breaker shall conform to enclosed specification section 6.5.2 for EHV Circuit Breaker along with data sheets.

b) The external finish paint shade for the Circuit Breaker, mounting structure, mechanism box and its accessories if any shall be Shade 632 of IS 5. The type of paint shall be epoxy coated. The interior of the panel shall be painted with glossy white enamel paint.

c) Bidders shall offer porcelain clad outdoor type Sulphur hexafluoride (SF6) Circuit breakers.

d) SF6 pressure monitoring system shall be provided.

e) MCB's of suitable rating shall be used in the control circuits.

f) All control wiring shall be of minimum size 2.5 Sq mm flexible multi-stranded copper wire, PVC insulated steel wire armoured FRLS PVC outer sheathed cable.

g) All secondary and auxiliary wiring terminals shall be finger touch proof shrouded design.

h) 20% spare terminal blocks shall be made available in each terminal block location for purchaser's use.

i) The terminals of the circuit breakers shall be suitable for horizontal take off of 50 mm (2") IPS Al tube and clamps and connectors shall be as indicated in dwg. No: PCPL-2329-4-GA-002.

j) Double compression type glands of suitable size shall be supplied along with marshalling box of Circuit Breaker.

3.3.2 66kV Isolator:

a) The isolator shall conform to enclosed specification Section 6.6.2 for EHV Isolator along with data sheets.

b) Isolator shall be complete with earthed operating handle for main and earth switch. The contacts of isolator shall be with electrolytic grade copper duly silver plated. The moving contact shall be copper tube silver plated and the type of contact arrangement shall be turn and twist.

c) Limit switches for main and earth switches shall be provided as specified in Data Sheet-A duly wired to the terminal block for Interlocks and remote status indication.

d) Isolator and earth switch shall be provided with interlocks as specified in Clause-4, Section 6.6.2.

e) The marshalling box for the isolator shall be outdoor type with IP55 protection. The door of the cabinet shall have facility for pad locking. Provision shall be available inside the cabinet for taking 1 phase supply through an industrial power socket controlled by one 16A, 30mA DP RCBO.

f) The finish shade for the marshalling box and its accessories shall be 632 of IS 5. The type of paint shall be epoxy coated. The interior of the panel shall be painted with glossy white enamel paint. All other metallic parts shall be hot dip galvanised as per IS to a thickness of 75 microns.

g) The marshalling box shall be provided with suitable earthing studs of tin plated brass of suitable size for connecting to the Purchaser's earth grid.

h) The terminal blocks used in the Marshalling Box shall be suitable for 4 Sq.mm. conductors and 20% spare shall be available for purchaser's use. The Marshalling Box shall be provided with a lamp and switch. The Marshalling Box shall be complete with double compression type glands for control and power cables. Internal wiring shall be with FRLS PVC insulated multi-strand copper conductor of min. size 2.5 Sq.mm.

i) All control circuits shall be designed with fuse less system. Each control circuit shall be provided with suitable rating MCBs for protection instead of fuses.

j) All power & control wiring shall be with finger touch proof terminations.

k) The terminals of isolators shall be suitable for horizontal take off of 50mm (2") IPS Al tube and clamps and connectors shall be as indicated in Dwg. No: PCPL-2329-4-GA-002.

3.3.3 **66kV CT:**

a) The CT shall conform to enclosed specification Section 6.7.2 for EHV CT & PT along with data sheets.

b) The finish shade shall be 632 of IS 5. The type of paint shall be epoxy coated. The interior of the terminal box shall be painted with glossy white enamel paint. All metal parts coming in contact with oil shall be painted with oil resistant paint.

c) CTs shall be hermetically sealed type and their corresponding terminal boxes shall have a degree of protection of IP 55.

d) The terminals for CT secondary shall be shorting type and suitable for conductor size up to 4 Sq.mm. Minimum of 6 spare terminal connectors shall be available in CT junction boxes for Purchaser's use.

e) Double compression type glands of suitable size shall be supplied along with CT terminal boxes.

f) CT terminals shall be suitable for horizontal take off of 50mm (2") IPS Al tube and clamps and connectors shall be as indicated in Dwg. No: PCPL-2329-4-GA-002.

3.3.4 **60kV Lightning Arrestor:**

a) The Lightning Arrestor (LA) shall conform to enclosed specification Section 6.8.1 for Lightning Arrestor along with data sheets.

b) The finish shade shall be 632 of IS 5. The type of paint shall be epoxy coated.

c) The LA's shall be supplied with insulating base to monitor the discharge currents.

d) Each LA shall be supplied with one discharge counter and leakage current indicator. The discharge counter shall be provided with M12 tin plated brass studs with two nuts,

brass washers & spring washer for connections to Purchaser's earth grid. Suitably rated bypass shunt for bypassing the discharge counter shall also be provided.

e) The discharge counter shall be suitable for outdoor installation with IP55 protection.

f) The insulated flexible connector required for connecting LA to the discharge counter is in the scope of the bidder.

g) The flexible connectors shall be of adequate length with margin.

h) The LA will be connected to 50mm (2") IPS Al TUBE. The terminals shall be suitable for vertical takeoff and clamps and connectors shall be as indicated in Dwg. No: PCPL-2329-4-GA-002.

3.3.5 **66kV Control and Relay Panel:**

a) The Panels shall conform to enclosed specification Section 6.9.1 for Control and Relay Panels along with data sheets and single line diagrams. These panels shall be PLC and SCADA compatible and ready design.

b) The protection, metering and controls to be provided in the control and relay panel shall be as indicated in Data Sheet-A3 of Section 6.9.2.

c) All the interconnecting cabling for various instruments mounted on the panels shall be included in the scope of VENDOR.

d) All protection relays shall be numerical type. All the numerical relays shall have RS 485 port for communication with PLC and SCADA.

e) All meters shall have provision for communication with SCADA.

f) The indicating lamps shall be cluster LED type of suitable colour depending on the functions.

g) Each panel shall be provided with danger sign label as per IS, both at front, side and rear.

h) Mimic diagram:

   i) The width of the mimic bus shall not be less than 6 mm.

   ii) The height of the mimic bus shall be 415 mm from top.

   iii) Mimic diagram shall be as per drawing no: PCPL-2329-4-SLD-002 and shall be subjected to Institute's approval.

   iv) Colour of the mimic shall be golden brown (shade 414 of IS 5) for 66kV.

i) The status of equipments like Isolator, Isolator earth switches, Isolator operation commands Circuit Breaker Local/ Remote switches, Circuit Breaker Alarm and Trip Indications, Circuit Breaker operation commands, Supply Fail Indications, Circuit Breaker healthiness, Power transformer faults, Power transformer alarm and trip indications, CT & PT information, any abnormal conditions of field devices, hardwares mounted on / inside panel, trip relay monitoring etc shall be made available to/from SCADA by providing necessary RTUs and any other necessary hardware required in the Control and Relay panel.

j) New BCU shall be compatible with the existing SAS panel and software, shall be mounted on CRP panel.

3.3.6 **Supply and Installation of Cables**

a) HV Power Cables:

   i) The cables shall be 11kV, Earthed grade, XLPE insulated, screened, armoured, PVC sheathed and shall conform to enclosed specification Section 6.10.1 and associated data sheets.

   ii) The cable sizes and quantities shall be as furnished in Section-7.1.

iii) Heat shrinkable type straight through joints shall be supplied wherever mentioned in Section-7.1.

iv) Heat shrinkable type cable termination kits shall be supplied as furnished in Section-7.1.

b) MV Power Cables:

i) The Cables shall be 1100 Volt grade, XLPE insulated, FRLS-PVC sheathed and shall conform to enclosed specification Section 6.11.1 and associated data sheets.

ii) The cable sizes and quantities shall be as furnished in Section-7.1.

iii) The cable termination shall be as furnished in Section-7.1.

c) Cabling System

The scope of work shall include supply, installation, testing and commissioning of the following:

A. All the power and control cables required for completion of work and proper functioning of the system.

B. Complete cable carrier system which shall include:

i) Galvanised bolted type Cable trays, tray covers and all accessories such as coupler plates, elbows, tees, bends, reducers, stiffeners etc and all hardware.

ii) All rigid and flexible conduits and pipes with accessories.

C. All Cable Glands, Lugs, termination kits etc., for cable terminations.

d) Cable size and cable number shall be marked near cable termination.

e) Bidders shall quote for cable carrier system, power and control cables and their terminations based on the quantity indicated in price schedule (Section-7.1).

f) Cable carrier system sizing shall be carried out considering 20% empty space for addition of future cables.

g) The installation of the cabling system shall be in accordance with the following specifications:

i) Section 6.15.2: Cabling system.

ii) Section 6.17.1: Cable Installation Notes.

h) All cable schedules and interconnection schedules shall be submitted for approval.

i) The following formats will be furnished by Institute during detailed engineering for Contractor to fill in and submit for Institute's reference and records:

i) Cable schedule.

ii) Interconnection schedule.

Further, cable numbering and cable tray numbering shall be done based on the procedure that would be given by the Institute during detailed engineering.

3.3.7 **General technical Requirement for equipment Marshalling Boxes**

a) The Marshalling Boxes for equipment shall be of outdoor type with IP55 protection. The door of the cabinet shall have facility for pad locking. Provision shall be available inside the cabinet for taking single phase supply through 32A industrial metal clad power socket controlled by one 32A, 30mA DP RCBO. The control cabinet shall be provided with suitable earthing studs of tin plated brass of suitable size for connecting to the earth grid.

b) The entire power & control network have been designed as fuse less system. Hence, no fuses shall be used in control circuits of equipment. MCBs of suitable rating and type shall be used in the control circuits (AC/DC). MPCBs/ RCBOs of suitable rating are to be used for control circuits and PT secondary circuits in place of fuses.

c) The indicating lamps shall be cluster LED type of suitable colour depending on the functions.

d) All control cabling shall be of minimum size 2.5 Sq mm flexible multi-stranded copper wire, FRLS-PVC insulated cables. However, for CT circuits minimum size of 4 Sq mm flexible multi-stranded copper wire to be used.

e) All power & control cabling shall be with finger touch proof terminations. The instrumentation, meters, switches, etc., used shall have terminal shrouding for human safety.

f) Contact multiplication for the auxiliary contacts to be achieved only through VAJC type auxiliary relay and not by means of air break contactors.

g) All un-used terminals of all relays, meters, instrumentation shall be wired out to the terminal blocks.

3.3.8 **Substation accessories:**

a) The scope of work shall include supply, erection/stringing, testing and commissioning of the following:

   i) 2" IPS Al tube for Bay bus.

   ii) 2.5" IPS Al tube for Main bus.

   iii) Bus post insulators.

   iv) Clamps and connectors with all hardware.

b) The main busbar from the existing switchyard shall be extended to the new transformer bay as shown in drawing: PCPL-2329-4-GA-001.

c) Busbar joints shall be avoided to the extent possible. In case of unavoidable busbar joints, the same shall be of welded type with welding sleeves.

d) All clamps and connectors wall thickness shall not be less than 12mm and shall not have any sharp edges to mitigate corona discharge. Bolts of the terminal connectors and clamps shall be tightened with torque as specified by the manufacturers of equipment/ clamps and connectors.

e) The Substation accessories shall conform to enclosed specification Section 6.12.1.

f) Bidders to quantify the clamps and connectors based on the Switchyard layout drawing enclosed and quote Lump sum price. However, two clamps and connectors of each type shall also be supplied as part of the package as spares

3.3.9 **Earthing System**

a) Existing earthing system will hold good. However, wherever, new equipment are provided and old equipment are relocated, the leads from the new/relocated equipment shall be connected to the existing earth grid by appropriate earth grid size. The supply and installation work shall be carried out in accordance with the following specification:

   i) Section 6.13.2: Earthing
   ii) Section 6.16.2: Earthing system installation notes.

b) Switchyard earthing layout if required will be furnished to the successful bidder.

c) The bidder shall quote for the earthing materials required for the switchyard as per the quantity indicated in Section-7.1. The material, type, minimum sizes shall be selected as detailed below:

   i) Switchyard buried earthing conductor – 50 x 10 GS Flat.
   ii) Switchyard risers to equipment earthing – 50 x 10 GS Flat.
   iii) Earthing electrode – 100mm Dia. x 3m long GI pipe with 13mm wall thickness.
   iv) 7/3.15 Successful bidder shall carryout the soil resistivity measurements before commencement of site works and carryout the earthing design based on the measured soil resistivity.

v) Shield wire for Lightning protection.
vi) Strain clamps suitable for 7/3.15 shield wire.
vii) Pin insulator for 7/ 3.15 shield wire.

3.3.10 **Structures:**

a) Supporting steel structures need to be provided for all new 66kV Switchyard electrical equipments include NIFPS. The existing structures will be removed including foundation and new structure shall be made with New Foundation.

3.3.11 **Power Transformer:**

a) Power Transformer, On Load Tap Changer (OLTC), and OLTC Control panel, shall conform to enclosed specification Section 6.4.1 and Section 6.4.3 along with Data Sheets.

b) The transformers shall be SCADA compatible and shall be provided with all devices and fittings required for Nitrogen injected fire protection system.

c) Transformer shall be supplied with One (1) set – Nitrogen Injected Fire Protection System (NIFPS) complete with local control box, remote control panel, signal box, heat detectors and all other accessories as per enclosed specification Section 6.4.4 and the data sheets. The Transformer NIFPS shall be compatible to SCADA.

d) All the interconnecting cabling for various instruments mounted on the transformer and OLTC and its local control cubicle shall be included in the scope of Bidder.

e) All RTCC and OLTC alarm indications, status indications, measurements etc shall be made available to SCADA by providing necessary RTUs and any other necessary hardware required in the RTCC.

f) The finish shade for the transformer and its accessories shall be 632 of IS 5. The type of paint shall be epoxy coated.

g) Bidders are required to offer transformer with low losses. No load and Load losses shall not exceed 9.7kW and 70kW respectively for Power Transformer. The losses mentioned are subject to IS tolerance.

h) The losses quoted by the bidders shall be evaluated for Power Transformers based on the following formula:

Capitalised cost of Transformer Losses = Quoted price of Transformer in Rs + 296471 x Wi + 199229 x Wc

Where

W_i = No Load Loss (Iron) in kW

W_c = Load Loss (Copper) in kW

i) Institute reserves the right to reject the Transformer, if the losses exceed the guaranteed values plus tolerance as per Table-7 of IS 2026 (Part-1).

j) However, the transformer can be accepted if the Vendor modifies the design and offers the transformer for retesting within a reasonable time. All costs towards this rework shall be to the vendor's account.

k) The transformer shall be provided with 50 x 8 mm Cu earth bus from the neutral bushing terminal to the transformer bottom, supported on insulators for connections to earth pits.

l) Transformer shall be supplied with the essential spares listed at Data Sheet – A under section – 6.4.2.

m) The transformer shall be designed with IS tolerance on the impedance.

n) In the event of conflict between the contents of section-6.3.1 to section 6.3.3 and other sections of the specification (except Data Sheet-A of section-6.4 to section 6.18), the former shall govern. In the event of conflict between Data sheet-A of section-6.14 to section 6.18 and the contents of section-6.3.1 to section 6.3.3, the former shall govern.

o) Vendor shall submit quality assurance plan, which would form part of purchase order, to enable the Institute to assure the quality of components at various stages of manufacture.

p) Negotiation of technical parameters by Bidder after the bids are opened will not be entertained

3.3.12 **Control Room Equipment**

a) 66kV Control & Relay Panel for Transformer 1

b) RTCC for Transformer 1

c) New 11kV DG Incomer Panel

d) Cable Box Modification in the existing 11kV Incomer- TR#1

3.3.13 **DG Room Equipment**

e) New 11kV DG Outgoing Panel

3.3.14 **Erection, testing and commissioning**

a) All the equipment to be supplied under the scope shall be erected, tested and commissioned in accordance with the enclosed specification Section 6.14.2: Electrical contract works.

b) All checks and tests as per manufacture's drawings and instruction manuals, relevant codes of installation and the entire commissioning check list specified in the above specification shall be carried out as part of the installation work.

c) The electrical installation work shall comply with the latest applicable standards, regulation, electricity rules and safety codes. Nothing in this specification shall be construed to relieve the contractor of this responsibility.

3.3.15 **Civil Works**

a) **The following works shall be included in the scope of Electrical Contractor** :

i) Civil works for foundations for all 66kV Switchyard equipment supporting Structure.

ii) Supporting Steel Structure for all 66kV Switchyard equipment.

iii) Civil works for installation of earthing systems.

iv) Civil works associated with the electrical installation work.

v) Civil works for transformers soak Pit.

vi) Civil Works for Transformer NIFPS.

b) The respective Contractor shall also remove the debris accumulated on account of installation of equipment from site and dispose of safely as directed by the Institute.

c) Detailed scope/requirement for civil works for the project has been furnished in Specific Technical Requirement-Civil Works (Section 6.3.2).

3.3.16 **SCADA System**

a) New Transformer TR#1 Bay need to be integrated with Existing SCADA System.

b) The Supervisory Control and Data Acquisition System (SCADA) shall conform to enclosed specifications Section 6.3.3 and Section 6.18.2. along with Data Sheets.

c) The SCADA shall also conform to with the drawings and data sheets listed in the specification.

4.0 APPROVED MAKES:

SL. NO.	EQUIPMENT	PREFERRED MAKES
1.	Power Transformer	TOSHIBA / HITACHI / GE / KEC / KIRLOSKAR
2.	On Load tap changer mechanism and control panel	CTR / OLG/TELK / BHEL
3.	Nitrogen Injection Fire protection System	CTR / SHOOTFIRE / SSCOMP
4.	66 kV SF 6 Circuit breaker	SIEMENS / HITACHI / GE / CGL
5.	66 kV CTs	CGL / SIEMENS / HITACHI / VIDYUT CONTROL / TELK
6.	66 kV Isolators	SIEMENS / HITACHI / CGL / HIVELM / GR POWER / SWITCHGEAR & STRUCTURALS
7.	66 kV PTs	CGL / SIEMENS / HITACHI / VIDYUT CONTROL / TELK
8.	60kV Lightning Arrestors	CGL / OBLUM / HITACHI / RAYCHEM
9.	11Kv Switch gear Panel (New Panel)	SIEMENS / HITACHI / GE / SCHNEIDER / LK
10.	SCADA UPGRADATION	Only GE (Suitable for Existing Substation SCADA)
11.	ACSR Conductors & Shield wire	STERLITE IND ./ GALADA POWER / APAR INDUSTRIES / MOHAN / SHARAVATHY CONDUCTORS
12.	Clamps & connectors	TYCO-RAYCHEM / EXALT ENGG / MEGHA IND. / ENERGY ENTERPRISES / SUPREME & CO
13.	Al Tube	INDAL / HINDALCO / BHORUKA / NALCO
14.	Bus post / Solid core/ Disc Insulators	ADITYA BIRLA / MPL / BHEL / MODERN / JSI / INSULATOR & ELECTRICALS
15.	Control & Relay Panels	Only GE (Shall be suitable for Existing SCADA)
16.	Relays	GE / SCHNEIDER (Shall be suitable for Existing SCADA)
17.	Interposing transformers, Auxiliary instrument transformers & Control transformers.	INSTRANS / KAPPA / PRAYOG / KALPA
18.	Switches, Push buttons, actuators Ind. Lamps	KAYCEE / SIEMENS / SCHNEIDER / LK (L&T) / SALZER / SELECTRON

SL. NO.	EQUIPMENT	PREFERRED MAKES
19.	Meters & Instruments	SIEMENS / SCHNEIDER / AE / MECO / RISHAB / SELEC
20.	Annunciation Facia type	PROCON / DIGICONT / APLAB / JVS / MINILEC
21.	Terminals	PHOENIX / WAGO/CONNECTWELL / ELMEX
22.	MCB, RCBO, ELCB, Contactors	SIEMENS/ HITACHI / SCHNEIDER / MDS LEGRAND
23.	Enclosure	RITTAL / SCHNEIDER / SIEMENS / HITACHI/ EL STEEL / HENSEL (FOR OUTDOOR)
24.	Cable Trays	PROFAB / MDS LEGRAND
25.	Switches & sockets	MDS LEGRAND / MK GERMANY / CLIPSAL/ PANASONIC
26.	Panel space heaters	RITTAL
27.	Humidistat	RITTAL
28.	11kV UG Cable	ASIAN / KEC RPG / UNIVERSAL / POLYCAB / APAR / GEMSCAB
29.	415V UG Cable	ASIAN / KEC RPG / UNIVERSAL / POLYCAB / APAR / GEMSCAB
30.	11kV Class termination and jointing kits	RAYCHEM / COMPAQ INTERNATIONAL
31.	Power and Control Cables	UNIVERSAL / POLYCAB / ASIAN / KEC RPG / GEMSCAB
32.	Cable Glands	BALIGA / COMET / STROKES
33.	Cable lugs	DOWELL / AMP / STROKES
34.	Steel	SAIL / VSP
35.	Safety Accessories (Gloves, Rubber MAT etc.,)	3M / RAYCHEM / KARAM

5.0 INSPECTION AND TESTING:

5.1 General

5.1.1 All the equipment, apparatus, materials and supplies provided by the contractor under this contract shall be subjected to tests in the shop and at the field in the presence of Project Engineer cum Estate officer for conformity with the requirements of the specifications. The details of the test procedures and test equipment to be used shall be intimated to the Institute.

5.1.2 The Contractor shall submit a detailed quality assurance plan within 30 days after the purchase order.

5.2 Test Reports:

5.2.1 Within 15 days of completion of each and every specified test, including commissioning tests, the Contractor shall submit six signed copies of the test reports to the Institute.

5.2.2 The test report shall include, but not necessarily be limited to the following.

a) A description of the test equipment with diagram showing arrangement of the test instruments and devices.

b) Sample computations, wherever necessary to show the test values employed in the equations.

c) Curves showing relation of tested quantities.

d) Data in tabulated form.

e) The comparison of the test results with the guaranteed requirements of the specification and explanation of deviations, if any.

5.3 **Shop Tests:**

The shop tests shall include type, routine and acceptance tests as applicable as well as any other tests as required.

5.4 **Retesting**

The Contractor shall, at its own expense, promptly make good all defects evident by testing or made apparent in any other ways. After defects in the equipment have been rectified, the equipment will be subjected to such retesting as may be necessary until the equipment is proved to be in satisfactory operation/condition.

5.5 **Quality Assurance Plan (QAP)**

The contractor shall furnish Quality Assurance Plan (QAP) for each equipment/system which shall include the following details:

a) List of areas in manufacturing process where stage inspection by Project Engineer cum Estate officer shall be carried out.

b) Hold points in the manufacturing process for Project Engineer cum Estate officer inspection.

c) Shop test schedules for the Project Engineer cum Estate officer to witness the tests.

d) The hold points and shop test schedule shall be discussed with the Project Engineer cum Estate officer before the QAP is finalised.

5.6 **Inspection By Project Engineer cum Estate officer**

a) The Project Engineer cum Estate officer/Authorized Repesentative will do inspection at the hold points during manufacture as per approved QAP.

b) The Project Engineer cum Estate officer/ Authorized Repesentative will witness the type and routine tests as well as other shop tests as per approved QAP.

c) The Project Engineer cum Estate officer/ Authorized Repesentative will witness any retesting that may be required as specified in Para 5.4.

d) The costs of travel, food and lodging and other incidental expenses for Project Engineer cum Estate officer for the inspection and witnessing of tests shall be borne by the Contractor.

e) The bidder shall give the IISC a minimum of ten (10) days' written notice whenever any equipment / component / material is ready for testing. The IISC shall attend such tests on the notified scheduled date of testing.

f) The bidder shall arrange for joint inspection with authorized representatives (at least 3 persons) of the IISc Bangalore. Their travelling by Air, local transportation, boarding and lodging are to be borne by the bidder.

g) No Boarding and Lodging facility will be arranged by the Owner for the deputed personnel for this work. Also, no "to and from" traveling expenses for the deputed personnel will be borne by the Owner.

6.0 DOCUMENTATION:

6.1 Bidder shall submit the following documents for all equipment in **THREE SETS** with the bid:

a) All drawings as mentioned in respective specification

b) Catalogue of all Equipment along with the filled in data sheet-B.

c) Bill of material with type, ratings and makes of all components.

d) Copies of valid type test certificates (not older than 5 years from the date of bidding) carried out on offered equipment for short circuit, impulse, temperature rise and IP class.

6.2 Whether explicitly mentioned or not in the various sections of this specification, Vendor's documentation shall include hard copies of all drawings related to this package, operating and instruction manuals, training manuals, etc., in **SIX sets** after delivery of equipments to site. The GA and schematic diagrams shall be in AutoCAD software compatible and shall preferably be carried out in Promise or equivalent software. Vendor shall submit the following documents, in **THREE** sets each to IISc and PCPL for approval after award of contract and before start of manufacture.

a) Overall general arrangement drawings giving plan, section, foundation loading data (both static and dynamic), side view, etc.

b) Internal component layout drawings.

c) Sizing calculation for busbar selection and earthing conductor selection.

d) Catalogue of the Equipment along with the filled in data sheet-B.

e) Bill of material with type, ratings and makes of all components.

f) Control and schematic diagrams for circuit breakers, isolators and CRP with ferrule and terminal numbers.

g) Testing and calibration certificate of all meters.

h) Interconnection schedule.

i) Cable schedule.

j) Copies of valid type test certificates (not older than 5 years from the date of bidding) carried out on offered equipment for short circuit, impulse, temperature rise and IP class shall be submitted in THREE SETS along with the drawing for review and approval.

7.0 COMPLETION SCHEDULE:

All equipments to be procured under this specification shall be supplied to site and erected within the period as specified in the forwarding letter. BIDDER shall submit a bar chart for various activities of manufacturing, testing, inspection, delivery, erection, testing and commissioning.

8.0 QUANTITY VARIATION:

8.1 The quantities for supply and installation are furnished at Section-8. The bidder shall quote unit rates for all items. The unit rate schedule shall be binding for any quantity variation.

8.2 For cabling, earthing, lightning protection and lighting the estimated quantities are given at Section-8. However; the bidder shall estimate the quantities from the drawings and quote accordingly.

8.3 In addition to the Bill of material specified at Section-6, the Bidder shall study the tender drawings and shall highlight any item/equipment that is required for completion of the job.

8.4 The quantities and unit rates for such non- tendered items shall be quoted separately. Prior approval for unit rates for non-tendered items shall be taken before carrying out the work.

9.0 PERFORMANCE GUARANTEE:

The equipment shall have a warranty of 18 months from the date of commissioning.

6.3.2 Specific Technical Requirement (Civil)

1.0 SCOPE OF ENQUIRY:

1.1 The scope of this enquiry is to briefly describe the various civil and structural works required as a part of Electrical System up-gradation works at the IISc. Campus at Bangalore. As part of the up-gradation works, it is proposed to upgrade the existing 5MVA transformer bay with 12.5 MVA transformer. Equipments viz. Circuit Breaker, Isolator, CT, LA will be replaced with new ones. The proposed layout is shown in the drawing No. PCPL-2329-4-GA-002.

1.2 In brief following works are part of the scope of contractor:

1.3 Demolition of existing foundation of 5MVA transformer.

1.4 Construction of RCC foundations for Transformer, other equipment structures, etc.

1.5 Modification of cable trenches, pipes connecting to burnt oil pit, etc.

1.6 Any other minor civil works required for the completion of the entire work.

1.7 Construction of CR masonry for if required.

1.8 Supplying, Fabricating & Erecting galvanised steel for equipment support structures.

2.0 SCOPE OF WORK

2.1 The following is the scope of tender, unloading and storage at site, erection, testing and commissioning for the project:

Sl. No.	Item Description	Quantity
	66kV Switchyard	
49	Demolishing RCC Works	(Refer Civil BOQ)
50	Plain Cement Concrete works	(Refer Civil BOQ)
51	Reinforced Cement Concrete works	(Refer Civil BOQ)
52	Shuttering	(Refer Civil BOQ)
53	Earth work excavation	(Refer Civil BOQ)
54	Steel Reinforcement for RCC works	(Refer Civil BOQ)
55	Rails for Transformer foundation	(Refer Civil BOQ)
56	Supplying, Fabricating & Erecting galvanised steel structures	(Refer Civil BOQ)
57	Brick works	(Refer Civil BOQ)
58	Cement Plastering	(Refer Civil BOQ)
59	Epoxy Painting	(Refer Civil BOQ)
60	Providing & Filling 40mm Coarse Aggregates	(Refer Civil BOQ)
61	Dismantling steel works	(Refer Civil BOQ)
62	Backfilling	(Refer Civil BOQ)

3.0 EARTHWORK SPECIFICATION :

3.1 In general, earthwork excavation in different materials, site grading, filling back around foundations and in plinths, disposal of surplus spoils or stacking them properly, compaction and all related work shall be carried out as per the following specifications.

3.2 The following Indian Standard codes, latest versions, shall be applicable.

3.2.1 IS-1200 - Method of measurement of Building Works.

3.2.2 IS-3764 - Safety code for excavation works.

3.2.3 IS-3385 - Code of practice for measurement of Civil Engineering works.

3.2.4 IS-2720 - Part – II - Determination of moisture Content

3.2.5 Part –VII- Determination of Moisture Content-Dry Density Relation Using Light Compaction.

3.2.6 Part-VIII – Determination of Moisture Content-Dry Density Relation Using Heavy Compaction.

3.2.7 Part-XXVIII- Determination of Dry Density of Soils, in-place, by the Sand Replacement Method

3.2.8 Part-XXIX- Determination of Dry Density of Soils, in-place, by the Core Cutter Method.

3.3 Owner will furnish drawings wherever such drawings are required to show areas to be excavated/filled, sequence of excavation etc. Contractor shall strictly follow such drawings.

3.4 Contractor shall furnish all tools, plants, instruments, qualified supervisory personnel, labour materials, any temporary works, consumables, any and everything necessary for completion of the job in accordance with requirements.

3.5 Contractor shall carry out the survey of the site before excavation and set properly all lines and establish levels for various works such as earthwork in excavation for grading, basement foundations, plinth filling, roads, drains, cable trenches, pipelines etc. Such survey shall be carried out taking accurate cross sections of the area perpendicular to established reference/grid lines determined by Owner based on ground profile. These shall be properly recorded.

3.6 The excavation shall be done to correct lines and levels. This shall include proper shoring to maintain excavations and also the furnishing, erection and maintenance of substantial barricades around excavated areas and warning lamps at night for ensuring safety.

3.7 The rates quoted shall also include dumping of excavated materials in regular heaps, bunds, riprap with regular slopes as directed by Owner, within the lead specified and levelling the same so as to provide natural drainage. Soil excavated shall be stacked properly as directed by Owner. As a rule all softer material shall be laid along the centre of the heaps, the harder and more weather resistant materials forming the casing on the sides and the top.

3.8 The area to be excavated / filled shall be cleared of fences, trees, plants, logs, stumps, bush, vegetation, rubbish, slush, etc. and other objectionable matter. If any roots or stumps of trees are met during excavation, they shall also be removed. The material so removed shall be burnt or disposed off as directed by Owner. Where earth fill is intended, the area shall be stripped of all loose/soft patches, topsoil containing objectionable matter/materials before fill commences. All materials to be excavated are classified into one of the following classes and shall be paid for the rate tendered for that particular class of material. No distinction shall be made whether the material is dry, moist or wet. The decision of Owner regarding the classification of material shall be final and binding on Contractor.

3.9 Earthwork is classified under any of the following categories:

3.9.1 Ordinary & Hard Soils: - These include all kinds of soils containing Kankar, sand silt, murrum and/or shingle, gravel, clay, loam, peat, ash, shale, etc. which can generally be

excavated by spade, pick axes and shovel, and which is not classified under soft and decomposed rock" and "hard rock" defined below. This shall also include embedded rock boulders not longer than 3 feet in any direction and not more than 8 inches in any one of the other two directions.

3.9.2 Soft and decomposed rock:- This shall include rock, boulder, slag, chalk, slate, hard mica schist, laterite and all other rock materials, that do not need blasting and could be removed with picks, hammer, crow bars, wedges, and pneumatic breaking equipment. Rock boulders not longer than 3 feet in any direction and not more than 20 inches in any one of the other two directions are included in this category.

3.9.3 Hard rock: - This shall include all rock occurring in large continuous masses, which cannot be removed except by blasting for loosening it. Harder varieties of rock with or without veins and secondary minerals which, in the opinion of Owner require blasting shall be considered hard rock. Boulders of rock not classified above shall also be classified as hard rock.

3.10 Excavation for permanent work shall be taken out to such widths, lengths, depths and profiles as are shown on the drawings. Rough excavation shall be carried out to a depth of 6 inches above the final level. The balance shall be excavated with special care. Soft pockets shall be removed at the final level. The final excavation shall be carried out just prior to laying the mud-mat.

3.11 Contractor may, for facility of work or similar other reasons excavate, and also backfill later, outside the lines shown on the drawings. Payment, however, shall be made only as per the drawings. Should any excavation be taken below the specified levels, Contractor shall fill it up, with concrete of the same class as in the foundation resting thereon, upto the required level. No extra payment shall be made to Contractor on this account.

3.12 All excavations shall be done to the minimum dimensions as required for safety and working facility. Prior approval by the Owner shall be obtained by Contractor for the method he proposes to adopt for excavation, Including dimensions, side slopes, dewatering, disposal, etc. This approval, however, shall not in any way relieve Contractor of his responsibility for any consequent loss or damage. Side slopes shall be as step that will stand safely for the actual soil conditions encountered. Every precaution shall be taken to prevent slips. Should slips occur, the slipped material shall be removed and the slopes dressed to a modified stable slope. Removal of the slipped earth will not be paid for if the slips are due to the negligence of Contractor.

3.13 All loose boulders, semi detached rocks (along with earthy stuff which might move therewith) not directly in the excavation but so close to the area to be excavated as to be liable, in the opinion of the Owner, to fall or otherwise endanger the workmen, equipment, or work, etc., shall be removed away from the area of the excavation. The method used shall be such as not to shatter or render unstable or unsafe, the portion which was originally sound and safe.

3.14 Any material not requiring removal as contemplated in the work, but which in the opinion of the Owner, is likely to become loose or unstable later, shall also be removed as directed by the Owner. The cost of such stripping will be paid for at the unit rates accepted for the class of material in question.

3.15 All fill material will be subject to Owner's approval. If any material is rejected by Owner, Contractor shall remove the same forthwith from the site at no extra cost to the Owner. Surplus fill material shall be deposited / disposed off as directed by Owner after the fill work is completed. No earth fill shall commence until surface water discharges and streams have been properly intercepted or otherwise dealt with.

3.16 To the extent available, selected surplus spoils from excavated material shall be used as backfill. Fill material shall be free from clods, salts, sulphates, organic or other foreign material. All clods of earth shall be broken or removed. Where excavated material is mostly rock, boulders shall be broken into pieces not longer than 6 inches size, mixed with properly graded fine material consisting of murrum or earth to fill up the voids and the mixture used for filling.

3.17 If any selected fill material is required to be borrowed. Contractor shall make arrangements for bringing such material from outside borrow pits. The material and source shall be subject to prior approval of Owner. The approved borrow pit area shall be cleared of all bushes, roots of trees, plants, rubbish etc. Top soil containing salts/sulphate and other foreign material shall be removed. The material so removed shall be burnt or disposed off. Contractor shall make necessary access roads to borrow areas and maintain the same, if such access road does not exist, at his cost.

3.18 As soon as the work in foundation has been accepted and measured, the spaces around the foundations, structures, pits, trenches etc. shall be cleared of all debris and filled with earth layers not exceeding 200 mm when finished, each layer being watered, rammed and properly consolidated, before the succeeding one is laid. Each layer shall be consolidated to 90% Modified Proctor Density and to the satisfaction of Owner. Earth shall be rammed with approved mechanical compaction machines. The final backfill surface shall be trimmed and levelled to proper profile as indicated on the drawings.

3.19 Plinth filling shall be carried out with approved material in layer not exceeding 200 mm finished, watered and compacted with mechanical compaction machines, when filling reach final level, the surface shall be flooded with water, unless otherwise directed, for at least 24 hours, allowed to dry and then the surface again compacted as specified above to avoid settlements at a later stage. The finished level of the filling shall be trimmed to the level/slope specified.

3.20 Where specified in the schedule of works, compaction of the plinth fill shall be carried out by means of 12 tonne rollers smooth wheeled, sheep-foot or wobbly wheeled rollers. As rolling proceeds water sprinkling shall be done to assist consolidation. Water shall not be sprinkled in case of sandy fill. The finished thickness of each unconsolidated fill layer can in this case be up to a maximum of 300 mm. Rolling shall commence from the outer edge and progress towards the centre and continue until the compaction is to the satisfaction of Owner. But in no case less than 10 passes of roller will be accepted for each layer. The compacted surface shall be properly shaped, trimmed and consolidated to an even and uniform gradient. All soft spots shall be excavated and filled and consolidated.

3.21 For filling with local sand, sand shall be clean, medium grained and free from impurities. The filled-in-sand shall be kept flooded with water for 24 hours to ensure maximum consolidation. Any temporary work required to contain sand under flooded condition shall be included in Contractor's rate for sand filling. The surface of the consolidated sand shall be dressed to required level or slope. Construction of floors or other structures on sand fill shall not be started until Owner has inspected and approved the fill.

3.22 Filling in trenches for pipes and drains shall be commenced as soon as the joints of pipe and drains have been tested and passed. The backfilling material shall be properly consolidated by watering and ramming, taking due care that no damage is caused to the pipes.

3.23 Where the trenches are excavated in soil, the filling from the bottom of the trench to the level of the centreline of the pipes shall be done by hand compaction with selected approved earth in layers not exceeding 8 inches. Backfilling above the level of the centreline of the pipe shall be done with selected earth by hand compaction or other approved means in layers not exceeding 6 inches.

3.24 Filling of the trenches shall be carried simultaneously on both sides of the pipe to avoid unequal pressure on the pipe.

3.25 Site grading shall be carried out as indicated in the drawings and as directed by Owner. Filling and compaction shall be carried out as specified herein.

3.26 If no compaction is called for, the fill may be deposited to the full height in one operation and levelled. If the fill has to be compacted, it shall be placed in layers not exceeding 225 mm and levelled uniformly and compacted before the next layer is deposited.

3.27 To ensure the fill has been compacted as specified, field and laboratory tests shall be carried out by Contractor at his cost. Contractor's quoted rates for all earth/sand filling items are deemed to include such all tests for compaction.

3.28 Field compaction test shall be carried out at different stages of filling and also after the fill to the entire height has been completed.

3.29 The fill shall be carried out to such dimensions and levels as indicated on the drawings. The fill shall be considered as incomplete if the desired compaction has not been obtained.

3.30 The compaction, shall comply with the specified (proctor/ modified proctor) density at moisture content differing not more than 4 percent from the optimum moisture content. Contractor shall demonstrate adequately at his cost, by field and laboratory tests that the specified density has been obtained.

3.31 Lead for deposition/disposal of excavated material, shall be as specified in the respective item of work. For the purpose of measurement of lead the are to be excavated or filled or area on which excavated material is to be deposited/disposed off shall be divided into suitable blocks and for each of the blocks, the distance between centre lines shall be taken as the lead which shall be measured by the shortest straight line route on the plan and not the actual route taken by Contractor.

3.32 All excavation shall be measured net, as per drawings. Dimensions for purpose of payment shall be reckoned on the horizontal area of the excavation at the base of foundation of the walls, columns, footings, tanks, rafts, or other foundations/structures to be built, multiplied by the average depth from the surface of the ground in accordance with the drawings. Excavation in side slopes will not be paid for. Contractor may make such allowance in his rates to provide for excavation in side slopes keeping in mind the nature of the soil and safety of excavation.

3.33 Unless otherwise specified, the unit rates quoted for excavation in different types of materials shall also account for a basic lead of 130 m for disposal as specified or as directed. Only leads beyond the basic 130 m will be considered as extra lead and paid for at the rates quoted in the schedules.

3.34 Backfilling as per specification the sides of the foundations of columns, footings, structures, walls, tanks, rafts, trenches etc. with excavated material will not be paid separately, if item rate calls specifically for excavation and backfilling. Excavation and backfilling shall include excavation, stacking of excavated materials as directed, excavation/packing of stacked selected material, conveying it to the place of final backfill, compaction etc. as specified. As a rule, material to be backfilled will be stacked temporarily within the basic lead of 130 m unless otherwise directed by Owner. If Owner directs/permits a lead over 130 m for such material, the conveyance of the material for the extra distance over the basic lead of 130 m for backfilling will be paid for.

3.35 Payment for plinth/trench filling work will be made based on measurement of plinth/trench dimensions filled. The plinth ground level shall be surveyed before hand for this purpose.

3.36 Backfilling, plinth filling etc. with borrowed earth will be paid for at rates quoted. The quoted rate shall include all operations such as clearing, excavation, lead and transport, fill, compaction etc. as specified. Actual quantity of consolidated filling shall be measured and paid for. The lead, lift etc. shall be as indicated in the schedule of quantities.

3.37 Actual quantity of consolidated sand filling shall be measured and paid.

4.0 DEWATERING SPECIFICATIONS

4.1 Excavations shall be kept absolutely free of water. Areas around the excavation pits shall be graded such as to prevent surface water from entering excavated areas. Contractor shall remove any water including rain water and subsoil water accumulated in the pits, by pumping or other adequate means approved by Owner, and keep excavations dry until foundation work is completed and the pits backfilled. Sumps shall be made for dewatering at locations clear of excavations to be done further. Approval of Owner shall be obtained for the method of pumping the Contractor wishes to adopt. The pumping arrangement shall be such as not to cause any subsoil movement or blowing in due to differential head of water

during pumping. Adequate pumping arrangement shall be made to ensure timely completion of scheduled work.

4.2 If the inflow of ground water is considerable, well-point system – single stage or multistage shall be adopted. Contractor shall submit his scheme for the well-point system indicating the stages, the spacing, number and diameter of well-points, headers etc., and the number, capacity and location of pumps for approval of Owner. The cost of dewatering shall be included in the item rate for excavation unless separately provided for.

5.0 SPECIFICATIONS FOR STRUCTURAL CONCRETE WORKS

5.1 This specification covers the general requirements for concrete to be used using on-site production facilities including requirements relating to the quality, handling, storage of ingredients, proportioning, batching, mixing and testing of concrete and also requirements relating to the quality, storage, bending and fixing of reinforcement. This also covers the transportation of concrete from the mixer to the place of final deposit and the placing, curing, protecting, repairing and finishing of concrete.

5.2 The following specifications, standards and codes are made a part of this specification. All standards, specifications and code of practices referred to herein shall be the latest edition including all applicable amendments and revisions. In case of discrepancy between this specification and those referred to herein, this specification shall govern.

5.2.1 I.S. 269 Specification for ordinary, rapid hardening and low heat Portland cement

5.2.2 I.S. 650 Specification for standard sand for testing of cement

5.2.3 I.S. 383 Specification for coarse and fine aggregates from natural sources for concrete

5.2.4 I.S. 2386 (Part I to VIII) Methods of test for aggregates for concrete.

5.2.5 I.S. 516 Methods of test for strength of concrete

5.2.6 I.S. 1199 Methods of sampling and analysis of concrete

5.2.7 I.S. 3025 Methods of sampling and testing (physical and chemical) water used in industry

5.2.8 I.S. 432 (Part I & II) Specification for mild steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement.

5.2.9 I.S. 1139 Specification for hot rolled mild steel and medium tensile steel deformed bars for concrete reinforcement

5.2.10 I.S. 1566 Specification for plain hard drawn steel wire fabric for concrete reinforcement

5.2.11 I.S. 1785 Specification for plain hard drawn steel wire for pre-stressed concrete

5.2.12 I.S. 1786 Specification for cold twisted steel bars used in pre-stressed concrete

5.2.13 I.S. 2090 Specification for high tensile steel bars used in pre-stressed concrete

5.2.14 I.S. 4990 Specification for plywood for concrete Shuttering work

5.2.15 I.S. 2645 Specification for integral cement water Proofing compounds

5.2.16 I.S. 1791 Specification for batch type of concrete Mixers

5.2.17 I.S. 2438 Specification for roller pan mixer

5.2.18 I.S. 2505 Specification for concrete vibrators immersion type

5.2.19 I.S. 2506 Specification for creed board concrete Vibrators

5.2.20 I.S. 2514 Specification for concrete vibrating tables

5.2.21 I.S. 3366 Specification for pan vibrators

5.2.22 I.S. 4656 Specification for form vibrators of concrete

5.2.23 I.S. 2722 Specification for portable swing, weigh-batchers for concrete (single and double bucket type)

5.2.24 I.S. 2750 Specification for steel scaffoldings

5.2.25 I.S. 456 Code of practice for plain and reinforced concrete.

5.2.26 I.S. 1343 Code of practice for pre-stressed concrete

5.2.27 I.S. 3370 (Parts I to V) Code of practice for concrete structures for storage of liquids

5.2.28 I.S. 3935 Code of practice for composite construction

5.2.29 I.S. 34201 Criteria for design & construction of precast concrete trusses

5.2.30 I.S. 2204 Code of practice for construction of reinforced shell roof

5.2.31 I.S. 2210 Criteria for design of R.C. Shell structures and folded plates

5.2.32 I.S. 2751 Code of practice for welding of mild steel bars used for reinforced concrete construction

5.2.33 I.S. 2502 Code of practice for bending and fixing of bars for concrete reinforcement

5.2.34 I.S. 3558 Code of practice for use of immersion vibrators for consolidating concrete

5.2.35 I.S. 3414 Code practice for design and installation of joints in buildings.

5.2.36 I.S. 4014 (Parts I & II) Code of practice for steel tubular scaffolding.

5.2.37 I.S. 2571 Code of practice for laying in-situ cement concrete flooring

5.2.38 I.S. 3696 (Parts I & II) Safety code for scaffolds and ladders

5.2.39 I.S. 1200 Method of measurement of building work

5.2.40 I.S. 3385 Code of practice for measurement of Civil engineering works

5.3 In the event that the local statutory or pollution control board requirements are more stringent than those set forth in this specification, such requirements shall be considered part of this specification and shall supersede this specification where applicable.

5.4 Owner shall inspect the source/s of material, the operation of procurement and the layout for storage of materials, the concrete batching and mixing equipment, and the quality control system. Such an inspection shall be arranged and Owner's approval obtained, prior to starting of concrete work.

5.5 The materials to be used in manufacture of standard concrete shall consist solely of a standard type Portland cement, clean sand, natural coarse aggregate, clean water, admixtures, if specially called for on drawings or specifications.

5.6 Unless otherwise specified in the drawings or called for by Owner, cement shall be ordinary Portland cement in 50 kg. Bags. Changing of brands or type of cement within the same structure will not be permitted.

5.7 A certified report attesting to the conformance of the cement to I.S specifications by cement manufacturer's chemist shall be furnished, for each consignment received at site to Owner.

5.8 Contractor will have to make his own arrangement for the storage of adequate quantity of cement. If supplies are arranged by Owner, cement will be issued in quantities to cover work requirements for one month or more, as deemed fit by Owner and it is the responsibility of the Contractor to ensure adequate and proper storage. Cement bags shall be stored in a dry closed shed (Storage under tarpaulins is not permitted), well away from the outer walls and elevated from the floor to avoid contact with moisture from ground and so arranged as to provide ready access. Damaged or reclaimed or partly set cement is not permitted to be used and shall be removed from the site. The storage arrangements shall be such that there is no dead storage. Not more than 12 bags shall be stacked in any tier. The storage arrangement shall be approved by Owner. Consignments of cement shall be stored as received and shall be consumed in the order of their delivery.

5.9 Cement held in storage for a period of ninety (90) days or longer shall be tested. Should at any time Owner has reasons to consider that any cement is defective, then irrespective of its origin and/or manufacturer's test certificate, such cement shall be tested immediately at Contractor's cost at an approved laboratory, and until the results of such tests are found satisfactory, it shall not be used in any work. Contractor is not entitled to any claim of any nature on this account.

5.10 Definition of different aggregates:

5.10.1 "AGGREGATE" in general designates both fine and coarse inert materials used in making concrete.

5.10.2 "FINE AGGREGATE" is aggregate most of which passes through 4.75 mm IS sieve

5.10.3 "COARSE AGGREGATE" is aggregate most of which is retained on 4.75 mm sieve.

5.11 All fine and coarse aggregate proposed for use in the work shall be subject to Owner's approval and after specific materials have been accepted, the source of supply of such materials shall not be changed without prior approval of Owner.

5.12 Aggregate shall, consist of natural sands, crushed stone and gravel from source known to produce satisfactory aggregate for concrete and shall be chemically inert, strong, hard, durable against weathering, of limited porosity and free from deleterious material that may cause corrosion of the reinforcement or may impair the strength and/or durability of concrete. The grading of aggregate shall be such as to produce a dense concrete of specified strength and consistency that will work readily into position without segregation and shall be based on the "mix design" and preliminary tests on the concrete specified later.

5.13 Samples of aggregate for mix design and determination of suitability shall be taken under the supervision of Owner and delivered to the laboratory, and records of test results on aggregates and concrete submitted to Owner in advance of the scheduled placing of concrete.

5.14 All fine and coarse aggregate shall be stacked separately in stockpiles in the material yard near the work site in bins properly constructed to avoid inter mixing of different aggregates. Contamination with foreign materials and earth during storage and while heaping the materials shall be prevented. The aggregate must be of specified quality not only at the time of receiving at the site but also at the time of loading it into mixer. Rakers shall be used for lifting the coarse aggregate from bins or stock piles, coarse aggregate shall be piled in layers not exceeding 1.20 meters in height to prevent coning or segregation. Each layer shall cover the entire area of the stock pile before succeeding layers are started. Aggregates that have become segregated shall be rejected.

5.15 Aggregates having a specific gravity below 2.6 (saturated surface dry basis) shall not be used.

5.16 Fine aggregate shall consist of natural or crushed sand to I.S. 383. The sand shall be clean, sharp, hard, strong and durable and shall be free from dust, vegetable substances, and adherent coating. Clay, loam, alkali, organic matter, mica, salt, or other deleterious substances, which can be injurious to the setting qualities / strength/durability of concrete.

5.17 Sand shall be prepared for use by such screening or washing, or both, as necessary, to remove all objectionable foreign matter.

5.18 The percentage of deleterious substances in sand delivered to the mixer shall not exceed the following :

5.18.1 Percent by weight

	Uncrushed	Crushed
1) Material finer than 75 micron I.S. sieve	3.00	15.00
2) Shale	1.00	-

3) Coal lignite	1.00	1.00
4) Clay lumps	1.00	1.00
Total of all above substances including Items 1) to 4) for un-crushed sand and crushed sand	5.00	2.00

5.18.2 Unless otherwise directed or approved, the grading of sand shall be within the limits indicated below:

Percentage passing for:

I.S. Sieve Designation	Grading Zone I	Grading Zone II	Grading Zone III	Grading Zone IV
10 mm	100	100	100	100
4.75 mm	90-100	90-100	90-100	95-100
2.36 mm	60-95	75-100	85-100	95-100
1.18 mm	30-70	55-90	75-100	90-100
600 micron	15-34	35-59	60-79	80-100
300 micron	5-20	8.30	12-40	15-50
150 micron	0-10	0-10	0-10	0-15

5.19 Where the grading falls outside the limits of any particular grading zone of sieves, other than 600 micron I.S. sieve, by total amount not exceeding 5 percent, it shall be regarded as falling within that grading zone. This tolerance shall not be applied to percentage passing the 600 micron I.S. sieve or to percentage passing any other sieve size on the coarser limit of Grading Zone I or the finer limit of Grading Zone IV. Fine aggregates conforming to Grading Zone IV shall not be used.

5.20 The sand shall have a fineness modulus of not less than 2.6 or more than 3.2. The fineness modulus is determined by adding the cumulative percentage retained on the I.S. sieve sizes 4.75 mm 0.36 mm, 1.18 mm, 600 micron, 300 micron, 150 micron and dividing the sum by 100.

5.21 Coarse aggregate for concrete shall conform to I.S. 383. This shall consist of natural or crushed stone and gravel, and shall be clean, free from elongated, flaky or laminated pieces adhering coatings, clay lumps, coal residue, clinkers, slag, alkali, mica, organic matter or other deleterious matter.

5.22 Natural gravel and crushed rock shall be screened and/or washed for the removal of dirt, or dust coating.

5.23 Coarse aggregate shall be graded in and the grading shall be within limits.

5.24 The pieces shall be angular in shape and shall have granular or crystalline surfaces friable, flaky and laminated pieces. The Maximum size of coarse aggregate shall be the maximum size specified. The amount of fine particles occurring in their free state or as loose adherent shall not exceed 1 % when determined by laboratory sedimentation tests as per IS 2386. After 24 hours immersion in water, a previously dried sample shall not have gained more than 10 % of its oven dry weight in air, as determined by IS 2386.

5.25 Water used for both mixing and curing shall be free from injurious amounts of deleterious materials. Potable water is generally satisfactory for mixing and curing concrete.

5.26 In case of doubt, the suitability of water for mixing concrete shall be ascertained by the compressive strength and initial setting time test specified in I.S. 456. The sample of water taken for testing shall be typical of the water proposed to be used for concreting, due account taken of seasonal variations. The sample shall be stored in clean container previously rinsed out with similar water.

5.27 Average 28 days' compressive strength of at least three 15 cm concrete cubes prepared with water proposed to be used shall not be less than 90 % of the average strength of three similar concrete cubes with distilled water.

5.28 In initial setting time of test block made with appropriate test cement and the water proposed to be used shall not be less than 30 minutes and shall not differ more than 30 minutes from the initial setting time of control test block prepared with the appropriate test cement and distilled water. The test blocks shall be prepared and tested in accordance with the requirements of I.S. 4031.

5.29 Where water can be shown to contain an excess of acid, alkali sugar or salt, Owner may refuse to permit its use. Percentage of solids in water when tested in accordance with the method indicated below, shall not exceed the following :

5.29.1

	Percent	Method of Test (ref. To I.S. 3025)
Organic	0.20	10 and 11 (organic solids=total solids minus ignited residue)
Inorganic	0.30	11 (Ignited residue)
Sulphates (as So4)	0.50	20
Alkali, Chlorides (as Cl)	0.01	24

5.30 Reinforcement bars, if supplied by Contractor, shall be either plain round mild steel bars grade I as per I.S. 432. (Part I) or medium tensile steel bars as per I.S. 432 (Part I) or hot rolled mild steel and medium tensile steel deformed bars as per I.S. 1139 or cold twisted steel bars as per I.S.1786, as shown and specified on the drawings. Wire mesh or fabric shall be in accordance with I.S. 1566. Substitution of reinforcement will not be permitted except upon written approval from Owner.

5.31 The reinforcement shall not be kept in direct contact with the ground but stacked on top of an arrangement of timber sleepers or the like. Fabricated reinforcement shall be carefully stored to prevent damage, distortion, corrosion and deterioration.

5.32 All steel shall be of Grade I quality. No re-rolled material will be accepted. If demanded by Owner, Contractor shall submit the manufacturer's certificate for steel. Random tests on steel supplied by Contractor may be performed by Owner as per relevant I.S. All costs incidental to such tests shall be at Contractor's expense. Steel not conforming to specifications shall be rejected.

5.33 All reinforcement shall be clean, free from grease, oil, paint dirt, loose mill scale, loose rust, dust, bituminous material or any other substances that will destroy or reduce the bond. All rods shall be thoroughly cleaned before being fabricated. Pitted and defective rods shall not be used. All bars shall be rigidly held in position before concreting. No welding of rods to obtain continuity shall be allowed unless approved by Owner. If welding is approved, the work shall be carried out as per I.S. 2751, according to latest modern practices and as directed by Owner. In all cases of important connections, tests shall be made to prove that the joints are of the full strength of bars welded. Special precautions, as specified by Owner, shall be taken in the welding of cold worked reinforcing bars and bars other than mild steel.

5.34 Laps and splices for reinforcement shall be as shown on the drawings. Splices in adjacent bars shall be staggered and the locations of all splices, except those specified on the drawings, shall be approved by Owner. The bars shall not be lapped unless the length required exceeds maximum available lengths of bars at site.

5.35 All bars shall accurately bent according to the sizes and shapes shown on the detailed working drawings/ bar bending schedules. They shall be bent gradually by machine or other approved means. Reinforcing bars shall not be straightened and re-bent in a manner that will injure the material. Bars containing cracks or splits shall be rejected. They shall be bent cold. No reinforcement shall be bent when in position in the work without approval, whether or not it is partially embedded in hardened concrete. Bars having kinks or bends other than those required by design shall not be used.

5.36 Reinforcement shall be accurately fixed by any approved means and maintained in the correct positions shown in the drawings by the use of blocks, spacers and chairs as per I.S. 2502, to prevent displacement during placing and compaction of concrete. Bars intended to be in contact at crossing points shall be securely bound together at all such points with no. 16 gauge annealed soft iron wire. The vertical distance required between successive layers of bars in beams or similar members shall be maintained by the provision of mild steel spacer bars at such intervals that the main bars do not sag between adjacent spacer bars.

5.37 Erected and secured reinforcement shall be inspected and approved by Owner prior to placement of concrete.

5.38 For payment of work done under this item, the actual quantity of steel as required by and as calculated from the drawings and approved by Owner, irrespective of the level or the height at which the work is done, shall be taken. The unit rate for reinforcement shall include all wastage, binding wire, etc., for which no separate payment shall be made. Laps as shown in drawings and as per required at site and approved by Owner, shall be measured and paid for.

5.39 All concrete in the work shall be "Controlled Concrete" as defined in I.S. 45, unless it is a nominal mix concrete such as 1:3:6, 1:4:8 or 1:5:10. Whether reinforced or otherwise, all controlled concrete works to be carried out under this specification shall be divided into the following.

5.40 Minimum compressive strength of 15 cm. cubes at 7 and 28 days after mixing, conducted in accordance with IS. 545

Class	Preliminary Test kg/cm2		Works test kg/cm2		Maximum size of aggregate mm
	At 7 days	at 28 days	at 7 days	at 28 days	
M40	335	500	270	400	20
M35	300	440	235	350	20
M30	250	380	200	300	40 or 20
M25	220	320	170	250	40 or 20
M20	175	260	135	200	40 or 20
M15	135	200	100	150	40 or 20

Note: It shall be understood that whenever the class of concrete such as M20 is specified it shall be Contractor's responsibility to ensure that maximum crushing strength stipulated for the respective class of concrete is obtained.

5.41 Contractor shall carry out concrete mix design to investigate the grading of aggregates, water to cement ratio workability and the quality of cement required to obtain the maximum strength specified of preliminary and work cubes. The proportions of the mix shall be determined by weight. Adjustment of aggregate proportions due to moisture present in the aggregate shall be made.

5.42 Whenever there is a change either in required strength of concrete or water/cement ratio or workability or the source of the aggregates and/or cement, preliminary tests shall be repeated to determine the revised proportion of mix to suit the altered conditions.

5.43 Test specimens shall be prepared with at least two different water/cement ratios for each class of concrete, consistent with workability required for the nature of the work. The materials and proportions used in making preliminary tests shall be similar in all respects to those to be actually employed in the works. It is Contractor's duty to carry out these tests and he shall furnish to Owner a statement of proportions proposed to be used for the various concrete mixes. For preliminary tests, the following procedure shall be followed.

5.44 Materials shall be brought to room temperature and all materials shall be in dry condition. The quantities of water, cement and aggregate for each batch shall be determined by weight to an accuracy of I part in 1000 parts.

5.45 It shall be done in a small batch mixer as per I.S.516 in such a manner as to avoid loss of water. The whole batch is mixed thoroughly for a period of not less than 2 minutes until the resulting concrete is uniform in appearance.

5.46 The consistency of each batch of concrete shall be measured immediately after mixing, by the slump test in accordance with I.S.1199.

5.47 Concrete test cubes shall be moulded by placing fresh concrete in the mould and compacted as specified in I.S.516.

5.48 Curing shall be as specified in I.S.516. The cubes shall be kept in moist air of at least 90% humidity at a temperature of 27 ◦C. For 24 hours from time of adding water to the dry ingredients. They shall be removed from the moulds and kept immersed in clean, fresh water kept at 27 ◦C temperature until required for test. Curing water shall be renewed every seven days. A record of maximum and minimum temperatures at the place of storage shall be maintained during the period they are in storage.

5.49 The strength shall be determined based on not less than three cube test specimens for each age and each water-cement ratio. All these laboratory test results shall be tabulated and furnished to Owner. The test result shall be accepted by Owner if the average compressive strengths of the specimens tested is not less than the compressive strength specified for the age at which specimens are tested, subject to the condition that only one out of the three consecutive tests may give a value less than the specified strength for that age, but in no case none of the test values shall fall below 90% of the specified strength. If the results are not satisfactory Owner may direct the Contractor to make such changes, as he considers necessary to meet the requirements. All these preliminary tests shall be conducted by the Contractor at his own cost in an approved laboratory and his rates for concrete items are deemed to include the cost of these operations and tests.

5.50 The proportions that shall be decided by preliminary tests shall be by weight. These proportions of cement, fine and coarse aggregate shall be maintained during subsequent concrete batching. The grading of fine and coarse aggregate shall be checked as frequently as possible, to ensure maintaining of grading in accordance with the samples used in preliminary mix design. The material shall be stock piled well in advance of use.

5.51 Only such quality of water shall be added to cement and aggregates in the concrete mix as to ensure dense concrete, specified surface finish, satisfactory workability, consistent with the strength stipulated for each class of concrete. The water added to the mix shall be such as not to cause segregation of materials or the collection of excessive water on the surface of the concrete.

5.52 The water cement (W/C) ratio is defined as the weight of water in the mix (including the surface moisture of the aggregates) divided by the weight of cement in the mix.

5.53 The actual water cement ratio to be adopted shall be determined in each instance by Contractor and approved by Owner.

5.54 The W/C ratio specified for use shall be maintained. Contractor shall determine the water content of the aggregates frequently as the work progresses and as specified in I.S.2386 (Part III) and the amount of mixing water added at the mixer shall be adjusted as directed by Owner so as to maintain the specified W/C ratio. To allow for the variation in weight of aggregates due to variation in their moisture content, suitable adjustments in the weights of aggregates shall also be made.

5.55 After the amount of water required is determined, the consistency of the mix shall be maintained throughout the progress of the work and approved tests e.g. slump tests, compacting factor tests, in accordance with I.S.1199, shall be conducted from time to time to ensure the maintenance of such consistency.

5.55.1 The following slumps shall be achieved for various types of construction.

Slumps for various types of constructions	Slump in millimetres		
	Maximum	Minimum	
Reinforced foundation walls and footings, pile caps	80	50	
Plain footings, Caissons and substructure walls	75		35
Slabs, Beams and reinforced walls	100	50	
Columns	100	60	

5.56 The materials and proportions of concrete materials as established by the preliminary tests for the concrete mix design shall be rightly followed for all concrete on the project and shall not be changed except when specifically permitted by Owner.

5.57 Concrete shall be of strength stipulated in the respective items. All concrete shall be mixed in mechanically operated batch mixers complying with IS 1791, and of approved make with suitable provision for correctly controlling the water delivered to the drum. The quantity of water actually entering the drum shall be checked with reading of the gauge or valve setting, when starting a job. The test should be made while the mixer is running. The volume of the mixed materials shall not exceed the manufacturer's rated mixer capacity. The batch shall be charged into the mixer so that some water will enter the drum in advance of cement and aggregates. All water shall be in the drum by the end of the first 15 seconds of the specified mixing time. Each batch shall be mixed until the concrete is uniform in colour, for a minimum period of two minutes after all the materials and water are in the drum. The entire contents of the drum shall be discharged in one operation before the raw materials for the succeeding batches are fed into the drum.

5.58 Each time the work stops, the mixer shall be cleaned out and when next commencing the mixing, the first batch shall have 10% additional cement to allow for sticking in the drum

5.59 Facilities required for sampling materials & cement in the field shall be provided by the Contractor and this cost shall be included in his quoted rates.

5.60 At least 6 test cubes of each class of concrete shall be made for every 2000 cft. Concrete or part thereof. Such samples shall be drawn on each day for each type of concrete. Of each set of 6 cubes, three shall be tested at 7 days age and three at 28 days of age. The laboratory test results shall be tabulated and furnished to Owner. Owner will pass the concrete if the average strength of specimens tested is not less than the strength specified, subject to the condition that only one out of three consecutive tests may give a value less than the specified strength but this shall not be less than 90% of the specified strength.

5.61 Slump tests shall be carried out immediately after sampling.

5.62 Admixtures may be used in concrete only with the approval of Owner after ensuring that, with the passage of time neither the compressive strength nor its durability is reduced. Calcium chloride shall not be used for accelerating the set of cement for any concrete containing reinforcement, or embedded steel parts. When admixtures are used, the designed concrete mix shall be corrected accordingly. Admixtures shall be used as per manufacturer's instructions.

5.63 Where specified and approved by Owner, suitable air entertaining agent may be used to produce specified amount of air in the concrete mix and these agents shall conform to the requirements of ASTM standard 6-260, Air Entraining Admixtures for Concrete. The recommended air content of the concrete is 4% + or - 1%. The method of measuring air content shall be as per I.S. 1199

5.64 Where specified and approved by Owner, water reducing admixtures shall be added in quantities specified by owner. The admixtures shall be added in the form of a solution.

5.65 Where specified and approved by Owner, retarding agents shall be added to concrete mix in quantities specified by Owner.

5.66 Where specified and approved by Owner, water proofing agent conforming to IS.2645, shall be added in quantities specified by Owner.

5.67 Owner may at his discretion instruct the Contractor to use any other admixture in the concrete.

5.68 Tests shall be carried out on cement, sand, coarse aggregate in accordance with the relevant Indian Standards, at regular intervals, whenever any new batch of material is received at site. Tests on cement shall include :

a) Fineness test

b) Test for normal consistency

c) Test for setting time

d) Test for soundness

e) Test for tensile strength

f) Test for compressive strength

g) Test for heat of hydration (by experiment and by calculations) in accordance with IS 269.

5.69 Tests on sand shall include:

a) Sieve test

b) Test for organic impurities

c) Decantation test for determining clay and silt content

d) Specific gravity test

e) Test for unit weight and bulkage

f) Test for sieve analysis and fineness modulus.

5.70 Tests on coarse aggregate shall include

a) Sieve analysis

b) Specific gravity and unit weight of dry, loose and rodded aggregate

c) Soundness and alkali aggregate reactivity

d) Petro organic examination

e) Deleterious materials and organic impurities

f) Test for aggregate crushing value.

5.71 The above test shall be carried out by Contractor, even if the materials are supplied by Owner. No separate payment shall be made for these tests & Contractor shall include the cost of these in his unit rates of concrete works.

5.72 If the work cubes do not give stipulated strength, Contractor shall dismantle portions of the work, which are un-acceptable and re-do the work to the standard stipulated at Contractor's cost. The unit rate for concrete shall be all inclusive, including making preliminary mix design and test cubes, works cubes, testing them as per specification, slump test, optional tests etc., complete.

5.73 In the event of any work being suspected of faulty material or workmanship or both, Owner before requiring its removal and reconstruction, may order that it should be load tested in accordance with the following provisions

5.74 The test load shall be 125% of the maximum superimposed load for which the structure was designed. Such test load shall not be applied before 56 days after the effective hardening of concrete. During the test, struts strong enough to take whole load shall be placed in position leaving a gap under the members. The test load shall be maintained for 24 hours before removal.

5.75 If within 24 hours of the removal of the load, the structure does not show a recovery of at least 75 percent of the maximum deflection shown during the 24 hours under the load, the test loading shall be repeated after a lapse of at least 72 hours, the structure shall be

considered to have failed to pass the test if the recovery after the second test is not at least 75 percent of the maximum shown during the second test. The cost of the load test shall be borne by the Contractor.

5.76 Any other tests, e.g. taking out in an approved manner concrete cores, examination and tests on such cores removed from such parts of the structure as directed by Owner, sonic testing etc., shall be carried out by Contractor if so directed.

5.77 Should the result of any test prove unsatisfactory, or the structures show signs of weakness, undue deflection or faulty construction, Contractor shall remove and rebuild the member or members involved or carry out such other remedial methods as may be required by Owner. Contractor shall bear the cost of doing so.

5.78 Before the concrete is actually placed in position, the insides of the formwork shall be inspected to see that they have been cleaned and oiled. Temporary openings shall be provided to facilitate inspection, especially at bottom of columns and wall forms, to permit removal of saw dust, wood shavings, binding wires, rubbish dirt etc., Openings shall be placed or holes drilled so that these materials and water can be removed easily. Such openings/ holes shall be later suitably plugged.

5.79 The various trades shall be permitted ample time to install drainage and plumbing lines, floor and trench drains, conduits, hangers, anchors, inserts, sleeves, bolts, frames and other miscellaneous embedment's to be cast in concrete as indicated on the drawings or as is necessary for the proper execution of the work. All such embedment's shall be correctly positioned and securely held in the forms to prevent displacement during depositing and vibrating of concrete.

5.80 Slots, openings, holes, pockets etc., shall be provided in the concrete work in the positions indicated in the drawings or as directed by Owner.

5.81 Reinforcement and other items to be cast in concrete shall have clean surfaces that will not impair bond.

5.82 Prior to concrete placement all work shall be inspected and approved by Owner and if found unsatisfactory, concrete shall not be poured until after all defects have been corrected at Contractor's cost.

5.83 Approval by Owner of any and all materials and work as required herein shall not relieve Contractor from his obligation to produce finished concrete in accordance with the drawings and specifications.

5.84 No concrete shall be placed in wet weather or on a water covered surface. Any concrete that has been washed by heavy rain shall be entirely removed, if there is any sign of cement and sand having been washed away from the concrete mixture. To guard against damage which may be caused by rains, the works shall be covered with tarpaulins immediately after the concrete has been placed and compacted before leaving the work unattended. Any water accumulating on the surface of the newly placed concrete shall be removed by approved means and no further concrete shall be placed thereon until such water is removed. To avoid flow of water above / around freshly placed concrete, suitable drains & sumps shall be provided.

5.85 Immediately before concrete placement begins, prepared surfaces, except formwork, which will come in contact with the concrete to be placed, shall be covered with a bonding mortar as specified later in this document.

5.86 All buckets, containers and conveyors used for transporting concrete shall be mortar-tight. All means of conveyors shall be suitable to deliver concrete of the required consistency and plasticity without segregation or loss of slump whatever method of transportation is employed. Chutes shall not be used for transport of concrete without the written permission of Owner and concrete shall not be re-handled before placing.

5.87 Concrete must be placed in its final position before it becomes too stiff to work. On no account water shall be added after the initial mixing. Concrete which has become stiff or has been contaminated with foreign materials shall be rejected and disposed off as directed by Owner.

5.88 All equipment used for mixing, transporting and placing of concrete shall be maintained in clean condition. All pans, buckets, hoppers, chutes, pipelines and other equipment shall be thoroughly cleaned after each batch of placement.

5.89 Before any concrete is placed, the entire placing programme consisting of equipment, layout, proposed procedures and methods shall be submitted to Owner for approval and no concrete shall be placed until Owner's approval has been received. Equipment for conveying concrete shall be of such size and design as to ensure a practically continuous flow of concrete during depositing without segregation of materials, considering the size of the job and placement location.

5.90 Concrete shall be placed in its final position before cement reaches its initial set and concrete shall normally be compacted in its final position within thirty minutes of leaving the mixer, and once compacted it shall not be disturbed.

5.91 Concrete shall, in all cases, be deposited as near as practicable directly to its final position, and shall not be re-handled or caused to flow in a manner which will cause segregation, loss of materials, displacement of reinforcement, shuttering or embedded inserts or impair its strength. For locations where direct placement is not possible, and in narrow forms, Contractor shall provide suitable drop and "Elephant Trunks" to confine the movement of concrete. Special care shall be taken when concrete is dropped from a height, especially if reinforcement is in the way, particularly in columns and thin walls.

5.92 Except when otherwise approved by Owner, concrete shall be placed in the shuttering by shovels or other approved implements and shall not be dropped from a height more than 1.2 metres or handled in a manner which will cause segregation.

5.93 The control of placing shall begin at the mixer discharge. Concrete shall be discharged by a vertical drop into the middle of the bucket or hopper and this principal of a vertical discharge of concrete shall be adhered to throughout all stages of delivery until the concrete comes to rest in its final position.

5.94 Central-bottom-dump buckets of a type that provides for positive regulation of amount and rate of deposition of concrete in all dumping position shall be employed.

5.95 In placing concrete in large open areas, the bucket shall be spotted directly over the position designated and then lowered for dumping. The open bucket shall clear the concrete already in place and the height of drop shall not exceed 1.2 metres. The bucket shall be opened slowly to avoid high vertical bounce. Dumping of buckets on the swing or in any other manner which results in separation of ingredients or disturbance of previously placed concrete will not be permitted.

5.96 Concrete placed in restricted forms by barrows, buggies, cars, short chutes or hand shovelling shall be subjected to the requirement of vertical delivery of limited height to avoid segregation and shall be deposited as near as practicable to its final position.

5.97 Where it is necessary to use transfer chutes, specific approval of the Owner must be obtained to type, length, slopes, baffles, vertical terminals and timing of operations. These shall be so arranged that an almost continuous flow of concrete shall be obtained at the discharge and without segregation. To allow for the loss of mortar against the ides of chutes, the first mixes shall have less coarse aggregate. During cleaning of chutes, the waste water shall be kept clear of the forms. Concrete shall not be permitted to fall from the end of the chutes by more than 1.2M. Chutes, when approved for use, shall have slopes not flatter than 1 vertical: 3 horizontal. and not steeper than 1 vertcal:2 horizontal. Chutes shall be of metal or metal lined and of rounded cross section. The slopes of all chute sections shall be approximately the same. The discharge end of the chutes shall be maintained above the surface of the concrete in the forms.

5.98 Concreting, once started, shall be continuous until the pour is completed. Concrete shall be placed in successive horizontal layers of uniform thickness as directed by the Owner. These shall be placed as rapidly as practicable to prevent the formation of cold joints or planes of weakness between each succeeding layer within the pour. The thickness of each layer shall be such that it can be deposited before the previous layer has stiffened. Any

tendency to segregation shall be corrected by redesign of mix or other means, as directed by Owner.

5.99 The top surface of each pour and bedding planes shall be horizontal unless otherwise instructed.

5.100 Concrete shall be compacted during placing, with approved vibrating equipment until the concrete has been consolidated to the maximum practicable density, is free of pockets of coarse aggregates and fits tightly against all form surfaces reinforcement and embedded fixtures. Particular cars shall be taken to ensure that all the concrete placed against the form faces and into corners of forms or against hardened concrete at joints is free from voids or cavities. The use of vibrators shall be consistent with the concrete mix and caution exercised not to over vibrate the concrete to the point that segregation results.

5.101 Vibrators shall conform to IS specification. Type of vibrator to be used shall depend on the structure where concrete is to be placed. Shutter vibrators, to be effective, shall be firmly secured to the formwork which must be sufficiently rigid to transmit the vibration and strong enough not to be damaged by it. Immersion vibrator shall have “no load” frequency, amplitude and acceleration as per IS 2505 depending on the size of the vibrator. Immersion vibrators in sufficient numbers and of adequate size shall be used to proper consolidate all concrete. Tapping or external vibrating of forms by hand tools or immersion vibrators will not be permitted. Thin walled elements shall be compacted using 25 mm dia immersion vibrators.

5.102 Immersion vibrators shall be inserted vertically at points not more than 450 mm apart and withdrawn when air bubbles cease to come to the surface. Immersion vibrators shall be withdrawn very slowly. In no case shall immersion vibrators be used to move concrete inside the forms. Particular attention shall be paid to vibration at the top of a lift, e.g. in a column or wall.

5.103 When placing concrete in layers, which are advancing horizontally as the work progresses, great care shall be exercised to ensure adequate vibration, mixing and joining of concrete between the succeeding layers.

5.104 The immersion vibrators shall penetrate the layer being placed and also penetrate the layer below while under layer is still plastic to ensure good bond and homogeneity between the two layers and prevent the formation of cold joints.

5.105 Care shall be taken to prevent the contact of immersion vibrators against reinforcement steel. Immersion vibrators shall not be allowed to come in contact with reinforcement steel after start of initial set. They shall also not be allowed to come in contact with forms or finished surfaces.

5.106 Form attached vibrators shall be used only with specific permission of Owner

5.107 The use of surface vibrators will not be permitted under normal conditions. However for thin slabs, surface vibration by specially designed vibrators may be permitted, on approval by Owner.

5.108 The formation of stone pockets or mortar pondages in corners and against faces of forms shall not be permitted. If these occur, they shall be dug out, reformed and refilled to sufficient depth and shape for thorough bonding, as directed by Owner.

5.109 Except when placing with slip forms, each placement of concrete in multiple lift work shall be allowed to set for at least 24 hours after final set of concrete and before the start of a subsequent placement.

5.110 When placing concrete in walls with openings, in floors of integral slab and beam construction and other similar conditions, the placing shall stop, when the concrete reaches the top of the openings in the walls or bottom horizontal surface of the slab, as the case may be placing shall be resumed before the concrete in place reaches initial set, but not until it has had time to settle as determined by owner.

5.111 When placing concrete through reinforcing steel, care should be taken to prevent segregation of the coarse aggregate.

5.112 If bleeding or free water on top surface of concrete being deposited into the forms occurs, the concrete pour shall be stopped and the conditions causing this defect corrected before any further concreting resumed.

5.113 Concrete shall be placed without interruption until completion of the work between predetermined construction joints, as specified hereinafter.

5.114 If stopping of concreting becomes unavoidable anywhere, a properly formed construction joint shall be made where the work is stopped. Joints shall be either vertical or horizontal, unless shown otherwise on drawings. In case of an inclined or curved member, the joint shall be at right angles to the axis of the member. Vertical joints in the walls shall be kept to a minimum. Vertical joints shall be formed against a stop board; horizontal joints shall be level and wherever possible, arranged so that the joint lines coincide with the architectural features of the finished works. Battens shall be nailed to the formwork to ensure a horizontal line and, if directed shall also be used to form a grooved joint. For tank walls and similar work joints shall be formed as per I.S. 3370. Concrete that is in the process of setting shall not be disturbed or shaken by traffic either on the concrete itself or upon the shuttering. Horizontal and vertical construction joints and shear keys shall be located and shall conform in detail to the requirements of the plans unless otherwise directed by Owner. Where not described, the joint shall be in accordance with the following.

5.115 In a column, the joint shall be formed 75 mm below lowest soffit of the beam including haunches, if any. In flat slab construction the joint shall be 75 mm below the soffit of column capital. At least two hours shall elapse after depositing concrete in columns, piers or walls, before depositing in beams, girders or slabs supported thereon.

5.116 Concrete in a beam shall be placed throughout without a joint but if the provision of a joint is unavoidable the joint shall be vertical and at the center or within the middle third of the span unless otherwise shown on the drawings. Where a beam intersects a girder, the joint in the girder shall be offset a distance equal to twice the width of the beam and additional reinforcement provided for shear. The joints shall be vertical throughout the full thickness of the concrete member. A joint in a slab shall be vertical and parallel to the principal reinforcement. Where it is unavoidably at right angles to the principal reinforcement, the joint shall be vertical and at the middle of the span.

5.117 Vertical construction joints in watertight construction shall not be permitted unless indicated on the drawings. Where a horizontal construction joint is required to resist water pressure, special care shall be taken in all phases of the construction to ensure maximum water-tightness.

5.118 Dowels for construction work not likely to be taken up in the near future, shall be wrapped in tar paper & burlap.

5.119 Mass foundations shall be poured in lifts not exceeding 0.5 M in height unless otherwise indicated on drawings or approved by Owner.

5.120 A driver mix shall be used for the top lift of horizontal pour to avoid laitance. All laitance and loose stones shall be thoroughly and carefully removed by wire brushing / hacking and surface washed.

5.121 Just before concreting is resumed, the roughened joint surface shall be thoroughly cleaned and loose matter removed, and then treated with a thin layer of cement grout of proportion specified by Owner worked well into the surface. The new concrete shall be well worked against the prepared face before the gout/mortar sets. Special care shall be taken to obtain thorough compaction and to avoid segregation of the concrete along the plane of the joint.

5.122 Keeping it continuously damp for the time of period required for complete hydration and hardening to take place shall cure all concrete. Preference shall be given to the use of continuous sprays, or ponded water, continuously saturated coverings of sacking, canvas, hessian or other absorbent materials, or approved effective curing compounds applied with spraying equipment capable of producing a smooth even-textured coat. Extra precautions shall be exercised in curing concrete during hot and cold weather as outlined herein after. The quality of curing water shall be the same as that used for mixing concrete.

5.123 Certain types of finish or preparation for overlaying concrete must be done at certain stages of curing process and special treatment required for specific concrete surface finish.

5.124 Curing of concrete made of high alumina cement and super sulphated cement shall be carried out as directed by Owner.

5.125 Fresh concrete shall be kept continuously wet for a minimum period of 10 days from the date of placing of concrete. After 12 to 24 hours have elapsed after laying concrete. The curing of horizontal surfaces exposed to the drying winds shall however begin immediately the concrete has hardened. Water shall be applied to the unformed concrete surfaces within 1 hour after concrete has set. Water shall be applied to formed surfaces immediately upon removal of vertical side forms. Quantity of water shall be controlled so as to prevent erosion of freshly placed concrete.

5.126 Ample water supply should be assured under pressure in pipes if required, with all necessary appliances of hose, spraying devices.

5.127 Whenever a covering such as wet gunny bags which will prevent loss of moisture from concrete is used, the covering shall be kept continuously wet during the curing period.

5.128 All equipment, men, materials required for curing shall be on hand and ready for use before concrete is placed.

5.129 Fresh concrete shall be protected from damage due to construction operations by leaving forms in place for ample period specified later in this specification. Newly placed concrete shall be protected by approved means such as tarpaulins from rain, sun and winds. Steps shall be taken to protect immature concrete from damage by debris, excessive loading, vibration, aberration or contact with other materials etc. that may impair the strength and/or durability of the concrete. Workmen shall be warned so as to prevent from disturbing green concrete during its setting period. If it is necessary that workmen enter the area of freshly placed concrete, bridges shall be placed over the area

5.130 Initially after the shuttering is removed, the surface of the concrete shall be very carefully gone over and all defective areas shall be brought to the attention of the Owner who may permit the patching of the defective areas or else reject the concrete unit partially or in its entirely. Rejected concrete shall be removed and replaced by Contractor at no additional expenses to Owner. Holes left by form bolts etc. shall be filled up and made good with mortar composed of one part of cement to one and a half parts of sand after removing any loose stones adhering to the concrete. Mortar filling shall be struck off flush at the face of concrete. Concrete surfaces shall be finished as required by Owner. No patching work shall be done without prior inspection of the defective area and without prior permission of Owner.

5.131 Superficial honeycombed surfaces and rough patches shall be similarly made good immediately after the removal of shuttering, in the presence of Owner and superficial water and air holes shall be filled in. The mortar shall be well packed into the surface with a wooden float. Excess water shall be avoided. The surface of the exposed concrete placed against the shuttering shall be rubbed down immediately on removal of shuttering to remove fins or other irregularities, care being taken not to damage the surface. Surface irregularities shall be removed by grinding.

5.132 If reinforcement is exposed or honey combing occurs at vulnerable positions e.g. ends of beams or columns it may be necessary to cut out the member completely or in part and reconstruct. If only the patching is necessary, the defective concrete shall be cut out till solid concrete is reached. An area extending 6 inches beyond the edge and the surface of the prepared voids shall be wetted with water for 24 hours immediately before patching material is placed.

5.133 The use of epoxy for bonding fresh concrete used for repairs will be permitted upon written approval of Owner. Epoxies shall be applied strictly in accordance with the instructions of the manufacturer.

5.134 Small size holes such as holes left after removal of form bolts, grout insert holes and slots cut for repair of cracks shall be repaired as follows. The hole to be patched shall be

roughened and thoroughly wetted with clean water until absorption stops. A 5 mm thick layer of grout of equal parts of cement and sand shall be well brushed into the surface to be patched, followed immediately by patching concrete, which shall be consolidated with a wooden float. The concrete patch shall be built up in 10 mm thick layers. After an hour or more, depending upon weather conditions, it shall be worked off flush with a wooden float and a smooth finish obtained by wiping with hessian, a steel trowel shall not be used for this purpose. The mix for patching shall be of the same materials and in the same proportions as that of the concrete being repaired. Smaller size of the coarse aggregate may be used and the mix shall be kept as dry as possible.

5.135 Mortar filling by air pressure (guniting) shall be used for repair of areas too large and/or shallow for patching with mortar. Patched surfaces shall be given a final treatment to match the colour and the texture of the surrounding concrete. White cement shall be substituted for ordinary cement, if so directed by Owner, to match the shade of the patch with the original concrete.

5.136 Two hours after the repair works, the area patched shall be covered with an approved non-staining, water saturated material such as gunny bags which shall be kept continuously wet and protected against sun and wind for a period of 24 hours. Thereafter, the patched area shall be kept wet continuously by a fine spray or sprinkling for not less than 6 days.

5.137 All materials, procedures and operations used in the repair of concrete and also the finished repair work shall be subject to the approval of Owner. All fillings shall be tightly bonded to the concrete and shall be sound, free from shrinkage cracks after the fillings have been cured and dried.

5.138 The type of finish for the formed surface of concrete shall be as follows, unless otherwise specified by Owner. For surfaces against which backfill or concrete is to be placed, no treatment is required except repairs of defective areas.

5.139 For surfaces below grade which will receive water proofing treatment the concrete shall be free of surface irregularities which would interfere with proper application of the waterproofing materials.

5.140 Unless specified, surfaces which will be exposed when the structure is in service shall receive no special finish, except repair of damaged or defective concrete, removal of fins and abrupt irregularities, filling of holes left by form ties and rods and clean up of loose or adhering debris.

5.141 Surfaces which will be exposed to weather and which would normally be level shall be sloped for drainage. Unless the drawings specify a horizontal surface or shows the slope required, the tops of narrow surfaces such as stairs, treads, walls, curbs and parapets shall be sloped across the width as required by the Owner. Surfaces that will be covered by backfill or concrete, sub-floors to be covered with concrete topping, terrazzo or quarry tile, and similar surfaces shall be screened and levelled to produce even surfaces. Surface irregularities shall not exceed 6 mm Surface which will not be covered by backfill, concrete or tile toppings such as outside decks, floors and galleries and sumps, parapets, gutters, sidewalks, floors & slabs, shall be removed before final finishing. Floating may be done with hand or power tools and started as soon as the screened surface has attained a stiffness to permit finishing operations and these shall be the minimum required to produce a surface uniform in texture and free from screed marks or other imperfections. Joints and edges shall be tooled as called for on the drawings or as directed by the Owner.

5.142 Exposed concrete shall mean any concrete, other than floors or slabs, exposed to view upon completion of the job. Unless otherwise specified on the drawings, the standard finish for exposed concrete shall be a smooth finish. A smooth finish shall be obtained with the use of lined or plywood forms having a smooth and even surfaces and edges. Panels and form linings shall be of uniform size and be as large as practicable and installed with closed joints. Upon removal of forms the joint marks shall be smoothed off and all blemishes, projections etc., removed leaving the surface reasonably smooth.

5.143 Where specified on the drawings integral cement concrete finish of specified thickness for floors and slabs shall be applied either monolithic or bonded, as specified on the drawings

as per I.S.2571. The surface shall be compacted and then floated with a wooden float or power floating machine. The surface shall be tested with a straight edge and any high and low spots eliminated. Floating or trowelling of finish shall be permitted only after all surface water has evaporated. Dry cement or a mixture of dry cement and sand shall not be sprinkled directly on the surface of the cement finish to absorb moisture or to stiffen the mix.

5.144 All concrete shall be protected against damage until final acceptance by Owner.

5.145 The formwork shall consist of shores, bracings, sides of beams and columns, bottom of slabs etc, including ties, anchors, hangers, inserts etc, complete which shall be properly designed and planned for the work. False work shall be so constructed that vertical adjustments can be made at compensate for camber and settlements. Wedges may be used at the top or bottom of timber shores, but not at both ends, to facilitate vertical adjustments or dismantling of formwork.

5.146 The design and the engineering of formwork as well as its construction shall be the responsibility of the Contractor. The drawings and/or calculations for the design of the formwork shall be submitted to the Owner for approval before proceeding with the work, with no extra cost to the Owner. Owner's approval however shall not relieve the Contractor of the full responsibility for the design and construction of the formwork. The design shall take into account all the loads vertical as well as lateral that the forms will be carrying including live and vibration loads.

5.147 Tolerance is a specified permissible variation from lines, grade or dimension given in the drawings. Unless otherwise specified, the following tolerance will be permitted

1. Variation from the plumb - In the lines and surfaces of columns, piers, walls and in arises 6 mm per 2.5 m. but not more than 25 mm
2. For exposed columns and other conspicuous lines
   a) In any bay or 5 m maximum -6 mm
   b) In 10 m or more -10 mm
3. Variation from the level or from the grades indicated on the drawings.
   a) In slab soffits, ceilings, beam soffits and in arises
      i) In 2.5 m -6 mm
      ii) In any bay or 5 m. Maximum -8 mm
      iii) In 10. or more -16 mm
   b) For exposed lintels, sills, parapets, horizontal grooves and other conspicuous lines.
      i) In any bay of 5 m. maximum -6 mm
      ii) In 10 m. or more -10 mm
4. Variation of the linear building lines from established position in plan and related position of columns, wall and partitions.
   In any bay or 5 m. maximum -16 mm
   In 10 m. or more -20 mm
5. Variation in the sizes and location of sleeves, openings in wall and floors, except in the case of anchor bolts : 6 mm
6. Variation in cross-sectional dimensions of columns and beams and in the thickness of slabs and walls: minus 6 mm Plus 10mm
7. Variation in dimension in plan: minus 6 mm Plus 50mm
8. Misplacement of eccentricity minus 2% of footing width in the direction of misplacement but not more than minus 2
9. Reduction in thickness -6 mm

10. Variation in steps

In a flight of stairs — Rise – minus 3 mm, Tread – minus 6 mm

11. In consecutive steps – Rise - Minus 3 mm, Tread – minus 3 mm

5.148 Form work may be of timber, plywood, metal, plastic or concrete. For special finishes the formwork may be lined with plywood, steel sheets, oil tempered hard board. etc. Sliding forms and slip forms may be used with the approval of Owner

5.149 Form shall conform to the shapes, lines grades and dimensions including camber of the concrete as called for on the drawings. Ample studs, walers, braces, ties, straps shores, etc. shall be used to hold the forms in proper position without any distortion whatsoever to permit the use of immersion vibrators and until the concrete has sufficiently set. The shuttering shall be close boarded. Timber shall be well seasoned free from sap, shakes, loose knots, worm holes, warps or other surface defects. Faces coming in contact with the concrete shall be free from adhering grout, plaster, paint, projecting nails, splits or other defects. Joints shall be sufficiently tight to prevent loss of water and fine material from concrete.

5.150 Plywood shall be used for exposed concrete surfaces. Sawn and wrought timber may be used for unexposed surfaces. Inside faces for concrete surfaces which are to be rubbed finished shall be planned to remove irregularities or unevenness in the face.

5.151 All new and used form lumber shall be maintained in a good condition with respect to shape, strength, rigidity, water tightness, smoothness, cleanliness of surfaces. Form lumber unsatisfactory in any respect shall not be used and if rejected by Owner shall be removed from the site.

5.152 Shores supporting successive storeys shall be placed directly over those below or be so designed and placed that the load will be transmitted directly to them. Trussed support shall be provided for shores that cannot be secured on adequate foundations.

5.153 Formwork, during any stage of construction, showing signs of distortion or distorted to such a degree that the intended concrete work will not conform to the exact contours indicated on the drawings, shall be repositioned and strengthened. Poured concrete affected by faulty formwork, shall be removed completely and the formwork corrected prior to placing new concrete.

5.154 Excessive construction camber to compensate for shrinkage, settlement, etc, which may impair the structural strength of members, will not be permitted.

5.155 Forms shall be so designed and constructed that their removal will not damage the concrete. Face formwork shall provide true vertical and horizontal joints conform to the architectural features of the structure as to locations of joints and be as directed by Owner.

5.156 Where exposed concrete finishes are required, the forms shall be constructed with special care so that the resulting concrete surfaces require a minimum finish.

5.157 Shuttering shall be braced, strutted, propped and so supported that it shall not deform under weight and pressure of the concrete and also due to the movement of men and other materials. Bamboos shall not be used as props or cross bearers.

5.158 The shuttering for slabs and beams shall be so erected that the shuttering on the sides of the beams and under the soffit of slabs can be removed without disturbing the beam bottoms. Repropping of beams shall not be done. Vertical props shall be supported on wedges or other measures shall be taken whereby the props can be gently lowered vertically while striking the shuttering.

5.159 If the shuttering for the column is erected for the full height of the column, one side shall be left open and built up in sections as placing of concrete proceeds, or windows may be left for pouring concrete from the sides to limit the drop of concrete to 1.2 M maximum.

5.160 Care shall be taken to see that the faces of form work coming in contact with concrete are perfectly cleaned and proper mould oil applied before fixing reinforcement and placing concrete. Such coating shall be insoluble in water, non-staining and not injurious to the

concrete. It shall not become flaky or be removed by rain or wash water. Use of engine oil is not permitted to be used as mould oil. Concrete shall not be placed until coating of the forms is complete. Adjoining concrete surfaces shall also be protected against contamination from the coating material.

5.161 All corners and angles exposed in the finished structure shall be formed with mouldings to form chamfers or filets on the finished concrete. Care shall be exercised to ensure accurate mouldings. The diagonal face of the moulding shall be planed or surfaced to the same texture as then forms to which it is attached.

5.162 Vertical construction joints or faces which will be exposed after the completion of the work shall be chamfered except where not permitted by Owner.

5.163 Wire ties passing through the walls are not allowed. In their place bolts passing through sleeves may be used.

5.164 Before reuse, all forms shall be thoroughly scrapped, cleaned, nails removed, holes that may leak suitably plugged and joints examined and when necessary, repaired and the inside retreated to prevent adhesion, to the satisfaction of Owner. Warped lumber shall be resized.

5.165 Contractor shall record on the drawing or a special register the date upon which the concrete is placed in each part of the work and the date on which the shuttering is removed there from.

5.166 In no circumstances shall forms be struck until the concrete reaches strength of at least twice the stress due to self weight and any construction/erection loading to which the concrete may be subjected at the time of striking formwork.

5.167 In normal circumstances (generally where temperatures are above 20°C) forms may be struck after expiry of the following period. :

5.167.1 Walls. Columns and vertical sides of beams, 24 to 48 hours footings, pile caps etc.

5.167.2 Sides of walls which are cast against earth

a) Beam soffits 18 days

b) Slabs 10 days

5.168 Striking shall be done slowly with utmost care to avoid damage to arises and projections and without shock or vibrations, by gently easing the wedges. If after removing the formwork, it is found that timber has been embedded in the concrete, it shall be removed and the concrete made good as specified earlier.

5.169 Reinforced temporary openings shall be provided, as directed by Owner, to facilitate removal of formwork which otherwise may be inaccessible.

5.170 The rods, clamps, form bolts, etc, which must be entirely removed from walls or similar structures shall be loosened not sooner than 24 hours and not later than 40 hours after the concrete has been deposited. Ties, except those required to hold forms in place, may be removed at the same time. Ties, withdrawn from walls and beams shall be pulled toward the inside face.

5.171 Soft or spongy areas shall be cleaned out and backfilled with either a soil-cement mixture, lean concrete or clean sand fill compacted to a minimum density of 90% Modified Proctor.

5.172 Prior to construction of formwork for any item where soil will act as bottom form, approval shall be obtained from Owner as to the suitability of the soil.

5.173 Where concrete has to rest on rock, just the rock surface shall be cleaned with high pressure water and air jet.

5.174 Prior to placing concrete, the rock surface shall be kept wet for a period of 2 to 4 hours unless otherwise directed by the Owner.

5.175 All earth surfaces upon which or against which concrete is to be placed, shall be well compacted and free from standing water, mud or debris. Soft, yielding soil shall be removed and replaced with suitable earth and well compacted. Where specified, lean concrete shall

be provided on the earth stratum for receiving concrete. The surface of absorptive soils against which concrete is to be placed shall be moistened thoroughly so that no moisture will be drawn from the freshly placed concrete and later shall help to cure the concrete.

5.176 The preparation of concrete surfaces on which additional concrete is to be placed later, shall preferably be done by cleaning. All laitance shall be removed and the surface roughened. The surface should not contain any unsound concrete and glazed mortar.

5.177 After rock or concrete surfaces upon which new concrete is to be placed have been roughened, cleaned and wetted, a coat of cement-sand mortar shall be placed on the surface. The mortar shall have the same cement-sand proportions as the concrete which shall be placed on it. The Water-cement ratio shall be determined by prevailing conditions of placing and as approved by Owner.

5.178 The mortar shall be placed in sufficient quantity to cover completely the surface about 10 mm thick for rock surfaces and about 5 mm thick for concrete surfaces. It shall be brushed or broomed over the surface and worked thoroughly into cracks, crevices and depressions. Accumulations or puddles of mortar shall not be allowed to settle in depressions and shall be brushed out to satisfactory degree, as determined by Owner.

5.179 Vertical construction joints shall be cleaned as specified above. In placing concrete against formed construction joints, the surfaces of the joints, where accessible shall be coated thoroughly with the bonding mortar immediately before they are covered with concrete or by scrubbing with wire brooms dipped into the fresh concrete. Where it is impracticable to apply such mortar coating, special precautions shall be taken to ensure that the new concrete is brought into adequate contact with the surface of the joint by careful puddling and spading with aid of vibrators and suitable tools.

5.180 Provision shall be made for expansion and contraction in concrete by use of special type of joints located as shown on the drawing. Contraction joint surfaces shall be treated as directed by the specifications or the drawings or as directed by the Owner.

5.181 Under all ordinary conditions all foundations shall be dewatered and concrete placed in the dry.

5.182 Side shutters shall not be struck in less than 24 hours after depositing concrete and no pre-cast unit shall be lifted until the concrete reaches strength of at least twice the stress to which the concrete may be subjected to at the time of lifting.

5.183 The lifting and removal of pre-cast units shall be undertaken without causing shock, vibration or undue bending stresses to or in the units. Before lifting and removal takes place Contractor shall satisfy Owner that the methods he proposes to adopt for these operations will not over- stress or otherwise affect seriously the strength of the precast units. The reinforced side of the units shall be clearly marked.

5.184 All pre-cast work shall be protected from the direct rays of the sun for at least 7 days after casting and during that period each unit shall be kept constantly watered or preferably be completely immersed in water if the size of the unit so permits.

5.185 Slots, openings or holes, pockets etc., shall be provided in the concrete work in the positions indicated in the drawings or as directed by Owner. Any deviation from the approved drawings shall be made good by Contractor at his own expense, without damaging any other work. Sleeves, bolts, inserts, etc. shall also be provided in concrete work where so specified.

5.186 All materials, workmanship and finished construction shall be subject to the continuous inspection and approval of Owner.

5.187 All material supplied by Contractor and all work or construction performed by Contractor rejected as not in conformance with the specifications and drawings, shall be immediately replaced at no additional expense to the Owner.

5.188 Approvals of any preliminary materials or phase of work shall in no way relieve the Contractor from the responsibility of supplying concrete and or producing finished concrete in accordance with the specifications and drawings.

5.189 Upon the completion of the concrete work, all forms, equipment, construction tools, protective coverings and any debris resulting from the work shall be removed form the premises.

5.190 All debris, i.e. empty containers, scrap, wood, etc. shall be removed to "dump" daily.

5.191 The finished concrete surfaces shall be left in a clean condition satisfactory to Owner.

5.192 The unit rate for concrete work under various categories shall be all inclusive and no claims for extra payment of account of such items as leaving holes, pockets, embedding inserts, etc. shall be entertained unless separately provided for in the schedule of quantities. No extra claim shall be entertained due to change in the number, position and/or dimensions of holes, slots or openings, sleeves, inserts or on account of any increased lift or scaffolding etc. All these factors should be taken into consideration while quoting the unit rates. Unless provided for in the schedule of quantities the rates shall also include fixing inserts in all concrete work, whenever required.

5.193 Payments of concrete will be made on the basis of unit rates quoted for the respective items in the schedule of quantities. No deduction in the concrete quantity will be made for reinforcements, inserts, etc. and openings less than 0.5 sq.ft. in area where concrete is measured in sq.ft. and 1/3 cft. Where concrete is measured in cu.feet. Similarly the unit rate for concrete work shall be inclusive or exclusive of shuttering is paid for separately, it shall be very clearly understood that the payment for formwork is inclusive of form work, shuttering, shoring, propping, scaffolding, etc. complete.

5.194 Payment for beams will be made for the quantity based on the depth measured from the undersides of the slabs and length measured as the actual length without deducting for supports. Height reckoned upto the undersides of beams.

6.0 GALVANISED STEEL FOR EQUIPMENT SUPPORT STRUCTURES:

6.1 GENERAL

6.1.1 This sub-section covers the furnishing of galvanized structural steel for EQUIPMENT SUPPORT STRUCTURES .It includes supply of all materials, , detailing fabrication, galvanizing, and erection of structures with necessary anchor bolts , connection bolts, step bolts and other miscellaneous material required to make complete lightning mast tower.

6.1.2 This sub-section is intended for use with complimentary sections and appropriate drawings, which outline electrical clearances, loading assumptions and other details pertaining to, specified standards.

6.1.3 All materials of construction shall be brand new and free of pitting, dents, bends and other defects.

6.2 MATERIALS OF CONSTRUCTION

Materials shall conform to the following specifications: -

6.2.1 Rolled Shapes and Plates

All materials shall be hot rolled of structural and/or high-strength structural steel. All structural steel shall be made by the open hearth or electric furnace process.

a) Structural Mild Steel and/or High-strength Structural Steel

Structural mild steel shall conform to the applicable standards .

The CONTRACTOR shall purchase steel from either prime manufacturers or reputed rerollers acceptable to the INSTITUTE.

6.2.2 Connection Bolts, U-Bolts and Nuts

a) Steel for connection bolts, U-bolts, nuts and locknuts shall be in accordance with the applicable standards.

b) Bolts, U-Bolts, nuts and locknuts shall be of uniform quality, either mild steel or high strength, and no combination of bolts in a tower is permitted.

6.2.3 Step bolts, foundation bolts, spring washers and plain/bevelle washers shall conform to the applicable standards ..

6.2.4 Connection Bolts & Nuts

All connections of the tower shall be bolted type Rivets shall not be used. Welding, if used, for minor details is subject to prior approval of the Institute / Project Engineer cum Estate Officer.
All bolts shall be with hexagonal heads and nuts also shall be hexagonal. All nuts shall be locked in by approved means, either by self-locking type nut or by use of split-spring lock washer. All bolts nuts and lock nuts shall be hot dip galvanized where as washers shall be Electro galvanized.

6.3 DETAILS & DETAILING PRACTICE:

6.3.1 General

Detailed drawings and erection drawings shall be prepared based on designs furnished by the Institute / Project Engineer cum Estate Officer. The details of all connections and splices to be used shall be subject to the approval of the Institute / Project Engineer cum Estate Officer.

6.3.2 Shop Detail Drawings

Shop detail drawings shall be prepared and they shall indicate the following in complete details:-

a) Tower dimension in metric system, framing, member sizes and lengths, number, size and lengths of bolts gusset plates thickness of each packing material, accessories etc.

b) Identification mark of each and every member to be fabricated.

c) All cutting, punching and other information required for fabrication of each member.

d) All holes, hole sizes and distances between working points.

6.3.3 All web members shall be in one piece where practicable. All double diagonal web system members shall be connected at their point of intersection by at least one bolt.

6.3.4 In lap splices the heel of inside clear angle shall be ground suitably to fit it with the outer member properly and snugly.

6.3.5 All jointing shall be such that additional stresses due to eccentricity are kept as minimum as practicable. Opening between members at the bolt tightening points shall be completely filled by packing washers with proper thickness. For all bolts in sloped flanges, bevelled washers shall be provided**.**

6.3.6 Minimum bolt spacing, flange width and edge distances shall be as follows:

Bolt Diameter	Minimum flange Width	Minimum spacing (centre to centre)	Minimum distance to rolled edge	Minimum distance to sheared edge
(mm)	(mm)	(mm)	(mm)	(mm)
12	40	35	19	22
16	45	45	21	25
20	55	55	24	30

The above edge distance shall not be reduced by under run due to fabrication tolerances or rolling tolerances.

6.3.7 Step bolts shall be minimum of 16-mm diameter with round or button head. Each bolt shall be provided with two (2) hexagonal nuts and spring washer. The minimum clear projected length beyond face of leg shall be 150 mm.Step bolts shall not be used as connection bolts.

Step bolts shall be spaced alternatively on inner gauge of each face of angle about 400mm on centres. They shall be furnished on two diagonally opposite legs of each tower from the point 2.5 meters above ground level to the peak of tower. Each bolt shall be capable of withstanding a vertical load of not less than 150 kilograms.

6.3.8 Spring lock washers shall be minimum 2.5mm thick and have a hole diameter approximately 2 mm larger than nominal bolt diameter

6.3.9 Bill of Material

Each type of tower shall be supplied with bill of material. The bill of material will indicate material, size, length and galvanized weight of each member and the total weight of body, body extension and stub. It shall also include the number of bolts of various lengths, step bolts, flat/bevelled washers, spring washers, U-bolts, hanger, various sign plats, etc. required for the completeness of tower.

6.4 FABRICATION

6.4.1 General

All workmanship and finish shall be of best quality, first class throughout and shall conform to the best-approved method of fabrication. All the pieces shall be finished straight, true to detail drawings. All holes and edges shall be free from burrs. Shearing and chipping, bevel cutting, bending, grinding etc. shall be neatly and accurately done. Unless otherwise directed/approved, reference may be made to the applicable standards indicated in Data Sheet-A2 for providing standard fabrication tolerances. Material for fabrication shall be kept clean and protected from weather**.**
All identical pieces bearing the same erection number must be exactly interchangeable with each other and interchangeable in their relative position in all towers or structures of which they form a part**.**

6.4.2 Connections

6.4.2.1 All connections shall be bolted type only.

6.4.2.2 Bolts shall be full size in shanks. Threads of bolts and nuts shall be clearly rolled or cut and face & head of nut shall be truly at right angle to the axis of bolt. The shank will be round and free of projected fins. The bolt head shall be hexagonal properly centered on the shank and have a bearing surface truly at right angle to the axis of bolt, free from burrs and reasonably smooth**.**

6.4.2.3 Nuts shall be hexagonal of dimensions adequate to develop full strength of bolts. All nuts shall be securely locked by the use of lock nuts or spring washers or by other means approved by Institute / Project Engineer cum Estate Officer. The nuts and locknuts shall fit freely for entire length of bolt threads.

Dimensions of spring washers shall meet the following requirements:-

Nominal Diameter	Basic inside diameter	Maximum outside diameter	Average thickness
(mm)	(mm)	(mm)	(mm)
12	12.2	21.1	2.5
16	16.2	27.4	3.0
20	20.2	33.5	4.0

6.4.2.4 In all cases where bearing is critical, the unthreaded bolt shall bear on members assembled. A suitable washer of adequate thickness may be provided to exclude the

threads from the bearing thickness, in case a longer grip bolt has to be used for this purpose. As far as possible not more than four (4) thicknesses shall be connected together at any one point.

6.4.3 Fabrication

a) Straightening

Rolled material shall be straightened before being worked, unless otherwise specified. The straightening or flattening shall be done without any injury to the material or its strength. Long plates shall be straightened by passing through levelling rolls and structural shapes by use of mechanical or hydraulic bars/section straightening machines. Heating or forgoing shall not be resorted to without the prior approval of Institute / Project Engineer cum Estate Officer in writing.

b) Cutting

i) Cutting may be by shearing, cropping or sawing. Flame cutting shall be avoided as far as possible.

ii) All re-entrant corners shall be shaped notch-free to a radius of at least 12 mm. Sheared or cropped edges shall be dressed to a neat workmanlike finish and shall be free from burrs and distortions so as to avoid any difficulty of assembly caused by the interference of end sections with other members at the time of assembling the tower.

c) Punching and Drilling

a. Holes may be punched through material not over 12 mm thickness. Holes for thickness higher than 12 mm shall preferably be drilled and the burrs removed effectively.

b. The diameter of bolt hole shall not exceed 1.5 mm over the nominal diameter of bolt used. Special care shall be exercised to ensure exact spacing of holes and their distance from the back of angle and to the end of piece. Any member having holes or cuts more than 1.0 mm from correct position will be subject to rejection. NO welding, filling or plugging will be permitted unless approved by the Institute / Project Engineer cum Estate Officer. Poor matching, over-drilling and quality in holes shall be subject to rejection. Burning holes with gas is strictly prohibited.

c. Holes in bent members likely to be affected by bending operation shall be laid out and punched or drilled after bending.

d) Welding

a. Welding shall be avoided as far as possible, however if used, shall be carried out before galvanizing. Electrodes for shielded arc manual welds shall comply with the requirements of appropriate standard and shall be of approved make. Welding shall be exercised to obtain full penetration of weld when welding light members to heavy members.

b. All welds shall be made only by welders and welding operators who have been properly trained and previously qualified by tests to perform the type of work required as prescribed in the relevant applicable standards.

c. All welds shall be free from defects like blow holes, slag inclusion, lack of penetration, under cutting, cracks etc. All welds shall be cleaned of slag or flux and show uniform sections, smoothness of weld metal, feather edges without overlap and freedom from porosity.

d. Fillet welds larger than 8 mm shall be made with 2 or more passes. Each layer of multiple layer welds, except the root and surface run, may be moderately peened with light blows from a blunt tool. Care shall be exercised to prevent scaling or flaking of weld and base metal from overpeening.

e) Bending

a. All bending of high-strength structural steel must be done hot. Bends of difficult nature on mild steel would be done hot; otherwise cold bending could be employed.

b. If cold bending is adopted, the Institute / Project Engineer cum Estate Officer shall have the right to make any test in accordance with the relevant standard.

c. Members bent hot shall be heated in non-oxidizing flame over a sufficient area to prevent excessive deformation. Hot bends shall be cooled by natural air cooling method and not by quenching. In case where bends are near splices, the upset metal shall be forged smooth for full bearing on the contact surface.

d. All bends shall be finished free from waves, folds, localized reduction in sectional area or reduction in leg length in excess of 5%.

f) Tolerances

a. The acceptable limits for straightness (sweep and camber) for rolled or fabricated members are:

i. Main struts and legs of towers L/1000 or 10 mm whichever is smaller.

ii. For other members not primarily in compression such as redundant members. L/500 or 15 mm whichever is smaller.

b. Where L is the axial length of member between point of lateral supports.

c. Tolerances in specified length of finished for contact bearing shall be as follows:

i. Finished member without ends finished for contact bearing shall have tolerances +/- 1.5mm for members up to 3 m in length.

ii. For members over 3 m long an additional 1 mm for every 3 m length may be allowed, but in no case will a tolerance more than 3 mm be allowed for any member.

g) Marking

a. After checking and inspection, all members shall be marked for identification during erection. The mark shall conform to the piece marks on the detail drawings.Markings shall be stamped with metal dye prior to galvanising and the figures & letters shall be at least of 20 mm height and to such optimum depth as to be clearly visible even after the member is galvanized.

b. All the erection marks shall be on outer surface and placed preferably near one end in the same relative position on each member so as to be easily seen after assembly of tower. They shall be stamped so as not to reduce the effective net section of the member. Members having length more than 4 metres shall have marking at both ends.

c. After galvanizing the marking shall be encircled boldly be distinguishable paint to facilitate easy location. Member having identical size and details shall have the same marking regardless of its position in the structure.

h) Errors

a. Any error in shop work which prevents proper assembling and fitting up of parts in the field by moderate use of drift pin or moderate amount of reaming shall be rejected as defective workmanship. All charges incurred by the INSTITUTE either directly or indirectly because of such defective workmanship will be deducted from the amount due to the CONTRACTOR before payment is made. The amount of such deduction will consist of the sum total to the cost of labour, direct or indirect, material, plant, and transportation equipment rental and overhead expenses.

b. In case the INSTITUTE / PROJECT ENGINEER CUM ESTATE OFFICER chooses to reject the material because of poor workmanship, the cost of all handling or returning the material to the CONTRACTOR, if he so desires, shall entirely to the account of CONTRACTOR. All the replacement material shall be supplied free and delivered at site in all such cases.

6.5 CLEANING & GALVANISING:

6.5.1. Workmanship:

a) After all the shop work is complete, all the structural materials shall be stamped with erection mark and the hot-dip galvanized.Before galvanizing, the steel shall be thoroughly cleared of any paint, grease, rust scale, acid or alkali or such other foreign matters as or likely to interfere with the galvanizing process or with the quality and durability of the zinc coating. Picking shall be very carefully done and shall be proper.

b) Galvanizing for structural steel members, bolts, nuts, step bolts and other accessories of tower, shall meet the requirements of the relevant applicable standards indicated in Data Sheet-A2 and shall be as follows:

Minimum weight of Zinc coating (grams/sq.meter) of surface			
		Average of Specimen Tested	**Any individual specimen**
a)	Structural steel members of thickness i) 5 mm & under ii) 6 mm & above	 610 700	 550 610
b)	Bolts, nuts, washers and accessories	381	305
c)	Stub members	850	800

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

d) There shall be no flaking or loosening when struck squarely with a chisel faced hammer.The galvanized steel member shall withstand minimum number of one minute dips in copper sulphate solution as per tests specified in the relevant standard indicated in Data Sheet-A2. The minimum repetition times for one minute dip in uniformity tests shall be as follows:

a. Structural members, gussets 6

b. Bolts, nuts & other accessories 4

e) Galvanizing of each member shall be carried out in one complete immersion. Double dipping shall not be permitted.However, in case of members over 7.5 m long, the CONTRCTOR shall take prior approval of INSTITUTE / PROJECT ENGINEER CUM ESTATE Officer for double dipping. When the steel section is removed from the galvanizing kettle section is removed by 'bumping'. The process known as 'wiping' or 'scraping' shall not be used for this purpose.

f) Whenever galvanized bolts, nuts, locknuts, washers, accessories etc. are specified, they shall be hot dip galvanized. Spring washers shall be Electro galvanized. Excess spelter from bolts, nut etc. Shall be removed by centrifugal spinning. Rechasing of bolt threads after galvanizing shall not be permitted. Nuts however may be tapped, but not to cause appreciable rocking of the nuts on the bolts.

g) Defects in certain members indicating presence of impurities in the galvanizing bath in quantities larger than that permitted by the Specifications, or lack of quality control in any manner in the galvanizing plant, shall render the entire production in the relevant shift liable to rejection.

h) All galvanized members shall be treated with Sodium Dichromate solution or an approved equivalent after galvanizing, so as to prevent white storage stains.

i) Prior approval shall be secured from INSTITUTE / PROJECT ENGINEER CUM ESTATE OFFICER if galvanizing is done outside CONTRACTOR's plant or place other than that indicated in his bid offer.

CONTRACTOR shall ensure that galvanizing is not damaged in transit and shall at his cost replace such members as are damaged in transit. If, INSTITUTE / PROJECT ENGINEER CUM ESTATE OFFICER accepts repair of minor damages, CONTRACTOR shall furnish sufficient quantity of appropriate paint, free of cost, for repairing galvanized surfaces damaged in transit.

6.6 MINOR REPAIRS

Materials on which galvanizing has been damaged shall be redipped unless in the opinion of the INSTITUTE / PROJECT ENGINEER CUM ESTATE OFFICER, the damaged is local and can be repaired by applying zinc rich/galvanizing repair paint. Where such repair is authorized, the damaged area shall be cleaned by wiping with clean rags saturated with mineral spirits of xylene, followed by wire brushing. Subsequently the area shall be recleaned with solvent to remove residue, and shall be given one heavy coat of zinc rich/galvanizing regular paint. The percentage of pure zinc by weight in dry film shall not be less than 85%.

6.7 SHOP ASSEMBLY

Tower shall be assembled in shop to ensure proper field erection. Reaming of holes not properly matching will not be permitted.A moderate amount of drifting will be allowed. If any errors on the drawings or fabrication are discovered in such assembly all the corrections or modifications shall be incorporated in the drawings and correct part refabricated & assembled. All revised drawings shall be resubmitted for approval.

6.3.3 Specific Technical Requirement (SCADA)

1.0 INTRODUCTION

1.1 The Indian Institute of Science (IISc), Bangalore is upgrading a part of a substation. Refer to the single line diagram Proposed 12.5 MVA Power Transformer Bay1.

1.2 The transformer TR#2 and TR#3 bay are renovated few years back. A SCADA system of GE ALSTOM was supplied and commissioned.

1.3 Provision is made in the existing GE SCADA system for future expansion. Now IISc is planning to include SCADA system for transformer T1 bay of 66kV switchyard.

2.0 SCOPE OF WORK:

2.1 The scope includes supply, unloading storage at site, erection, testing, commissioning and coordination with GE, the supplier of existing SCADA system and with other new equipment suppliers.

2.2 Refer to the SCADA system architecture drawing number PCPL-2329-5-SK-002.This drawing clearly identifies the existing system and the new SCADA requirements for the Transformer#1 bay.

2.3 Transformer #1 Bay Control and relay Panel need to be provided with Bay control Unit which is suitable to control Bay Equipments like Isolator, Circuit Breaker and NIFPS

2.4 Proposed TR#1 Bay Control Unit will be Supplied part of Control and Relay Panel as a Loose Item and it needs to be installed in existing SAS Panel.

2.5 New BCU Installation and Integration, Testing, Commissioning at Existing SAS Panel are included part of this tender.

2.6 Bay control Unit will be provided with Dual IEC 61850 Port which will compatible with existing SCADA. It can be installed in Existing SCADA Panel.

2.7 Bay Control Unit shall be provided with minimum 16DO and 32 DI.

2.8 The new SCADA system shall be interfaced with following panels/system supplied by others and enable complete monitoring and control of transformer bay #T1 from the existing monitors.

a) Transformer control and relay panel.

b) Remote tap changer panel.

c) Transformer marshalling box.

d) Multifunction meters (MFM) and other IED relays.

e) Existing communication main bus, SCADA system components, operating devices and peripherals.

f) 11kV incomer panel for transformer bay #T1 (Existing Panel)

g) 66kV CB/isolator control & relay panel

Hard wired signal cables from these panels will be connected to the I/O modules referred in clause 2.3.

2.9 A new BCU is proposed to cater to 66kV Transformer #1 control and monitoring. This unit will accept signals from field sensors/ through data bus from intelligent modules as the case may be. This unit will be hooked up to main communication data bus (redundant) enabling operation (control) and monitoring of 66kV TR#1 Bay equipment from the existing monitors. The BCU and necessary computer hardwares will be included as a part of CRP supplies as a Loose items. For details refer to clause 5.0 section 6.9.1. It is proposed to mount the new BCU and other hardwares in the existing SAS panel. Refer to dwg no :PCPL-2329-5-SK-001 titled SAS panel(Existing). The SCADA system vendor shall co-ordinate with bay equipment suppliers and suitably interface the BCU unit according to their requirements. The necessary software compatible with the existing one will be included as part of the scope.

2.10 The new SCADA equipment need to be synchronised with the existing GPS receiver unit.

2.11 Necessary communication buses, cables and hardware to complete the system need to be supplied as a part of SCADA vendor scope.

a) Fibre optic cables, conduits and installation materials.

b) Ethernet switches.

c) Start up spares.

d) 2 years maintenance spares.

e) Training of Engineers.

f) Necessary software for the intelligent devices supplied under the contract.

2.12 The SCADA system shall be interfaced with the fire alarm system.

2.13 Additional input modules need to be provided to link it with existing system to scan the inputs to the resolution of one millisecond and communicate with present sequence of event recording system.

2.14 The vendor shall co-ordinate with all equipment supplier in getting the I/O list, consolidate the same and configure in SCADA with specific reference to control relay panel supplier vide section 6.9.1.

2.15 For Bill of Material/price schedule refer to section 1.17.1 and 1.1.7.2

3.0 OPERATION PHILOSOPHY:

3.1 The 66kV line equipment and 66kV/11kV transformer T1 bay equipment will be operated from the existing monitors and same peripheral printers will be used.

3.2 The normal start up, shut down emerging operations will be performed from these existing monitors.

3.3 The control relay panel for circuit breakers, isolators, transformers etc. are located in the switchgear room and are provided with necessary control switches, push buttons, indicating lamps, display indicators, local/remote selector switch etc., for operation of these electrical components.

4.0 AUXILIARY POWER SUPPLY SYSTEM

The redundant 110V DC feeders will be made available from the 110V DC feeder panel.

5.0 TRAINING

5.1 Training shall be provided for the following Institute's staffs so that self sufficiency will be achieved by the staff to configure, operate and to maintain both the softwares and hardwares. Training manuals shall be provided for all the engineers / technicians.

5.1.1 The training period for each of them will be minimum one (1) month.

5.2 The extent of training shall meet the following specific requirements:

5.2.1 Operation of Man Machine Interface (MMIS) for normal and emergency conditions of 66kV/11kV sub-station. This will also include start up and shut down operations.

5.2.2 All the structuring functions like building up the various types of displays, alarm settings, designing control plaques, configuration of relays etc.

5.2.3 Maintenance of SCADA system hardwares and softwares.

5.2.4 Carrying out trouble shooting.

5.3 In addition to this, the VENDOR will train the operation and maintenance staff at site.

5.4 Three (3) copies of the training manuals will be included as a part of training.

6.0 DOCUMENTATION AND INSTRUCTION MANUALS FOR ALL EQUIPMENT AND SYSTEM SUPPLIED

6.1 All documents shall be in English. Documents that are multilingual, including English, on the same page is not acceptable. Vendor shall provide Ten (10) identical copies of all documentation necessary to operate, maintain, enhance, or to understand the facilities and functions of the system. This shall include but not limited to at least the following.

6.1.1 Hardware Installation Manuals containing outline dimensions, equipment specifications, mounting details, power and signal connection details, weights, heat loads and power requirements for all equipment.

6.1.2 Parts lists with prices for all equipment for major system components, subsystem, power supplies, and printed circuit boards, cards, and modules including bought out items.

6.1.3 Maintenance Manuals containing:

6.1.4 Theory of operation.

6.1.5 All necessary schemes, including block schematics of all input /output modules.

6.1.6 Maintenance instructions for trouble shooting, routine adjustment and preventive maintenance procedures, assembly and disassembly instructions, on and off line testing procedures and all other information required for installation of the system.

6.1.7 Operating instructions and equipment user manuals for all components, workstations, printers, controllers, data acquisition devices, etc.

6.1.8 Configuration instructions covering standard configuration tasks of all I/O, control, logic and displays required by this specification.

6.1.9 Hardware Technical Description Manuals.

6.1.10 System configuration Diagrams, in block diagrams identifying all the sub-systems with name and (family) model numbers.

6.1.11 Fill in the blank type programming sheets.

6.1.12 Program disk.

6.1.13 Program listing.

6.1.14 As built drawings for

a) Over All general assembly of the Cabinets.

b) Internal Layouts.

c) Internal wiring schemes.

d) I/O listing with card assignments.

e) All field modifications including cables and terminations.

f) All displays configured in the monitor.

g) All logs and reports.

6.1.15 Hard Copy of all Operator Interface Screens like graphics, overview etc.

6.1.16 Alarm assignments.

6.1.17 Serial Data Links listings with encoding information.

6.1.18 All the Application Engineering documentation in soft copy with proper indexing.

6.1.19 Hard and software copies of all the configurations (displays) and alarm displays including the various settings like various like relays and Alarm settings.

6.2 All software documents both in hand copy and electronic medium.

7.0 DELIVERY SCHEDULE

7.1 The equipment shall be supplied to site within the period stipulated in the forwarding letter of this specification.

7.2 Bidder shall prepare and submit to the INSTITUTE / PROJECT ENGINEER CUM ESTATE OFFICER after award of contract, a detailed time schedule of the activities required to accomplish the entire work. The schedule shall include a separate entry for each item of the work.

7.3 It shall be the Bidder's responsibility to maintain the progress of his work in accordance with the schedule.

8.0 DEVIATION SCHEDULE

8.1 The bidder shall bring out all deviations to the specification. The cost implication, if any, to meet specification requirements shall be furnished.

9.0 DATA/ INFORMATION TO BE SUBMITTED WITH THE BID

Sl. No.	Information Required
1	Technical data sheet
2	Detailed manufacturer's quality assurance standards and programme and ISO 9000 series or equivalent national certification

9.1 **BIDDER DATA**

9.2 The BIDDER shall provide the following minimum requirements all in original:

a) Detailed catalogue and manuals for all the products and systems.

b) SCADA configuration drawing identifying all the components of the SCADA system and describing the various functions of these components.

c) Details of the training that will be provided for the various categories like operation engineers, Maintenance and Configuration Engineer and technicians.

d) Bill of quantity identifying make, type, model no along with nomenclature, price schedule and spare parts list with prices.

e) List of deviations from the specifications duly certified.

f) Price schedule in the same format as called for.

g) I/O list specifically indicating the assignments to the cards.

h) Control Room / SCADA Room layout identifying all the equipment with dimensions and maintenance requirements.

i) Detailed layout of the items mounted on the cabinets and Control Desk clearly indentifying the various items.

j) Recommended spare parts list for two (2) years identifying the components and prices.

k) Any other details as called for in the specification:

   i) Clients certificate to prove that a similar system is in successful operation for a minimum period of two (2) years.

   ii) Bar chart of various activities of manufacturing, testing, inspection and delivery.

l) Details of additional expandability and capacity considered in the system.

10.0 DATA / INFORMATION TO BE SUBMITTED AFTER THE AWARD OF CONTRACT

10.1 The following data shall be furnished within three weeks from the award of contract

Sl No.	Information Required
1	Weight of equipment
2	Weight of components separately
3	Dimensions L x B x H
4	Foundation details

10.2 The VENDOR will provide all the drawings and details called for in addition to the following for approval.

i) System configuration and specifications.

ii) SCADA room layout.

iii) Cabinets & control desk.

iv) Power supply schemes.

v) Cables/ Data bus specification.

vi) All product data sheets.

vii) Training procedures.

viii) I/O list and assignments.

ix) All mimics for displays and operations.

x) Annunciation list and priorities.

xi) List of SER points.

xii) Alarm and SER formats, and priority / colour assignments.

xiii) Recommended maintenance programme for all SCADA equipment and accessories

10.3 The following test reports and QA plan shall be submitted.

Sl. No.	Information Required
1	Type Test Report for tests conducted not earlier than 5 years shall be furnished for all equipment in detail (along with relevant drawings/procedures/photographs). The type tests shall be conducted as per IEC standards. Parameters guaranteed for every piece of equipment shall be duly verified vis-a-vis the submitted test certificates.
2	List of routine tests along with sample test reports
3	QA Plan

11.0 APPROVED MAKES:

11.1 The following makes of components are acceptable. Any other make if offered shall be subject to PURCHASER's approval:

1	SCADA	GE (Compatible with Existing)
2	Network switches	CISCO,Rugged com, Hirschmann, and D-link
3	Software (only Data Base Upgradation- Substation Automation)	GE (Compatible with Existing)
4	MCB/RCBO	ABB, Siemens, Schneider Electric, GE Power Controls., MDS Legrand (Lexic range), Hager (marketed by LK), Klockner Moeller
5	Terminal connectors	Wago/Phoenix
6	RS 485 & LAN Cables	CCI, NICCO, Asian (RPG), Polycab, Lapp Kabel, Universal, RR Kabel
7	MODBUS RS485- LAN CONVERETR	D Link,
8	Optic Fiber Patch Cords	D Link,
9	Cable Lugs	Dowells, Jainson

10	Cable Glands	Baliga, Comet, SMI
11	Cable Trefoil/ Wire ducts	Profab, MDS Legrand

NOTE: New Transformer#1 Bay need to be integrated with existing SAS. Thus, we considered SCADA accessories with reference to Existing SAS.

SCADA Accessories like Engineers Work Station, Operating Work station, LED Monitor, Keyboard, SNTP server, Main Ethernet Switch are not considered in this Tender Specification.

6.4.1 Oil Filled Power Transformer

12.0 SCOPE OF WORK:

This Specification covers the design, material, construction features, manufacture, inspection and testing at the VENDOR's/his SUB-VENDOR's works, delivery to Site and performance testing of oil filled power transformers.

13.0 CODES & STANDARDS:

13.1 The design, material, construction, manufacture, inspection, testing and performance of power transformers shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment will be installed. The equipment shall also conform to the latest applicable standards and codes of practice. Nothing in this specification shall be construed to relieve the VENDOR of this responsibility.

13.2 Transformers shall conform to the currently applicable standards and codes of practice as specified in Data Sheet-A. In case of conflict between the applicable reference standards and this Specification, this specification shall govern.

14.0 GENERAL CONSTRUCTIONAL FEATURES:

3.1 All material used shall be of best quality and of the class most suitable for working under the conditions specified and shall withstand the variations of atmosphere temperature and other atmospheric conditions, overloads, over-excitation, short circuits as per specified standards, without distortion or deterioration or the setting up of undue stresses in any part, and also without affecting the strength and suitability of the various parts for the work which they have to perform.

3.2 Similar parts, particularly removable ones, shall be interchangeable.

3.3 Exterior of pipes and pipe fittings, screws, studs, nuts and bolts used for external connections shall be hot dip galvanised.

15.0 ELECTRICAL & PERFORMANCE REQUIREMENTS:

4.1 Transformers shall operate without injurious heating at the rated kVA at any voltage within 10% of the rated voltage of that particular tap.

4.2 Transformers shall be capable of delivering the rated current at a voltage equal to 105% of the rated voltage without exceeding the limiting temperature rise.

4.3 Overloads shall be allowed with in the conditions defined in the loading guide of the applicable standard. Under these conditions, no limitations by terminal bushings, tap-changers or other auxiliary equipment shall apply.

4.4 The neutral terminal of windings with star or zig-zag connection shall be designed for the highest overcurrent that can flow through this winding.

4.5 Every care shall be taken to ensure that the design and manufacture of the transformers shall be such as to reduce noise and vibration to the level obtained in good modern practice. The noise level shall not exceed the level specified in applicable standard.

4.6 For transformers with tapping, full power tapping shall be provided.

4.7 The thermal and dynamic ability to withstand short circuit shall be demonstrated by tests or by reference to tests on similar transformers.

4.8 The transformers shall be designed with particular attention to the suppression of harmonic voltage, especially the third and fifth, so as to minimize wave form distortion and from any possibility of high frequency disturbances reaching such a magnitude as to cause interference with communication circuits.

4.9 All rated quantities subject to the VENDOR's guarantees shall be within the tolerances given in applicable standards.

4.10 Unless otherwise specified in Data Sheet –A transformers shall be designed for the following over fluxing withstand capability:

a) 110% - Continuous for all transformers

b) 125% - For 1 minute and 140% for 5 Sec. for generator transformers and unit aux. transformers

Transformers shall operate below the knee of the saturation curve at 110% voltage to preclude ferro resonance and non-linear oscillations.

4.11 The maximum flux density in any part of the core and yokes, at normal voltage and frequency shall be such that the flux density under over voltage conditions as per clauses 4.1, and 4.10 shall not exceed the maximum permissible values for the type of core and yoke material used. The type of material and values of flux density in the core/ yoke for the 100%, 110%, 125% and 140% and the hysterisis characteristic curves shall be included in the bid and in relevant Data Sheet B, and shall be subject to the PURCHASER's approval.

4.12 Transformers, complete with bushings/ cable boxes, shall be designed and constructed to withstand without damage, the effects of external short circuits (as specified at Data Sheet A) as per the specified standards. Account shall be taken of the different forms of system faults that can arise in service, such as line to earth faults and line to line faults associated with the relevant system and transformer earthing conditions.

16.0 CORE:

5.1 The magnetic circuit shall be constructed from high-grade cold rolled non-ageing grain oriented silicon steel laminations.

5.2 The laminations shall be free of all burrs and sharp projections. Each sheet shall have an insulating coating resistant to the action of hot oil.

5.3 The construction is to be of 'core' type.

5.4 The insulation structure for the core to bolts and core to clamp plates shall be such as to withstand a voltage of 2000 V for one minute.

5.5 The completed core and coil assembly of core type units shall be so assembled that the axis and the plane of the outer surface of the coil stack shall not deviate from the vertical plane by more than 25 mm.

5.6 All steel sections used for supporting the core shall be thoroughly shot or sand-blasted, after cutting, drilling and welding.

5.7 The finally assembled core with all the clamping structures shall be free from deformation and shall not vibrate during operation.

5.8 The core clamping structure shall be designed to minimise eddy current loss.

5.9 The core shall be provided with lugs suitable for lifting the complete core and coil assembly.

5.10 The core and coils assembly shall be so fixed in the tank that shifting will not occur during transport or short circuits.

5.11 The framework and clamping arrangements shall be securely earthed in accordance with clause 6.0.

17.0 INTERNAL EARTHING :

6.1 All internal metal parts of the transformer, with the exception of individual laminations, core bolts and their individual clamping plates shall be earthed inside the tank by copper strap connection to the tank.

6.2 The top clamping structure shall be connected to the tank by a copper strap. The bottom clamping structure shall be earthed by one or more of the following methods:

a) By connection through vertical tie-rods to the top structure

b) By direct metal to metal contact with the tank base

c) By connection to the top structure on the same side of the core as the main earth connection to the tank.

6.3 The magnetic circuit shall be connected to the clamping structure at one point only and this shall be brought out of the top cover of the transformer tank through a suitably rated bushing. A disconnecting link shall be provided on transformer tank to facilitate disconnection from ground for IR measurement purpose.

6.4 Coil clamping rings of metal at earth potential shall be connected to the adjacent core clamping structure on the same side as the main earth connection in Clause 6.2.

18.0 WINDINGS:

7.1 Windings shall be subjected to a shrinking and seasoning process, so that no further shrinkage occurs during service.

7.2 Windings shall be of copper unless specifically approved by the PURCHASER. The conductors shall be transposed at sufficient intervals in order to minimise eddy currents and equalise the distribution of currents and temperatures along the windings.

7.3 Materials used in the insulation and assembly of the windings shall be insoluble, non-catalytic and chemically inactive in the hot transformer oil, and shall not soften or be otherwise affected under the operating conditions.

7.4 Varnish application on coil windings may be given only for mechanical protection and not for improvement in dielectric properties. In no case varnish or other adhesive be used which will seal the coil and prevent evacuation of air and moisture and impregnation by oil.

7.5 All threaded connections shall be locked. Leads from the winding to the terminal board and bushings shall be rigidly supported to prevent injury from vibration. Guide tubes shall be used where practicable.

7.6 Windings and connections shall be braced to withstand shocks during transport or short circuits.

7.7 Permanent current carrying joints in the windings and leads shall be welded or brazed. Clamping bolts for current carrying parts inside oil shall be made of oil resistant material which shall not be affected by acidity in the oil. Steel bolts, if used, shall be suitably treated.

7.8 The completed core and coil assembly shall be dried in vacuum at not more than 0.5mm of mercury absolute pressure and shall be immediately impregnated with oil after the drying process to ensure the elimination of air and moisture within the insulation. Vacuum may be applied in either vacuum oven tank or in the transformer tank. Vapour phase dry out shall be preferred.

19.0 TANK:

8.1 Tank shall be made from good commercial grade, low carbon steel and shall be of welded construction.

8.2 Tank shall be designed to permit lifting, by crane or jacks of the complete transformer assembly filled with oil. Suitable lugs and bosses shall be provided for this purpose.

8.3 Tank together with radiators, conservator, bushings and other fittings shall be designed to withstand without permanent distortion for the following conditions:

a) Full vacuum of 760mm of Hg. for filling with oil by vacuum.

b) Internal gas pressure of 0.35 kg/cm^2 (5 lbs/sq.in) with oil at operating level.

8.4 The transformer top shall be provided with a detachable tank cover with a bolted flanged gasket joint. Lifting lugs shall be provided for removing the cover. The surface of the cover shall be suitably sloped so that it does not retain rainwater.

8.5 The material used for gaskets shall be cork-neoprene or approved equivalent. Gasketted joints for tank, bushings and other bolted attachments shall be so designed that the gasket will not be exposed to the weather.

8.6 The exterior of tank and other steel surfaces exposed to the weather shall be thoroughly cleaned and have a priming coat of zinc chromate applied. The second coat shall be of an oil and weather resistant nature, preferably of distinct colour from the prime and finish coats. The final coat shall be of a glossy, oil and weather resisting non-fading paint of specified shade. The interior of the tank shall be cleaned by shot blasting and painted with two coats of heat resistant and oil insoluble paint.

8.7 Tank shall be provided with a pressure release device, which shall operate at a pressure below the test pressure for the tank and radiators. The device shall be rainproof after blowing and shall be provided with a device visible from ground to indicate operation. An equaliser pipe connecting the pressure relief device to the conservator shall be supplied. This device shall be provided for all transformers rated 500 kVA and above. Explosion vent shall be equipped with remote monitoring/alarm contacts.

8.8 Adequate space shall be provided at the bottom of the tank for collection of sediments.

8.9 Manholes with bolted covers shall be provided in the top or sides of transformer for easy access to the lower ends of bushings, tap changers and to permit replacement of auxiliaries without removing tank cover.

9.0 VALVES:

9.1 Valves shall be of forged carbon steel up to 50mm size and of gunmetal or of cast iron bodies with gunmetal fittings for sizes above 50mm. They shall be of full-way type with screwed ends and shall be opened by turning counter clockwise when facing the hand wheel. There shall be no oil leakage when the valves are in closed position.

9.2 Every valve shall be provided with an indicator to show the open and closed positions and shall be provided with facility for padlocking in either open or closed position. All screwed valves shall be furnished with pipe plugs for protection.

9.3 All valves shall be provided with flanges having machined faces drilled to suit the applicable requirements. Oil-tight blank flanges shall be provided for each connection for use when any radiator is detached and for all valves opening to atmosphere. If any special radiator valve tools are required, the VENDOR shall supply the same.

9.4 Each transformer shall be provided with following valves on the tank:

a) Drain valve with cover plate so located as to completely drain the tank. The same can be used as bottom filter valve and the size shall be 50 mm.

b) Filter valve at top of transformer tank, one of 50mm size.

c) Oil sampling valves not less than 8 mm, at top and bottom of main tank.

d) One 15 mm air release device.

e) Valves between radiators

f) Two plugged pipe outlets for applying vacuum

10.0 UNDER-CARRIAGE:

The under-carriage of the transformer shall be provided with detachable steel flanged wheels or flat rollers as specified in Data Sheet-A. Flanged wheels shall be spaced to allow specified rail gauge. Wheels shall be provided with suitable bearings, which will resist rust and corrosion and shall be equipped with fittings for lubrication. Unless otherwise approved, it shall be possible to swivel the wheels or rollers in two directions, at right angles to or parallel to the main axis of the transformer, thereby permitting movement in two directions. The wheels or rollers will be swivelled after jacking the transformer and they shall be lockable in both the positions.

11.0 TRANSFORMER COOLING:

11.1 Radiators shall be designed to withstand the vacuum and pressure conditions specified for the tank. They shall be so designed as to avoid pockets in which moisture may collect, to completely drain oil into the tank and to prevent formation of gas pockets when the tank is being filled.

11.2 The clearance between all pipe work and live parts shall be more than the clearance for live parts to earth.

11.3 Unless otherwise approved, for transformers rated 5000kVA and above, tank mounted radiators/ coolers shall be of the detachable type with bolted and gasketed flanged connections. The following accessories shall be provided for radiator:

a) Shut-off valves and blanking plates on transformer tank at each point of connection.

b) Top and bottom shut-off valves and blanking plates on each radiator.

c) Lifting lugs

d) Top oil filling plug 19mm size

e) Air release plug at top

f) Oil drain plug at bottom, 19 mm size.

12.0 TAP CHANGING GEAR

12.1 Off-Circuit Tap Changing Gear

The off circuit tap changer shall be operable by means of an operating handle brought outside the tank and operable from ground level. It shall be equipped with an indicating device to show the tap in use and shall be provided with a locking arrangement to lock the switch in any tap position. The tap changer contacts and connections shall be accessible through an access hole having a bolted gasketted cover.

12.2 On-load Tap Changing Gear (OLTC)

The OLTC gear, if specified, shall comply with requirements of enclosed specification section 6.4.3.

13.0 CONTROL CABINETS

	OLTC remote control Cabinet	OLTC local control cabinet transformer marshalling box & cooler control Cabinet

Execution	Indoor	Outdoor, weather proof
Mounting	Floor mounted	Tank mounted or mounted on a separate foundation
Wiring	All cooler control, alarm and trip circuits shall be wired for auxiliary DC supply as specified	
General specifications	In accordance with enclosed specification Clause 6.8 and latest applicable standards	
Special requirements		Bottom of the tank mounted cabin shall be at least 600mm from floor level. Top surface shall be sloped. Indicating lamps & meters shall be covered by a glass window. Gland plates and cable glands as required shall be provided at the bottom

14.0 BUSHINGS:

14.1 All porcelain used in bushings shall be homogeneous, non-porous, uniformly glazed to brown colour and free from blisters, burns and other defects.

14.2 Stresses due to expansion and contraction in any part of the bushing shall not lead to deterioration.

14.3 Bushings shall be designed and tested to comply with the applicable standards specified in Data Sheet-A. If type test certificates are not available, these tests shall also be carried out in addition to the routine tests.

14.4 Bushings rated for 400 A and above shall have non-ferrous flanges and hardware.

14.5 Liquid / oil filled bushings 36kV and above shall be equipped with liquid level indicators and means for sampling and draining the liquid. The angle of inclination to vertical shall not exceed $30^{O}C$.

14.6 Oil in oil filled bushings shall meet the requirements of the transformer oil standards specified in Data Sheet-A.

14.7 Fittings made of steel or malleable iron shall be galvanised.

14.8 Whenever specified in Data Sheet-A, bushings shall be supplied with terminal connector/ clamp suitable for fixing to bushing terminal and the PURCHSER's specified conductors. The connector/ clamp shall be rated to carry the bushing rated current without exceeding a temperature rise of $45^{O}C$ in an ambient of $50^{O}C$.

14.9 Bushings for 36kV (except for neutral bushings) and above shall be provided with adjustable rod gap. For bushings rated lower than 36kV, the gap shall be of double series type to minimise interference from birds.

14.10 The neutral of the star connected winding shall be brought out to a separate bushing terminal. The neutral bushing shall be provided on the tank side to facilitate leading the earth conductor down to the ground level. In addition, tank mounted pin type support insulator shall be provided for supporting the neutral earthing bar of specified section along its run from the neutral bushing to ground level. In case of 4 wire system, additional neutral terminal shall be brought out to cable box or busduct terminal flange for PURCHASER's connection.

14.11 Bushings shall be so located on the transformers that full flashover strength will be utilised and minimum clearances as required for the BIL shall be realised between live parts and live parts to earthed structures.

14.12 The applicable routine and type tests (if certificates of same are not available), as stated in the specified bushing standards shall be carried out.

14.13 Bushing current transformers shall comply with specified standards.

a) It shall be possible to remove turret mounted CT's from the transformer tank, without removing the cover.

b) All the secondary leads including tappings shall be brought to a weather proof outlet box near the bushing. The VENDOR shall arrange conduit wiring from this outlet box up to the transformer marshalling box or control cabinet.

c) Bushing CT name plate shall be mounted on the equipment tank adjacent to the terminal box.

15.0 CABLE BOXES & DISCONNECTING CHAMBERS:

15.1 Cable boxes and sealing ends shall be complete with tinned copper lugs to suit the specified cable and all other accessories including compression glands, and armour earthing clamps.

15.2 Cable boxes shall be designed to accommodate all cable termination fittings or sealing ends as required, including stress/cones or other approved means for grading voltage stress on the terminal insulation of cables operating at voltage of 6.6 kV and above.

15.3 Phase to phase and phase to ground air clearances within the chamber shall be such as to enable either the transformer or each cable to be subjected separately to H.V tests. Clearances shall be subject to the PURCHASER's approval.

15.4 When specified in Data Sheet - A, disconnecting chamber shall be provided to enable the transformer to be removed without unsealing the cables or draining oil from the main tank. The disconnecting chamber shall be air insulated and complete with seal-off bushings, removable flexible connectors/links and removable covers.

16.0 BUS DUCT TERMINATIONS:

16.1 When bus duct termination is specified in Data Sheet A, a flanged bushing or equivalent connection shall be provided to suit PURCHASER's bus ducts. The winding terminations shall be on outdoor type of bushings. The material of the bus duct termination flange shall be non-magnetic unless otherwise approved by the PURCHASER.

17.0 MARSHALLING BOX:

17.1 All the contacts/ terminals of electrical devices mounted on the transformer shall be marshalled to a marshalling box. It shall be in the VENDOR's scope to provide:

a) the interconnecting cabling between the marshalling box and the accessory devices by either PVC insulated wires in GI conduits or PVC insulated armoured cables

b) Necessary compression type brass cable glands at the marshalling box for the above mentioned cables as well as for terminating the PURCHASER's incoming cables from remote panels.

17.2 Marshalling box shall be tank mounted, outdoor, weather proof sheet steel enclosed (min. 2mm thick), with hinged door having padlocking facility and painted as per clause 8.6. All doors, covers and plates shall be fitted with neoprene gaskets. Bottom shall be at least 600mm from the floor level and provided with gland plate and cable glands as required. Top surface shall be sloped.

17.3 All contacts for alarm, trip and indication circuits shall each be electrically free, wired for auxiliary D.C supply as specified and brought out to separate terminals at the terminal blocks in the marshalling box. Terminals shall be rated for 10A. Wiring shall be with stranded copper conductors of sizes not smaller than 1.5 sq. mm. for control and CT circuits.

18.0 OIL:

18.1 Transformer shall be supplied complete with new transformer oil complying with latest applicable standard. 10% extra oil shall be supplied for topping up at site. Oil shall either be filled in the transformer or be supplied in non returned steel drums as specified in Data sheet – A. Transformer shall be transported nitrogen filled, if specified in Data sheet – A.

19.0 FITTINGS & ACCESSORIES:

The following fittings and accessories shall be provided:

19.1 Bushing terminals complete with connectors for the PURCHASER's external conductors or cable boxes, as specified in Data Sheet A.

19.2 Neutral bushing terminal complete with connector for earth conductor specified in Data Sheet A.

19.3 Inspection covers on the top cover of the transformer (for transformers rated 500 kVA and above).

19.4 Terminal marking and rating plates as per the specified standard.

19.5 Two earthing terminals. The tank cover, detachable parts such as radiators, marshalling box, cooler control cabinet, cable boxes, motors etc., shall be effectively earthed.

19.6 Lifting lugs or eyes for:

a) lifting of fully assembled transformer with oil

b) lifting core and coils

19.7 Drain cum sampling valve with plug or cover plate.

19.8 Weather-proof dehydrating breather with silica-gel and oil seal to eliminate constant contact with the atmosphere.

19.9 Oil level indicator with minimum marking.

19.10 Thermometer pocket.

19.11 The conservator of sufficient volume to maintain the oil seal from the minimum ambient temperature of -5^{o} C up to an oil temperature of 100^{o} C, with oil level varying within the minimum and maximum visible levels. The conservator shall be provided with the following accessories:

a) Filling plug, sump and drain valve of 15 mm size for conservator of size 650 mm and 25 mm size for conservator above 650 mm diameter.

b) 150 mm diameter magnetic type oil level gauge with low oil level alarm contacts and/ or a prismatic oil sight gauge, as specified in Data Sheet-A and provided with markings for minimum oil level and oil level at rated temperature rise.

c) A bolted cover at one end for cleaning.

d) Valve for shutting off oil to the transformer

19.12 Jacking lugs, if the transformer filled with oil weighs above 3000kg.

19.13 Hauling eyes on each face of the transformer.

19.14 The under base provided with channel for fixing on a platform or plinth.

19.15 A pressure relief device with contacts for trip and alarm for transformers rated above 500kVA. The device shall be rainproof after operation. An equaliser pipe connecting the pressure relief device to the conservator shall also be supplied.

19.16 Dial type thermometer with two contacts for oil temperature "HIGH" and "TOO HIGH" alarms. Each contact shall be electrically independent and brought out to separate terminals, rated 220V DC, minimum 0.5 A.

19.17 A double float type Buchholz relay as per specified standard shall be provided whenever called for in Data Sheet-A. All gas evolved in the transformer shall collect in this relay. The relay shall be provided with a test cock suitable for flexible pipe connection for checking its

operation. A 5mm copper pipe shall be connected from the relay test cock to a valve located about 1.25m above ground level to facilitate sampling with the transformer in service. The device shall be provided with two electrically independent ungrounded contacts, one for alarm on gas accumulation and the other for tripping on sudden rise of pressure. These contacts shall be wired up to the transformer marshalling box. The relay shall be provided with shut-off valves on the conservator side as well as the tank side.

19.18 Gas sampling device at an accessible height and an air release cock for Buchholz relay.

19.19 The following valves shall be provided:

a) One (1) top filter valve with blanking plate.

b) One (1) bottom filter valve with blanking plate.

19.20 A device for measuring the hot spot temperature of the winding shall be provided when called for in the Data Sheet-A. The Winding temperature indicator, consisting of the following shall be provided:

a) Temperature sensing element

b) Image coil

c) Current transformer

d) 150mm dia. Local indicating instrument with settable electrically independent contact brought out to separate terminals for winding temperature "**HIGH**" and "**TOO HIGH**" alarms. Contacts shall be suitable for 220V DC, rated minimum 0.5 A.

e) A pointer to register the highest temperature reached and capable of being reset without tools.

f) Calibration device.

g) Automatic ambient temperature compensation.

h) In addition to the above, the following remote indication equipment shall be provided when called for in Data Sheet A:

i) Top oil resistor temperature detector in each winding of the transformer to be connected to the PURCHASER's multipoint temperature recorder for HV and LV winding temperature indication.

ii) Remote winding temperature indicator, flush mounted instrument for mounting on the PURCHASER's panel.

19.21 Transformers up to 500kVA shall be provided with explosion vent.

20.0 TESTS:

20.1 Routine Tests

20.1.1 All routine tests as per applicable standard shall be carried out on each transformer without any extra charges.

20.1.2 The routine tests shall also include the following:-

a) Oil leakage test: The main transformer tank and all oil filled compartments necessary for a complete transformer including coolers shall be filled with transformer oil and subjected to a pressure of 0.35kg/ sq cm above the pressure that would attain under normal conditions with full head of oil. The pressure shall be maintained for 12 hours during which time no oil leakage shall occur. When heat run test is specified, the oil pressure test shall be performed immediately after heat run. Otherwise, the test may be performed at ambient temperature.

b) Magnetic balance test for 3 phase units.

c) Measurement of tanδ and capacitance of each winding to earth (with all other windings connected to earth) and between all windings, connected together, to earth.

20.2 **Type Tests**

a) The type tests shall include all tests as per applicable standards. Type test reports not older than 5 years from the date of bidding will be considered for acceptance.

b) The dielectric tests shall include lightning impulse chopped on the tail.

c) The type test shall include vacuum withstand test on tank and radiators.

20.3 **Special Tests**

The bidder shall quote extra unit price for carrying out the following tests:-

a) Measurement of zero-sequence impedance of three phase transformer.

b) Short circuit test.(Type certificate acceptable)

c) Temperature rise test

d) Measurement of harmonics of the no load current.

e) Measurement of acoustic noise level.

f) Dielectric Test with Lightning impulse chopped on the tail.

20.4 All auxiliary equipment shall be tested as per the relevant standards. Test certificates shall be submitted for bought out items. High voltage withstand test shall be performed on auxiliary equipment and wiring after complete assembly.

20.5 **Test reports**

20.5.1 Test results shall be corrected to a reference temperature of 75^{o}C.

20.5.2 Two copies of test results shall be submitted for PURCHASER's approval before despatch of transformer.

21.0 LOSSES

21.1 Bids will be evaluated based on the formula furnished in Data Sheet - A.

21.2 For the purpose of evaluation of Bids, the quoted load losses and iron losses shall be increased to take into consideration tolerance as permitted by applicable standards.

21.3 Should the losses as measured on the transformer after manufacture be found in excess of the quoted values of the guaranteed losses with plus tolerance, the VENDOR shall pay to the PURCHASER, penalty charges based on the charges indicated in Data Sheet-A.

22.0 REJECTION

The PURCHASER may reject any transformer if during tests or service any of the following conditions arise:

22.1 No load loss exceeds the guaranteed value by 20% or more.

22.2 Load loss exceeds the guaranteed value by 20% or more.

22.3 Impedance value exceeds the guaranteed value by ± 10% or more.

22.4 The difference in impedance values of any two phases during single phase short circuit impedance test exceeds 2% of the average value guaranteed by the VENDOR.

22.5 Oil or winding temperature rise exceeds the specified value by 5^{o} C.

22.6 Transformer fails on impulse test voltage withstand test.

22.7 Transformer fails on power frequency voltage withstand test.

22.8 Transformer is proved to have been manufactured not in accordance with the agreed specification.

22.9 The PURCHASER reserves the right to retain the rejected transformer and take it into service until the VENDOR replaces, at no extra cost to the PURCHASER, the defective transformer by a new transformer.

22.10 Alternatively, the VENDOR shall repair or replace the transformer within a reasonable period to the PURCHASER's satisfaction at no extra cost to the PURCHASER.

23.0 DOCUMENTATION

On award of contract, the following drawings and data shall be furnished in four sets for approval before start of manufacture:

a) General arrangement (GA) drawings of transformer with plan and elevation and Bills of Material.

b) Transformer foundation layout drawing.

c) Shipping drawing showing dimensions and weights.

d) GA drawings of HV and LV bushings and termination details.

e) Rating plate diagram.

f) Valve schedule.

g) Control schematic and wiring diagram for transformer marshalling box/ cooler control cabinet.

h) Control schematic and wiring diagram for OLTC.

i) Erection drawing.

j) Quality plan for design, manufacture and testing.

k) O & M manual.

24.0 SPARES:

24.1 The BIDDER shall quote itemised prices for the following essential spares required for 3 years trouble free operation.

24.1.1 Complete set of gaskets.

24.1.2 One bushing of each type.

24.1.3 Dial type thermometer

24.1.4 Oil level gauge

24.1.5 Complete set of winding temperature-indicating equipment

24.1.6 Pressure relief value

24.1.7 Silica-gel breather

24.1.8 One valve of each type

24.1.9 Buchholz relay or fault pressure relay

24.1.10 One CT of each type

24.1.11 OLTC motor

24.1.12 Bushing of each type/ rating.

24.2 Bidder shall also quote unit prices for any other spares that he recommends to be kept in stock for 3 years trouble free operation.

24.3 Prices quoted for 'Essential spares' will be considered for bid evaluation whereas the prices quoted for 'Recommended spares' will not be considered for bid evaluation.

24.4 Ordered essential spares shall be delivered along with the main equipments. When erection, testing and commissioning of transformers is included in vendor's scope any requirement of commissioning spares may be met by drawing from essential spares and be replaced free of cost at the earliest.

25.0 INCLUSIONS

The following items shall be deemed to be included in the VENDOR's basic scope of supply:

25.1 Interconnecting cables with supporting and terminating accessories for connections between the transformer main marshalling kiosk and all electrical measuring, monitoring and protective devices mounted on the transformer. For this purpose, either PVC insulated wires in GI conduits or PVC insulated, armoured cables shall be used.

25.2 Necessary compression type, brass cable glands shall be provided at the marshalling box (kiosk) for the cables mentioned in clause 25.1 as well as for terminating the incoming power cables from remote panels.

6.4.2 Oil Filled Power Transformer-Datasheets

DATA SHEET-A1					
SL.NO		**DESCRIPTION**		**UNIT**	**DATA**
1.0 GENERAL	1.1	Application/ designation			Power Transformer
	1.2	Quantity required		Nos.	1
	1.3	Installation		Indoor/ Outdoor	Outdoor
	1.4	Degree of protection as per IS 2147			IP 55
2.0 RATINGS	2.1	Rating		**kVA**	**12500**
	2.2	Number of phases & frequency			Three phase,50Hz
	2.3	Number of windings			Two (2)
	2.4	Type of cooling			ONAN
	2.5	No load voltage	HV	**kV**	**66**
			LV	**kV**	**11.6**
			TV	kV	NA
	2.6	Winding Connection	HV		Delta
			LV		Star
			TV		NA
	2.7	Vector group			**Dyn11**
	2.8	Percentage impedance (HV to LV)		**%**	**8.05**
	2.9	Direction of Power Flow		HV to LV/ LV to HV/ Bi directional	HV to LV
	2.10	Winding Insulation Category	HV	Uniformly/ Non uniformly Insulated	Uniformly
			LV ~~& TV~~		Uniformly
3.0 SYSTEM VOLTAGE	3.1	Nominal system voltage	HV	kV	66
			LV	kV	11
			TV	kV	NA
	3.2	Highest system voltage	HV	kV	72.5
			LV	kV	12
			TV	kV	NA
	3.3	System fault level	HV/ LV	kA	31.5/16
4.0 N	4.1	System neutral			

DATA SHEET-A1					
SL.NO		**DESCRIPTION**		**UNIT**	**DATA**
		HV			Effectively Earthed
		LV			Effectively Earthed
	4.2	Transformer neutral			
		HV			NA
		LV			Effectively Earthed
5.0 INSULATION WITHSTAND	5.1	Impulse (1.2/50 μ sec wave)	HV	kV_p	325
			LV ~~& TV~~	kV_p	75
	5.2	Power frequency withstand voltage **DRY**	HV	kV	140
			LV ~~& TV~~	kV	28
		Power frequency withstand voltage **WET**	HV	kV	140
			LV ~~& TV~~	kV	28
	5.3	Transformer Neutral power frequency withstand voltage	HV	kV	NA
			LV	kV	28
6.0 TEMPERATURE RISE	6.1	Reference ambient temperature		°C	45
	6.2	Oil by thermometer over the ambient		K	45
	6.3	Winding by resistance over the ambient		K	50
7.0 TAP CHANGING	7.1	Taps required: On load / off circuit			On Load
	7.2	Tapping on windings			HV
	7.3	Total tapping range		%	+5 to -15
	7.4	Tapping Steps		%	1.25
	7.5	Control	Manual / automatic		Both
			Local / remote		Both
	7.6	Control cubicle by			Vendor
	7.7	Voltage class of OLTC		kV	72.5
	7.8	Current rating of OLTC		A	100
	7.9	Type of OLTC installation In tank/ Separately mounted			By Bidder
8.0 DETAILS OF TRAFO. FOR PARALLELOPERATION	8.1	Manufacturer's name			NA
	8.2	Rating		kVA	
	8.3	Exact turns ratio			
	8.4	Tapping range			
	8.5	Full load loss corrected to 75°C		kW	
	8.6	% impedance at principal tapping			
	8.7	Vector group			
9.0 BUSHINGS	9.1	Voltage class	HV Line end	kV	72.5
			LV Line end	kV	12
			TV Line end	kV	NA
			HV neutral	kV	NA
			LV neutral	kV	12
	9.2	Impulse wave	HV	kV_p	325

DATA SHEET-A1					
SL.NO		**DESCRIPTION**		**UNIT**	**DATA**
		withstand (1.2/50 μ sec wave)	LV ~~& TV~~	kV_p	75
	9.3	Power frequency withstand for 1 Min.	HV Line end	kV	140
			LV Line end	kV	28
			HV neutral	kV	NA
			LV neutral	kV	28
	9.4	Minimum clearance	HV ph to ph	mm	700
			LV ph to ph	mm	280
			HV ph to earth	mm	660
			LV ph to earth	mm	140
	9.5	Minimum creepage distance (total protected)	HV Line end	mm	1812.5
			LV Line end	mm	300
			HV neutral	mm	NA
			LV neutral	mm	300
	9.6	Bushing CT details	HV phase Bushings	Nos	NA
				Parameters	NA
			HV Neutral bushing.	Nos	NA
				Parameters	NA
			LV Phase Bushings	Nos	1 (at each bushing)
				Parameters	750-500/1A, Cl. PS (Vk, Rct and Im shall be decided during detail engg.)
			LV Neutral bushing	Nos	2
				Parameters	**NCT-1** 750-500/1A, Cl. 5P20, 15VA **NCT-2** 750-500/1A, Cl. PS, (Vk, Rct and Im shall be decided during detail engg.)
10.0 TERMINAL CONNECTIONS	10.1	HV line end bushing/ cable box/ Cable box with disconnecting chamber.			Bushing
	10.2	LV line end bushing/ cable box/ cable box with disconnecting chamber/ Bus duct.			Cable box with disconnecting chamber
	10.3	HV neutral bushing/ Cable box/ Cable box with disconnecting chamber			NA
	10.4	LV neutral bushing/ Cable box/ Cable box with disconnecting chamber/ Bus duct.			Bushing (Cu, 50x8)
	10.5	Bushing terminals	Required	Yes/No	Yes
			Size of take off conductor	HV	2" IPS Al Tube
				LV	NA

DATA SHEET-A1					
SL.NO		**DESCRIPTION**		**UNIT**	**DATA**
	10.6	Cable box, lugs and glands	Required	Yes/No	Yes
			Size of cable	HV	NA
				LV	3R x 3C x 240 Sq.mm., 11kV (E) grade, Al, XLPE, Armoured power cable
11.0 EARTHING TERMINAL	11.1	Material of conductor	Body		GS strip
			Neutral		Copper
	11.2	Size of conductor	Body	mm	50 x 10
			Neutral	mm	50 x 8
12.0 MISCELLANEOUS	12.1	Wheels	Plain/ flanged		Plain
			Unidirectional/ bi-directional		Bi-Directional
	12.2	Vacuum withstand capability of Main tank with bushings, radiators, fittings & accessories			760mm of Hg
	12.3	Transformer to be transported	Filled with oil	Yes/No	Yes
			Without oil with inert gas, Gas Cylinder and accessories, pressure gauge	Yes/No	NA
13.0 OPTIONAL FITTINGS REQUIRED	13.1	Magnetic oil level gauge with low oil level alarm contacts as per clause 19.10		Yes/No	Yes
	13.2	Pressure relief device as per clause 19.15		Yes/No	Yes
	13.3	Dial type thermometer with two contacts for oil temp. as per clause 19.16		Yes/No	Yes
	13.4	Gas and oil actuated i.e., Bucholz relay as per clause 19.17		Yes/No	Yes
	13.5	Winding temperature indicator with two contacts with two contacts as per clause 19.20		Yes/No	Yes
	13.6	On load tap changer as per specification section 6.4.3		Yes/No	Yes
	13.7	Oil surge relay with alarm and trip contacts for OLTC		Yes/No	Yes
	13.8	Valves as per clause 9.0		Yes/No	Yes
	13.9	Four plain rollers in place of fixing channels		Yes/No	Yes
14.0 EVALUATION & PENALTY	14.1	Formula for evaluation of bids (W_i = No Load loss, W_c = Load loss & W_p = Auxiliary Loss)			Refer Section-6.3.1 (Specific technical req.)
	14.2	Rates of penalty for exceeding the guaranteed losses per kW		W_i W_c W_p	Refer Section-6.3.1 (Specific technical req.)
15.0 ESS	15.1	Complete set of gaskets		Set	1
	15.2	Bushing of each type		Nos	1

DATA SHEET-A1				
SL.NO		**DESCRIPTION**	**UNIT**	**DATA**
	15.3	Dial type thermometer	Nos	1
	15.4	Complete WTI equipment	Nos	1
	15.5	Pressure relief valve/ Explosion vent diaphragras	Nos	1
	15.6	Silica gel breather	Nos	1
	15.7	Buchholz relay	Nos	1
	15.8	One valve of each type	Nos	1
	15.9	Cooler fan & Fan motor of each type		NA
	15.10	Oil pump & Pump motor of each type		NA
	15.11	OLTC motor	Nos	1 No
	15.12	Oil Level gauge	Nos	1 No
	15.13	Bushing CT of each type		1 No
	15.14	Miscellaneous spare (contactors, control switches, MCBs, indication lamps etc)	10% of quantity used	
16.0 NOTES	16.1	Remote winding Temperature monitoring. a) The remote winding temperature indicator as per clause 19.20 of the specification shall be mounted on the remote tap changer control panel (RTCC) b) The temperature detector shall also provide continuous winding temperature monitoring in the SCADA.		
	16.2	On Line DGA a) Transformer shall be provided with one on-line dissolved gas analyser (DGA) for continuous monitoring of dissolved gases and moisture. All fittings and fixtures required to connect the DGA shall be provided b) The DGA shall be provided with local and remote display of upto date data. c) The DGA shall also be provided with programmable alarm system.		

DATA SHEET-A1				
SL.NO		**DESCRIPTION**	**UNIT**	**DATA**
	16.3	Nitrogen Injected Fire Protection (NIFP) system. All fittings and fixtures required to connect the nitrogen injected fire protection system shall be provided. These shall include the following as per NIFP system requirements:- a) Oil drainage valve near the top of the tank b) Nitrogen injection openings c) Arrangement for fixing fire detectors d) Arrangement for fixing conservator isolation valve to be fitted in the conservator pipe line between conservator and buchholz relay. e) Arrangement for fixing the signal box.		
	16.4	The remote Tap changer control panel (RTCC) shall be provided in accordance with clause 3.11 of specification section 6.4.3. In addition the following shall be provided in a) Digital voltmeter with phase selection facility for indication of transformer LV side (11kV) voltage.		

Note : Present 12.5MVA transformer impedance is 7.79%. The proposed transformer shall be compatible with existing transformer for parallel operation.

DATA SHEET A2 APPLICABLE STANDARDS			
SL.NO.	**ITEM**	**STANDARD**	
1.0	Power transformer	IS 2026	IEC 60076
2.0	Fitting & Accessories for Power transformers	IS 3639	IEC
3.0	Guide for Loading of oil immersed transformers	IS 6600	IEC 60354
4.0	Insulating Oil	IS 335	IEC 60296
5.0	Bushings	IS 2099	IEC 60137
6.0	Degree of protection	IS 2147	IEC 60144
7.0	Buchholz relay	IS 3637	IEC
8.0	On load tap changer	IS 8468	IEC 60214
9.0	Application Guide for OLTC	IS 8478	IEC 60542
10.0	Code of Practices for selection, Installation and maintenance of Transformer	IS 10028	IEC

DATA SHEET B (To be filled in by the BIDDER and enclosed with the bid)					
SL. NO.		**DESCRIPTION**		**UNIT**	**BIDDER'S DATA**
1.0 GENERAL	1.1	Make			
	1.2	Quantity required		Nos.	
	1.3	Installation		Indoor/Outdoor	
	1.4	Degree of protection as per IS 2147			
2.0 RATINGS	2.1	Rating		kVA	
	2.2	Number of phases & frequency			
	2.3	Number of windings			
	2.4	Type of cooling			
	2.5	No load voltage	HV	kV	
			LV / TV	kV / kV	
	2.6	Winding Connection	HV		
			LV / TV		
	2.7	Vector group			
	2.8	Percentage impedance		%	
	2.9	Direction of Power Flow		HV to LV	
				LV to HV	
				Bi directional	
	2.1	Winding Insulation Category	HV	Uniformly/ non uniformly Insulated	
			LV / TV		
	2.11	Winding Conductor Material			
	2.12	Highest System Voltage for which transformer windings are suitable	HV	kV	
			LV / TV	kV / kV	
	2.13	Transformer Neutral Earthing	HV		
			LV		
3.0 INSULATION WITHSTAND	3.1	Impulse (1.2/50 µ-sec wave)	HV	kV_p	
			LV / TV	kV_p / kV_p	
	3.2	Power frequency withstand voltage **DRY**	HV	kV	
			LV / TV	kV / kV	
		Power frequency withstand voltage **WET**	HV	kV / kV	
			LV	kV	
		Transformer Neutral-power frequency withstand voltage	HV	kV	
			LV	kV	
4.0 TEMPERATU	4.1	Reference ambient temperature		^oC	

DATA SHEET B (To be filled in by the BIDDER and enclosed with the bid)					
SL. NO.		**DESCRIPTION**		**UNIT**	**BIDDER'S DATA**
	4.2	Oil by thermometer over the ambient		^{O}C	
	4.3	Winding by resistance over the ambient		^{O}C	
5.0 TAP CHANGING	5.1	Taps provided On load / off load			
	5.2	Tapping on windings			
	5.3	Total tapping range		%	
	5.4	Tapping Steps		%	
	5.5	Control	Manual / automatic		
			Local / remote		
	5.6	Control cubicle by			
	5.7	Voltage class of OLTC		kV	
	5.8	Current rating of OLTC		A	
	5.9	Type of OLTC installation			
		In tank/ Separately mounted			
6.0 DETAILS OF TRANSFORMER FOR PARALLEL OPERATION	6.1	Manufacturer's Name			
	6.2	Rating		kVA	
	6.3	Exact turns ratio			
	6.4	Tapping range			
	6.5	full load loss corrected to $75^{o}C$		kW	
	6.6	% impedance at principle tapping			
	6.7	Vector Group			
7.0 BUSHINGS	7.1	Voltage Class	HV Line end	kV	
			LV Line end / TV	kV / kV	
			HV Neutral	kV	
			LV Neutral	kV	
	7.2	Impulse wave withstand (1.2/50 μ Sec wave)	HV	kVp	
			LV / TV	kVp	
	7.3	Power frequency withstand for 1 min	HV Line end	kV	
			LV & TV Line end	kV	
			HV Neutral	kV	
			LV Neutral	kV	
	7.4	Minimum clearance	HV Ph to Ph	mm	
			LV & TV Ph to Ph	mm	
			HV Ph to earth	mm	

DATA SHEET B (To be filled in by the BIDDER and enclosed with the bid)						
SL. NO.		**DESCRIPTION**			**UNIT**	**BIDDER'S DATA**
				LV & TV Ph to earth	mm	
	7.5	Minimum creepage distance (total protected)		HV Line end	mm	
				LV & TV Line end	mm	
				HV neutral	mm	
				LV neutral	mm	
	7.6	Bushing CT details		LV Phase Bushings	Nos.	
					Parameters	
				LV Neutral bushing		
8.0 TERMINAL CONNECTIONS	8.1	HV line end bushing/ cable box/ Cable box with disconnecting chamber.				
	8.2	LV line end bushing/ cable box/ cable box with disconnecting chamber/ Bus duct.				
	8.3	HV neutral bushing/ Cable box/ Cable box with disconnecting chamber				
	8.4	LV neutral bushing/ Cable box/ Cable box with disconnecting chamber/ Bus duct.				
	8.5	Bushing terminals	Required		Yes/No	
			Size of take off conductor		HV	
					LV	
	8.6	Cable box, lugs and glands	Required		Yes/No	
			Size of cable		HV	
					LV	
9.0 EARTHING TERMINAL	9.1	Material of conductor				
	9.2	Size of conductor			mm	
10.0 MISCELLANEOUS	10.1	Wheels		Plain / flanged		
				Unidirectional / bi-directional		
	10.2	Vacuum withstand capability of Main tank with bushings, radiators, fittings & accessories				
	10.3	Transformer to be transported	Filled with oil		Yes/No	
			Without oil with inertgas, Gas Cylinder and accessories, pressure gauge		Yes/No	
11.0 FITTINGS PROVIDED	11.1	Magnetic oil level gauge with low oil level alarm contacts as per clause 19.10			Yes/No	
	11.2	Pressure relief device as per clause 19.15			Yes/No	
	11.3	Dial type thermometer with two contacts for oil temp. as per clause 19.16			Yes/No	

DATA SHEET B (To be filled in by the BIDDER and enclosed with the bid)				
SL. NO.		**DESCRIPTION**	**UNIT**	**BIDDER'S DATA**
	11.4	Gas and oil actuated i.e., Bucholz relay as per clause 19.17	Yes/No	
	11.5	Winding temperature indicator with two contacts with two contacts as per clause 19.20	Yes/No	
	11.6	On load tap changer as per section 6.4.3	Yes/No	
	11.7	Valves as per clause 9.0	Yes/No	
	11.8	Four plain rollers in place of fixing channels	Yes/No	
	11.9	Online dissolved gas analyser with all fillings as per specification	Yes/No	
	11.10	All fittings and fixtures for nitrogen injected fire protection system as per specification.	Yes/No	
12.0 GUARANTEED LOSSES	12.1	No load looses (core loss and dielectric loss) at 100% voltage and frequency	kW	
	12.2	Load loss at rated current as 75°C winding temperature	kW	
	12.3	Auxiliary load losses at rated output	kW	
13.0 GUARANTEED PERFORMANCE DATA	13.1	Regulation at full load, 0.85 pf at 75°C winding temperature		
	13.2	External short circuit withstand capacity	KA	
			Sec	
			%	
	13.3	Magnetising current as rated voltage and frequency in percent of full load current		
	13.4	No Load current	A	
	A	At 100% of rated voltage	A	
	B	At 110% of rated voltage		
	13.5	Efficiency at 75°C	%	
	A	Full load, unity power factor	%	
	B	Full load, 0.85pf		
	13.6	Maximum flux density	Wb/m^2	
	A	At rated voltage	Wb/m^2	
	B	At 110% rated voltage		
	13.7	Over fluxing capability	Yes/No	
14.0		OLTC Control scheme conforms to specification	Yes/No	
15.0		Remote OLTC control panel conforms to specification	Yes/No	
16.0		Transformer marshalling Box and cooler control cabinet conforms to specification	Furnish list	
17.0 TESTS	17.1	List of Routine Test to be carried out	Furnish list	
	17.2	List of type carried out / to be performed	Furnish list	

DATA SHEET B (To be filled in by the BIDDER and enclosed with the bid)					
SL. NO.		**DESCRIPTION**		**UNIT**	**BIDDER'S DATA**
	17.3	List of other tests to be carried out against extra price, quoted else where		Furnish list	
18.0		Total weight	Without oil	Kg	
19.0		Over all oil Dimension (L x W x H)		mm	
20.0		Total Quantity of Oil			
21.0		General arrangement drawing of the transformer attached with the bid		Yes/No DRG No	
22.0 ESSENTIAL SPARES	22.1	Complete set of gaskets		No	
	22.2	Bushing of each type		No	
	22.3	Dial type thermometer		No	
	22.4	Complete WTI equipment		No	
	22.5	Pressure relief valve/ Explosion vend diaphragras		No	
	22.6	Silica gel breather		No	
	22.7	Buchholz relay		No	
	22.8	One valve of each type		No	
	22.9	Cooler fan & Fan motor of each type		No	
	22.10	Oil pump & Pump motor of each type		No	
	22.11	OLTC motor		No	
	22.12	Oil Level gauge		No	
	22.13	Bushing CT of each type		No	
	22.14	Miscellaneous spare (contractors control switches, MCBs, indication lamps in cooler control Cabinet)			

6.4.3 On Load Tap Changer (OLTC)

1.0 SCOPE OF WORK

This Specification covers on load tap changing gear (OLTC) with remote control equipment for power transformers.

2.0 CODES & STANDARDS

2.1 The design, manufacture and performance of equipment shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment will be installed. Nothing in this Specification shall be construed to relieve the VENDOR of this responsibility.

2.2 Unless otherwise specified, equipment shall conform to the latest applicable Indian, IEC standards. Equipment complying with any other authoritative standards such as British, American, VDE, etc., will also be considered, if offered.

3.0 REQUIREMENTS

3.1 The OLTC gear shall be designed to complete successfully tap changes for the maximum current to which transformer can be loaded i.e. 150% of the rated current. Devices shall be incorporated to prevent tap change when the through current is in excess of the safe current that the tap changer can handle. The OLTC gear shall withstand through fault current without injury.

3.2 When a tap change has been commenced, it shall be completed independently of the operation of the control relays and switches. Necessary safeguard shall be provided to allow for failure of auxiliary power supply or any other contingency, which may result in the tap changer movement not being completed once it is commenced.

3.3 Oil in compartments, which contain the making and breaking contacts of the OLTC, shall not mix with oil in other compartments of the OLTC or with transformer oil. Gases released from these compartments shall be conveyed by a pipe to a separate oil conservator or to segregated compartment within the main transformer conservator. A Buchholz relay shall be installed in the above pipe. The conservator shall be provided with a prismatic oil level gauge.

3.4 Oil, in compartments of OLTC, which do no contain the make and break contacts, shall be maintained under conservator head by sloped pipe connections. All gas leaving these compartments shall pass through the Buchholz relay before entering the conservator.

3.5 Oil filled compartments shall be provided with filling plug, drain valve with plug, air release vent, oil sampling device, inspection opening with gasketed and bolted cover with lifting handles.

3.6 OLTC driving mechanism and its associated control equipment shall be mounted in an outdoor, weather-proof cabinet, which shall include:

a) Driving motor (415V, 3-Phase, 50 Hz, AC squirrel cage)

b) Motor starting contactor with thermal overload relays, MPCB of suitable rating.

c) Duplicate sources of power supply with automatic changeover from the running source to the standby source and vice versa

d) Control switch: Raise/off/lower (spring return to normal type).

e) Remote/local selector switch (maintained contact type).

f) Mechanical tap position indicator showing rated tap voltage against each position and re-settable maximum and minimum indicators.

g) Limit switches to prevent motor over-travel in both direction and final mechanical stops.

h) Brake or clutch to permit only one tap change at a time on manual operation.

i) Emergency manual operating devices (hand crank or hand wheel).

j) A five digit operation counter.

k) Electrically interlocked reversing contactors (preferably also mechanically interlocked).

l) 240V. 50Hz, AC space heaters with RCBO Protection.

m) Interior lighting fixture with lamp door switch and RCBO Protection.

n) Gasketed and hinged door with locking arrangements.

o) Terminal blocks, internal wiring, earthing terminals and cable glands for power and control cables.

p) Necessary relays, contractors, current transformers etc.

3.7 Control Requirements for OLTC

The following electrical control features shall be provided:

a) Positive completion of load current transfer, once a tap change has been initiated, without stopping on any intermediate position, even in case of failure of external power supply.

b) Only one tap change from each tap change impulse even if the control switches or push button is maintained in the operated position.

c) Cut-off of electrical control when manual control is resorted to.

d) Cut-off of a counter impulse for a reverse tap change until the mechanism comes to rest and resets the circuits for a fresh operation.

e) Cut-off of electrical control when it tends to operate the tap beyond its extreme position.

3.8 Automatic Control of OLTC

If automatic OLTC control is specified the following items shall be included:

a) Voltage setting device

b) Voltage sensing and voltage regulating devices.

c) Line drop compensator with adjustable R and X elements.

d) Timer 5-25 seconds for delaying the operation of the tap changer in the first step for every tap change operation.

e) Adjustable dead band for voltage variation.

3.9 Parallel Operation with other OLTC

When parallel operation is specified, the following shall be included:

a) CT's of relaying class if paralleling by circulating current method.

b) Line drop compensator with adjustable X, suitable for reversing, if paralleling by reserve reactance method.

3.10 Alarms

The following alarms shall be provided:

a) A.C supply failure

b) Drive motor auto tripped

c) Other protective purpose considered essential by the VENDOR.

d) Out of step operation on the same tap are operating at different taps.

e) Tap change delayed

3.11 Remote Control Equipment

The OLTC remote control equipment shall be housed in an indoor sheet cubicle to be located in a remote control room. It shall generally be in line with the following:

a) Control switch: Raise/off/lower (spring return to normal type)

b) If automatic operation is specified, auto/ manual selector switch (maintained contact type)

c) If parallel operation specified, master/ follower selector switch (maintained contact type).

d) Tap position indicator.

e) Facia type alarm annunciator with "Accept" and "Lamp test" facilities for the conditions.

f) Digital AVR for automatic tap control.

g) Necessary auxiliary relays.

h) Lamp indications for – Tap change in progress, Lower limit reached and Upper limit reached.

i) Cable glands for power and control cables

j) 240 V rated panel space heater with ON-OFF switch and 30mA RCBO Protection.

k) Fluorescent type interior lighting fixture with lamp and door switch.

l) MCB's as required for the control and power circuits (in place of HRC Fuses).

m) Terminal blocks.

n) Internal wiring.

o) Earthing terminal.

6.4.4 NIFPS for Transformer

1.0 SCOPE:

1.1 This specification covers the design, material, construction features, manufacture, inspection and testing at the VENDOR'S/his SUB-VENDOR'S Works, delivery to Site of Nitrogen Injected Fire Protection System (NIFPS) for fire prevention and fire extinction of oil filled transformers.

2.0 CODES AND STANDARDS:

2.1 The design, material, construction features, manufacture, inspection, testing and performance of NIFPS shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment will be installed. The equipment shall also conform to the latest applicable standards. Nothing in this specification shall be construed to relieve the VENDOR of this responsibility.

2.2 The requirements of the following standards shall be generally applicable:-

2.2.1 IS 1646: Code of practice for fire safety of electrical installation.

2.2.2 IS 3034: Fire Safety of Industrial Buildings.

2.2.3 CBIP Manual no 295 on Transformers.

3.0 GENERAL DESCRIPTION:

3.1 The Nitrogen Injected Fire Protection System shall be provided for each oil filled transformers. The parameters of the transformers are specified in enclosed Data Sheet A.

3.2 Nitrogen Injection Fire Protection System shall prevent tank explosion and the fire during internal faults resulting in an arc and also extinguish the external fires on transformer top cover due to tank explosion and / or external failures like bushing fires, OLTC fires and fire from surrounding equipment. The system shall be fully automatic and shall require minimum maintenance.

3.3 The system shall work on the principle of Drain and stir and on activation, shall drain a pre-determined quantity of oil from the tank top through outlet valve to reduce the tank pressure and inject nitrogen gas under pressure from the lower side of the tank creating stirring action and reduce the temperature of top oil surface below flash point to extinguish the fire.

3.4 Conservator tank oil shall be isolated during the operation to prevent flow of oil into the tank.

4.0 SYSTEM OPERATION

4.1 The NIFPS system shall be provided with automatic control. The system shall also be provided with electrical control from remote panel and also local manual control.

4.2 The general guide lines for system operation are given below. The bidder shall furnish full details of the system offered in the bid.

4.3 Prevention of Fire

4.3.1 The System shall be activated by the operation of the following devices:

a) Operation of any of the transformer protection relays and

b) Operation of the pressure relief valve (PRV) on the transformer.

4.3.2 The activation of the system shall perform the following functions:

a) Open the depressurisation valve in the control cabinet which is connected to the transformers top outlet valve and drain a predetermined quantity of oil from the tank top to reduce the tank pressure.

b) Close the conservator shutter valve which is fitted in the conservator pipe line between the conservator and Buchholz relay. Closure of this valve shall block the oil flow from the conservator to the tank.

c) Tip the HV side and LV side circuit breaker of the transformer, if these are not already tripped by the protection relays.

4.3.3 On receipt of signals that the HV and LV side circuit breakers have been opened and other conditions have been fulfilled, the system shall inject nitrogen under pressure with prefixed rate at the bottom of the transformer tank to create a stirring action there by bringing the temperature of the top oil surface below ignition point.

4.4 Extinguishing of Fire

4.4.1 Linear heat detectors or other suitable type of fire detectors shall be provided by the vendor and fitted on the transformer tank.

4.4.2 The system shall be activated by the operation of any protection relay of the transformer and operation of the fire detectors.

4.4.3 On activation, the system shall operate in the same manner as described in para 4.1

4.4.4 The Nitrogen shall be injected continuously for sufficient time to cool the oil to ambient temperature.

4.5 In case of fire, even if the HV and/or LV circuit breakers have not tripped, the system shall inject nitrogen when the transformer is live and shall give alarm signal to the operator to manually isolate the circuit breakers.

5.0 DETAILS OF SYSTEM EQUIPMENT TO BE SUPPLIED

5.1 The following equipment shall be supplied for each transformer. The vendor shall supply all equipment and devices as required for the system.

5.2 Local Control Cabinet

The Control cabinet shall be cold rolled, sheet steel enclosed, 2.5mm thick, outdoor type with degree of protection IP 55. The control cabinet shall generally include the following:

5.2.1 Nitrogen Cylinder – The capacity and N2 pressure shall be as required for the transformer specified in data sheet A

5.2.2 Quick depressurisation valve with 4 NO + 4 NC contacts.

5.2.3 Nitrogen release device with 4 NO + 4 NC contacts.

5.2.4 Manometer with low pressure signal contacts.

5.2.5 Non return valve and other valves as required.

5.2.6 Signal contacts as required.

5.2.7 Oil drain assembly and oil drain pipe for connection to oil pit.

5.2.8 Push button for manual activation.

5.2.9 Inspection manhole.

5.2.10 Heater with humidistat control.

5.2.11 Terminal box for electrical connection.

5.2.12 All other devices to complete the system.

5.3 Remote control Panel

The remote control panel shall be located in the control room and shall generally include the following:

5.3.1 Selector switches for:

a) Local / Remote

b) Automatic/Manual

5.3.2 Push buttons for:

a) Manual activiation

b) LED test

5.3.3 Indicating Lamps (LED) for :

a) HV circuit breaker ON/OFF

b) LV circuit breaker ON/OFF

c) Conservator shutter valve CLOSE/OPEN

d) Nitrogen Gas injection valve CLOSE/OPEN

e) Depressurisation valve CLOSE/OPEN

f) System on Auto mode

g) System on Manual Mode

h) Other indicating lamps as considered necessary by the vendor

5.3.4 Facia annunciation with accept, test and reset push buttons for:

a) System activated

b) Nitrogen low level/low pressure

c) Shutter line fault

d) Heat detector line fault

e) Heat detectors ON

f) Transformer protection activated

g) PRV activated

h) Other signals as considered necessary by vendor.

5.3.5 Auxiliary relays, time delay relays as required for control, interlock, indication and alarm.

5.3.6 All other devices as required for the system.

5.4 SCADA connections

5.4.1 System shall be suitable for activation from SCADA.

5.4.2 Potential free contacts shall be provided for input into SCADA for

a) All the lamp indications mentioned in para 5.3

b) All the alarm signals mentioned in para 5.3

5.5 Transformer conservator isolation valve with 4 NO + 4 NC contacts to be connected between conservator and Buchholz relay with isolating valves.

5.6 Fire detectors – Required type and number of fire detectors rated for heat sensing at temperature recommended by the vendor.

5.7 Pipe connections of required type, size and length for connections between transformer and local control box for :-

5.7.1 Top oil drainage

5.7.2 Nitrogen Injection

5.8 Cables

5.8.1 All cables required for connections between the transformer and local control cabinet shall be included in vendor's scope.

5.8.2 The cable shall be ERLS PVC insulated, 1100 V grade armoured with stranded copper conductor of 2.5 Sq mm.

5.8.3 Shielded cables shall be supplied, if required.

5.9 Auxiliary Supply

5.9.1 DC supply shall be used for control, indication and alarm circuits. The voltage of the DC supply shall be as indicated in data sheet A.

5.9.2 240 V, single phase AC supply shall be used for space heaters, panel lights etc.,

6.0 TESTS AND TEST REPORTS

6.1 All type tests and routine tests shall be carried out as per relevant standards. Type tests should have been carried out within the last 5 years from the date of offer.

6.2 All test reports shall be submitted for purchaser's approval.

7.0 DRAWINGS AND DATA TO BE SUBMITTED WITH THE BID

7.1 Technical Data

The bidder shall submit duly signed guaranteed technical particulars as per enclosed Data sheet B.

7.2 Drawings and Data

7.2.1 Technical write up of the system offered.

7.2.2 Schematic drawings of the system.

7.2.3 General arrangement drawings for the local and remote control cabinets.

7.3 Type test reports

7.4 Experience List

7.5 List of recommended spares and special tools.

6.4.5 NIFPS for Transformer-Datasheets

DATA SHEET - A

Sl. No.		Description		Unit	Data
1.0 TRANSFORMER DATA	1.1	Manufacturer			
	1.2	Rating		MVA	12.5
	1.3	Rated Voltage	HV	kV	66
			LV	kV	11.6
			TV	kV	NA
	1.4	Quantity of Oil	Tank	Ltrs	Shall be furnished after receipt of transformer vendor drawings
			Conservator	Ltrs	
			OLTC	Ltrs	
			Total	Ltrs	
	1.5	Type of cooling			ONAN
	1.6	For OF cooling		Nos	Not Applicable
		a) No of Pumps		Nos	
		b) Rating		kW	
	1.7	Main Tank Dimensions			
		a) Length		mm	Shall be furnished after receipt of transformer vendor drawings
		b) Width		mm	
		c) Height		mm	
	1.8	Arrangement of bushings			Shall be furnished after receipt of transformer vendor drawings
	1.9	Provision on transformer for			
		a) Oil drainage valve near the top of the tank			Yes
		b) Nitrogen injection openings			Yes
		c) Brackets for fire detector fixing			To be fixed
		d) Arrangement for fixing conservator isolation valve			Yes
		e) Arrangement for signal box fixing			To be fixed
2.0 CONTROL CABINET	2.1	Applications			Local control cabinet & remote control panel
	2.2	Sheet steel for enclosure, doors, covers	Type		Cold rolled
			Thickness	mm	2.5
	2.3	Degree of enclosure protection	Outdoor		IP55
			Indoor		IP54
	2.4	Colour Finish shade	Interior		Glossy white
			Exterior		631 of IS 5
	2.5	Wiring details			
		a) Material of Conductor			Stranded copper
		b) Size of wires		Sq mm	2.5
		c) Voltage grade		Volts	1100
		d) Type of insulation			FRLS PVC
		e) Type of terminals			Screw type
3.0 CABLES	3.1	Application			Connection between transformers and local control cabinet
	3.2	Material of conductor			Stranded copper
	3.3	Size of wire		Sq mm	2.5

	3.4	Voltage grade	Volts	1100
	3.5	Type of insulation		PVC
	3.6	Type of sheath		FRLS PVC
	3.7	Armouring		Shall be provided as per IS
	3.8	Shielded cable		Shall be supplied as required
4.0 AUXILIARY SUPPLY	4.1	DC Voltage for control, interlock, signalling	Volts DC	110V
	4.2	AC voltage for space heater, panel lights	Volts AC	240V, 1 Ph

DATA SHEET – B (To be filled in by the BIDDER and submitted with the BID)					
Sl. No.		**Description**		**Unit**	**Bidder's Data**
1.0 GENERAL	1.1	Manufacturer's Name			
	1.2	Country of Manufacturer			
	1.3	Applicable standards (Furnish list of standards)			
2.0 LOCAL CONTROL CABINET	2.1	Type			
	2.2	Sheet steel for enclosure, doors, covers	Type		
			Thickness		
	2.3	Degree of enclosure protection	Outdoor		
			Indoor		
	2.4	Colour Finish shade	Interior		
			Exterior		
	2.5	Wiring details			
		a) Material of Conductor			
		b) Size of wires			
		c) Voltage grade			
		d) Type of insulation			
		e) Type of terminals			
	2.6	Capacity of Nitrogen cylinder			
	2.7	Pressure of Nitrogen filling			
	2.8	Minimum distance of cabinet from the transformer			
	2.9	Method of mounting			
	2.10	Dimensions Length x Width x Height		mm	
	2.11	Weight		kg	
	2.12	The following devices are provided in the cabinet			
		a) Manometer		Yes/No	
		b) Pressure regulator		Yes/No	
		c) Oïl drain valve & De-pressurisation unit		Yes/No	
		d) Nitrogen release unit		Yes/No	
		e) Pressure/limit switches as required		Yes/No	
		f) Signal contacts as specified		Yes/No	
3.0 EQUIPMENT DETAILS	3.1	Depressurisation Valve			
		a) Make			
		b) Type			
		c) Size			
		d) Type of Metal			
	3.2	Nitrogen Injection valve			

		a) Make			
		b) Type			
		c) Size/Material			
		d) Quantity provided			
	3.3	Oil drain pipe			
		a) Size			
		b) Length			
		c) Material			
	3.4	Nitrogen Injection Pipe			
		a) Size			
		b) Length			
		c) Material			
	3.5	Conservator Shutter Valve			
		a) Make			
		b) Type			
		c) Location			
		d) Pipe Size			
	3.6	Fire Detectors			
		a) Type			
		b) Make			
		c) Quantity required			
		d) Method of fixing			
		e) Temperature of heat sensing			
	3.7	Signal Box			
		a) Make			
		b) Location			
		c) Enclosure Protection			
		d) Method of mounting			
4.0 REMOTE CONTROL PANEL	4.1	Make			
	4.2	Sheet steel for enclosure, doors, covers	Type		
			Thickness		
	4.3	Degree of enclosure protection	Outdoor		
			Indoor		
	4.4	Colour Finish shade	Interior		
			Exterior		
	4.5	Wiring details			
		a) Material of Conductor			
		b) Size of wires			
		c) Voltage grade			
		d) Type of insulation			
		e) Type of terminals			

4.0 REMOTE CONTROL PANEL	4.6	Whether all switches, push buttons, audio and visual indications and alarms are provided as per spec	Yes/No	
	4.7	Potential free contacts provided for SCADA	Yes/No	
	4.8	DC Control Voltage	Volts DC	
	4.9	Dimensions L X W X H	mm	
	4.10	Weight	kg	
	4.11	Method of Mounting		
5.0 CABLES	5.1	Make		
	5.2	Type		
	5.2	Material of conductor		
	5.3	Size of wire		
	5.4	Voltage grade		
	5.5	Type of insulation		
	5.6	Type of sheets		
	5.7	Armouring		
	5.8	Shielded cable		
6.0 DOCUMENTS ENCLOSED	6.1	Detail write up of the proposed system	Yes/No	
	6.2	General arrangement drawings and Bill of material for a) Local Control Cabinet b) Remote control Panel	 Yes/No Yes/No	
	6.3	Details of all component devices	Yes/No	
	6.4	Type test reports	Yes/No	
	6.5	Experience List	Yes/No	
	6.6	Spare parts list	Yes/No	

6.5.1 - EHV Circuit Breaker

1.0 SCOPE:

1.1. This Specification covers requirements of power circuit breakers rated up to 220 kV.

2.0 CODES & STANDARDS:

2.1. The design, material, construction, manufacture, inspection, testing and performance of outdoor high voltage circuit breakers shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment will be installed. The equipment shall also conform to the latest applicable standards. Nothing in this Specification shall be construed to relieve VENDOR of this responsibility.

2.2. Circuit breakers shall conform to the latest applicable standards specified in Data Sheet-A. In case of conflict between the standards and this Specification, the stringent of the two requirements shall govern.

3.0 FEATURES OF CONSTRUCTION:

3.1. Type of breaker shall be as specified in Section-6.3.1 and Data Sheet-A.

3.2. The circuit breakers shall comprise one three-phase unit or three identical single phase units linked together, either mechanically or electrically. Type of execution, whether single phase or three phases shall be as specified in Data Sheet-A.

3.3. Circuit breakers shall be supplied with a common base and factory installed inter-phase wiring.

3.4. All similar parts, particularly removable ones, shall be interchangeable with one another.

3.5. The circuit breaker shall withstand the seismic acceleration specified in Data Sheet - A. If the construction of the breaker is of wheel mounted type, suitable locking clamps designed for the specified seismic acceleration shall be provided.

3.6. SF6 Circuit Breakers

3.6.1. SF_6 circuit breakers shall be of single pressure type and shall be based on puffer technology (preferably with cross blasting) for interrupting circuit currents.

3.6.2. In the live tank type of construction, the tank containing SF6 gas and the interrupters, which is at the potential of the circuit to which the circuit breaker is connected when the breaker is in service, shall be insulated from earth by providing suitable support insulators. SF6 gas shall serve as the quenching medium and insulation between open contacts of the circuit breaker.

3.6.3. Each SF6 circuit breaker pole shall be provided with its own self-contained gas system.

3.6.4. The SF6 breaker shall be designed to ensure that condensation of moisture is controlled by proper selection of organic insulating materials having low moisture absorbing characteristics, complete drying of container and breaker, selection of 'O' ring etc. Materials such as activated alumina or molecular sieve shall be provided at appropriate locations as moisture absorbents.

3.6.5. The service connections for gas handling shall be located on each pole tank to facilitate servicing.

3.6.6. Unit type gas handling system shall be provided for above purpose.

3.6.7. The SF6 gas supplied shall conform to Specification and Acceptance of new sulphur hexafluoride.

3.6.8. The SF_6 gas shall have the following characteristics:

a) Physical properties		Colourless, odourless, non toxic and non flammable
b) Density at 20^0C and/Bar		6.08 g/I
c) Electric strength		2 1/2 times that of nitrogen
d) Compatibility		Up to temperature of about 180^0C, its compatibility with material used in electrical construction is similar to nitrogen
e) Toxic impurities		SF_6 gas shall comply with requirements of the tests as per IS
f) Dew point		Between -40 and 41^0C
g) Impurities		SF_6 shall not have more than the maximum allowable quantities of impurities given below :
	Impurity Group	Max. Permitted Concentration Mass by Mass
	CF4	0.05%
	Oxygen + Nitrogen(Air)	0.05%
	Water	15 ppm

	Acidity expressed as HF	0.3 ppm
	Hydrolysable fluorides expressed as HF	1.0 ppm
	Oil content	Substantially free from oil
h) Preferred cylinder sizes		10 and 40 litre.
I) Test pressure of cylinder		70 bars
j) Maximum filling ratio for tropical country		0.75 kg/1

3.7. Vacuum Breakers

3.7.1. Vacuum breakers shall have completely sealed interrupting units for interruption of arc inside the vacuum. The breakers shall be provided with "contact wear indicator" visible from the front of the equipment, without requiring opening of the control cubicle door, allowing the operator to access the conditions of the interrupters whilst the unit is in service. It shall be possible to isolate easily the vacuum interrupter unit from the breaker operating mechanism for mechanical testing of the interrupter to check loss of vacuum.

3.7.2. The Vacuum interrupters shall be housed in glazed porcelain hollow bushings conforming to the specifications detailed at Data Sheet A. The entire unit shall be sealed for entry of moisture and dust by gasketting.

3.7.3. The vacuum breakers shall be provided with suitable damping mechanism for each pole to totally avoid/ minimise the contact bounce during closing and opening operations. This arrangement should in no way reduce the operating speeds of the breaker.

3.7.4. BIDDER to furnish in his proposal the type designation of vacuum bottle used on the circuit breaker and its complete technical information.

4.0 OPERATING MECHANISM:

4.1. Circuit breakers shall be power operated either by pneumatic mechanism or by a motor charged spring operated mechanism as mentioned in Data sheet A. Main poles of the breaker shall be such that the design shall ensure a close pole spread with a maximum of 4 ms opening and 6 ms closing.

4.2. Circuit breakers shall feature high repeatability of absolute closing time over a wide range of parameters (ambient temperature, pneumatic pressure, control voltages, etc.). Operating mechanism shall be non-pumping electrically and either mechanically or pneumatically under every method of closing (except during manual closing of a breaker for maintenance). Electrical anti-pumping feature shall be obtained by means of an auxiliary relay and use of a contactor to achieve this feature shall not be acceptable.

4.3. Operating mechanism shall be suitable for high speed reclosing. It shall be non-pumping electrically and either mechanically or pneumatically under every method of closing (except during manual closing of a breaker for maintenance). A latch checking switch shall be provided on mechanically trip free mechanisms to prevent reclosure before the breaker latches have reset.

4.4. Main poles shall operate simultaneously. There shall be no objectionable rebound and the mechanism shall not require any critical adjustment. It shall be strong, rigid, positive and fast in operation.

4.5. Trip coil shall be rated for not less than 500 W continuously and two numbers to be provided.

4.6. Disagreement circuit shall be provided which shall detect pole position discrepancy in case of three single phase units.

4.7. The design of the circuit breaker shall be such that contacts will not close automatically upon loss of gas.

4.8. A mechanical indicator shall be provided inside the operating mechanism box to show open and closed positions where it will be visible through a glass window to a man standing on the ground with the mechanism housing closed. An operation counter shall also be provided.

4.9. A closing release shall operate correctly at all values of voltage between 80% and 110% of the rated voltage. A shunt trip shall operate correctly under all operating conditions of the circuit breaker up to the rated breaking capacity of the circuit breaker and at all values of supply voltage between 50% and 110% of rated voltage.

4.10. Working parts of the mechanism shall be of corrosion resisting material. Bearings which require grease shall be equipped with pressure type grease fittings. Bearing pin, bolts, nuts and other parts shall be adequately pinned or locked to prevent loosening or changing adjustment with repeated operation of the breaker.

4.11. It shall not be possible for any leakage of air from the pneumatic equipment to build up pressure in the closing cylinder.

4.12. Provision shall be made for attaching an operation analyser to perform speed tests after installation of the breakers at Site.

4.13. Spring Operated Mechanism

4.13.1. Spring operated mechanism shall be complete with motor, opening spring, closing spring with limit switch for automatic charging and all necessary accessories to make the mechanism a complete operating unit.

4.13.2. As long as power is available to the motor, a continuous sequence of closing and opening operations shall be possible.

4.13.3. After failure of power supply to the motor, at least one open-close-open operation of the circuit breaker shall be possible.

4.13.4. Breaker operation shall be independent of the motor, which shall be used solely for compressing the closing spring.

4.13.5. Motor rating shall be such that it requires not more than 30 seconds for fully charging the closing spring. Motors shall conform to Data Sheet A.

4.13.6. Closing action of the circuit breaker shall compress the opening spring ready for tripping.

4.13.7. When closing springs are discharged, after closing a breaker, closing springs shall automatically be charged for the next operation. Facility for manual charging of the closing spring shall be provided.

4.13.8. Mechanism shall be such that failure of any auxiliary spring shall not prevent tripping and will not cause tripping or closing operation of the power operated closing devices. When the circuit breaker is already closed, failure of any auxiliary spring shall not cause damage to the circuit breaker or endanger the operator.

4.13.9. Mechanical indicators to indicate charged and discharged condition of spring shall be provided. Means shall be provided to slowly open and close the breaker manually for maintenance purpose when the operating power is not available.

4.14. Pneumatically Operated Mechanism

4.14.1. Pneumatically Operated Mechanism shall obtain the supply from a unit compressed air system.

4.14.2. The operating mechanism shall include necessary monitoring and safety interlocks such as pressure gauges with alarm contacts for high/ low/ minimum and lockout pressure signals. The minimum operating pressure shall be such that the breaker shall be capable of one

opening if the breaker is in closed position before the lockout pressure blocks breaker opening/ closing/ reclosing.

4.14.3. Independently adjustable pressure switches with electrically insulated contacts shall be provided on the circuit breaker for purposes of low and high pressure alarm and lockout in case of insufficient pressure to complete a closing, opening or reclosing duty.

4.14.4. Local air receiver shall be sufficient to carry out two CO operations.

4.15. Operating Mechanism Control

4.15.1. Operating mechanism shall normally be operated by remote electrical control. Electrical tripping shall be performed by shunt trip coils. Provision shall be made for local electric control. 'Local/Remote' selector switch of lockable type shall be provided in the operating mechanism cubicle.

4.15.2. A conveniently located manual tripping lever or button shall also be provided for local tripping of the breaker and simultaneously opening the reclosing circuit. A local manual closing device which can easily be operated by one man standing on the ground shall also be provided for maintenance purposes. Direction of motion of handle shall be clearly marked.

5.0 OPERATING MECHANISM HOUSING:

5.1. Operating mechanism, unit compressor, if offered, and all accessories shall be enclosed in a weather-proof mechanism cabinet of hot dip galvanised sheet steel construction, the thickness of which shall not be less than 2 mm. Hinged doors giving access to the mechanism at the front and sides shall be provided. Suitable gaskets shall be provided to make the mechanism housing water-proof and dust-proof. The housing shall have an enclosure, as specified in Data Sheet-A. The housing latch shall accommodate padlock requiring a 12 mm diameter hole. Padlock and duplicate keys shall be furnished by the VENDOR.

5.2. The operating mechanism control and all other controls shall be contained in a free standing cabinet in the front of the system.

5.3. Common marshalling box with necessary tubing and cables shall be provided. A light point with door switch and one 3 pin 240 V AC 15 A socket outlet shall be provided in the housing.

5.4. In all other respects, operating mechanism housing and marshalling box shall conform to enclosed Data Sheets A.

6.0 BUSHINGS/ INSULATORS:

6.1. Porcelain used for the manufacture of bushing/ insulator shall be homogeneous, free from laminations, cavities and other flaws or imperfections that might affect the mechanical or dielectric quality and shall be thoroughly vitrified, tough and impervious to moisture.

6.2. Glazing of the porcelain shall be of uniform brown colour free from blisters, burns and similar other defects. Bushings/ insulator shall be designed to have ample mechanical strength and rigidity for the conditions under which they will be used. All bushings of identical ratings shall be interchangeable.

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

6.4. All iron parts shall be hot dip galvanised and all joints shall be airtight. Surface of the joints shall be trued-up; porcelain parts by grinding and metal parts by machining. Bushing design shall be to ensure a uniform compressive pressure on the joints.

6.5. All current carrying contact surfaces shall be silver faced. Silver facing shall not be less than one mil in thickness.

6.6. Bushings/ insulator shall satisfactorily withstand the insulation level specified in relevant standards specified in Data Sheet-A.

7.0 CONTACTS:

7.1. Main contacts shall have ample area and contact pressure for carrying the rated current and the short time rated current of the breaker without excessive temperature rise, which may cause pitting, or welding. Contacts shall be adjustable to allow for wear, easily replaceable and shall have a minimum of movable parts and adjustments to accomplish these results. Main contacts shall be the first to open and the last to close so that the contact burning and wear shall be least.

7.2. Arcing contacts, if provided, shall be the first to close and the last to open and shall be easily accessible for inspection and replacement. Tips of arcing and main contacts shall be silver faced or have tungsten alloy tipping.

7.3. Positive mechanical interconnection shall be provided between interrupting contacts, blast valve mechanism, if any, to ensure maximum operating reliability and retention timing.

7.4. If multi-break interrupters are used, they shall be so designed and augmented that a fairly uniform voltage distribution is developed across them.

8.0 TANKS FOR SF6 BREAKERS:

8.1. Tanks shall be of seam welded construction fabricated from boiler quality plates and shall be hydrostatically tested. All cover seats, flange joints, threaded connections and pipe fittings shall be properly machined and fitted with gaskets to maintain gas tightness. Gaskets shall be of a material which, will not deteriorate under service conditions. Metallic compression stops shall be provided for compressible gaskets.

8.2. Tanks shall be designed to have ample insulating clearances and shall be provided with insulating liners. Interphase barriers shall be provided for single tank circuit breakers. Provision shall be made to prevent gas vapour from passing from one phase to the other or to breaker mechanism. Floor and skid mounted tanks shall be provided with access manholes in the side, near bottom of each tank to allow for inspection, adjustment or replacement of the contacts. Cleat shall be provided at the top of each tank to safeguard workmen from slipping off. Tank shall be designed to shed off all rain water.

8.3. Circuit breaker compartment comprising fixed and moving contacts within an insulating enclosure shall be gas filled and mounted on a supporting chamber.

9.0 TERMINALS:

9.1. Two clamp type earthing terminals each suitable for the clamping PURCHASER's earthing conductor shall be provided on each circuit breaker. Size of the conductor shall be as indicated in Data sheet A.

10.0 ADDITIONAL DUTY REQUIREMENTS:

10.1. Circuit breakers shall be restrike free.

10.2. Circuit breakers shall be capable of clearing short line faults with the same impedance behind the bus corresponding to the rated fault current.

10.3. Circuit breakers shall be capable of breaking 25% of rated fault current at twice rated voltage under out of phase conditions as per standards specified in Data Sheet-A.

10.4. The Bid shall highlight the design features provided to effectively deal with:

a) Breaking of inductive currents and capacitive currents.

b) Charging of long lines and cables

c) Clearing developing faults within the full rating of the breaker.

d) Opening on phase opposition.

11.0 NAME PLATE:

11.1. Each breaker shall be provided a name plate in English, with the following data indelibly marked on it.

a) Manufacturer's name or trade mark.

b) Serial number and type designation.

c) Rated voltage

d) Rated current

e) Rated insulation level

f) Rated frequency

g) Rated breaking capacities (symmetrical and asymmetrical).

h) Weight (for circuit breakers) including oil/gas

i) Rated short time (for duration as specified in Data Sheet A) current.

12.0 FITTINGS & ACCESSORIES:

A partial list of some of the major fittings and the accessories to be furnished by the VENDOR as an integral part of the equipment is given below. Number and exact location of these parts shall be indicated in the Bid.

12.1. Operating mechanism housing complete with:

a) Padlocks and duplicate keys

b) Space heaters equipped with automatic humidistat control

c) Local/remote changeover switch

d) Manually operated tripping push button/lever (mechanical) conveniently located to trip all three phases simultaneously.

e) Operation counter

f) Terminal boards with minimum 6 spare terminals

g) Control switches to cut off control power supplies

h) MCB's as required

i) Two earthing terminals

j) Auxiliary relays required for satisfactory operation

k) Automatic Direct-on-line (DOL) starter with necessary components such as MPCB, contactor, Thermal overload relay, push buttons etc, as required to automatic and manual start of the motor.

l) Breaker local control switch

m) 3 pin 15A socket outlet and cubicle lamp

n) Steel frames for frame mounted breakers

o) Manually operated device for breaker closing under failure of normal power

p) Maintenance closing device

q) Foundation templates

r) Foundation bolts

s) Galvanised Steel bracket for mounting current transformers

t) Gas filling and filtering valve.

12.2. Clamps and connectors, as specified in Data Sheet-A.

13.0 SPARE PARTS:

Whether included in the VENDOR's recommendations or not, unit prices of the following items shall be quoted together with their suggested quantities and catalogue numbers:

a) One complete pole of the breaker with the control

b) Main interrupter units

c) Grading capacitor units

d) Closing coils

e) Tripping coils

f) Accelerating and damping springs

g) Spring charging motor - In case of spring operated mechanism

h) Compressor motor – in case compressed air operation

i) Cross head and lift rods

j) Pressure switches

k) Set of gaskets

l) Pressure gauges

m) Compressor equipment parts

n) Local/remote changeover switch

o) Bushings / Insulators (all types)

p) Fixed contact assemblies

q) Moving contact assemblies

r) Arcing contact assemblies

s) Quenching chambers

t) Vacuum bottle.

u) Pressure pipe insulator

v) Arcing chamber insulator

w) Silica gel charge

14.0 TESTS & TEST REPORTS:

14.1. The BIDDER shall indicate the MANUFACTURER's standard routine tests. The VENDOR shall completely assemble and test each breaker to ensure satisfactory working of all component parts and assembled as a whole.

14.2. All type and routine tests shall be as per latest standards specified in Data Sheet-A.

14.3. Type tests and routine tests shall be carried out on all associated equipment and to be assembled unit as per relevant standards.

14.4. Speed curves for each breaker obtained with the help of a suitable operation analyser to determine breaker contact movement during opening; closing, auto-reclosing and trip free operation under normal as well as limiting operating conditions (of Control Voltage, Pneumatic Pressure, etc.). The tests shall show the speed of contacts at various stages of operation, travel of contacts, opening time, closing time, shortest time between separation and meeting of contacts at break-make operation etc.

14.5. All vessels and accessories which operate under pressure shall be tested according to relevant standards and adequate number of copies of test certificates incorporating the following minimum information shall be submitted. Description of item, CONTRACTOR/MANUFACTURER serial numbers, date of manufacture and tests, drawing number, material composition, working and design pressures, details of tests carried out and reference standards, test results, identification mark, name and seal of approval of testing authority.

14.6. The result of tests conducted in works / laboratory shall be furnished for review and approval before shipment of the circuit breakers. Bound copies of complete test results as specified in the distribution schedule shall be furnished with the circuit breakers. These shall include complete reports and results of the routine test, as also certified copies of type tests carried out on circuit breakers of identical design.

15.0 DRAWINGS & DATA:

15.1. As a part of the proposal, the BIDDER shall furnish relevant descriptive and illustrative literature and the following drawings for preliminary study:

a) General outline drawings showing dimensions, net and shipping weights, quantity of SF6 / air receiver capacity, etc.

b) Sectional views showing the general constructional features of the circuit breaker including operating mechanism, arcing chambers, contacts, Vacuum bottle, with bushing lifting dimensions.

c) Typical and recommended schematic diagrams for control, supervision and reclosing

d) General arrangement of the foundations or structure mountings.

e) Short circuit oscillograms and certificates for similar type tested breaker.

f) All drawings and data shall be annotated in English.

g) **EHV Circuit Breaker-Data Sheets**

DATA SHEET A1					
SL.NO		**PARTICULARS**		**UNIT**	**DATA**
1.0 GENERAL	1.1	Application			Outdoor
	1.2	Quantity		Set	1
	1.3	Type of circuit breaker			SF_6
	1.4	Number of Poles			Triple Pole
2.0 RATING	2.1	Voltage	Rated	KV	66
			Maximum	KV	72.5
	2.2	Frequency		HZ	50
	2.3	Continuous current under site conditions		Amps	1250
	2.4	Short circuit breaking current	rms AC Component	kA	31.5
			% DC Component		≥ 40
	2.5	Short time current Withstands	Current	kA	31.5
			Duration	Sec	3
	2.6	Making capacity	Sec	kA_{peak}	78.75
	2.7	Auto reclosing	1-Pole / 3-Pole		3-pole simultaneously

DATA SHEET A1					
SL.NO		**PARTICULARS**		**UNIT**	**DATA**
			Time setting		
	2.8	Operating duty			O-0.3 Sec-CO-3 min-CO
	2.9	Total break time		Cycles	< 3 Cycles
	2.10	Make time		Cycles	<4 Cycles
3.0 ADDITIONAL PARTICULARS		Transient Recovery Voltage			
	3.1	Terminal Faults			
		First pole to clear factor			1.5
	3.2	Additional Breaking Current Ratings			
	a	Out-of-phase breaking current		kA	7.875 kA
	b	Line charging breaking current		A	10A
	c	Cable charging breaking current		A	125A
	d	Capacitor bank breaking current		A	400A
	e	Small inductive breaking current			0.5 to 10A without switching over voltage exceeding 2.3 p.u
	3.3	Temperature			
	a	Reference ambient temperature		^{0}C	45
	b	Max. permissible temperature rise over ambient temperature:		K	40
	3.4	Insulation withstand test voltages			
	a	1.2/50 µS impulse +ve & -ve		kV_{peak}	325
	b	Switching surge		kV_{peak}	Not Applicable
	c	One Minute power frequency dry & wet		kV	140
	3.5	Air Clearances			
	a	Phase to phase (min.)		mm	630
	b	Phase to ground (min.)		mm	630
	c	Ground Clearance		mm	4900 (to bay bus bottom line)
	3.6	Phase Spacing		mm	2000
	3.7	Minimum Creep age distance for insulators	Total	mm	1813
			Protected	mm	906.5
	3.8	Auxiliary Control Voltages			
	a	Voltage for close and Trip Coils, Interlocks, Indicating Lamps etc.		Volts	110
				AC/ DC	DC
	b	Applicable Variation in Supply voltage			
		i) For closing coils and associated devices			70-110 %
		ii) For trip coil and associated devices			70-110 %
	3.9	Number of trip coils to be provided		Nos	2
4.0 OPERATING MECHANISM	4.1	Type			
	a)	Electro-pneumatic		Yes / No	No
	b)	Motor compressed spring		Yes / No	Yes
	4.2	Fixed trip / trip free			Trip Free
	4.3	Compressed air system required		Yes / No	No
	4.4	Spring Charging/ Unit Compressor Motor			
	a)	Voltage			240 Volt AC
	b)	Variation in supply voltage			-15% to +10%
	c)	Mode of Starting			Direct on line
	d)	Degree of Protection			IP 55
	4.5	IP class of control cubicle			IP 55

DATA SHEET A1					
SL.NO		**PARTICULARS**		**UNIT**	**DATA**
	4.6	External finish of control cubicle			Shade 632 of IS 5
	4.7	Internal finish of control cubicle			Glossy white enamel paint
5.0 MISCELLANEOUS	5.1	Bushing CT	Required	Yes/No	No.
			For details refer		
	5.2	No. of Spare Aux. Contacts	NO	Nos.	6
			NC	Nos.	6
			Make before break		Yes
	5.3	SF6 Gas pressure monitor with fault contacts as follows:-			Required
		a) Gas pressure low alarm.			
		b) Gas pressure low, stage II for close lock out and alarm.			
		c) Gas pressure very low trip lock out and alarm.			
	5.4	Earthing Conductor	Material		GS
			Size		50 x 10 mm
	5.5	Mounting structure included in vendor's scope of supply		Yes/No.	Yes
	5.6	Clamps & Connectors	By purchaser/vendor		By Vendor
			Takeoff- Hor/Vert/Other		Horizontal
			Conductor size		2" IPS Tube
			Conducting material		Aluminium
			Clamp material		Aluminium Alloy
	5.7	Support structure for circuit breaker & control cubicle			Hot dip galvanised MS
	5.8	Control accessories required	CB Control switch		1 No for each CB
			Local/ Remote selector switch		1 No for each CB
			CB ON/ OFF/ Spring charged indicating lamps		1 set for each CB
			Anti-pumping relay		1 set for each CB

Note: The Ratings mentioned above are the minimum ratings required, however the bidder can quote based on the minimum ratings mentioned in IS standard.

DATA SHEET A2		
APPLICABLE STANDARDS		
1 Circuit breakers	IS 13118	IEC 62271-100
2. Common specifications for high-voltage switchgear and control gear standards		IEC 60694
3 Bushings	IS 2099 BS 223 IS 10314, 5621 13134	IEC 60137
4 Large hollow porcelains	IS 5621	
5 Bushings CT	IS 2705	
6 Clamps & connectors	IS 5561	IEC 60305
7 Hot dip galvanising	IS 2629	
8. Specification and acceptance of new sulphur hexafluoride		IEC 60376
9. Degrees of protection provided by enclosures (IP code)		IEC 60529
10. High-voltage switchgear and control gear – Use and handling of sulphur hexafluoride (SF6) in high-voltage switchgear and Control gear		IEC 61634

DATA SHEET B (Bidders to fill in the Data Sheet and submit along with the bid)			
Sl. No.	**Description**	**Unit**	**Bidder's Data**
1.0	Maker's name & country of manufacture		
2.0	Manufacturer's type and designation		
3.0	Applicable standard		
4.0	Rated voltage	kV	
5.0	Service voltage	kV	
6.0	Rated continuous voltage for rated breaking capacity a) Maximum b) Minimum	 kV kV	
7.0	Type of circuit breaker & Number of Poles		
8.0	Ambient temp. assumed for design a) Maximum b) Minimum	 ^{0}C ^{0}C	
9.0	Continuous current a) Rated b) Under site conditions	 Amps Amps	
10.0	Short time current withstand a) Rated short time current b) Rated time	 kA(rms) Sec	
11.0	Maximum rise of temperature over ambient for current rating under a) Clause 9 above b) Clause10 above	 ^{0}C ^{0}C	
12.0	Rated operating duty		
13.0	Interrupting capacity based on duty cycle in 12 above a) RMS value of AC component b) Percentage DC component	 kA %	
14.0	Additional breaking current ratings: a) Out of phase breaking current	 KA	
	b) Line charging breaking current	A	
	c) Cable charging breaking current	A	
	d) Capacitor bank breaking current	A	
	e) Shall Induction Breaking Current	A	
15.0	Rated transient recovery voltage a) Method of representing TRV b) Value of parameters c) First pole to clear factor d) Type of devices, used to limit the rate of rise of restriking voltage	 4/2 parameters	
16.0	Rated making capacity a) At higher rated voltage b) At lower rated voltage	 kA(peak) kA(peak)	
17.0	Latching current	kA	

DATA SHEET B (Bidders to fill in the Data Sheet and submit along with the bid)			
Sl. No.	**Description**	**Unit**	**Bidder's Data**
18.0	Short circuit test certificate enclosed	Yes/No	
19.0	Type of devices, if any, used to obtain uniform voltage distribution between breakers		
20.0	a) Type of main contacts b) Type of arcing-contacts and/or arc control device		
21.0	Material of contacts a) Main b) Arcing c) Whether contacts are silver faced		
22.0	Insulation level of the breaker a) One minute power frequency withstand voltage b) Switching surge withstand test voltage c) Impulse withstand test voltage	 kV(rms) kV(peak) kV(peak)	
23.0	Corona and visual discharge a) Radio interference voltage i) Test voltage ii) RI level b) Visual discharge voltage for falling power frequency voltage	 kV Micro-volt kV	
24.0	Minimum clearances in air/oil a) Between phases (live parts) b) Between live parts and earth c) Centre to centre distance between phases	 mm mm mm	
25.0	Whether the circuit breaker is fixed trip or trip free		
26.0	Method of tripping a) Normal b) Emergency		
27.0	Tripping mechanism a) Type b) Normal voltage of trip coil c) Pick-up range d) Power Consumption at normal voltage e) Number of trip coils provided a) Power at normal voltage of closing mechanism b) Power at 85% of normal voltage	 Volts Volts Watts Nos Watts Watts	
28.0	Closing mechanism a) Type b) Normal voltage of closing coils c) Pick up range d) Power Consumption at normal voltage e) Number of trip coils provided	 Volts Watts Watts	
29.0	Total interrupting time measured	Cycles	

DATA SHEET B (Bidders to fill in the Data Sheet and submit along with the bid)			
Sl. No.	**Description**	**Unit**	**Bidder's Data**
	from instant of trip coil energisation to arc-extinction of resistor current		
30.0	Closing time measured from instant of application of power to closing device up to arcing contacts touching	Cycles	
31.0	Critical current (current giving the longest arc when a break takes place)	A	
32.0	Maximum voltage factor of the circuit breaker when switching off: a) Unloaded transformers b) Loaded transformers c) Open circuited lines		
33.0	When switching off asynchronous system: a) Maximum current b) Maximum recovery voltage between contacts of one pole	 kA kV	
34.0	Number of openings at rated capacity, the circuit breaker is capable of performing without inspection & replacement of contacts or other main parts		
35.0	FOR SF6 BREAKERS		
	a) Pressure of SF6	Bar	
	b) Type of operating mechanism pneumatic/spring/hydraulic charged		
	c) If pneumatic, air pressure	Bar	
	d) Capacity of the local air receiver	m^3	
	e) Whether monitor for SF6 gas provided for alarm and lockout as per specification.		
	f) Leakage of SF6 gas		
36.0	GENERAL a) Weight of complete 3 phase circuit breaker	kg	
	b) Impact loading for foundation design, to include dead load plus impact value on opening at max. interrupting rating in terms of equivalent static load	kg	
	c) Overall dimensions of complete 3 phase breaker : Height Width Length	 mm mm mm	
37.0	BUSHING/ INSULATOR a) Make		

DATA SHEET B (Bidders to fill in the Data Sheet and submit along with the bid)				
Sl. No.	**Description**	**Unit**	**Bidder's Data**	
	b) Type c) Descriptive pamphlet No. d) Weight e) Transport dimensions f) Height above floor required to remove bushings g) Insulation class h) One minute dry power frequency withstand voltage i) Flashover voltage j) Full wave impulse withstand voltage k) Switching surge withstand voltage l) Corona discharge voltage m) Nature of the dielectric medium employed in the bushings n) Creepage distance - Total - Protected at 900 o) Volume of insulating medium per bushing p) Permissible safe cantilever loading on installed bushing	 kg mm mm kV (rms) kV kV(peak) kV(peak) kV mm mm Litres kg.		
38.0	Drawing as per Clause 15 of Section-6.5.2 enclosed	Yes/No		
39.0	Whether terminal clamps are included in the scope. If yes, a) Alloy composition of : i) Clamp body ii) Bolts	Yes/No		
	b) Range of diameter of conductors that can be received	mm		
	c) Max. temp. rise when carrying rated current at specified ambient temp.	^{0}C		
	d) Weight of each type of clamp	kg		
	e) Whether horizontal or vertical take-off			
	f) Flexible/rigid			
40.0	Whether all type test reports as per latest relevant standards are enclosed?	Yes/No		
41.0	Whether all routine/acceptance tests as per latest relevant standards will be carried out on each circuit breaker	Yes/No		
42.0	a) Whether breaker construction suitable for up rating later b) If yes, feasibility and extent of up rating possible	Yes/No		
43.0	a) Linking mechanism for single		For Closing	For Tripping

DATA SHEET B (Bidders to fill in the Data Sheet and submit along with the bid)				
Sl. No.	**Description**	**Unit**	**Bidder's Data**	
	pole units Electrical Mechanical Pneumatic Hydraulic Any other			
	b) Details of construction of linking mechanism components like operating rod Material Material specification Fluid used Pressure	kg/cm^2		

6.6.1 EHV Isolator

1.0 SCOPE

1.1 This Specification covers design, material, constructional features, manufacture, testing at the VENDOR'S Works and delivery to Site of high voltage group operated, air-break alternating current isolators and earthing switches, suitable for indoor or outdoor use. Pantograph type isolators are outside the scope of this Specification.

2.0 CODES AND STANDARDS

2.1 The design, material, construction, manufacture, inspection and testing of isolators shall be with all currently applicable statutes, regulations and safety codes in the locality where the equipment will be installed. The equipment shall also conform to the latest applicable standards. Nothing in this Specification shall be construed to relieve the VENDOR of this responsibility.

2.2 Isolators shall conform to the latest applicable standards. In case of conflict between the standards and this Specification, the stringent of the two shall apply.

3.0 DESIGN FEATURES

3.1 Constructional Features

3.1.1 The isolator/earthing switch shall be complete with all parts that are necessary or essential for efficient operation. Such parts shall be deemed to be within the scope of supply, whether specifically mentioned or not.

3.1.2 All similar parts shall be interchangeable.

3.1.3 Base channels and other structural steel members such as operating pipes, phase coupling rods etc. operating mechanism boxes, bolts, pins etc., shall be hot dip galvanised or metallised. All castings except current carrying parts shall be made of galvanised steel.

3.1.4 Live metal parts shall be of non-rusting and non-corroding metal. Current carrying parts shall be of non-ferrous materials such as aluminium or copper. Bolts, screws and pins shall be provided with lock washers, keys or equivalent locking facilities, and current carrying parts shall be made of non-rusting and non-corroding metal, such as copper silicon alloy.

3.1.5 The isolator design shall be such that it is free from visible corona discharge in both closed and open positions at the visible discharge test voltages as per applicable standards. Necessary stress relieving rings or shields shall be provided to meet this requirement.

3.1.6 Isolators and earthing switches including their operating mechanism shall be such that they cannot be dislodged from their open or closed positions by gravity, wind pressure, vibrations, shocks or accidental touching or seismic forces or breaking of the connecting rods or the operating mechanism.

3.1.7 The design shall be such that no lubrication of any part is required except at very infrequent intervals.

3.1.8 During the course of normal operation, it is likely that the isolator/earth switch may be left in the Open/Closed position for long periods of time. They shall be designed to operate satisfactorily even after being kept in one position for long periods.

3.1.9 The isolator or earthing switch shall be provided with high current carrying contacts on the hinge and jaw faced copper.

3.1.10 The isolators and earth switches shall be designed to withstand stresses corresponding to short circuit duties specified in Data Sheet-A.

3.1.11 The insulators shall withstand the seismic force level given in Data Sheet-A.

3.2 Accessories

3.2.1 Position Indicator

A mechanical position indicating device shall be provided for each isolator/earthing switch, irrespective of whether the isolating distance is visible or not.

3.2.2 Earthing Pads

Each pole of the isolator shall be provided with two earthing pads of non-corrosive material at opposite ends, brazed to the channel base. Flexible copper earth connectors shall be provided for connecting operating handles of isolators and earthing system.

3.2.3 Counter Balance Springs

These shall be provided for counter balancing the isolators to prevent impact at the end of travel both on opening and closing of the isolator/earthing switch. The springs shall be non-rusting alloy.

3.2.4 Name-Plate

A weatherproof and corrosion-proof nameplate shall be provided on isolators, earthing switches and operating devices. The nameplate shall conform to applicable standards.

3.2.5 Adequately rated, renewable type arcing tips shall be provided on the isolators to make and break the magnetising or line/bus charging currents.

3.3 Earthing Switch

Earthing switch, whenever specified in Data Sheet-A, shall form an integral part of each pole of the isolator. Two independent earthing pads each with flexible copper braids and suitable connection for the specified size of earth conductor lead shall be provided at the hinge end of the switch.

3.4 Interlocks

3.4.1 Isolators and earthing switches shall be provided with padlocking facility to lock them in fully open or fully closed positions. Padlocks shall be supplied with the isolators.

3.4.2 Isolator and earthing switches shall be mechanically interlocked such that it will not be possible to close the earthing switch when the isolator is closed and vice-versa.

3.4.3 Isolator shall be provided with electrical interlocking feature. This shall be in the form of bolt interlock comprising an interlock coil of latch-in type to lock the isolator-driving shaft and hence prevent isolator operation in the latch in condition. It shall be possible to release the latch by energising the interlock coil when certain pre-set conditions of PURCHASER'S

interlocking scheme are fulfilled. For this purpose the VENDOR shall provide facilities for wiring PURCHASER'S external interlocking contacts both in isolator opening and closing circuits. Further, a separate bypass switch shall be provided on the local control cabinet to facilitate emergency manual operation of isolator.

3.4.4 Electrical interlocking arrangement shall be failsafe type.

3.4.5 Isolator shall be provided, when specified in Data Sheet-A, with mechanical interlocking feature in addition to electrical interlocking feature described above.

3.5 Insulators

3.5.1 Porcelain used for the manufacture of insulators shall be homogeneous, free from flaws or imperfections that might affect the mechanical or dielectric quality. They shall be thoroughly vitrified, tough and impervious to moisture. The glazing of the porcelain shall be of uniform brown colour, free from blisters, burns and other similar defects. Insulators of the same rating and type shall be interchangeable.

3.5.2 The porcelain and metal parts shall be assembled in such a manner that any thermal expansion differential between the metal and the porcelain parts throughout the range of temperature variation shall not loosen the part or create undue internal stresses which may affect the electrical mechanical strength and rigidity. Each cap and base shall be of high-grade cast steel or malleable steel casting and they shall be machine faced and smoothly galvanised. The cap and base of the insulators shall be interchangeable with each other.

3.6 Operating Mechanism and Controls

3.6.1 The operating mechanism shall provide quick, simple and effective operation. Time of operation shall not exceed 12 seconds. One man shall be able to operate the isolator/earthing switch (when manually operated) without undue effort.

3.6.2 The ganging mechanism shall be provided with sufficient adjustment to allow for Final alignment of the isolator blades for simultaneous operation. Adjustable stops shall be provided to prevent over travel in either direction.

3.6.3 The isolator shall be provided with positive continuous control throughout the entire cycle of operation. The operating pipes and rods shall be sufficiently rigid to maintain positive control under most adverse conditions and when operated in tension or compression for isolator closing. They shall also be capable of withstanding all torsional and bending stresses due to operation of the isolator.

3.6.4 It shall not be possible, after final adjustment has been made, for any part of the Mechanism to be displaced at any point in the travel sufficiently to allow improper functioning of the isolator when the isolator is opened or closed at any speed. All holes in cranks, linkages etc., having pins shall be drilled to accurate fit so as to maintain the minimum amount of slack and lost motion in the entire mechanism.

3.6.5 The manual operating handles shall be mounted on the base of supporting structure. Guide bearings shall be provided if necessary at a height of 750mm above grade level. All brackets, angles, guides, guide bearings or other members necessary for attaching the operating mechanism and operating handles to the supporting structure and foundations shall be supplied as an integral part of the isolator. Rustproof pins and bearings of the bronze bushing, ball and roller type, shall be furnished. All bearings shall be weather protected by means of covers and grease retainers. Bearing pressures shall be kept low to ensure long life and ease of operation.

3.6.6 A weather-proof galvanised steel cabinet with gasketed hinged door and padlocking facility shall be provided to house driving mechanism, motor starters, solenoids for control and interlock, auxiliary switches etc., in case of power operated isolators and the auxiliary switches in case of manually operated isolators. This steel control cabinet (operating mechanism box) shall comply with Specification entitled Control Cabinets. The operating mechanism box shall have enclosures operating conforming to IP 67. All cabling from operating mechanism and auxiliary contacts (of isolator and earthing switch) to operating mechanism box shall be carried our using 1100/650V grade, 2.5sq.mm-stranded copper

conductor, PVC or XLPE insulated, armoured, multi core cables or single core wires laid in heavy gauge galvanised steel conduits, unless otherwise specified.

3.6.7 The orientation of disposition of the operating mechanism box with respect of isolator shall be as specified in Data Sheet-A.

3.6.8 In addition to the limit switch contacts required for control of power operated isolators, the number of auxiliary contacts mentioned inn Data Sheet-A shall be provided. These switch contacts shall be positive acting type and shall be directly driven from the isolator shaft through minimum linkages. The auxiliary contacts shall be of silver faced copper. When make before break contacts are specified, they shall be wiping type. The contacts shall be designed to carry 10A continuously without undue temperature rise. All contacts shall be suitable for breaking an inductive current of 0.2A.

3.6.9 Power operation of isolator and earthing switch shall be by a motor or a pneumatic device as indicated in Data Sheet-A.

3.6.10 A local isolating MCB unit for disconnection of power supplies a local/remote selector switch and in the operating mechanism box for power operated isolators.

3.6.11 The control shall be so arranged such that the desired operation shall be completed when corresponding push button is pressed momentarily. The control circuit shall be so arranged that necessary interlocks with associated breakers and earthing switch can be incorporated in it.

3.6.12 Arrangement shall be provided to permit manual operation of power operated isolators. The arrangement shall be such that when manual operating handle is in the engaged position, the power operation shall be made inoperative. Padlocking facility shall be provided for the manual-operating handle. Two detachable manual operating handles for every group of the (10) power operated isolators are acceptable.

3.6.13 The operating mechanism design shall be such that during the operation of the isolator (especially manual operation) the moving blades once they reach the sparking distance, springs shall take over to give a quick, snap action enclosing so that the isolator closing is independent of manual efforts. Similarly, the springs must assist during the opening operation to give quick breaking feature.

3.6.14 Motor Drive

a) For Motor/driven isolators, the drive motors shall be in accordance with Date Sheet-A.

b) Motors shall be totally enclosed, weatherproof outdoors type and tropicalised. Magnetic contactor type of starters suitable for direct on-line duty shall be provided for control of motors.

c) The operating mechanism box shall be provided with Local/ Remote selector switch and push buttons for local closing and opening of the Isolator.

d) Direct-on-line (DOL) type reversible starter with necessary components such as MPCB, overload relays etc shall be supplied.

e) Suitable reduction gearing shall be provided between the motor and the drive shaft of the isolator. A quick Electro-mechanical brake shall be fitted on the higher speed shaft to effect rapid braking.

f) Limit switches for motor control shall be fitted on the isolator shaft, within the cabinet, to sense the open and close positions of the isolator.

3.7 Insulation Levels

3.7.1 The rated insulation levels shall be in accordance with the applicable standards.

3.8 Temperature Rise

The temperature rises of any part of the isolator and associated equipment shall not exceed the maximum permissible temperature rise values as stipulated in the applicable standard, corresponding to design ambient temperature specified in Data Sheet-A.

3.9 Clamps and Connectors.

Clamps and connectors shall be supplied as a part of the isolator whenever called for in Data Sheet-A.

4.0 SHORT CIRCUIT REQUIREMENTS

4.1 The rated peak short-circuit current or the rated short time current carried by an isolator or earthing switch for the rated maximum duration of short circuit shall not cause:

a) Mechanical damage to any part of the isolator or earthing switch.

b) Separation of the contacts or contact welding; and

c) A temperature rise likely to damage insulation.

4.2 After the passage of these currents, the isolator shall be able to carry its rated current under specified conditions and the operation of the operating device shall not be impaired.

4.3 If earthing switch is combined with an isolator as a single unit, the rated peak short circuit current and the rated short time current, of the earthing switch shall be at least equal to those specified for the isolator. The earthing switch shall be capable of making on a dead short circuit without damage of endangering the operator.

5.0 SUPPORTING STRUCTURE

5.1 Supporting structures for isolator and earthing switches, which may be of RCC or steel are excluded from the VENDROR'S scope of supply. However, the VENDOR shall furnish detailed dimensioned drawings indicating weights and all fixing details and relative locations of chassis, operating mechanism box and operating handles. The VENDOR shall review and comment on the PURCHASER'S drawings for isolator supporting structures with regard to supporting and mounting arrangements, interference etc. Final responsibility for ensuring that mounting and supporting arrangements of isolator are proper and that there is no interference of any part of the isolator with supporting structures rests with the VENDOR.

5.2 The mounting heights indicated in Data Sheet-A are only tentative and are likely to vary within ±25%. This will be confirmed at the time of the drawing approval.

6.0 TESTS

6.1 Type tests when called for in Data Sheet-A and all routine tests shall be performed in the presence of the PURCHASER'S representatives

6.2 All tests shall be conducted in accordance with the relevant standards.

6.3 All tests shall be made on completely assembled isolators, earthing, switches, their operating devices and auxiliary equipment.

7.0 DRAWINGS

7.1 Two (2) complete sets of drawings incorporating following particulars shall be submitted with the offer. Complete assembly drawing showing the plan and elevation views of the isolator and earthing switch incorporating mounting dimensions, overall dimensions, weight, details of operating mechanism details of jaws, details of terminal studs.

8.0 SPARE PARTS

8.1 Whether included in the VENDORS' recommended list or not unit prices for following items should be quoted.

a) Spare insulator.

b) Fixed contacts with contact pins

c) Moving contacts

d) Arcing contacts

e) Spring

f) Motor for motor operated isolator

9.0 ASSEMBLY

9.1 Direct delivery of insulators from insulator manufacturer's works will not be accepted. Isolators shall be completely assembled at the works to ascertain that all the parts fit correctly.

6.6.3 EHV Isolator-Data Sheets

DATA SHEET- A1						
SL. NO.		**PARTICULARS**		**UNIT**	**DATA**	
1.0 RATINGS	1.1	Application			Transformer isolation	
	1.2	Quantity				
	a	Isolator without earth switch		Set	NA	
	b	Isolator with ES on one side		Set	1	
	c	Isolator with ES on both sides		Set	0	
	1.3	Voltage.	Rated	kV	66	
			Maximum	kV	72.5	
	1.4	Frequency.		Hz	50	
	1.5	No. of Phases			3	
	1.6	Rated current for site conditions		A	1250	
	1.7	Interrupting capacity	magnetising current	A	NA	
			line charging current	A	NA	
	1.8	Short circuit withstand	Current	kA	31.5	
			Duration	Sec		
	1.9	Dynamic rated peak short circuit Current		kAp	78.75	
	1.10	One minute power frequency withstand Voltage		kV (rms)	To earth & between poles	Across isolating distance
					140	160
	1.11	1.2/50 µs impulse withstand Voltage		kVp	325	375
2.0 DESIGN REQUIREMENTS	2.1	Reference ambient temperature.		°C	45	
	2.2	Seismic Zone		G	Zone-II	
	2.3	Insulation level		Full/reduced	Full	
	2.4	Phase spacing		mm	2000	
	2.5	Earthing switch required		Yes / No	Yes (Qty. As per Sl. No: 1.2 above)	
	2.6	Type of break			Double Break	
	2.7	Type of mounting			Upright	
	2.8	Height of mounting above GL		mm	4900 (To bay bus Bottom Line)	
	2.9	Operating device	For isolator		Manual / Motorised	
			For earthing switch		Manual	
	2.10	Aux. Voltage for operating motor			240V AC	

DATA SHEET- A1						
SL. NO.		**PARTICULARS**			**UNIT**	**DATA**
	2.11	Orientation of operating mechanism box w.r.t isolator				Facility to mount on any side of isolator
	2.12	Auxiliary contacts for purchasers use	NO + NC			
			For main switch			6+6
			For earthing switch			4+4
			Make before break			2
3.0 INSULATOR	3.1	Rated voltage	kV			66
	3.2	Creep age distance.	Total		mm	1812.5
			Protected		mm	906.25
	3.3	Minimum strength	Torsional		kg	Shall meet design requirements
			Cantilever		kg m	
4.0 MISCELLANEOUS	4.1	Aux. Supply for Control	V & Hz /AC / V. DC			240V & 50Hz / 110V DC
	4.2	Clamps & Connectors.	Take off			Horizontal
			Size and material			2" IPS Al tube
	4.3	Interlocks with circuit breaker	Electrical	Type		110V DC Solenoid Switch
				Quantity		1 Each main and Earth Switch
				Code engraving		At contract Stage
			Mechanical	Type		Castle/ Kirk/ Yale
				Quantity		Vendor to furnish
				Code engraving		Vendor to furnish
	4.4	Interlock between Isolator and earth switches.	Mechanical	Type		Castle/ Kirk/ Yale
	5	Accessories				
	5.1	Isolator Control Switch (trip neutral close)	Quantity			1No.
	5.2	Local/ Remote Electric switch	Quantity			1No.
	5.3	Mechanical position indicator for Isolator				Required
	5.4	Mechanical Position indicator for earth switch				Required
5.0 TESTS	WHETHER TYPE TESTS ARE TO BE CARRIED OUT					VALID TEST REPORTS ARE ACCEPTABLE IN LIEU OF TYPE TESTING

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Note:

The Rating mentioned above is the minimum rating required, however the bidder can quote based on minimum ratings mentioned in IS standard.

DATA SHEET A2		
APPLICABLE STANDARDS		
1 Isolators	IS 1818, IS 9921	IEC 60129
2 Insulators	IS 2544	IEC 60168
3 Bushings	IS 2099,10314, 5621, 13134	IEC 60137
4 Large hollow porcelains	IS 5621	
5 Clamps & connectors	IS 5561	IEC 60305
6 Hot dip galvanising	IS 2629 IS 2633	

DATA SHEET B (To be filled in by the BIDDER and submitted with the BID)			
Sl. No.	**Item**	**Unit**	**Bidder's Data**
1.0	Maker's name & country of manufacture		
2.0	Manufacturer's type and designation		
3.0	Applicable standard		
4.0	Rated voltage	kV	
5.0	Maximum design voltage at which the isolator can operate	kV	
6.0	Frequency	Hz	
7.0	Current rating		
	a) Continuous at site conditions	A	
	b) Dynamic peak	kAp	
	c) One second	kA	
8.0	Derating factor, if any, for specified site conditions	Hz	
9.0	a) Reference ambient temperature b) Maximum temperature of current carrying parts when carrying rated current continuously	^{0}C ^{0}C	
10.0	Short circuit type test certificate or report enclosed	Yes/ No	
11.0	Insulation tests		
11.1	One min. power frequency wet withstand voltage a) Across the isolating distance b) To earth and between poles	 kV rms kV rms	
11.2	1.2 x 50 micro sec. impulse withstand voltage (+ & - polarity) a) Across isolating distance b) To earth and between poles	 kVp kVp	
12.0	a) Contacts and material of current carrying parts		
	b) Type of main and arcing contacts		
	c) Material of contacts Main Arcing		
	d) Whether contact are silver faced material used for current carrying parts	Yes/ No	

DATA SHEET B (To be filled in by the BIDDER and submitted with the BID)				
Sl. No.	**Item**		**Unit**	**Bidder's Data**
13.0	Capacity to interrupt magnetising current (@ pf.)		A	
14.0	Capacity to interrupt line charging current (@ pf.)		A	
15.0	Clearance a)Between poles		mm	
	b)Between live parts and earth		mm	
	c)Between live parts when the switch is open On the same pole Between adjacent poles		 mm mm	
16.0	Whether suitable for specified phase spacing		Yes/ No	
17.0	Type of interlocks	Electrical		
		Mechanical		
18.0	Torque required to operate the gang operated isolator		Kg-m	
19.0	INSULATOR DATA (for complete stack) Type Number of units Height of stack Bolt circle diameter Tensile strength Compressive strength Torsional strength Cantilever strength upright Power frequency dry flash-over voltage Power frequency wet flash-over voltage Impulse flash-over positive wave (1.2/50μs) Impulse withstand negative wave (1.2/50μs) power frequency puncture voltage Creepage distance Total Protected Visual discharge voltage Dry arcing distance		 Nos mm mm Kg Kg Kg-m Kg kV kV kVp kVp kV mm mm kV mm	
20.0	Switch design ROTATING/ TILTING/ LIFTING Horizontal/ Vertical break			
21.0	Operating mechanism	Isolator	Manual / Motor	
		Earth Switch		
22.0	Motor operating device Operating voltage Rated output of motor		 V kW	

DATA SHEET B (To be filled in by the BIDDER and submitted with the BID)			
Sl. No.	**Item**	**Unit**	**Bidder's Data**
23.0	Control Cubide a) Degree of Protection b) Whether all devices as per Data sheet A1 provided	 Yes/No	
24.0	Terminal stud Whether horizontal or vertical Diameter Length	 mm mm	
25.0	Clamps (if included in scope) Clamp body – Alloy composition Bolts – alloy composition Range of diameter of conductors that can be received Maximum temperature rise when carrying rated current above ambient Weight of each type of clamp Whether horizontal/ vertical take-off Flexible / rigid	 ^{0}C kg	
26.0	Base Size Weight	 mm kg	
27.0	Total weight of Isolator (3Ph) Metallic's only Isolator without Earth switch Isolator with Earth switch	 kg kg kg	
28.0	List of descriptive literature and drawings as called for in Clause 7 of specifications	Yes/ No	
29.0	Whether all type test reports as per latest Standard are enclosed	Yes/ No	
30.0	Whether all routine/ acceptance tests as per latest Standard will be carried out on each Isolator	Yes/ No	

6.7.1 EHV CT & PT

1.0 SCOPE:

1.1 This Specification covers the design, material, constructional features, manufacture inspection and testing at the VENDOR's Works and delivery to Site of outdoor electromagnetic type voltage transformers and current transformers.

2.0 CODES & STANDARDS:

2.1 The design, material, construction, manufacture, inspection, testing and performance of high voltage outdoor voltage and current transformers shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment will

be installed. The equipment shall also conform to the latest applicable standards. Nothing in this Specification shall be construed to relieve VENDOR of this responsibility.

2.2 Voltage and current transformers shall conform to the latest applicable standards specified in Data Sheet-A3. In case of conflict between the standards and this Specification, this Specification shall govern.

3.0 GENERAL REQUIREMENTS:

3.1 Secondary terminal box for voltage transformers shall include MPCB rating for protecting the secondary circuit Contact of the MPCB shall be brought out for remote supervision .Facility shall be provided for short circuiting and grounding the CT secondary at the terminal box. Glands and lugs for terminating PURCHASER's external cable connections shall be provided.

3.2 Terminal and polarity marks shall be indelibly marked on each CT on the associated terminals and these marks shall be in accordance with relevant standards.

3.3 The secondary terminal box for the voltage transformers shall also include necessary HRC fuses for protecting the secondary circuit. Further, for the purpose of fuse supervision on remote panel both terminals of fuse shall be brought out to the terminal box.

3.4 Voltage and current transformers shall be provided with the following accessories:

a) H.V. connectors for the PURCHASER's conductor.

b) Two earthing terminals on tanks on opposite sides for connecting the PURCHASER's earthing conductors specified in Data Sheet - A1/A2.

c) Oil level gauge

d) Filling & draining plugs

e) Facility for lifting bushings and tanks

f) Insulating oil required for first filling. Power factor of the transformer oil shall not exceed 0.005. Insulation oil shall comply with applicable standards.

g) Rating and diagram plate as per relevant standards.

3.5 Voltage and current transformers shall be given tropicalised treatment for satisfactory operation in hot and humid climate.

3.6 PT/CT assembly shall be suitably braced to withstand stresses induced due to a seismic coefficient indicated in Data Sheet - A1/A2.

3.7 The temperature rise shall not exceed the figures given in applicable standards for operation under ambient temperature conditions specified in Data Sheet - A1/A2.

3.8 The tanks/base and all exposed ferrous parts shall be hot dip galvanised conforming to applicable standards.

3.9 Each CT shall, when called for in Data Sheet-A2, be equipped with an over voltage protective device to limit the voltage developed across the secondary terminals to a safe value not exceeding 3 kV. The protective device shall not require attention after it has operated and shall not interfere with the proper operation of relays or instruments connected to the secondary circuits.

3.10 In the case of multi-core CTs, it shall be possible to adjust the tap settings on any core independent of the setting on the other cores, for which purpose these tappings will have to be provided on the secondary windings.

3.11 All CT cores under this Specification shall be of low reactance type.

3.12 No turns compensation shall be used in case of class 'PS' CTs. Turns compensation, if any, should be clearly brought out in the offer in Data Sheet-B.

3.13 In case of multi ratio CTs, the minimum specified requirements in respect of VA, accuracy and Knee Point Voltage and maximum secondary resistance specified shall be met at all taps.

3.14 Magnetising characteristics (extending well beyond KPV) and secondary impedance values shall be furnished in Data Sheet - B for all protection cores.

3.15 Whenever a PT secondary winding is used for both measurement and protection application, it shall have dual accuracy class of 0.5/3.0, unless otherwise specified.

3.16 In case of unearthed voltage transformers both the terminals of the primary winding shall be brought out through bushings rated for full line voltage. In case of earthed voltage transformers, the end of the primary winding intended to be earthed shall be brought out through a bushing and earthing connection shall be made outside. This is required to facilitate meggering of the primary winding for which the earth connection has to be removed. The neutral side bushings of the voltage transformers shall be rated for 1.1 kV class.

4.0 INSULATORS/BUSHINGS:

4.1 Insulators/Bushings shall conform to applicable standards and shall be made of homogenous vitreous porcelain, the glazing of which shall be of uniform brown or dark brown colour.

4.2 Oil filled insulator/bushings shall be hermetically sealed to prevent ingress of moisture. A cushion of nitrogen gas shall be provided to allow for expansion. For 123 kV and above, oil-filled condenser type insulator/bushing shall be used.

4.3 Bushings for use in systems of nominal voltage rating 123 kV and above shall be provided with grading rings and arcing horns, if specified in Data Sheet-A1.

5.0 TESTS:

5.1 The following routine tests shall be carried out on all electromagnetic PT's in the presence of the PURCHASER / PURCHASER's authorised representative:

a) Verification of terminal markings and polarity.

b) Power frequency tests on primary windings.

c) Power frequency tests on secondary windings.

d) Determination of errors according to the requirements of the appropriate accuracy class.

5.2 The following routine tests shall be carried out on all CT's in the presence of the PURCHASER / PURCHASER's authorised representative:

a) Verification of terminal markings and polarity.

b) High voltage power frequency test on primary windings.

c) High voltage power frequency test on secondary windings.

d) Over voltage inter-turn test.

e) Determination of errors according to the requirements of the appropriate accuracy class.

5.3 The following routine tests shall be carried out on all bushings in the presence of the PURCHASER / PURCHASER's authorised representative:

a) Visual examination.

b) One minute dry withstand test.

c) Oil tightness test.

d) Partial discharge test.

e) Test for capacitance and power factor measurement.

5.4 The following type tests shall be carried out on one of the PT's, if specified in Data Sheet - A1 and a type test certificate for type tests carried out on another PT or identical design shall be furnished. Extra price, if any, for carrying out the type tests shall be indicated in relevant price schedule.

a) Verification of terminal markings and polarity.

b) Power frequency tests on primary windings.

c) Power frequency test on secondary windings.

d) Determination of errors according to the requirements of the appropriate accuracy class.

e) Temperature rise test.

f) Impulse voltage test on voltage transformers for service in electrically exposed installations.

g) Setting of the protective gap.

h) Radio influence voltage test.

5.5 The following type tests shall be carried out on one of the CT's, if specified in Data Sheet-A2 and a type test certificate for type tests carried out on another CT of identical design shall be furnished. Extra price, if any, for carrying out the type tests shall be indicated in relevant price schedules.

a) Verification of terminal markings and polarity

b) High voltage power frequency test on primary windings

c) High voltage power frequency test on secondary windings

d) Over voltage inter-turn test

e) Determination of errors according to the requirements of appropriate accuracy class

f) Short time current test

g) Temperature rise test

h) Impulse voltage test

i) Setting of protective gap

j) Radio influence voltage test

5.6 The following type tests shall be carried out on one of the bushings or a type test certificate for type tests carried out on another bushings of identical design shall be furnished:

a) Power frequency visible discharge test

b) One minute power frequency withstand test

c) Full wave impulse voltage withstand test

d) Under oil flashover or puncture withstand test

6.0 DRAWINGS:

Complete assembly drawing plan and elevation views of the current and voltage transformers incorporating mounting dimensions, overall dimensions, weight, details of terminal studs etc. shall be submitted with the offer.

6.7.2 EHV CT & PT Datasheets

DATA SHEET - A1 (VT & CVT)				
Sl. No		**Description**		**Data**
1.0 GENERAL	1.1	Designation		NA
	1.2	Type		
	1.3	Quantity		
	1.4	Nominal system voltage & Frequency (kV & Hz)		
	1.5	Highest system voltage (kV)		
	1.6	System neutral earthing	a) Type	
			b) Co. eff of earthing	
	1.7	Standard for insulation withstand characteristics STD I / STD II		
2.0 DESIGN REQUIREMENTS	2.1	1 Rated primary voltage (kV)		
	2.2	2 Rated secondary voltage	S1 V	
			S2 V	
	2.3	3 Winding material		
	2.4	Method of connection	Primary winding	
			Secondary winding S1	
			S2	
	2.5	Application	S1	
			S2	
	2.6	Rated burden	S1 VA	
			S2 VA	
	2.7	Rated power factor	S1	
			S2	
	2.8	Accuracy class	S1	
			S2	
	2.9	Rated voltage factor		
	2.10	Class of winding insulation		
	2.11	Max. winding temp. at 110% excitation & rated burden in oil		
	2.12	Creepage distance	Total (mm)	
			Protected (mm)	
	2.13	Secondary cable/conduit size		
	2.14	Earthing conductor	Material	
			Size	
	2.15	Seismic coefficient		
	2.16	1.2/50 μ sec. impulse withstand +ve & -ve kV(peak)		
	2.17	One min. power frequency withstand kV(rms)		

DATA SHEET - A1 (VT & CVT)			
Sl. No		**Description**	**Data**
3.0 TEST	3.1	Whether type tests to be carried out as per Cl.5.4 of Section 4(Yes/No)	NA
4.0 ESSENTIAL SPARES	4.1	Complete set of gasket	
	4.2	Bushing	
	4.3	Insulating Oil	
	4.4	Oil filling draining & sampling plug	
	4.5	Oil level gauge	

DATA SHEET – A2 (CT)				
SL. No		**Description**		**Data**
1.0 GENERAL	1.1	Designation		Current Transformer
	1.2	Type		Porcelain Clad, Oil filled, Live tank design
	1.3	Quantity		Refer SLD and Electrical BOQ
	1.4	Nominal system voltage & frequency (kV & Hz)		66 & 50
	1.5	Highest system voltage (kV)		72.5
	1.6	System neutral earthing	a) Type	Solidly earthed
			b) Co.eff of earthing	≤0 8
	1.7	Number of cores		3
2.0 PRIMARY CURRENT RATING	2.1	Primary current (A)		Refer SLD
	2.2	Extended primary current rating (clause 4 of IS 2705 Part-II) (A)		As per IS
	2.3	Short time thermal rating	Current (kA)	31.5
			Duration (Sec.)	1
	2.4	Dynamic rating (kA peak)		78.75
3.0 INSULATION	3.1	Class of insulation		Oil filled
	3.2	Maximum temperature rise of winding	Ambient (^{O}C)	45
			Temp. Rise (^{O}C)	40
	3.3	1.2/50 μ sec. impulse withstand +ve & -ve (kVpeak)		325
	3.4	One min. power frequency withstand (kVrms)		140
4.0 TESTS	4.1	Whether type tests to be carried out as per clause 5.5 of Section – 4 Yes/No		Test cert. of similar CT is acceptable.
5.0 MISCELLANEOUS	5.1	Creepage distance Total / Protected (mm)		1812.5 / 906.25
	5.2	Secondary cable / conduit size		Up to 10 Sq.mm Copper Conductor
	5.3	Earthing conductor	Material	GS
			Size mm	50x10
	5.4	Design seismic Zone		Zone II
	5.5	Whether arcing horns on bushing required Yes/No		NA
	5.6	Whether pressure relief valve required Yes/No		Yes
	5.7	Special requirement if any		CT's shall be hermetically sealed and nitrogen cushion shall be provided.

VI. DESIGN DETAILS												
Item No.	Core No.	Application	Current Ratio (A/A)	Rated extgernal	Accuracy class as per IS:0705 or	Accuracy limit factor	Instrument security	Min. knee point voltage	Max. CT sec. wdg. resis	Max. exciting current (MA) at voltage	Over voltage protective device across secondary (as per clause	Quantity (Nos)
Transformer Bay CT	Refer SLD											

VII. ESSENTIAL SPARES		
1.	Complete set of gasket	One set
2.	Bushing	1 No
3.	Insulating Oil	Not required
4.	Oil filling draining & sampling plug	1 No each
5.	Oil level gauge	1 No

Note: - For multi ratio CT core, the ratio to be used is underlined. All parameters specified shall be applicable for the underlined ratio.

DATA SHEET – A3 APPLICABLE STANDARDS				
1.	Current transformers	IS 2705	BS 3938	IEC 60185
2.	Voltage transformers	IS 3156	BS 3941	IEC 60186
3.	Capacitor Voltage Transformer	IS 9348 & IS: 3156 (part IV) IEC		
4.	Insulating Oil	IS 335 60296	BS 148	IEC
5.	Bushings	IS 2099 60137	BS 223	IEC
6.	Large hollow porcelains	IS 5621	BS	IEC
7.	Insulators	IS 2544	BS 3297	IEC 60168
8.	Hot dip galvanising	IS 2629 IS 2633	BS 729	IEC

DATA SHEET - B1 (VT)

Note to Bidders: This data sheet shall be filled up COMPLETELY. This original with a copy shall be forwarded with the bid. Notes, catalogues etc. enclosed with the bid shall be listed in the Data Sheet B.

Sl. No.	Item	Unit	Bidder's Data
1.0	Applicable standard		NA
2.0	Designation		
3.0	Number of PT's		
4.0	Insulation withstand level		
4.1	Impulse withstand voltage 1.2/50 micro sec. wave	kV peak	
4.2	One minute power frequency withstand voltage	kV rms	
5.0	Number of secondary windings for each PT		
6.0	Rated primary voltage	kV	
7.0	Rated secondary voltage	V	
8.0	Rated VA burden for each secondary winding	VA	
9.0	Rated power factor		
10.0	Accuracy class for each secondary winding Winding - 1 Winding - 2 Winding - 3 Winding - 4		
11.0	Method of connection		
11.1	Primary winding		
11.2	Each secondary winding Winding - 1 Winding - 2 Winding - 3 Winding - 4		
12.0	Rated voltage factor		
13.0	Maximum temperature rise of winding at 110% excitation and rated burden, when referred to specified ambient temperature	^{O}C	NA
14.0	Class of insulation of windings		
15.0	Creepage distance :		
15.1	a) Total	mm	
15.2	b) Protected	mm	

DATA SHEET - B1 (VT)

Note to Bidders: This data sheet shall be filled up COMPLETELY. This original with a copy shall be forwarded with the bid. Notes, catalogues etc. enclosed with the bid shall be listed in the Data Sheet B.

Sl. No.	**Item**	**Unit**	**Bidder's Data**
16.0	Radio influence voltage (for PT's rated at 220 kV and above)	Volts	
17.0	Details of high speed switch(es) on secondary winding (alternative to fuses)		
	a) Make, type, rating		
	b) Coil rating	Amp	
	c) Other technical details		
18.0	Type test certificate enclosed	Yes/No	
19.0	Technical/Description manual enclosed with Bid	Yes/No	

DATA SHEET - B2 (CT)

Note to Bidders:

This data sheet shall be filled up COMPLETELY. This original with a copy shall be forwarded with the bid. Notes, catalogues etc. enclosed with the bid shall be listed in the Data Sheet B.

Sl. No.	Description	Unit	Bidder's Data
1.0	Applicable standard		
2.0	Type of CT's		
3.0	Number of CT's		
4.0	Insulation withstand level	kV	
4.1	Impulse withstand voltage 1.2/50 micro sec. wave	kV peak	
4.2	One minute power frequency withstand voltage	kV rms	
5.0	Number of cores per CT		
6.0	Rated primary current for each core I_1 I_2 I_3 I_4 I_5	 A A A A A	
7.0	Rated secondary current for each core Core 1 Core 2 Core 3 Core 4 Core 5	 A A A A A	
8.0	a) Ratio taps for each core Core 1 Core 2 Core 3 Core 4 Core 5		
	b) Whether it is possible to adjust tap setting of any core independent of other cores	Yes/No	
9.0	Turns ratio for each core Core 1 Core 2 Core 3 Core 4 Core 5		
10.0	Application		
10.1	Core 1		
10.2	Core 2		

DATA SHEET - B2 (CT)

Note to Bidders:

This data sheet shall be filled up COMPLETELY. This original with a copy shall be forwarded with the bid. Notes, catalogues etc. enclosed with the bid shall be listed in the Data Sheet B.

Sl. No.	Description	Unit	Bidder's Data
10.3	Core 3		
10.4	Core 4		
10.5	Core 5		
11.0	For relaying cores (Data shall be furnished for all ratio taps. Bidder shall furnish data against sub items 1,2 and 3 or 4, 5 and 6, as may be applicable for that particular core)		
11.1	Accuracy class		
11.2	Rated burden	VA	
11.3	Accuracy limit factor		
11.4	Minimum knee point voltage V_K	Volts	
11.5	Maximum excitation current at V_K / $^{1/2}$ V_K Rated power factor	mA	
11.6	Maximum secondary resistance	Ohms	
12.0	For metering cores: (Data shall be furnished for all ratio taps)		
12.1	Accuracy class		
12.2	Rated burden	VA	
12.3	Rated power factor		
12.4	Instrument security factor		
13.0	Short time thermal current rating		
13.1	Current	kA	
13.2	Rated time	Sec.	
14.0	Dynamic current rating	kA peak	
15.0	Maximum temperature rise of windings at rated primary current and rated burden, when referred to specified ambient temperature	^{O}C	
16.0	Class of insulation of windings		
17.0	Magnetisation characteristics Mfr's Dwg. No.		
18.0	Recommended setting of protective device (spark gap, etc.)		

DATA SHEET - B2 (CT) **Note to Bidders:** This data sheet shall be filled up COMPLETELY. This original with a copy shall be forwarded with the bid. Notes, catalogues etc. enclosed with the bid shall be listed in the Data Sheet B.			
Sl. No.	**Description**	**Unit**	**Bidder's Data**
19.0	Gap setting flash over characteristics Mfr's Dwg. No.		
20.0	Creepage distance a) Total b) Protected	 mm mm	
21.0	Radio influence voltage (For CT's rated at 220KV & above)	V	
22.0	Secondary impedance value	Ohms	

6.8.1 Lightning Arrestor

1.0 SCOPE:

This Specification covers the design, material, constructional features, manufacture and testing at the VENDOR's Works and delivery to Site of non-linear, resistor type lightning arrestor for alternating current systems and suitable for outdoor installation.

2.0 CODES & STANDARDS:

2.1 The design, material, construction, manufacture, inspection and testing of lightning arrestors shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment will be installed. The equipment shall also conform to the latest applicable standards. Nothing in this Specification shall be construed to relieve VENDOR of this responsibility.

2.2 Lightning arrestors shall conform to the latest applicable standards as mentioned in Data Sheet-A. In case of conflict between the standards and this Specification, this Specification shall govern.

3.0 DESIGN FEATURES:

3.1 Constructional Features

3.1.1 Lightning arrestors shall be of the hermetically sealed type of self supporting construction, suitable for mounting on concrete or steel structures. They shall have adequate thermal discharge capacity for severe switching surges, long duration surges and multiple strokes. The lightning arrestors when provided with pressure relief devices shall be capable of withstanding the internal pressures developed during the above discharges without operation of the pressure relief devices. Alternatively, if specified in Data Sheet-A, the lightning arrestors shall be explosion-proof.

3.1.2 Spacers for gaps and valve elements or valve blocks shall be of ceramic material. These shall be provided in such a way as to obtain robust construction, with excellent mechanical and electrical properties.

3.1.3 Outer insulators shall be of porcelain having adequate mechanical strength and rigidity, for satisfactory operation under climatic conditions obtaining at Site. Porcelain shall be finely glazed and shall be free from imperfections.

3.1.4 Arrestors shall be designed to withstand seismic acceleration and wind pressure as specified in Data Sheet-A.

3.1.5 Arrestors shall incorporate anti-contamination feature to prevent arrestor failure, consequent to uneven voltage gradient across the stack in the event of contamination of the arrestor porcelain. These features shall be described in detail when submitting the Bid.

3.1.6 Arrestors shall be suitable for hot line washing.

3.1.7 All metal parts shall be of non-rusting and non-corroding metal. Bolts, screws and pins shall be provided with lock washers, keys or equivalent locking facilities. All similar parts, particularly removable ones, shall be interchangeable.

3.1.8 Arrestors shall be capable of spark over on frequent switching surges.

3.1.9 Arrestors shall be capable of discharging over-voltages occurring during switching of unloaded transformers, capacitor banks and long lines.

3.2 Accessories

3.2.1 Supporting Arrangement

Arrestors shall be complete with insulating boxes having provision for bolting to flat surface of supporting structure. Supporting structure is included in the scope of supply of the VENDOR. The VENDOR shall furnish detailed dimensional drawings indicating all fixing details and electrical clearance diagram for installation.

3.2.2 Discharge Counter

a) Self contained discharge counter, suitably enclosed for outdoor use and requiring no auxiliary or battery supply shall be provided for each single pole unit when specified in Data Sheet-A. The discharge counter shall be visible through an inspection window. The counter terminals shall be robust and shall be so located that incoming and outgoing connections are made with minimum possible bends. Suitably sized bypass shunts of copper to facilitate bypassing the discharge counter shall be furnished. The design of the terminal connectors shall permit the connection of these shunts.

b) The connecting conductor from lightning arrestor earth terminal to the discharge counter incoming terminal to the discharge counter incoming terminal shall be insulated for a minimum of 4 kV and this insulated conductor shall be supplied along with the arrestor by the VENDOR. This insulating conductor shall be of the type which does not require sealing ends or plumbed joints at its either end for terminations.

c) A leakage current detector as an integral part of the discharge counter shall be supplied. The counter along with the detector shall be so arranged that it will be possible to read the leakage current values from ground level. The value of leakage current beyond which the operation is abnormal shall be clearly marked in red colour on the detector.

3.2.3 Grading Rings

Grading rings shall be provided on each complete arrestor unit for proper stress distribution as dictated by the voltage class of the arrestor.

3.2.4 Terminals

Arrestor shall be complete with line and earth terminals. The terminal clamps/connectors on the earth terminal of the arrestors and the discharge counter incoming and outgoing terminals shall be within the scope of the VENDOR.

3.2.5 Name Plates

Each lightning arrestor shall be provided with non-rusting and non-corroding name plate bearing Arrestor Identification as per applicable standards.

4.0 TESTS:

4.1 Type tests shall be carried out as per relevant standards in the presence of the PURCHASER / PURCHASER's authorised representative. Type test certificates for any additional tests, if specified in Data Sheet-A, shall also be furnished. Extra price, if any, shall be indicated in price schedule.

4.2 Routine shop tests as per applicable standards shall be carried out on the arrestors in the presence of the PURCHASER / PURCHASER's authorised representative. Additional acceptance tests over and above those specified in applicable standards shall be carried out as and when specified in Data Sheet-A.

5.0 DRAWINGS:

5.1 Drawings incorporating the following particulars shall be submitted with the Bid:

5.1.1 Complete assembly drawing plan and elevation views of arrestors incorporating mounting dimensions, overall dimensions, weight, electrical clearances for installation, details of terminal studs etc.

5.1.2 Description of arrestor offered giving performance, salient features, ratings, features to make the arrestor explosion-proof, anti-contamination feature, suitability for hot line washing etc.

5.1.3 Volt/ time characteristic of the arrestor.

6.8.2 Lightning Arrestor Datasheets

DATA SHEET - A1				
SL. No.		**DESCRIPTION**	**UNIT**	**DATA**
1.0 GENERAL	1.1	Designation		Gapless ZnO, Lightning Arrestor
	1.2	Quantity	Nos	3
	1.3	Installation		Outdoor
	1.4	Class		Station Class (Class-3)
	1.5	Type of Connection		Phase to earth
	1.6	Applicable standard		IEC 60099
2.0 RATING	2.1	Rated arrestor voltage	kV	60
	2.2	Rated frequency	Hz	50
	2.3	Nominal discharge current of 8/20 micro sec. wave shape	kA (peak)	10
3.0 PERFOR	3.1	High current impulse withstand (4/10 μS wave).	kA(peak)	100
	3.2	Minimum switching surge spark over voltage	kV(peak)	160

DATA SHEET - A1					
SL. No.		**DESCRIPTION**		**UNIT**	**DATA**
	3.3	Maximum switching surge (30/60μS) residual voltage at 1kA peak		kV(peak)	136
	3.4	Maximum leakage current at rated operating voltage		mA	Resistive < 0.4 Capacitive < 1.5
	3.5	Maximum residual voltage at rated nominal discharge current		kV_{peak}	168
	3.6	Maximum residual voltage at Steep front impulse (1x20μs) at rated nominal discharge current		kV_{peak}	
4.0 DESIGN DATA	4.1	Discharge class (as per IEC - 60099)			III
	4.2	Min. discharge capability of arrestor		kJ/kV	7.5
	4.3	Maximum continuous operating voltage (MCOV)		kV_{rms}	51
	4.4	Temporary overvoltage withstand capacity at 1.0 sec		kV_{peak}	102
	4.5	Seismic Zone		g	Zone II as per IS 1893
	4.6	Wind velocity		m/ sec	
5.0 INSULATION	5.1	Withstand test voltages a) One minute power frequency dry & wet b) 1.2/50 μS Impulse		kV(rms) kV(peak)	 140 325
	5.2	Min creepage Distance a) Total b) protected		mm mm	 1812.5 906.25
6.0 ADDITIONAL REQUIREMENTS	6.1	Min. cantilever strength of arrestor assembly		KG	As per manufacturer's standard
	6.2	Max. radio interference voltage (as per NEMA-LA1, 1962)		μV	NA
	6.3	No visual discharge up to a voltage of		kV	NA
	6.4	Pressure relief class (as per IEC-60099) / IS 3070			A
	6.5	Current for pressure relief test		kA	40
	6.6	Special design requirement with regard to harmonic content in supply voltage			NA
	6.7	Accessories Required Yes/No	a) Discharge counter		Yes
			b) Leakage current monitor		Yes

DATA SHEET - A1					
SL. No.		**DESCRIPTION**		**UNIT**	**DATA**
			c) Grading rings		NA
			d) Clamps & connectors on arrestor terminals		Yes
	6.8	Purchaser's conductor sizes	a) Line side terminal		2" IPS AL Tube
			b) Earth side terminal		50 x 10 GS
7.0 TESTS	7.1	Test certificates in addition to those specified in IS:3070(Part I)	a) Type test		As per IEC to be submitted with the bid
			b) Acceptance tests		As per IEC

DATA SHEET A2			
APPLICABLE STANDARDS			
1.	Lightning Arrestor	IS 3070	IEC 60099
2.	Bushings	IS 2099 BS 223 IEC 60137 IS 10314, 5621 13134	
3.	Hot dip galvanising	IS 2629 BS 729 IEC IS 2633	
NOTES :Equipment, associated accessories, component/parts raw material and tests shall in general conform TO ---√-- IS ---------- BS ----------			

DATA SHEET-B (This data sheet shall be filled up COMPLETELY. This original with a print shall be forwarded with the bid. Notes, catalogues etc. enclosed with the bid shall be listed in the Data Sheet B)			
SL. NO.	**DESCRIPTION**	**UNIT**	**BIDDER'S DATA**
1.0	Maker's Name		
2.0	Country of manufacture		
3.0	Manufacturer's type designation		
4.0	Applicable standards		
5.0	Arrestor class and type		
6.0	Rated arrestor voltage	kV	
7.0	Rated frequency	Hz	
8.1	Nominal discharge current (8/20 micro sec. wave)	kA	
8.2	Minimum discharge capability	kJ/kV	
9.0	Maximum 100%, 1.2/50 micro-second spark over voltage	kV(peak)	
10.1	Minimum switching surge spark over voltage	kV(peak)	
10.2	Maximum switching surge spark over voltage	kV(peak)	
11.1	Maximum front-of-wave spark over voltage	kV(peak)	
11.2	Virtual steepness of front		
11.2.1	Rate of rise	kV/micro sec	
11.2.2	Time to spark over	kV(rms)	
12.0	Minimum dry and wet power frequency spark over voltage	kV(rms)	
12.1	Power frequency withstand voltage for : a) 30 sec b) 1 min	 kV(rms) kV(rms)	
13.0	Maximum residual voltage at nominal discharge current	kV(rms)	
14.1	Discharge voltage at 5 kA discharge current	kV(peak)	
14.2	Discharge voltage at 10 kA discharge current	kV(peak)	
14.3	Discharge voltage at 20 kA discharge current	kV(peak)	
15.0	Minimum reseal voltage of arrestor	kV(rms)	
16.0	Impulse current withstand :		

DATA SHEET-B (This data sheet shall be filled up COMPLETELY. This original with a print shall be forwarded with the bid. Notes, catalogues etc. enclosed with the bid shall be listed in the Data Sheet B)			
SL. NO.	**DESCRIPTION**	**UNIT**	**BIDDER'S DATA**
16.1	High current short duration (4/10 micro-sec wave)	kA(peak)	
16.2	Low current long duration	kA(peak)	
16.3	Virtual duration of rectangular wave	micro. sec	
17.0	One minute power frequency(dry) withstand voltage of arrestor housing	kV(rms)	
18.0	Impulse withstand test voltage of arrestor housing with 1.2/50 micro-sec wave	kV(peak)	
19.1	Total creepage distance of whole arrestor housing	mm	
19.2	Minimum protected creepage distance (at 90 deg)	mm	
20.0	Cantilever strength of complete arrestor	Kg	
21.0	Total height of the arrestor	mm	
22.0	Total weight of complete arrestor	Kg	
23.0	Maximum radio interference voltage (only for arrestors for systems rated 220 kV and above) at test voltage	V	
24.0	Visual discharge level for falling power frequency voltage	kV	
25.0	Pressure relief class (as per IEC 60099)		
26.0	Range of milli-ammeter provided for leakage current measurement	mA	
27.0	Drawings/information as called for under clause 5.0 Section D of this specification submitted with the bid	Yes/No	
28.0	Type tests carried out on similar arrestors :		
	a) Power frequency voltage spark over test	Yes/No	
	b) Standard lightning impulse spark over test	Yes/No	
	c) Lightning impulse spark over voltage/time curve test	Yes/No	
	d) Switching voltage spark over voltage/time curve test	Yes/No	

DATA SHEET-B (This data sheet shall be filled up COMPLETELY. This original with a print shall be forwarded with the bid. Notes, catalogues etc. enclosed with the bid shall be listed in the Data Sheet B)			
SL. NO.	**DESCRIPTION**	**UNIT**	**BIDDER'S DATA**
	e) Residual voltage test	Yes/No	
	f) Current impulse withstand tests	Yes/No	
	g) Operating duty tests	Yes/No	
	h) Pressure relief tests	Yes/No	
	i) Tests of arrestor	Yes/No	
	j) Tests on arrestor disconnects	Yes/No	
29.0	Routine acceptance tests which will be carried out on the arrestors to be supplied		
	a) Dry power frequency voltage spark over test on complete arrestor	Yes/No	
	b) Standard lightning voltage impulse spark over test on complete arrestor	Yes/No	
	c) Residual voltage test at the nominal discharge current (only when agreed between Manufacturer and Purchaser)	Yes/No	

6.9.1 66kV Control Relay Panel

1.0 SCOPE:

1.1 This specification covers the design, material, construction features, manufacture, inspection and testing at the VENDOR's/his SUB-VENDOR's Works, delivery to site and performance testing of relay and control panels for control and protection of equipment.

2.0 CODES AND STANDARDS:

2.1 The design, material, construction, manufacture, inspection, testing and performance of control panel shall comply with all currently applicable statutes, regulations and safety codes as noted below. The equipment shall also conform to the latest applicable standards mentioned in Data sheet A2. Nothing in this specification shall be constructed to relieve the VENDOR of this responsibility.

2.2 Supply items which are bought out by the VENDOR shall be procured from approved manufacturers acceptable to the PURCHASER/ENGINEER.

3.0 CONTROL AND RELAY PANELS:

3.1 Constructional features:

3.1.1 The Control Panels shall be simplex/ duplex/ desk type as specified in Data sheet A.

3.1.2 Control Panels shall be sheet steel enclosed and shall be dust, weather and vermin proof providing an enclosure degree of protection of IP 54. Sheet steel used shall be cold rolled and at least 2.0mm thick and properly braced to prevent wobbling.

3.1.3 Control and Relay Panel must comprises with Bay control unit and Bay Protection unit. In addition, IED should support for IEC61850.

3.1.4 Control Panels shall be provided with hinged door(s) with locking arrangement and suitable channels shall be provided for floor mounting.

3.1.5 The top surface must be suitable for lifting the panel and lifting eyes shall be fitted. Adequate strengtheners must be incorporated and longer panels (over 2000mm, depending on the panel structure) shall have a lifting beam fitted across the whole length of the panel.

3.1.6 All doors, removable covers and plates shall be gasketed all round with neoprene gaskets. All accessible live connections shall be shrouded and it shall be possible to change individual switches, MCBs etc., without danger of contact with live metal. Component access shall be from front and rear, unless front access only has been agreed.

3.1.7 Door locks shall be key operated to open. The doors shall lock itself on closure. Preferred lock is flush T type. Safety interlock switches to be fitted to all doors of sections that are not intended to permit access to non-electrical personnel. Standard micro switches are not permitted to be used for door interlock switches.

3.1.8 All live parts shall be provided with at least phase to phase and phase to earth clearances in air of 25 mm and 20 mm respectively.

3.1.9 Adequate interior cabling space and suitable removable cable gland plates shall be provided. Necessary number of cable glands shall be supplied and fitted on to this gland plate. Cable glands shall be screwed-on type and made of brass. The cable entry shall be from top or bottom as specified in Data sheet A1.

3.2 Control supply:

3.2.1 The DC Control Voltage shall be as specified in Data sheet A1. Any other DC Voltage required by the bidder shall be derived from the above voltage.

3.2.2 AC control equipment if any, shall be suitable for operation on 110V AC, 1 phase, 50 Hz, centre tap earthed system. This supply shall be obtained from station UPS supply.

3.2.3 Duplicate control supply feeders with auto changeover shall be provided.

3.3 Auxiliary power supply:

3.3.1 A separate feeder controlled by a DP MCB shall be taken for 1 phase, 240 V, 50Hz supply for panel space heating and lighting.

3.4 Miniature Circuit Breaker (MCBs):

3.4.1 MCBs shall be hand operated, air break, heavy duty, quick make, quick break type conforming to applicable standards.

3.4.2 MCBs shall be provided with overload/short-circuit protective device.

3.4.3 MCBs shall be provided with locking facility in OFF position.

3.5 Space heater:

3.5.1 Strip type space heaters of adequate capacity shall be provided inside each panel. Heaters shall be complete with a single-pole MCB with overload and short circuit protection on phase side, a link on the neutral and a humidistat to cut off the heater at 50% relative humidity.

3.6 Interior lighting and receptacle:

Control panel shall be provided with a 240 V, 1 phase, 50 Hz, lighting fixture with 15Watts power saver bulb for interior illumination controlled by a door limit switch and 240 V, 1 phase, 5 Amp, 2pin earth receptacle.

3.7 Panel internal wiring:

3.7.1 Control panel shall be supplied completely wired, ready for the PURCHASER's external connections at the terminal blocks. All control and auxiliary wiring shall be carried out with 1100V grade, XLPE/ FRLS-PVC insulated, flexible multi stranded Cu conductors. Power circuits shall be wired with flexible multi stranded copper conductors of adequate sizes to suit the rated circuit current. The minimum size shall be 4 sq.mm.

3.7.2 Engraved identification ferrules, marked to correspond with the wiring diagram shall be fitted at both ends of each wire. All wiring shall be terminated on terminal blocks. Terminals shall be adequately rated for the circuit current, the minimum rating shall be 10A.

3.7.3 Clearance between terminal blocks and gland plate and between two rows of terminal blocks shall be minimum 200 mm, if two or more rows are required. Terminals for AC & DC circuits with different voltages have to be grouped and separated by barriers. No live surfaces shall be exposed (covers or recessed terminals shall be provided).

3.7.4 Terminal blocks for CT & VT secondary leads shall be provided with test links and isolating facilities. Also CT secondary leads shall be provided with short circuiting and testing facilities.

3.7.5 The terminal blocks of CTs shall be suitable for connecting up to 4.0 sq. mm. Copper conductor.

3.7.6 Power circuits and control circuits must not be mixed - their components shall be separated by means of layouts and barriers.

3.7.7 Wiring for controls and power shall be kept separate as far as is practicable.

3.7.8 All cable ends to be separately terminated with the appropriately sized and shaped lugs. As far as practicable, lugs will be of the compression type (as opposed to the soldered type) being fitted using the correct crimping tool.

3.7.9 If terminal blocks of the "spring clamp technology" are being used the cable ends shall be prepared by removing correct length of insulation and terminating the exposed copper conductor into terminal block ensuring that no bare copper conductor is exposed outside the terminal block.

3.7.10 Cable shall be run continuously from terminal to terminal without joints or splices. Grouping of conductors at one terminal will not be accepted, a separate terminal shall be provided for each wire.

3.7.11 The number of wires put through trunking inside the panel must not exceed the maximum number permitted by regulation or manufacturers.

3.7.12 Wires inside trunking must be arranged in a tidy manner with cable ties and must be properly supported so that they do not fall out when the cover is removed. Adequate spare capacity of at least 10% available space must be left within each trunking for future expansion.

3.7.13 Unless requested otherwise, cable colour shall comply with relevant Indian Standard Specifications which is summarised in the following table

APPLICATION	COLOUR
Control circuit. (AC)	Red
Interlocking circuit.	Orange
Control circuit. (DC)	Blue
Earth circuit	Green with yellow stripes
Neutral circuit	Black
3 Ph Power circuit	Red/Yellow/Blue

3.7.14 Trip circuit shall be provided with ferrule 'T' at both ends of the connection.

3.8 Earthing:

3.8.1 Main Busbar: One main copper busbar of size as specified shall be provided. The busbar shall be indelibly marked with green and yellow to identify it as earth busbar (stripes or dots).

3.8.2 Earth Lead: Earth terminal of control gear components mounted inside the panel shall be connected to main earth busbar by means of individual earth leads or by forming a ring using adequately sized wires. VENDOR shall submit calculations for the same.

3.8.3 Earth connections: For termination on to main earth bus bar lug and stud type terminals shall be used with adequate number of pre-drilled holes of appropriate sizes. Insulated wires used for earthing shall be of green or yellow colour.

3.8.4 Main earth stud: 2 Nos. of main earth studs one at each end of the earth bus shall be provided for terminating PURCHASER's earth conductor. It must withstand the short circuit current specified.

3.8.5 Auxiliary Earth Rails: Auxiliary Earth Rails (e.g., component mounting DIN rails) can be used under the following conditions:

a) They are directly connected to main earth bar via a suitably sized earth lead

b) Internal earthing and bonding must only be done on main earth busbar.

c) Signal terminations for outgoing/incoming signals, to be mounted on such rails.

3.8.6 Earth Terminals: All earth terminals shall be of green or yellow colour or provided with earth symbol for easy identification.

3.9 Electromagnetic compatibility:

3.9.1 EMC compliance for panels housing sensitive electronic equipment shall be provided by means of additional shielding to panel, with high conductivity copper sheets. Earth leads for EMC purposes shall be of flexible copper braids.

3.9.2 Cross bonding between different parts of panel is allowed to ensure equi-potential within the panel. Any source of interference like transformers and chokes mounted in panel shall have an EMC enclosure. The panel shall be designed for EMC compatibility.

3.10 Labels and diagram plate:

3.10.1 Every equipment mounted in the panel shall be provided with individual labels with equipment designation/rating. In addition, the panel shall be provided on the front with a non-rusting label engraved with the designation of the panel as furnished by the PURCHASER. The labels/ name plates shall be made of either anodised aluminium or 3 ply plastic sheet. Labels made of self adhesive sheets are not acceptable.

3.10.2 Inside the door a circuit diagram engraved on non-rusting metal/PVC shall be fixed for reference.

3.10.3 Inscription labels/ name plates shall be fixed using either by rivets or screws. Fixing by glue is not acceptable.

4.0 CONTROL SYSTEM DESIGN:

4.1 The 66kV control panel shall comprise Intelligent Electronic Devices (IEDs) for control protection and monitoring.(For 11kV switchgear, these devices are mounted in the switchgear only)

4.2 The system shall include the following IEDs as required for each bay comprising the circuit breaker and associated disconnectors, earth switches and the instrument transformers of the circuit:-

a) Bay control unit (BCU) for control, monitoring and alarms functions. (Suitable to Existing SCADA IEC61850 - GE)

b) Bay protection unit (BPU) for protection functions. (As per SLD) (Suitable to Existing SCADA IEC61850 - GE)

4.3 The control systems shall be based on a decentralized architecture and on a concept of bay-oriented, distributed intelligence.

4.4 The main process information of the station shall be stored in distributed database. The typical system architecture shall be structured in two levels, i.e., in a station level and a bay level. At bay level, the IEDs shall provide all bay level functions regarding control, monitoring and protection, inputs for status indication and outputs for commands.

4.5 The IEDs should be directly connected to the switchgear without any need for interposition or transducer.

4.6 The bay control IEDs shall be independent from each other and its functioning shall not be affected by any fault occurring in any of the other bay control units of the station.

4.7 The existing BCU unit of transformer #3 and transformer bay #2 are already working with existing SCADA and new BCU unit will be supplied for 66kV for transformer #1 Bay inclusive of CRP as a loose item and it need to be installed and integrated with existing SCADA. (Part of this Tender)

4.8 The data exchange between the electronic devices on bay and station level shall take place via the communication infrastructure. Data exchange is to be realized using IEC 61850 protocol with a redundant managed switched Ethernet communication infrastructure.

4.9 At station level, the entire station shall be controlled and supervised from the existing station HMI of the SCADA system. It shall also be possible to control and monitor the bay from the bay level equipment at all times.

4.10 Clear control priorities shall prevent operation of a single switch at the same time from more than one of the various control levels i.e., station HMI, bay level or apparatus level. The priority shall always be on the lowest enabled control level.

4.11 The existing GPS time synchronizing signal for the synchronization of the entire system shall be provided.

4.12 Functional requirements

a). Station HMI in the SCADA system(existing) located in the SCADA room

b). Local HMI in Bay control unit IED located in switchgear room

c). Local control at the equipment level

Operation shall be possible by only one operator at a time. The operation shall depend on the conditions of other functions, such as interlocking, synchrocheck, etc.

4.13 Select-before-execute

For security reasons the command is always to be given in two stages: selection of the object and command for operation under all mode of operation except emergency operation. Final execution shall take place only when selection and command are actuated.

4.14 Bay/station interlocking and blocking

a). Software interlocking is to be provided to ensure that inadvertent incorrect operation of switchgear causing damage and accidents in case of false operation does not take place.

b). In addition to software interlocking hardwired interlocking shall also be provided

c). A software interlock override function shall be provided to bypass the interlocking function.

4.15 Run time command cancellation

Command execution timer (configurable) shall be available for each control level connection. If the control action is not completed within a specified time, the command should get cancelled.

4.16 Self supervision

Continuous self-supervision function with self-diagnostic feature shall be provided.

4.17 User configuration

The monitoring, controlling and configuration of all input and output logical signals and binary inputs and relay outputs for all built-in functions and signals shall be possible both locally and remotely.

5.0 BAY CONTROL UNIT (BCU):

5.1 General design features

5.1.1 The bay control unit (BCU) shall have IEDs for control monitoring and alarm functions. The BCU shall incorporate select-before-operate control principles as safety measures for operation via the HMI. The BCU shall perform all bay related functions, such as control commands, bay interlocking, data acquisition, data storage, event recording and shall provide inputs for status indication and outputs for commands. They shall be directly connected to the switchgear. The BCU shall acquire and process all data for the bay and transmit these to the other devices in sub-station automation system. In addition, this shall receive the operation commands from station HMI. The BCU shall have the capability to store all the data for at least 24 hours.

5.1.2 The BCU shall be equipped with analogue and Digital inputs/outputs for handling the control, status monitoring and analogue measurement functions. All bay level interlocks are to be incorporated in the BCU so as to permit control from the bay level with all bay interlocks in place, during maintenance and commissioning or in case of contingencies when the station HMI is out of service.

5.1.3 The BCU shall meet the requirements for withstanding electromagnetic interference according to relevant parts of IEC 61850. Failure of any single component within the equipment shall neither cause unwanted operation nor lead to a complete system breakdown.

5.2 Input / Output (I/O) modules

a) The I/O modules shall form a part of the BCU and shall provide coupling to the substation equipment. The I/O modules shall acquire all switchgear information (i.e. data coming directly from the switchgear or from switchgear interlocking devices) and transmit commands for operation of the switchgear. The measured values of voltage and current shall be from the secondaries of instrument transformers. The digital inputs shall be acquired with 1 ms resolution. Contact bouncing in digital inputs shall not be assumed as change of state.

b) For Transformer bay #T1 , I/O modules are specified in section 6.18.5.

c) For 66kV incomer line, two (2) nos of 16 channel input modules and one (1) no. of 10 channel output module shall be considered.

d) These are the minimum requirements and the bidders are advised to contact the main equipment suppliers and co-ordinate.

e) The I/O modules, CPU and other hardwares shall be supplied and commissioned in line with the SCADA specification section 6.18.1.

5.3 Bay control unit functions

The BCU shall perform the following functions in respect of all the equipment in the bay:-

a). Display single line diagram

b). Monitor and display voltage, current, frequency, active and reactive power and energy as shown in the single line diagram. However, Trivector Meter (TVM) or Multi Function Meter (MFM) shall be provided separately as shown in Single line diagram/Data sheet.

c). Select Local / Remote mode of control

d). Provide Close-Trip commands

e). Provide status indication for all the equipment and their operating mechanism.

f). Provide interlocks between different equipment for safe and reliable operation

g). Provide tripping of circuit breaker for all fault trip contacts of protection IED and GIS enclosure / Circuit breaker / Transformer fault contacts.

h). Provide alarms for all trip and non trip fault contacts of GIS enclosure, breaker, transformer and other equipment.

i). Generate events list

j). Interface with Bay Protection Unit (BPU) for tripping, alarms and events.

k). Monitor and display the following parameters of transformer based on analog signal inputs:-

i. Oil temperature

ii. Winding temperature

iii. Tap position

iv. Online DGA Output

l). Monitor the DC System voltage with under voltage and DC fail alarm.

5.4 Synchronism and energizing check

The synchronism and energizing check functions shall be bay-oriented and distributed to the bay control and/or protection devices. These features are:

a). Settable voltage, phase angle, and frequency difference.

b). Energizing for dead line-live bus, live line – dead bus or dead line – dead bus with no synchrocheck function.

c). Synchronizing between live line and live bus with synchrocheck function.

5.5 Event and disturbance recording function

a). Each IED should contain an event recorder capable of storing at least 200 time-tagged events. This shall give alarm if 70% memory if full.

b). The chronological event list shall contain :

i. Position changes of circuit breakers, disconnectors and earth switches.

ii. Indications of protection relay operation.

iii. Fault signals from switchgear, Transformer etc.

iv. Indications when analog measured values exceed upper and lower limits.

5.6 Local human-Machine Interface

Each BCU shall be provided with a local HMI station which shall have the following device:-

a). LCD displays of the single line diagram as applicable for the bay and other parameters.

b). Status indication LEDs

c). Alarm indication LEDs with user printable labels. The trip alarm shall have red colour and non-trip alarm yellow colour.

d). Key pad with push buttons for control purpose and switches for local/remote control selection and reset.

e). RS 485 port connection.

6.0 BAY PROTECTION UNIT (BPU):

6.1 The protection functions shall be independent of bay control functions. The protection shall be provided by separate protection IEDs comprising multifunction numerical relays.. The protection IEDs shall be connected to the communication infrastructure for data sharing and shall meet the real time communication requirements for automatic functions. The

data presentation and configuration of the various IEDs shall be compatible with the overall system communication and data exchange requirements.

6.2 The BPU shall comprise multi function IEDs (Numerical relay) for protection functions as specified in single line diagram/data sheet A.

6.3 The Multifunction numerical protection IEDs (relays) shall have the following features:-

a). All Currents and Voltages measured in true RMS values.

b). A LCD screen that shall show all the values measured by the protection IED as well as the preset parameters.

c). Programmable LED indications.

d). Programmable scheme logic which shall allow the user to customise the protection and control functions.

e). Independent protection settings for each protection IED element.

6.4 Supervisory Functions

The multifunction numerical IEDs shall provide the following supervisory functions:-

a). Self supervision of the IED with alarm for IED failure.

b). Trip circuit supervision of the breaker in both breaker open and closed states.

c). Voltage transformer supervision to detect loss of one, two or three phase VT signals.

d). Current transformer supervision to detect loss of phase CT signals and inhibit the operation of current dependent protection elements.

6.5 Post Fault Analysis

The numerical IED shall provide events, fault and disturbance records with the following features:-

a). All records shall be time lagged to a resolution of 1 ms using internal real time clock.

b). A lithium battery shall provide a back up for the real time clock and all records in the event of supply failure. The battery shall be supervised and shall easily be replaced from the front of the relay.

c). The event recorder shall store events in non-volatile memory which can be extracted using the communication ports or viewed on the front panel display. The number of events stored shall be in accordance with the functions of the relay.

d). The fault recorder shall maintain records for at least last 5 faults in non-volatile memory. Oscillographic fault records shall be provided.

e). The disturbance recorder shall store at least 20 disturbance records of up to 10.0 seconds in non-volatile memory. The data shall be sampled 12 times a cycle. All channels and trigger sources shall be user configurable.

6.6 Local and Remote Communications

The numerical protection IED shall provide the following communication facilities

a). The local communication shall be designed to fully support all the functions within the relay such as programme the settings, configure the programmable scheme logic, extract and view events, disturbances and fault records, view the measurement information dynamically and perform control functions.

b). The remote communication shall be provided by RS 485 port connection and communication protocol as stated in Data sheet. All internal information such as measurements, adjustments, settings, post fault analysis records shall be available via the communication network.

6.7 Necessary software for programming/ setting/ managing the protection IED through a laptop or through SCADA terminal shall be included in BIDDER's scope.

7.0 AUXILIARY IED/RELAYS:

7.1 Necessary auxiliary IED/ relays for alarm, as required shall be mounted inside the panel. Relays shall be equipped with hand reset, positive action operation indicator.

7.2 Auxiliary IED/ relays shall be rated to operate satisfactorily between 80% and 110% of the rated voltage.

7.3 Each Auxiliary IED/relay shall be provided with at least two potential free contacts for the PURCHASER's use.

7.4 Make and type of relay shall be subject to the PURCHASER's approval.

8.0 DIGITAL MULTIFUNCTION METER (MFM)

8.1 Digital multifunction meter (MFM) shall be supplied when specified in single line diagram/Data sheet A.

8.2 The MFM shall measure the following parameters:-

a). Voltage (line to line, per phase, average)

b). Current (phase wise, average)

c). Frequency

d). Power factor

e). Power (kVA, kW, kVAR) per phase and total

f). Energy (kVAh, kWh, kVARh inductive and capacitive)

8.3 The following features shall be provided:

a). Measurement of THD in % of Voltage and Current phase wise.

b). Monitoring of maximum demand with integration time adjustable from 5 to 30 minutes.

c). Measurement of import and export power and energy.

d). Trend recording of following parameters with memory capacity adequate for capturing data for 40 days with sampling interval of 15 min. intervals.

i. Phase current

ii. Phase voltage

iii. kW

iv. kVA

Necessary hardware and software required for downloading the captured data to purchaser's laptop and viewing the trends shall be included in Bidder's scope of supply.

8.4 The MFM shall measure true RMS value with 1 second update time.

8.5 The MFM shall have accuracy class as specified in Data sheet A1.

8.6 The MFM shall be provided with the following features:-

a). Monitoring of run hours and number of interruptions.

b). Front panel with LED displays.

c). RS 485 port connection for communication with PLC/ SCADA.

9.0 CONTROL PANEL ARRANGEMENT:

9.1 The 66kV system are shown in enclosed drawing No PCPL-2329-4-SLD-001: Single line diagram.

9.2 The proposed arrangements are specified below. However, the bidders may offer their own arrangement subject to purchaser's approval.

9.3 All the devices shown in the single line diagram and specified in enclosed data sheets A3 and A4 shall be supplied and mounted on the panels. The devices which cannot be provided in the BCU and BPU unit shall be provided separately.

9.4 66kV control and relay

The following panels shall be supplied

9.4.1 One No. of Transformer control and relay panel - TR#1. The panel shall comprise

a). Multi function meter.

b). 87T - Protection Relay as specified in data sheet A3

c). 64R - Protection Relay as specified in data sheet A3

d). Auxiliary IED/ relays as specified in data sheet A3

e). The BCU Shall be suppliedas loose item with CRP and it needs to be mounted and integrated in Existing SAS Panel. Refer to dwg no. PCPL-2329-5-SK-001, and PCPL-2329-5-SK-002

10.0 SCADA AND STATION HMI:

10.1 SCADA Configuration

The SCADA Configuration shall be as shown in the following drawings enclosed with the specification.

a). Drg.No.PCPL-2329-5-SK-002: SCADA Architecture

10.2 Communication with SCADA

a). Each BCU, BPU and MFM shall be provided with RC485 port connection for communication with SCADA.

b). The RS 485 port connections shall provide complete data exchange between BCU, BPU units and SCADA for all the function specified for BCU and BPU units.

10.3 SCADA shall provided close and open commands for breakers, disconnectors and earth switches with all interlocks.

10.4 All alarms and events shall be repeated in SCADA. The SCADA shall provide station wise chronological fault signalling and event and disturbance records.

10.5 It shall be possible to accept and reset alarms in BCU and BPU units from SCADA.

10.6 The SCADA shall provide direct tripping of circuit breakers from station HMI By-passing the BCU units.

10.7 The SCADA specification is provided in section no.6.3.3 and 6.18.1. The BCU/BPU and CRP shall be properly interfaced with SCADA to meet the SCADA requirements. The vendor shall co-ordinate with SCADA supplier to meet the requirements of SCADA and CRP mounted equipment to make the system totally functional and operational.

11.0 AVAILABILITY REQUIRMENTS:

11.1 All equipment covered in this specification shall be designed for maximum reliability and availability.

11.2 The system shall be designed with self diagnostics and troubleshooting features. Adequate facility shall be provided for quick repair/maintenance and on line replacement of faulty modules. This shall not result in spurious trips. Where a major equipment/unit trip is likely to be inhibited when the card is pulled out, it shall be identified by vendor.

11.3 Easy access shall be provided for all components in the equipment and system offered to reduce the down time.

11.4 The availability of IEDs shall be above 99.7% and this shall be guaranteed.

The bidder shall submit detailed calculations, which shall show that availability above 99.7% is possible. The method of calculation shall be as specified in the IEEE. This shall be submitted along with bid by the bidder. In case a standard other than IEEE is used a copy of the relevant portions of the standard shall be enclosed.

11.5 The bidder shall submit the procedure for availability test. This will be in accordance with prevailing standard.

12.0 TESTS AND TEST REPORTS:

12.1 Type, Routine and Acceptance tests for all supply equipment/components shall be carried out as per relevant standards for the respective equipment. The test reports shall be submitted to the purchaser for approval before despatch of the equipment.

12.2 Type Tests for control IEDs:

a). Power Input:

i. Auxiliary Voltage

ii. Current Circuits

iii. Voltage circuits

iv. Indications

b). Accuracy Tests:

i. Operational Measured Values

ii. Currents

iii. Voltages

iv. Time resolution

c). Insulation Tests

i. Dielectric tests

ii. Impulse voltage withstand test

d). Influencing quantities

i. Limits of operation

ii. Permissible ripples

iii. Interruption of input voltage

e). Electromagnetic compatibility test

i. 1 MHZ. burst disturbance test

ii. Electrostatic discharge test

iii. Radiated electromagnetic field disturbance test

iv. Electrical fast transient disturbance test

v. Conducted disturbance tests induced by radio frequency field

vi. Magnetic field test.

vii. Emission (Radio Interference Level) test.

viii. Conducted interference test

f). Function tests

i. Indication
ii. Commands
iii. Measured value acquisition
iv. Display indications

g). Environmental tests

i. Cold temperature
ii. Dry heat
iii. Wet heat
iv. Humidity (Damp Heat Cycle)
v. Vibration
vi. Bump
vii. Shock

12.3 Factory acceptance tests

The supplier shall submit a test specification for factory acceptance test (FAT) and commissioning tests for approval.

13.0 DOCUMENTATION:

13.1 The following documentation in English shall be submitted for purchases approval. The documents shall be consistent and CAD supported.

a) List of drawings
b) Panel general arrangement drawing
c) Block diagrams
d) Guaranteed technical parameters, functional design specification and guaranteed availability and reliability
e) Calculation for power supply dimensioning
f) I/O signal lists
g) Schematic diagrams
h) List of apparatus
i) List of labels
j) Logic diagram (Hardware & software)
k) Test specification for factory acceptance test (FAT)
l) Product Manuals
m) Operator's Manual
n) Complete documentation of implemented protocols between various elements
o) Listing of software in CD ROM.
p) Other documents as may be required during detailed engineering

13.2 Four sets of hard copy and four sets of CD ROM containing all the as built documents/drawings shall be provided.

14.0 SPARE PARTS / TEST EQUIPMENT

14.1 Two separate individual items wise priced, recommended spare parts list shall be specified by Vendor, one for Spare needed for start up and one for the spares required for 2 year operation.

14.2 Recommended spares for 2 years operation should take into account related factors of equipment reliability, equipment downtime, cost of parts and availability of services.

14.3 Start up spares shall include sufficient fuses, consumable, etc. for minimum three months of operation besides replacements for any failures during commissioning. Any spare part used from recommended spares during start up by VENDOR, the same shall be replenished.

15.0 DOCUMENTS AND DATA TO BE FURNISHED WITH THE BID

15.1 Technical Data:

The Bidder shall submit duly signed guaranteed technical particulars in accordance with the enclosed data sheets B.

15.2 Drawings and Catalogues:

The bidder shall furnish preliminary copies of the following drawings with the bid.

a). Plan and section drawings of the control and relay panels.

b). Single line diagram.

c). Complete technical details of control and protection IEDs.

15.3 Type Test Reports:

The bidder shall submit with the bid copies of valid type test reports (not older than 5 years from the date of bidding) carried out on offered equipment.

15.4 Experience List:

The bidder shall submit the experience list for IED based control and protection system.

15.5 Recommended spares

6.9.2 66kV Control Relay Panel-Datasheets

DATA SHEET - A1					
Sl. No.		**Description**		**Unit**	**Data**
1.0 GENERAL REQUIREMENTS	1.1	Designation			66kV Control and Relay Panel
	1.2	Location			Indoor
	1.3	Type of mounting and construction		Simplex/ Duplex/ Desk	Floor mounted, single front type with lockable doors
	1.4	Sheet steel	Type	Cold/Hot rolled	Cold Rolled
			Thickness		2
			a) Front & rear	mm	
			b) Sides, top, bottom	mm	1.6
	1.5	Degree of Protection			IP 54
	1.6	Cable entry		Top/Bottom	Bottom through cable glands
	1.7	Painting			
		a) Process			Powder Coating

DATA SHEET - A1					
Sl. No.		**Description**		**Unit**	**Data**
		b) Colour finish shade as per IS 5	Exterior		RAL 7032
			Interior		Glossy White
	1.8	Purchaser's Earthing conductor	Material		GS
			Size		50x10
	1.9	Earth bus in Panel	Material		Copper
			Size		25x6
2.0 DRAWING ENCLOSED	2.1	Single line diagram		Yes/ No	Yes
	2.2	Logic Diagrams		Yes/ No	No
	2.3	Schematic Diagrams		Yes/ No	No
	2.4	Bill of Material		Yes/ No	Yes (Refer Data Sheet-A3)
3.0 POWER SUPPLY	3.1	Power devices, Motor drives, etc.			NA
	3.2	Control & Protection	DC		110V
			AC		NA
	3.3	Auxiliary power supply for meters & relays		Volts	110V DC
				AC/ DC	
	3.4	Duplicate supply required for 3.2		Yes/ No	Yes
	3.5	Auto change over scheme required for 3.4		Yes/ No	Yes
	3.6	Space heater / Panel interior light			1ph, 240V AC, 50Hz
	3.7	Power Receptacle			1ph, 240V AC, 50Hz
4.0 INSTRUMENT & METERS	4.1	Bill of Material enclosed		Yes / No	Yes
	4.2	Indicating Instruments			Required
		a) Type		Analogue/ Digital	As per BOQ (Refer Data Sheet-A3)
		b) Size			As per BOQ
		c) Accuracy class			Same as CT/PT accuracy class (Refer SLD)
	4.3	Power Monitors			Required
	4.3.1	Accuracy class			Same as CT/PT accuracy class (Refer SLD)
	4.3.2	Measurements required			As per clause 8.0 of specification Section 6.9.1
	4.3.3	THD measurement required	Voltage	Yes/No	
			Current	Yes/No	
	4.3.4	Maximum demand indication & recording required		Yes/No	
	4.3.5	Import and Export metering required		Yes/No	
	4.3.6	Communication port connection	Type		RS-485
			Protocol		Modbus
	4.4	Recording Meters			NA
	4.4.1	Metering parameters to be recorded			
	4.4.2	Range of parameters			
	4.4.3	Accuracy			
	4.4.4	No of hours of spring reserve in case of auxiliary power failure			

DATA SHEET - A1					
Sl. No.		**Description**		**Unit**	**Data**
5.0 PROTECTION RELAYS	5.1	Type of Relay			Yes (As per SLD, Specification and BOQ furnished in Data Sheet-A3)
	5.2	Front LCD Screen as per specification		Yes /No	
	5.3	Programmable LED indication		Yes /No	
	5.4	Programmable scheme logic		Yes /No	
	5.5	Supervisory function as per specification			
		a) Self Supervision of relay		Yes /No	
		b) Trip circuit Supervision of breaker in both closed and open positions		Yes /No	
		c) Voltage transformer supervision		Yes /No	
		d) Current transformer supervision		Yes /No	
	5.6	Events recorder as per specification		Yes /No	
	5.7	Fault recorder with Oscillographic records as per specification		Yes /No	
	5.8	Disturbance recorder as per specification			
	5.9	Communication port	Type		
			Protocol		
6.0 MIMIC DIAGRAM AND POSITION INDICATORS	6.1	Mimic diagram required		Yes/ No	Yes
	6.2	Colour scheme as per IS 11954	Voltage		66kV
					Golden Brown (As per IS 11954) Shade 414 as per IS 5
	6.3	Automatic position (Semaphore) indicators required as part of mimic diagram		Yes/ No	Yes
7.0 PANEL WIRING & TERMINATIONS	7.1	Voltage grade		Volts	1100
	7.2	Material of conductor			Stranded copper
	7.3	Size of wires:			
		a) CT circuits		mm^2	2.5
		b) PT circuits		mm^2	2.5
		c) Control circuits		mm^2	2.5
		d) Small power circuits for space heater, interior lighting etc		mm^2	2.5
	7.4	Type of insulation		XLPE/ FRLS PVC	FRLS PVC
	7.5	Colour of wire			
		a) Control circuit AC			Red
		b) Control circuit DC			Blue
		c) Interlocking circuits			Orange
		d) Earth circuit			Green with Yellow stripes
		e) 3 Phase power circuits			Red/yellow/Blue
		f) Neutral			Black
	7.6	Termination			With solder less, compression type crimp
	7.7	Terminal block			Screw type, Finger touch proof design

DATA SHEET – A2			
APPLICABLE STANDARDS			
Sl. No.	**Description**	**STANDARDS**	
01	Switchgear General Requirements	IS:4237	
02	Panel Wiring	IS:5578 & 11353	
03	Factory built assemblies of Switchgear and control gear for voltages up to and including 1000V AC & 1200V DC.	IS:8623	
04	Miniature circuit breakers	IS:8828	
05	HRC Cartridge Fuses	IS:9224	IEC: 60265-1
06	D Type Fuses	IS:8187	
07	Control switches/ Push buttons	IS:13947 (Part 5)	
08	Current transformers	IS:2705	IEC 60185
09	Voltage transformers	IS:3156	IEC 60186
10	Relays	IS:3231	IEC 60255
11	Indicating instruments & meters	IS: 722,13010, 13779,11448, 8530	IEC: 60051
12	Degree of protection	IS:2147	IEC: 60144
13	Climate proofing of electrical Equipment	IS:3202	
14	Code of practice for phosphating iron & steel	IS:6005	
15	Environmental test for Electronic and Electrical equipment	IS:9000	
16	Environmental requirements for semiconductor devices and integrated circuits	IS:6553	
17	Guide for colour coding of electrical mimic diagram	IS:11954	

DATA SHEET –A3			
66kV CONTROL AND RELAY PANEL BOQ			
SL. No.	**Device**	**Description**	**Qty.**
			Transformer C&R panel
Protection			
1.	87T	Transformer Differential Relay, Numeric type Triple pole high speed complete with restraint features for harmonics and magnetising inrush current and CT ratio mis-match correction. In addition, Overflux, Over Voltage and Under Voltage function shall be provided. DI and DO shall be considered with 20% Spare, IEC61850 Compatible with Dual Channel, also RS485 to be included	1 No.
2.	51NS&64R	Transformer Restricted earth fault protection Relay, Numeric Type with Three phase and Neutral current elements to operate protection function as follows 51NS and 64R DI and DO shall be considered with 20% Spare, IEC61850 Compatible with Dual Channel, also RS485 to be included	1 No.
3.	51/50/51N/50N	Transformer Backup protection Relay, Numeric Type with Three phase and Neutral current elements to operate protection function as follows 51, 50,50N, 51N, and 50LBB, BI and BO shall be considered with 20% Spare, IEC61850 Compatible with Dual Channel, also RS485 to be included	1 No.
4.	BCU	Bay Control Unit for Transformer#1 bay IEC61850 Compatible with Dual Channel, also RS485 to be included. BI and BO shall be considered with 20% Spare (It needs to be Installed in Existing SAS Panel)	1 No.
5.	80	DC supply supervision relay the relay shall include alarm/annunciation of failure of DC supply to the panel.	1 No.
6.	86	Master trip (lock out) relay high speed hand reset with minimum Eight auxiliary contacts in any NO & NC combination. The relay shall be suitable for continues monitoring for open circuit.	1 No.
7.	63-GP1-X	Voltage Operated two coil, aux. relay for Buchholz alarm and trip.	1 No.

DATA SHEET –A3			
66kV CONTROL AND RELAY PANEL BOQ			
SL. No.	**Device**	**Description**	**Qty.**
			Transformer C&R panel
8.	63- GP2-X	Voltage Operated two coil, aux. relay for Oil Surge relay alarm and trip	1 No.
9.	PRD-X	Voltage Operated single coil, aux. relay for Pressure Relief Device alarm and trip	1 No.
10.	63- GP3	Voltage Operated two coil, aux. relay for SF6 pressure in CB low alarm and too low lock-out.	1 No.
11.	49-X1	Voltage Operated two coil, aux. relay for Oil temperature alarm and trip	1 No.
12.	49-X2	Voltage Operated two coil, aux. relay for Winding temperature alarm and trip	1 No.
13.	71-X1	Voltage Operated one coil, aux. relay for Oil level alarm.	1 No.
14.	98	Relay for supervision of Breaker trip coils (two coils) in both close and open position of the breaker. The relays shall have 3 pairs of contacts for alarm and indication.	1 No.
Indications			
15.	R, G, A, W, B	ON, OFF, TRIP, Trip circuit healthy, Spring charged Indicating lamps,	1 Set
16.	R, G	ON, OFF Indicating lamps for isolator main blade & earth blade status indication.	2 Sets
17.	W	DC Supply ON and FAIL Indicating lamps	1 Set
18.	R11,R12	L/R switch position indication	2 Sets
19.	SEM - 1	40mm Semaphore Indicator for CB status indication	1 No.
20.	SEM - 2	25mm Semaphore Indicator for Isolator Main Blade status indication	1 No.
21.	SEM - 3	25mm Semaphore Indicator for Earth Blade status indication	1 No.
22.	ANN	18 Window Facia Annunciator with Accept / Reset / Test push button	1 Set
Metering			
23.	A	110mm sq. 240^{O} scale Substation duty, Ammeter	1 No.
24.	AS	3 Position + Off Ammeter Selector Switch	1 No.
25.	MFM	Multifunction meter for metering	1 No.
26.	V	Voltmeter	-
Controls			

DATA SHEET –A3			
66kV CONTROL AND RELAY PANEL BOQ			
SL. No.	**Device**	**Description**	**Qty.**
			Transformer C&R panel
27.	25 S/S	Synchronising selector switch	-
28.	TNC	Trip Neutral Close Control Switch for CB.	1 No.
29.	TNC	Trip Neutral Close Control Switch for Isolator.	1 No.
30.	L/R	Local/Remote selection switch	1 No.
Miscellaneous			
31.	Ter & Wiring	Set of terminal blocks and wiring, glands, etc.,	1 Set
32.		DC Hooter for Alarm annunciation	
33.		AC Bell for DC Fail annunciation	1 Set
34.		Panel illumination CFL bulk head luminare with door limit switch	1 Set
35.		Panel space heater with Humidistat control	1 Set
36.		1 x 240VAC Socket outlet with RCBO control	1 Set
37.		Painted Mimic diagram of Golden Brown colour (Shade 414 as per IS-5) for 66kV	1 Set

Notes:

1. Two sets of 2x3 element auxiliary relays can be used for items under serial nos. 10 to 16.
2. Comprehensive numerical relays shall be offered wherever applicable.
3. MFM and all numerical relays must have RS 485 port for communication with RTU/SCADA.
4. Numerical relay must have IEC61850 LAN port and Dual channel need to be provided to ensure redundancy.
5. All protection relays and auxiliary relays shall have at least one spare contact for input into SCADA.

DATA SHEET – B

(To be filled in by the BIDDER and submitted with the BID)

Sl. No.		Description		Unit	BIDDER'S DATA
1.0 GENERAL PARTICULARS	1.1	Panel designation			
	1.2	Make & country of manufacture			
	1.3	Location			
	1.4	Type of mounting and construction		Simplex/ Duplex/ Desk	
	1.5	Sheet steel	Type	Cold/ Hot rolled	
			Thickness a) Front & rear	mm	
			b) Sides, top, bottom	mm	
	1.6	Degree of Protection			
	1.7	Cable entry		Top/Bottom	
	1.8	Painting a) Process			
		b) Colour finish shade as per IS 5	Exterior		
			Interior		
	1.9	Operating temperature range		± °C	
	1.10	Tropicalisation provided for all devices		Yes/No	
	1.11	Earth bus in Panel	Material		
			Size		
2.0 DOCUMENTS ENCLOSED	2.1	General Arrangement drawing of:- a) Individual panel sections		Yes/No	
		b) Overall arrangement of complete panels		Yes/No	
	2.2	Single line diagrams		Yes/No	
	2.3	Logic diagrams		Yes/No	
	2.4	Schematic drawings		Yes/No	
	2.5	Bill of material for each type of panel		Yes/No	
	2.6	Technical literature of major components		Yes/No	
	2.7	Type test reports of major components		Yes/No	
	2.8	List of special tools and devices required for maintenance		Yes/No	
3.0 POWER SUPPLY	3.1	Power devices, Motor drives, etc.			
	3.2	Control & Protection		DC	
				AC	
	3.3	Auxiliary power supply for meters & relays		Volts AC/ DC	
	3.4	Duplicate supply provided for 3.2		Yes/ No	
	3.5	Auto change over scheme provided for 3.4		Yes/ No	
	3.6	Space heater / Panel interior light			
4.0 INSTRUMENTS &	4.1	Indicating Instruments a) Make			
		b) Type			
		c) size			
		d) CT,VT secondary current and voltage			

DATA SHEET – B (To be filled in by the BIDDER and submitted with the BID)							
Sl. No.		**Description**		**Unit**	**BIDDER'S DATA**		
		e) Accuracy class					
		f) VA burden					
	4.2	Power Monitors					
	4.2.1	Make & Maker's type designation					
	4.2.2	CT,VT secondary current and voltage					
	4.2.3	Accuracy class					
	4.2.4	The following features provided as per specification					
		a) All measurement function		Yes/ No			
		b) THD measurement		Yes/ No			
		c)Maximum Demand indication & recording		Yes/ No			
		d) Important and Export metering		Yes/ No			
		e) Communication port connection	Type				
			Protocol				
	4.2.5	VA burden	Current coil	VA			
			Voltage coil	VA			
	4.2.6	Auxiliary power supply	Voltage				
			VA burden				
	4.3	Recording meters					
	4.3.1	Make					
	4.32	Marker's type designation					
	4.3.3	Metering parameters to be recorded					
	4.3.4	Range of parameters					
	4.3.5	Range of speed available					
	4.3.6	Accuracy					
	4.3.7	No of hours of spring reserve in case of auxiliary power failure					
	4.3.8	Auxiliary power supply					
	4.3.9	Burden	Current coil	VA			
			Voltage coil	VA			
5.0 PROTECTION RELAYS	5.1	Application					
	5.2	Make and country of Manufacturers type designation					
	5.3	Manufacturer's type designation					
	5.4	The following functions are provided as per specification					
	5.4.1	Protection functions as specified		Yes/No			
	5.4.2	Self supervision of relay		Yes/No			
	5.4.3	Trip circuit supervision of breaker		Yes/No			
	5.4.4	Voltage transformer supervision		Yes/No			

DATA SHEET – B (To be filled in by the BIDDER and submitted with the BID)							
Sl. No.		**Description**		**Unit**	**BIDDER'S DATA**		
	5.4.5	Current Transformer supervision		Yes/No			
	5.4.6	a) Events recorder provided		Yes/No			
		b) Number of events stored		Nos			
	5.4.7	a) Fault recorder provided		Yes/No			
		b) Number of faults recorded					
		c) Oscillographic records provided		Yes/No			
	5.4.8	a) Disturbance recorder provided		Yes/No			
		b) Number of disturbances recorded		Nos			
		c)Time for which each disturbance is recorded		Seconds			
	5.4.9	Communication port connection	Type				
			Protocol				
	5.4.10	VA Burden	Current coils				
			Voltage coils				
	5.4.11	Auxiliary power supply	Voltage				
			VA burden				
	5.5	All aux. relays required. with main protection Relay schemes included		Yes/No			
	5.6	Minimum rating of contacts for aux. and output Relays : Voltage		V, DC			
		Continuous current		A, DC			
		Make & carry for 1 sec		A, DC			
		Breaking capacity	(i) Resistive	Watts			
			(ii) Inductive	Watts			
	5.7	Aux. CT/PT provided wherever required		Yes/No			
	5.8	For Relays/Components: a)Mean time between failures (MTTF)		Months			
		b) Mean time to repair (MTTR)		Hours			
		c) Protection against volt surges & noise signals provided		Yes/No			
		d)Card failure indicator provided on the panel		Yes/No			
		e)Prefabrication cables & plug-in type terminals provided		Yes/No			
		f) Shielded & twisted pair conductors provided		Yes/No			
		g) Test point provided on each card		Yes/No			
6.0 AUX RELAYS	6.1	Make					
	6.2	Type designation					
	6.3	No of contacts	Normally open				
			Normally closed				
	6.4	Contacts, Hand reset/self reset					
	6.5	Contact rating	Continuous current	A			
			Voltage	V			
			Make & Break currents				
	6.6	Burden of Relay		VA			
7.0 MISCELLENE	7.1	Control & Selector Switches					
	7.1.1	Make					
	7.1.2	Contact rating	Continuous current	A			
			Voltage	V			

DATA SHEET – B (To be filled in by the BIDDER and submitted with the BID)					
Sl. No.		**Description**		**Unit**	**BIDDER'S DATA**
			Make & Break currents		
	7.2	Push buttons			
	7.2.1	Make			
	7.2.2	Shrouded to prevent inadvertent operation		Yes/No	
	7.2.3	Number of No & NC Contacts		Nos	
	7.2.4	Contact rating	Continuous current	A	
			Voltage	V	
			Make & Break currents		
	7.3	Indicating Lamps			
	7.3.1	Type			
	7.3.2	Rating	Voltage	V	
			Wattage	W	
	7.3.3	Series Resistor	Ohms	Ω	
			Wattage	W	
8.0 ANNUNCIATOR	8.1	Make			
	8.2	Type			
	8.3	Sequence of operation as per specification		Yes/No	
	8.4	Lamps	No. per window		
			Voltage	V	
			Wattage	W	
	8.5	Initiating contacts	Making current	A	
			Impulse Duration	m-sec	
9.0 MIMIC DIAGRAM	9.1	Mimic Diagram provided			
	9.2	Mimic strip	Material		
			Width		
	9.3	Colour Scheme as per specification		Yes/No	
	9.4	Position (Semaphore) indication provided as required		Yes/No	
10.0 WIRING &TERMINATION	10.1	Voltage grade			
	10.2	Material of conductor			Stranded copper
	10.3	Size of wires:			
		a) CT circuits		mm^2	
		b) PT circuits		mm^2	
		c) control circuits		mm^2	
		d) Small power circuits for space heater, interior lighting etc		mm^2	
	10.4	Type of insulation		XLPE/FRLS PVC	
	10.5	Colour of Wires as per specification		Yes/No	
	10.6	Termination			
	10.7	Terminal Block			

DATA SHEET C

DATA TO BE FURNISHED BY THE VENDOR AFTER THE AWARD OF CONTRACT

1.0 LIST OF DRAWINGS

The VENDOR shall furnish the following drawings against each of the panel/desks/cubicles to be supplied. The Vendor shall furnish the time schedule for submission of these for approval by PURCHASER

1.1 Outline dimensions including plan, front elevation, rear elevation, side elevation and door opening sizes

1.2 Drawings showing foundation details, floor openings for cabling and weight of each panel

1.3 Schematic control circuit and block logic diagrams. The latter shall indicate the location of all devices, relays, sensors, transducers, instruments and their interactions to serve as a basis for developing wiring diagrams

1.4 Layouts and cross–section views of front/rear panel and desks complete with identification markings for all mounted devices and complete material list giving ratings, make and type.

1.5 Switch development diagrams

1.6 One line diagrams of power circuits and control power circuits arrangement and distribution

1.7 Detailed wiring drawings including identification of devices, terminal block numbers, ferrule numbers and cable connections. The VENDOR shall be solely responsible for correctness of these drawings on the basis of approved schematic diagrams

1.8 Largest package for shipment(Weight and dimensions)

1.9 Internal interconnection diagrams indicating terminals and external connections between panel & panel to field devices. The interconnection diagrams shall indicate maximum resistance to permit correct operation of equipment at minimum voltage.

2.0 TEST CERTIFICATE

The VENDOR shall furnish the following test certificates:

2.1 Type test certificates for the following:

a) Relays, timers

b) Electronic components

c) Instruments, meters

d) Switches, push buttons

e) Any special cable/wires supplied by the VENDOR.

2.2 Routine test certificates for the following should be furnished before despatch of the panels.

a) Control and relay panels

b) Relays, Timers

c) Electronic components

d) Instruments, meters

e) Switches, push buttons

f) Any special cables/wires supplied by the VENDOR

2.3 Equipment shall not be despatched unless the test certificates are duly approved by the PURCHASER

3.0 INSTRUCTION MANUALS

The VENDOR shall furnish specified No. of copies of the instruction manual which would contain detailed step by step instructions for all operational and maintenance requirements. The manual shall be furnished at the time of despatch of the equipment and shall include the following aspects:

3.1 Storage for prolonged duration

3.2 Unpacking

3.3 Erection

3.4 Handling at site

3.5 Pre-commissioning tests

3.6 Operating procedures

3.7 Maintenance procedures

3.8 Precaution to be taken during operation and maintenance work

3.9 Outline dimension drawings showing relevant cross-sectional views and constructional features

3.10 Catalogue numbers of all components liable to be replaced during the life of panels

3.11 Rated voltages, current, duty cycle and all other information which may be necessary for safe operation of the panels

6.10.1 Cross Linked Polyethylene Insulated Cables up to 33kV

1.0 SCOPE

This specification covers the requirements of high voltage cross-linked polyethylene cables and associated accessories like straight joints, and terminations, etc. for working voltages from 3.3 kV up to and including 33 kV.

2.0 CODES AND STANDARDS

2.1 The design, manufacture and performance of the cables shall comply with all currently applicable statutes, regulations, and safety codes in the locality where they will be installed. Nothing in this specification shall be construed to relieve bidder of his responsibility in this regard.

2.2 The cables shall conform to the latest applicable standards as specified in the relevant Data Sheet A2. In case of conflict between the standards and this specification, the stringent of the two shall apply. Equipment complying with other authoritative standards such as British, American, VDE will also be considered, if offered.

3.0 DESIGN AND PERFORMANCE REQUIREMENTS:

3.1 **Cable Construction:**

3.1.1 Three Core Cables:

a) Conductor

Well compacted, stranded copper or Aluminium circular shaped as mentioned in data sheet A.

b) Conductor screen

Conductor screen shall be provided over the conductor by extrusion of non – metallic semiconducting compound.

c) Insulation

Cross-linked polyethylene applied by extrusion. The XLPE shall be gas cured. The thickness of the insulation shall be as per applicable standards.

d) Insulation Screen

Shall consist of two parts, namely metallic and non metallic.

i) The non metallic part shall be applied directly over the insulation of each core by extruded semiconducting compound.

ii) The metallic part shall consist of non magnetic metallic tape (preferably copper tape) applied over the non metallic part.

e) Core identification

By colouring of XLPE insulation up to 3.3kV cables. By numerals printed on the cores for cables above 3.3kV

f) Inner sheath

The laid up cores shall be provided with extruded PVC compound inner sheath. The shape of the cable shall be as circular as possible. The thickness of the inner sheath shall be as per applicable standard.

g) Armouring

Single/ double galvanised steel wire/ strip armouring shall be provided as mentioned in Data sheet A. The thickness of galvanised steel wire or strip shall be as per applicable standards.

h) Outer Sheath

The outer sheath shall be applied by extrusion. The thickness of the outer sheath shall be as per applicable standards.

The outer sheath shall be:-

i) With PVC/FRLS PVC compound type ST2 as specified in data sheet A.

ii) With reduced flame propagation property.

iii) Resistant to termite, fungus and rodent attack.

iv) Black in colour.

3.1.2 Single Core cables

The cable construction shall be similar to three-core cable except the following:-

a) The armouring shall constitute the metallic part of screening.

b) The armour shall be of non – magnetic material.

3.2 **Requirement of special FRLS-PVC sheath:**

3.2.1 Outer sheath for FRLS cables shall meet the following test requirements related to flame retardance, low smoke emission, low acid and toxic gas emission. The BIDDERS shall have proper test apparatus to conduct all the relevant tests as per the applicable standards mentioned herein.

3.2.2 Test for Flame Retardance

a) Oxygen Index

The critical oxygen index value shall be minimum 29 at 250^0C when tested for temperature index test as per ASTMD-2863.

b) Flammability

i) Cables shall pass test under fire conditions as per IEC-332-1.

ii) Cables shall also pass tests as per Swedish standard S5424-1475 for Chimney tests for Class-F3.

iii) Fire survival (FS) cables in addition to tests I and II above shall pass tests as per IEC-331.

3.2.3 Test for Smoke Generation

The cables shall satisfy the tests conducted to evaluate the percentage obscuration by smoke in an optical system placed in the path of the smoke. The smoke density rating shall be in accordance with the values specified under notes in Data Sheet-A or as agreed to between Purchaser and Vendor before placement of order. The tests shall be conducted in accordance with the following Standards/ Test methods:

a) ASTM-D-2843

b) ASTM-E-662

c) 3 metre cube test chamber.

3.2.4 Tests for Acid Gas Generation

The hydrochloric acid generation when tested as per IEC 754-1 shall be less than the values specified under notes in Data Sheet-A or as agreed to between Purchaser and Vendor before placement of order. Suitable test methods shall be agreed upon between PURCHASER and VENDOR before placement of order with regard to tests for other toxic and corrosive gases generated from the sheath under fire conditions.

3.2.5 Tests for Resistance to Ultra Violet Radiation

These shall be as specified under notes in Data Sheet-A or as agreed to between PURCHASER and VENDOR before placement of order.

3.2.6 Tests for Water Absorption

Outer sheath shall be subjected to tests for water absorption as per IS 10810. When additional characteristics are required, the tests shall be carried out as agreed to between PURCHASER and VENDOR before the placement of order.

3.2.7 Any other special tests on the sheath in addition to the above shall be as indicated under notes in Data Sheet-A or as agreed to between PURCHASER and VENDOR before placement of order.

3.3 **General -** The cables shall withstand all mechanical and thermal stresses under steady state and transient operating conditions.

4.0 TEMPERATURE RISE AND CURRENT RATINGS:

4.1 **Maximum conductor temperature -** The maximum conductor temperature shall not exceed 90^0C during continuous operation at full rated current. The temperature after a short circuit for 1.0 second, shall not exceed 250^0C, with initial conductor temperature of 90^0C

4.2 Current Ratings

4.2.1 The bidder shall furnish the following current ratings for the given ambient temperature, ground temperature and soil resistivity:-

a) Rated continuous current

b) Rated 1.0 second current

4.2.2 For multicore cables, the rated currents shall be furnished for both installation in air and in ground

4.2.3 For single core cables, the rated currents shall be furnished for the following installation conditions:-

a) Laid in ground and in air

b) Laid flat and laid in trefoil formation

c) The metallic screens with both ends bonding and with single point bonding/cross bonding.

4.3 **Rating factors -** Rating factors shall be given by the bidder for the following:

a) Variation in ground temperature

b) Variation in soil thermal resistivity

c) For two cables laid side by side at 300, 600 and 900 mm centres.

4.4 The bidder shall indicate the percentage overload that the cable can carry, its duration and final conductor temperature when operating initially at a conductor temperature of 90^0C.

5.0 CABLE ACCESSORIES

5.1 Bidder shall include in his offer, the equipment and materials required for making cable splices and cable termination. The terminations may be taped type for lower voltages up to 22 KV and prefabricated type for higher voltages. Full details of the splicing and terminating procedures shall be given in the tender.

5.2 The total creepage distance of the outdoor porcelain insulators of cable sealing ends shall be suitable for heavily polluted saline atmosphere and shall not be less than 25 mm per kV of highest line to line voltage. The protected creepage distance shall be half of the total creepage distance. The insulators shall be washable under live conditions by hot-line washing equipment.

6.0 CABLE DRUMS:

6.1 Cables shall be supplied in non-returnable drums of sturdy construction. All ferrous and other metal parts of drum shall be treated with a suitable rust preventive finish or coating to avoid rusting during transit or storage.

6.2 The length of cable on each drum shall be determined by the manufacturer considering the transport limitations from manufacturer's works to the site.

6.3 Bidders shall indicate in the offer, the maximum length for each size of cable, which can be furnished on one drum. However before packing the cables on drums, the successful bidder shall obtain Purchaser's approval for the drum length of cable in the drum

7.0 TESTS AND TEST REPORTS:

7.1 Bidder shall give a complete list of routine and type tests proposed to be performed in his tender.

7.2 Routine Tests shall be performed on each drum length. All tests as per applicable standard shall be performed.

7.3 Type Tests: Bidder shall furnish full particulars of the type tests as per applicable standard proposed to be carried out by him. Valid type test reports not older than 5 years shall be submitted with the bid. If such reports are not available, the tests shall be carried out without any extra cost.

7.4 Acceptance Tests: Acceptance tests shall be carried out in accordance with the applicable standard.

7.5 All test reports shall be subject to Purchaser's approval.

8.0 INFORMATION TO BE GIVEN BY BIDDER:

In addition to information called for in the Data Sheet B and Price Schedule enclosed with this specification, the bidder shall give the following information with the offer:

8.1 Detailed drawings with dimensions of the cable and all accessories, including –

a) Cross sectional view of cable, indicating the material used in each type of construction.

b) Splices, straight joints and trifurcating boxes

c) Terminations, showing mounting arrangement

8.2 Complete specifications of covering used to protect sheath and reinforcing tapes co corrosion

8.3 Descriptive information regarding cable and accessories and test of installations of similar cables now in service with description, cable performance, outages suffered and cause of outages.

8.4 Recommended method for locating conductor faults, apparatus required for locating the faults and their price.

9.0 ERECTION & MAINTENANCE TOOLS & EQUIPMENT AND SPARE:

9.1 Whether included in the bidder's scope or not, unit prices for the following items shall be quoted together with their suggested quantities and catalogue numbers. The Purchaser reserves the right to select any or all the items offered without assigning any reason.

9.2 Equipment:

a) Capacitance Bridge: This shall be suitable for operation on both A.C. mains and storage batteries. Facilities shall be provided for both audio and visual indications of the balance of the bridge.

b) Fault Locating equipment:

i) Digital fault locating equipment along with the accessories like surge generator etc.

ii) Acoustic detector for locating underground fault by capacitor discharge method.

iii) Equipment for locating PVC Sheath fault

6.10.2 Cross Linked Polyethylene Insulated Cables up to 33kV- Datasheets

DATA SHEET – A1					
SL. NO.		DESCRIPTION		UNIT	DATA
1.0 GENERAL	1	Application/ designation			Power Cable
	1.2	Installation	Above Ground		In cable trays
			Below Ground		Cable Trench
	1.3	Design ambient temperature		°C	45
	1.4	Ground Temperature		°C	35
	1.5	Minimum drum length		m	250
	1.6	Quantity Required		m	Refer BOQ
2.0 SYSTEM DATA	2.1	Number of phases & frequency			3Ph & 50 Hz
	2.2	Nominal system voltage		kV	11
	2.3	Highest system voltage		kV	12
	2.4	Impulse (1.2/50 μ sec wave)withstand voltage		kV_p	75
	2.5	Power frequency withstand voltage		kV	28
	2.6	System neutral			Solidly earthed

DATA SHEET – A1							
SL. NO.		**DESCRIPTION**	**UNIT**	**DATA**			
	2.7	System Fault Level	kA(rms)	16			
	2.8	CB Breaking capacity	kA(rms)	16			
	2.9	Relay & CB Opening time	m sec	3000			
3.0 DESCRIPTION OF CABLE	3.1	Cable type		H1	H1		
	3.2	No. of cores		3	3		
	3.3	Conductor size	Sq.mm	240	300		
	3.4	Conductors					
	a)	Material	Cu/Al	Al	Al		
	b)	Stranded	Yes/No	Yes	Yes		
	3.5	Conductor screen		Extruded non-metallic semi conducting compound			
	3.6	Core insulation					
	a)	Material		XLPE applied by extrusion. XLPE shall be gas cured			
	b)	Thickness of insulation		As per applicable standards			
	3.7	Insulation screen					
	a)	Non-metallic part		Extruded semi conductive compound			
	b)	Metallic part					
	i)	For single core cables		NA			
	ii)	For multi core cables		Copper tape			
	3.8	Core identification					
	a)	Up to 3.3 kV cables		NA			
	b)	Cables above 3.3 kV		By numerals printed on the cores			
				Cable type			
				H1	H2	H3	H4
	3.9	Inner sheath					
	a)	Material		Extruded conductor screening			
	b)	Thickness of inner sheath		As per applicable standards			
	3.10	Armouring					
	a)	Material Galvanised steel/Aluminium	GS/AL	GS			
	b)	Type: Single wire/strip / Double wire/strip		Single wire			
	c)	Dimension of wire/strip		As per applicable standards			
	3.11	Outer sheath					
	a)	Material PVC/FRLS PVC		PVC			
	b)	Thickness of outer sheath		As per applicable standards			
	c)	Colour		Black			
	3.12	Temperature rise					
	a)	Maximum conductor temperature during continuous operation at rated current		90 °C			
	b)	Temperature rise for short circuit rating with initial conductor temperature of 90 °C		250 °C			
	3.13	Quantity		As per BOQ (Section-7.1)			

DATA SHEET – A1			
SL. NO.	**DESCRIPTION**	**UNIT**	**DATA**

DATA SHEET – A2
APPLICABLE STANDARDS

SL #	DESCRIPTION	IS
1	Rubber insulated cables: Part 1 With Copper conductor	IS 434 : Part I : 1964
2	Rubber insulated cables: Part 2 With aluminium conductor	IS 434 : Part 2 : 1964
3	Flexible Trailing Cables for use in Coal Mines	IS 691:1984
4	Paper insulated lead-sheathed cables for rated voltage up to and including 33kV Specification	IS 692 :1994
5	Varnished cambric insulated cables (Revised)	IS 693 :1965
6	PVC insulated cables for working voltages up to and including 1100 V	IS 694 :1990
7	Code of practice for installation and maintenance of power cable up to and including 33kV rating (Second Revision)	IS 1255 :1983
8	PVC insulated (heavy duty) electric cables: Part 1 for working voltages up to and including 1100 V	1S 1554 : Part 1: 1988
9	Specification for PVC Insulated (Heavy duty) Electric cable -Part 2: For working voltage from 33kV up to and including 11kV	1S 1554 : Part 2: 1988
10	Polyethylene insulated cable for working voltage up to and including 1100 V	IS 1596: 1977
11	Aluminium conductor for insulated cables	IS 1753 :1967
12	Specification for Cotton Selvedge Tape for Electric Cables	1S 2847: 1964
13	Copper conductor is insulated cables and cords	IS 2982 :1965
14	Thermoplastic insulated weather proof cables : Part 1 PVC insulated and PVC sheathed	IS 3035 :Part1: 1965
15	Recommended current rating for cables : Part 4 Polyethylene insulated cables	IS 3961 : Part4 :1968
16	Recommended current rating for cables : Part 5 PVC insulated light duty cables	IS 3961 : Part5 :1968
17	Mild steel wires, formed wires and tapes for armouring of cables	IS 3975 :1999
18	PVC insulated (heavy duty) electric cables with solid aluminium conductor for voltages up to and including 1100 V	IS 4288 : 1988
19	Recommended short circuit rating of high voltage PVC cables	IS 5819 : 1970
20	PVC insulation and sheath of Electric Cables	IS 5831 :1984
21	Cross linked Polyethylene insulated and Thermoplastic sheathed cables Specification, Part-1 for working voltages up to and including 1100V	IS 7098 : Part 1 : 1988
22	Cross linked Polyethylene insulated and Thermoplastic sheathed cables Specification, Part-2 for working voltages from 3.3kV up to and including 33kV	IS 7098 : Part 2 : 1985
23	Cross linked Polyethylene insulated and Thermoplastic sheathed cables Specification, Part-3 for working voltages from 66kV up to and including 220kV	IS 7098 : Part 3 : 1993
24	Elastomeric insulation and sheath of electric cables	IS 6380 :1984
25	Polyethylene insulation and sheath of electric cables	IS 6474 : 1984
26	Brass glands for PVC cables	IS 12943 : 1990
27	Conductors of insulated electric cables and flexible cords (First revision)	IS 8130 :1984

DATA SHEET– B **(To be filled in by the BIDDER and submitted with the bid)**						
Sl. No.	**Description**	**Unit**	**Bidder's Data**			
1.0	Cable Type as per Data sheet A		H1	H2	H3	H4
2.0	Name of manufacturer					
3.0	Whether IS marked?	Yes/No				
4.0	Voltage grade					
5.0	Number of cores					
6.0	Conductor size	Sq. mm				
7.0	Conductors					
a)	Material					
b)	Number & diameter of wires					
8.0	Conductor screen					
9.0	Core insulation					
a)	Material					
b)	Curing process					
c)	Thickness of insulation	mm				
10.0	Insulation screen					
a)	Non-metallic part					
b)	Metallic part i) For single core cables ii) For multi core cables					
11.0	Core identification					
12.0	Inner sheath					
a)	Material					
b)	Thickness of inner sheath					
13.0	Armouring					
a)	Material (Galvanised steel/ Aluminium)	GS/AL				
b)	Type: Single wire/strip					
	Type: Double wire/strip					
c)	Dimension of wire/strip					
14.0	14.0	Outer sheath				
a)	Material PVC/FRLS PVC					
b)	Thickness of outer sheath					
c)	Colour					
15.0	Temperature rise					
a)	Maximum conductor temperature during continuous operation at rated current					
b)	Temperature rise for short circuit rating with initial conductor temperature of 90					
16.0	Quantity					
			Cable Type			
			H1	H2	H3	H4
17.0	Nominal overall diameter of completed cable	mm				

DATA SHEET– B **(To be filled in by the BIDDER and submitted with the bid)**						
Sl. No.	**Description**	**Unit**	**Bidder's Data**			
18.0	Nominal weight per meter of completed cable	Kg/mm				
19.0	Minimum radius of bend round which cable can be laid	mm				
a)	Direct					
b)	In ducts					
20.0	Nominal internal diameter of pipes or ducts required	mm				
21.0	Maximum D.C. resistance of conductor per Km at 20^0C	Ohm				
22.0	Maximum A.C. resistance of conductor per Km at 90^0C	Ohm				
23.0	Equivalent star reactance per Km of 3 phase circuit at power frequency	Ohm				
24.0	Maximum electrostatic capacitance per core per Km of cable	μF				
25.0	Maximum charging current per conductor per Km of cable at nominal voltage	A				
26.0	Maximum dielectric loss of cable per km of 3 phase circuit, laid direct in ground, at normal voltage, frequency and maximum conductor temperature					
27.0	Impedance per km of 3 phase circuit at normal power frequency and maximum conductor temperature:					
a)	Positive and negative sequence	Ohm				
b)	Zero sequence	Ohm				
28.0	Normal drum length of cable	m				
29.0	Approximate shipping weight & size of drum					
30.0	Rated current for standard condition of laying					
31.0	Derating factors for variations in					
a)	Ambient air temperatures					
b)	Ground temperatures					
c)	Ground thermal resistivity					
d)	Depth of burial of 0.5 m, 0.75 m, 1.25 m, 1.5m					
e)	For two cables laid side by side in ground at centre distances 300, 400, 600mm ,900 mm					
32.0	Furnish chart showing					

DATA SHEET– B (To be filled in by the BIDDER and submitted with the bid)						
Sl. No.	**Description**	**Unit**	**Bidder's Data**			
	derating factor for different spacing of cables considering multicore cables installed in horizontal formation in single row as well as in different tiers under the following methods of laying:					
a)	Cables laid in formed concrete trenches with removable covers					
b)	Cables laid in cable trays					
c)	Cables laid in ground one meter below the ground level					
d)	Cables laid in pipes or ducts					
33.0	Recommended operating temperatures:					
a)	Continuous	^{0}C				
b)	Emergency	^{0}C				
c)	After short circuit	^{0}C				
34.0	Short circuit capacity for 1 second, for initial and final conductor temperatures as per item 15	kA (RMS)				

6.11.1 Power & Control Cables

1.0 SCOPE

1.1 This specification covers the requirements of XLPE insulated Power Cables up to 1.1 kV and PVC insulated control cables rated 1.1kV.

2.0 CODES & STANDARDS

2.1 The design, construction, manufacture and performance of cables shall comply with all currently applicable statutes, regulations and safety codes in the locality where cables will be installed. Nothing in this Specification shall be construed to relieve the VENDOR of this responsibility.

2.2 Unless otherwise specified, the cables shall conform to the latest applicable standards as specified in the relevant Data Sheet A2.

3.0 DESIGN FEATURES OF POWER CABLES

3.1 **Multi Core Cables**

a) Conductor: Well compacted, stranded copper or aluminium as stated in Data sheet A.

b) Insulation: Cross linked Polyethylene (XLPE) applied by extrusion.

c) Inner Sheath: The laid up cores shall be provided with Extruded PVC inner sheath. It shall be as circular as possible.

d) Armouring: Shall be provided when specified in Data sheet A and shall be applied over the inner sheath.

e) Outer Sheath: Extruded outer sheath shall be applied over inner sheath in case of unarmoured cables and over the armouring in case of armoured cables.

3.2 **Single Core Cables**

The cable construction shall be similar to three core cables except the following:-

a) The armouring shall be applied over the insulation and shall be with non magnetic material as stated in data sheet A.

b) The extruded PVC outer sheath shall be applied over the insulation in case of unarmoured cables and over the armouring in case of Armoured cables.

3.3 **Armouring**

The armouring shall comprise the following:-

a) For multi core cables: Single / double steel wire / strip as stated in data sheet A.

b) For Single core cables: Single / double Aluminium or copper wire / strip as stated in data sheet A.

3.4 **Outer Sheath**

The outer sheath shall be as follows:-

a) With PVC / HR PVC / FRLS Compound as stated in Data sheet A.

b) Black in colour.

c) Shall have reduced flame propagation property.

3.5 **Requirement of special sheath for FRLS cable:**

3.5.1 Outer sheath for FRLS cables shall meet the following test requirements related to flame retardance, low smoke emission, low acid and toxic gas emission. The BIDDERS shall have proper test apparatus to conduct all the relevant tests as per the applicable standards mentioned herein.

3.5.2 Test for Flame Retardance

c) Oxygen Index

The critical oxygen index value shall be minimum 29 at 250^0C when tested for temperature index test as per ASTMD-2863.

d) Flammability

iv) Cables shall pass test under fire conditions as per IEC-332-1.

v) Cables shall also pass tests as per Swedish standard S5424-1475 for Chimney tests for Class-F3.

vi) Fire survival (FS) cables in addition to tests I and II above shall pass tests as per IEC-331.

3.5.3 Test for Smoke Generation

The cables shall satisfy the tests conducted to evaluate the percentage obscuration by smoke in an optical system placed in the path of the smoke. The smoke density rating shall be in accordance with the values specified under notes in Data Sheet-A or as agreed to between Purchaser and Vendor before placement of order. The tests shall be conducted in accordance with the following Standards/ Test methods:

d) ASTM-D-2843

e) ASTM-E-662

f) 3 metre cube test chamber.

3.5.4 Tests for Acid Gas Generation

The hydrochloric acid generation when tested as per IEC 754-1 shall be less than the values specified under notes in Data Sheet-A or as agreed to between Purchaser and Vendor before

placement of order. Suitable test methods shall be agreed upon between PURCHASER and VENDOR before placement of order with regard to tests for other toxic and corrosive gases generated from the sheath under fire conditions.

3.5.5 Tests for Resistance to Ultra Violet Radiation

These shall be as specified under notes in Data Sheet-A or as agreed to between PURCHASER and VENDOR before placement of order.

3.5.6 Tests for Water Absorption

3.5.7 Outer sheath shall be subjected to tests for water absorption as per IS:10810. When additional characteristics are required, the tests shall be carried out as agreed to between PURCHASER and VENDOR before the placement of order.

3.5.8 Any other special tests on the sheath in addition to the above shall be as indicated under notes in Data Sheet-A or as agreed to between PURCHASER and VENDOR before placement of order.

3.6 **Temperature Rise**

a) The maximum conductor temperature shall not exceed 90^0C during continuous operation at rated current.

b) The short circuit rating (current and withstand time) of cables shall be as specified in Data Sheet A. The temperature shall not exceed 250^0C with initial conductor temperature of 90^0C.

c) The bidder shall furnish charts for derating factors under different conditions of laying.

3.7 **The Cables shall withstand all mechanical and thermal stresses under steady state and transient operating conditions.**

4.0 DESIGN FEATURES OF CONTROL CABLES

4.1 **Cable Construction**

4.1.1 The Cables shall be multicore with number of cores as stated in Data Sheet A.

4.1.2 The Construction of the cables shall be as follows:

a) Conductor

i. Material: Shall be annealed high conductivity, stranded copper.

ii. Size: The cross sectional area of the conductor shall be as stated in Data Sheet A

b) Core Insulation

Shall be Extruded PVC compound Type A as per IS 5831.

c) Inner Sheath

The laid up cores shall be provided with Extruded PVC inner sheath.

d) Armouring

Shall be provided when specified in Data sheet A. The armouring shall be by single galvanised steel round wire or strip in accordance with the relevant standards.

e) Outer Sheath

Extruded outer sheath shall be applied over the inner sheath for unarmoured cables and over the armouring in case of armoured cables. The outer sheath shall be with PVC/ HR PVC/ FRLS PVC Compound as stated in Data Sheet A and shall have reduced flame propagating properties. It shall be black in colour.

f) Core numbering shall be in accordance with the relevant standards.

4.2 **Requirement of special sheath for FRLS cable:**

4.2.1 These shall be same as specified in Clause-3.5.

5.0 TESTS

5.1 The cables shall be tested in accordance with the latest applicable standard. The tests shall include Type tests, Acceptance tests and Routine tests as per applicable standards.

6.0 CABLE DRUMS

6.1 Cables shall be supplied in non-returnable wooden drums of heavy construction. The wood used for construction of the drum shall be properly seasoned, sound and free from defects and wood preservative shall be applied to the entire drum. All ferrous parts shall be treated with a suitable rust preventive finish or coating to avoid rusting during transit or storage.

6.2 The BIDDERS shall indicate in the offer, the maximum length for each size of cable, which can be furnished on one drum. The actual length supplied on each drum shall be within tolerance limit of +/- 5% unless otherwise indicated in Data Sheet A. However, before packing the cables on drums, the VENDOR shall obtain the PURCHASERS approval for the drum lengths.

7.0 CABLE LENGTH

7.1 Cable lengths specified in Data Sheet-A are approximate. Actual requirements will be advised to the successful BIDDER at the time of placing the order. Unless otherwise stated by the BIDDER, the unit rates shall apply for the actual lengths required. Cable length shall be marked on the outer sheath of the cable.

8.0 DATA TO BE FURNISHED

The BIDDER shall furnish technical data as required in Data Sheets B and also furnish technical and descriptive literature giving details of the insulation, sheathing, testing, etc., of the offered cables.

6.11.2 Power & Control Cables-Datasheets

DATA SHEET–A1-01 (POWER CABLES)			
Sl.No	**Description**	**Unit**	**Data**
1	SYSTEM PARTICULARS		
1.1	Nominal Power system Voltages	kV	1.1
1.2	Maximum system voltage for continuous operation	kV	1.1
1.3	System neutral earthing	UE/E	Earthed
1.4	Fault level of the system to which the cable will be connected	kA rms. for 1 sec	-
1.5	Ground temperature	°C	35
1.6	Design ambient temperature	°C	45
2	TYPE OF CABLE LAYING		
a)	Laid side by side touching	Above Ground	In Cable Trays
		Below Ground	Trenches
DESCRIPTION OF CABLES			
Sl.	**Description**	**Data**	

No		
1	Designation	Power Cables
2	Conductor	
a)	No. of wires	As per BOQ (Section-5)
b)	Size (sq. mm)	As per BOQ (Section-5)
c)	Stranded/ Solid	Stranded
d)	Material	Cu
3	Core Insulation Material	XLPE
4	Filler Material	PVC
5	Inner Sheath Material	Extruded PVC
6	Armour	
a)	Material	Single steel Wire/Strip
b)	Type	
7	Outer Sheath	FRLS PVC
NOTE: SIZE AND LENGTH OF CABLES AS PER Section-5		

DATA SHEET – A1-02 (CONTROL CABLES)			
Sl.No	**Description**	**Unit**	**Data**
1	SYSTEM PARTICULAR		
1.1	Nominal Power system Voltages	kV	1.1
1.2	Maximum system voltage for continuous operation	kV	1.1
1.3	System neutral earthing	UE/E	Earthed
1.4	Fault level of the system to which the cable will be connected	kA rms. for 1 sec	NA
1.5	Ground temperature	^{0}C	35
1.6	Design ambient temperature	^{0}C	45
2	TYPE OF CABLE LAYING		
a)	Laid side by side touching	Above Ground	In Cable Trays
		Below Ground	Trenches
DESCRIPTION OF CABLES			
Sl. No	**Description**	**Data**	
1	Designation	Control Cables	
2	Conductor		
a)	No. of wires	As per Section-5	
b)	Size (sq. mm)	As per Section-5	
c)	Stranded/ Solid	Stranded	
d)	Material	Cu	
3	Core Insulation Material	PVC	
4	Filler Material	PVC	
5	Inner Sheath Material	Extruded PVC	
6	Armour		
a)	Material	Single steel Wire/Strip	
b)	Type		
7	Outer Sheath	FRLS PVC	
NOTE: SIZE AND LENGTH OF CABLES AS PER Section-5			

DATA SHEET- A2		
APPLICABLE STANDARDS		
Sl. No.	**Description**	**Applicable Standards**
1	Rubber insulated cables: Part 1 With Copper conductor	IS 434 : Part I : 1964
2	Rubber insulated cables: Part 2 With aluminium conductor	IS 434 : Part 2 : 1964
3	Flexible Trailing Cables for use in Coal Mines	IS 691:1984
4	Paper insulated lead-sheathed cables for rated voltage up to and including 33kV Specification	IS 692 :1994
5	Varnished cambric insulated cables (Revised)	IS 693 :1965
6	PVC insulated cables for working voltages up to and including 1100 V	IS 694 :1990
7	Code of practice for installation and maintenance of power cable up to and including 33kV rating (Second Revision)	IS 1255 :1983
8	PVC insulated (heavy duty) electric cables: Part 1 for working voltages up to and including 1100 V	1S 1554 : Part 1: 1988
9	Specification for PVC Insulated (Heavy duty) Electric cable - Part 2: For working voltage from 33kV up to and including 11kV	1S 1554 : Part 2: 1988
10	Polyethylene insulated cable for working voltage up to and including 1100 V	IS 1596: 1977
11	Aluminium conductor for insulated cables	IS 1753 :1967
12	Specification for Cotton Selvedge Tape for Electric Cables	1S 2847: 1964
13	Copper conductor is insulated cables and cords	IS 2982 :1965
14	Thermoplastic insulated weather proof cables : Part 1 PVC insulated and PVC sheathed	IS 3035 :Part1: 1965
15	Recommended current rating for cables : Part 4 Polyethylene insulated cables	IS 3961 : Part4 :1968
16	Recommended current rating for cables : Part 5 PVC insulated light duty cables	IS 3961 : Part5 :1968
17	Mild steel wires, formed wires and tapes for armouring of cables	IS 3975 :1999
18	PVC insulated (heavy duty) electric cables with solid aluminium conductor for voltages up to and including 1100 V	IS 4288 : 1988
19	Recommended short circuit rating of high voltage PVC cables	IS 5819 : 1970
20	PVC insulation and sheath of Electric Cables	IS 5831 :1984
21	Cross linked Polyethylene insulated and Thermoplastic sheathed cables Specification, Part-1 for working voltages up to and including 1100V	IS 7098 : Part 1 : 1988
22	Cross linked Polyethylene insulated and Thermoplastic sheathed cables Specification, Part-2 for working voltages from 3.3kV up to and including 33kV	IS 7098 : Part 2 : 1985
23	Cross linked Polyethylene insulated and Thermoplastic sheathed cables Specification, Part-3 for working voltages from 66kV up to and including 220kV	IS 7098 : Part 3 : 1993
24	Elastomeric insulation and sheath of electric cables	IS 6380 :1984
25	Polyethylene insulation and sheath of electric cables	IS 6474 : 1984
26	Brass glands for PVC cables	IS 12943 : 1990
27	Conductors of insulated electric cables and flexible cords (First revision)	IS 8130 :1984

DATA SHEET-B1 (POWER CABLES) (To be filled in by the bidder and submitted along with the bid)						
SL. No.	**DESCRIPTION**		**UNIT**	**Type of Cable, as per BOQ**		
				A	**B**	**C**
1	Name of Manufacturer					
2	Standards as Applicable for the Specified Types of Cables in Data Sheet A1 & A2					
2.1	Whether IS marked?		Yes/No			
3	Conductor		Al/Cu			
3.1	Stranded Conductors as indicated in Data Sheets		Yes/No			
4	Core Insulation XLPE		Yes/No			
4.1	Core Insulation -					
	a) Extruded or any special feature					
	b) Dielectric strength		kV/mm			
4.2	Colour coding for cores					
5	Inner Sheath Insulation Extruded PVC		Yes/No			
6	Outer Sheath					
6.1	Type		Extruded PVC/ HR PVC/ FRLS			
6.2	Fungicide and termite proof		Yes/No			
6.3	Markings on outer sheath					
	a) IS					
	b) Length at one meter intervals					
7	Armour-					
	a) Material					
	b) Size					
8	Rated Voltage, suitable for Earthed system					
9	a) Conductor temperature for continuous ratings		^{0} C			
	b) Conductor temperatures for 1 Sec short circuit current ratings		^{0} C			
	c) Emergency overload temperature		^{0} C			
10	Minimum bending radius		mm			
11	Maximum length per drum and weight of drum for cable sizes:					
	a) Up to 10 mm^2		m, kg			
	b) Up to 70 mm^2		m, kg			
	c) For sizes> 70 mm2 (indicate for each specified size)	Sizes	mm^2			
		Drum				
		i) Length	m			

DATA SHEET-B1 (POWER CABLES) (To be filled in by the bidder and submitted along with the bid)					
SL. No.	**DESCRIPTION**	**UNIT**	**Type of Cable, as per BOQ**		
			A	**B**	**C**
	ii) Weight	kg			
12	Tolerance on drum length	± m			
13	a) All tests will be carried out as per applicable standards and any other tests if specified in Section '6.3.1' or Data Sheet A1 & 2 of the Specification	Yes/No			
	a) If 'No', give separate details or deviations here				
14	Other Parameters of Cables:				
14.1	Thickness of insulation	mm			
14.2	Diameter under armour	mm			
14.3	Diameter over armour	mm			
14.4	Overall diameter	mm			
14.5	Weight/ m	kg			
14.6	Resistance/ km	Ohm			
14.7	Reactance/ km	Ohm			
14.8	Capacitance/ km	µF			
15	Derating factors for variations in:				
15.1	Ambient air temperature				
15.2	Ground temperature				
15.3	Depth of laying				
15.4	Soil Resistivity				
15.5	Method of laying				

DATA SHEET-B2 (CONTROL CABLES) (To be filled in by the bidder and submitted along with the bid)					
SL. No.	**DESCRIPTION**	**UNIT**	**Type of Cable, as per BOQ**		
			A	**B**	**C**
1	Name of Manufacturer				
2	Standards as Applicable for the Specified Types of Cables in Data Sheet A1 & A2				
2.1	Whether IS marked?	Yes/No			
3	Conductor	Al/Cu			
3.1	Stranded Conductors as indicated in Data Sheets	Yes/No			
4	Core Insulation Extruded PVC	Yes/No			
4.1	Dielectric strength	kV/mm			
4.2	Colour coding for cores				
5	Inner Sheath Extruded PVC	Yes/No			
6	Outer Sheath				
6.1	Type Extruded PVC/ HR PVC/ FRLS				
6.2	Fungicide and termite proof	Yes/No			
6.3	Markings on outer sheath				
	a) IS				
	b) Length at one meter intervals				
7	Armour-				
	a) Material				
	b) Size				
8	Rated Voltage, suitable for Earthed system				
9	Conductor temperature for continuous ratings	^{0}C			
10	Minimum bending radius	mm			
11	Maximum length per drum and weight of drum for cable sizes specified in Data Sheet A:				
	a) Sizes	mm^2			
	b) Drum				
	i) Length	m			
	ii) Weight	kg			
12	Tolerance on drum length	± m			
13	a) All tests will be carried out as per applicable standards and any other tests if specified in Section '6.3.1' or Data Sheet A1 & 2 of the Specification	Yes/No			
	b) If 'No', give separate details or deviations here				
14	Other Parameters of Cables:				
14.1	Thickness of insulation	mm			
14.2	Diameter under armour	mm			
14.3	Diameter over armour	mm			
14.4	Overall diameter	mm			
14.5	Weight/ m	kg			
14.6	Resistance/ km	Ohm			
14.7	Reactance/ km	Ohm			
14.8	Capacitance/ km	µF			
15	Derating factors for variations in:				
15.1	Ambient air temperature				
15.2	Ground temperature				

DATA SHEET-B2 (CONTROL CABLES) (To be filled in by the bidder and submitted along with the bid)					
SL. No.	DESCRIPTION	UNIT	Type of Cable, as per BOQ		
			A	B	C
15.3	Depth of laying				
15.4	Soil Resistivity				
15.5	Method of laying				

6.12.1 Substation Accessories

1.0 SCOPE

1.1 This Specification covers the design, material, constructional features, manufacture and testing of the following equipment

a) AAC, ACSR Conductors and steel wires.

b) Insulator assemblies and line accessories.

c) Pedestal insulators.

d) Other miscellaneous accessories.

2.0 AAC,ACSR CONDUCTOR & STEEL WIRES

2.1 Codes And Standards

2.1.1 The design, material, construction, manufacture, inspection and testing of conductors shall comply with all currently applicable statutes, regulations and safety codes in the locality where the conductors will be installed. The equipment shall also conform to the latest applicable standards. Nothing in this Specification shall be construed to relieve the VENDOR of this responsibility.

2.1.2 The conductors shall conform to latest standards specified in Data Sheet-A. In case of conflict between the standards and this Specification, this Specification shall govern.

2.2 Material

2.2.1 Aluminium strands of All Aluminum Conductor (AAC) or Aluminum conductor, steel reinforced (ACSR) conductor shall be hard drawn from 99.5% pure electrolyte aluminium rods with 60% IACS conductivity. The VENDOR shall specify the guaranteed minimum and average values of conductivity. The copper conductor shall consist of hard drawn round copper wires and shall have 97% conductivity. The copper shall have resistivity of 0.017241 Ohm – mm^2/m at 20° C.

2.2.2 Chemical composition of the material shall comply with the requirements of relevant Standards.

2.2.3 The surface of conductor shall be clean and dry and free from any excess grease that may be used in its fabrication. The surface strands shall be smooth and free from burrs and other projections which may be cause for increasing corona losses when the conductor is used on extra high voltage lines.

2.2.4 If any particular corrosive atmosphere is mentioned in Data Sheet-A, the BIDDER shall advise the necessary treatment for the tubular bus conductor to make it free from corrosion. Treatment may be a multi-layer zinc-copper silvering plating or any standard type of electro-plating.

2.3 Galvanising

2.3.1 The steel wire strands of ACSR conductor and steel conductor shall be hot dip galvanised. Zinc coating shall be evenly and uniformly coated complying with relevant standards as specified in Data Sheet-A for heavily coated wires.

2.4 Greasing

2.4.1 When specified in Data Sheet-A, the steel core and the inner layer of aluminium wires, (where more than one aluminium layer exists), shall be protected with a special grease in order to provide additional protection against corrosion due to saline pollution. The grease shall fill the whole space between wires within circumscribed cylinder at inner aluminium layer or at steel core, if the conductor has only one aluminium layer.

2.4.2 The grease shall be chemically neutral with respect to aluminium, zinc and steel. It shall withstand weather conditions given under Section-B (Project Data) and permanent temperature of 85°C without alteration of its properties.

2.5 Tests

2.5.1 All tests on the required number of samples of raw materials and finished conductor as stipulated in the relevant standards shall be carried out. No manufacture shall be commenced prior to PURCHASER'S/ENGINEER'S written approval of the test certificates regarding raw materials.

2.6 Packing

2.6.1 Conductor shall be wound on non-returnable wooden drums made of seasoned and sufficiently strong wood, and conforming to relevant standards specified in Data Sheet-A. At least 12 mm clearance from the conductor to outer edges of the drum shall be provided prior to lagging.

2.6.2 All drums shall be painted inside and outside with aluminium paint. All drums shall have a layer of water-proof paper around the drum under the conductor and another layer over the conductor and under the lagging.

2.6.3 In addition to manufacturer's standard markings on the drums, batch of manufacture shall be clearly marked on each drum.

2.6.4 Drums shall have barrel of at least 1000 mm diameter with centre hole of 100 mm

3.0 INSULATOR ASSEMBLIES AND LINE ACCESSORIES

3.1 Insulator Assemblies

3.1.1 The insulator assemblies shall consist of the indicated number of Porcelain insulator discs, hardware, suspension clamps, compression type dead end clamps and arcing horns. The details are as shown on the drawings and shall meet the requirements thereafter described. An insulator assembly complete with all hardware fittings shall not exhibit excessive corona formation and discharge likely to cause radio interference at voltages less than the flashover voltage. Insulators shall be designed to avoid excessive concentration of electric stresses in any section or across leakage surfaces.

3.1.2 Insulators

The insulators disc shall be of the cap and pin, ball and socket type with zinc sleeve, radio interference free and shall have characteristics a shown on Data Sheet-A1. Each insulator disc shall comply with the following requirements.

a) Porcelain

The insulators shall be made of the highest grade, dense, homogenous, wet-process porcelain, completely and uniformly vitrified throughout to produce uniform mechanical and electrical strength and long life service. The porcelain shall be free from warping, roughness, cracks, blisters, laminations, projecting points, foreign matters and other defects, except those within the limits of standard accepted practice. Surfaces and grooves shall be shaped for easy cleaning. Shells shall be substantially symmetrical.

b) Cap and Pin

The cap and pin shall be of such design that it will not yield or distort under the specified mechanical load in such a manner as to change the relative spacing of the insulators or

add other stresses to the shells. The insulator caps shall be of the socket type provided with non-ferrous metal or stainless steel cotter pins and shall provide, positive locking of the coupling. The cap shall be made of good standard grade malleable iron or open hearth or electric furnace steel and hot dip galvanized. The cap shall be truly circular with the inner and outer surfaces concentric, and shall be free from cracks, shrinks, air holes, burrs and rough edges, to minimise field concentrations and radio disturbances. The insulator pins shall be made of malleable iron or drop/forged or machine steel free from cracks and air holes. All bearing surfaces shall be smooth and uniform so as to distribute the loading stresses evenly.

c) Glaze

All porcelain surfaces exposed to the weather shall be smoothly glazed with a good lustre and of uniform brown colour. The glaze shall be hard, dense, and of proper adherence to the porcelain and shall be unaffected by the weather, ozone, nitric acid, nitric oxides, alkali, dust or sudden changes in temperature within the atmosphere changes.

Total area not covered by glaze and area of any single glaze defect shall be within the internationally accepted tolerance.

d) Cementing

A high quality of Portland cement conforming to IS: 269 shall be used for cementing the porcelain to the cap and pin. There shall be no relative movement/play (axial/torsional) between cap and porcelain & porcelain and pin.

e) Marking

Each insulator shall have the rated combined mechanical and electrical strength marked clearly on the porcelain surface. Each insulator shall also bear symbols identifying the manufacturer, month, and year of manufacture etc. Marking on porcelain shall be printed, not impressed, and shall be applied before firing.

f) Tests

i) The manufacturer shall carry out adequate tests to demonstrate that the insulators meet the requirements of this specification. All requirements for Sampling, Inspections and Tests shall be as per applicable standards. Tests shall include vibration test on complete assembly as an Acceptance test apart from those specified in relevant applicable standards.

ii) The CONTRACTOR shall furnish certified copies of all tests whether or not inspection is waived. For the purposes of sampling and testing, the lot size shall be 5,000 units.

iii) PURCHASER will attend Routine tests on all the units and Acceptance tests on samples drawn from the lots as per standards.

3.1.3 Hardware

a) All hardware, except where otherwise specified, shall be malleable iron or steel for forging, metal mould casting or drop forging, hot dip galvanized, and shall have an ultimate strength not less than the mechanical and electrical strengths of the insulator discs for each type of insulator assembly. Where parallel insulators are used yoke plates at the end & bottom and the connecting hardware shall be of sufficient strength.

b) Assembly shall be performed in such a way that the mechanical properties are not affected by the zinc. Further, insulating part shall not be subjected to any mechanical stresses due to pressure exerted by the bottom edge of the cap. All current carrying parts shall be designed and manufactured to have minimum contact resistance.

c) Fitting intended to connect two dissimilar metals shall be designed to avoid harmful bimetallic corrosion under service conditions.

d) All fittings shall be such that corona visual voltage of the insulator string with fittings shall not exceed that of the string without any fittings. The radio interference voltage of the insulator shall be lower when measured with the fittings than without the fittings.

e) All fittings shall be suitable for "Hot Line Maintenance Work" such as replacing either whole or part of the insulator strings by conventional methods with ease, safety and speed. The items of hardware and fittings shall make complete assemblies and shall include all bolts, nuts, washers, locknuts, cotter pins and other miscellaneous pieces which are necessary or used for their satisfactory performance and efficient maintenance. All bolts nuts and locknuts shall made of steel. All cotter pins shall be made of non-ferrous or stainless steel and shall be of the self-locking type. For transposition hardwares, the use of special hardware fittings must be made by the CONTRACTOR and transportation effected. Necessary hardware's are to be supplied at no extra cost.

3.1.4 Arcing Horns

Arcing horns if specified in Data Sheet-A1, shall be provided.

3.1.5 Suspension Clamps

a) The suspension clamps for the ACSR conductor shall be made of aluminium alloy suitable for use on the conductor with performed armour rods installed. The suspension clamps shall have smooth surfaces free from burrs and the edges and fillets shall be rounded to minimize corona concentration and radio interference.

b) The clamps shall be designed to minimum magnetic loss with maximum permissible 50Hz current flowing through the conductor with armour rods. If dissimilar metals are used in making the clamps, suitable precautions shall be taken to minimize corrosion due to electrolytic action. Each suspension clamp shall have a suitable bell mouth and shall be capable of holding the conductor with performed armour rods without slipping under an unbalanced tension of 25% of the rated ultimate strength of the conductor and shall have ultimate strength equal to or exceeding the mechanical and electrical strength of the insulator disc. Each suspension clamp shall be furnished with bolts, two U-bolts with lock washers, a keeper piece and other required parts. The degree of U-Bolt tightening shall be in accordance with the recommendation of the suspension clamp manufacturer.

3.1.6 Strain Clamps

a) The strain clamps shall be dead-end compression type and shall have ultimate strength equal to that of the conductor.

b) Bolted type of strain clamps may be used in slack spans.

3.1.7 Compression Type Dead End Clamps

a) The compression type dead end clamps shall be suitable for use on specified conductor and shall consist of galvanized steel clevis end or steel oval eye end, aluminium dead end body, aluminium jumper connection with bolted connection between the jumper connector and the dead end.

b) The compression dead end clamps and the jumper connector shall have strength of not less than 95% and 30% rated ultimate tensile strength of the conductor respectively. The compression dead end clamp and jumper connector shall have an electric conductivity of not less than that of the conductor, and shall be free from all defects and shall not damage the conductor when attached. The position of compression shall be clearly marked on the surface of each clamp and jump socket. The steel parts shall be hot-dip galvanized.

c) Conductor accessories :

Supply and installation of the following conductor accessories as per the provisions laid down in the specification:

i) P.A.Rod.

ii) Vibration damper

iii) Repair sleeve

iv) Mid span compression joint.

d) Ground wire accessories :

Supply and installation of the following ground wire accessories as per the provisions laid down in the specification:

i) Suspension clamps.

ii) Tension clamps.

iii) Mid span compression joint.

e) Tests on Hardware fittings :

The hardware fittings shall fulfil the requirement of the following tests in accordance with the IS: 2486 or any latest amendment thereof. The BIDDER shall submit copy of the type tests on similar hardware fittings separately as well as fitted with the corresponding insulators carried out earlier.

f) Testing charges :

No testing charges shall be paid by the PURCHASER for the Routine and Acceptance tests of all the equipment covered under this package and the same shall be borne by the CONTRACTOR.

3.1.8 Miscellaneous Materials:-

Materials not specifically covered herein by detailed specifications shall be of standard commercial quality suitable for the intended use.

3.1.9 Galvanizing

Unless otherwise specified, all ferrous metal shall be galvanized in accordance with the relevant standard indicated in Data Sheet-A. All metal shall be free from burrs, sharp edges, lumps & shall be smooth so that interconnecting parts will fit properly and so that the parts may be assembled and disassembled readily. Bolts and nuts shall be galvanized after being threaded and excessive zinc shall be removed, and shall run freely (hand fit) for the entire length of the thread.

3.1.10 Tests of Hardware and Fittings

a) All routine and sample tests shall be done in the presence of the PURCHASER's representative. All tests for hardware's and fittings shall be carried out in accordance with the applicable standard indicated in Data Sheet-A.

b) The PURCHASER reserves the right to inspect and test the finished material as per standard specifications. The notice of the proposed date of such inspection shall be advised to the PURCHASER one month in advance.

c) Any inspection and tests whether carried or waived, by the PURCHASER shall not relieve the CONTRACTOR from his responsibility to supply the hardware's and fittings in accordance with the specification and /or from any of his obligations under the contract.

3.1.11 Packing

All materials shall be suitably packed in standard container, which shall strong enough to withstand rough handling.

4.0 OVERHEAD GROUND WIRE ASSEMBLIES

4.1 General.

The overhead ground wire assemblies shall consist of the indicated hardware and suspension clamps, compression type dead end clamps suitable for specified steel wire and shall meet the requirements hereafter described.

4.2 Hardware

All hardware and accessories shall be made of malleable iron or steel for forging, metal mould casting or drop ferrous process. Cotter pins shall be made of non-ferrous or stainless steel and shall be of the self-locking type. All hardware shall have ultimate strength equal to or exceeding the rated ultimate strength of overhead ground wire.

4.3 Suspension Clamps

The suspension clamps shall be made of malleable iron suitable for use on the galvanizing steel over-head ground wire with performed armour rods installed. Each suspension clamp shall be complete with bolts, two U-Bolts, a keeper piece and shall be capable of holding the overhead ground wire armour rods installed without slipping under unbalance tension of 25% of the rated ultimate strength of the overhead ground wire and shall have rated ultimate strength of not less than the ultimate strength of the overhead ground wire.Degree of U-bolt tightening shall be in accordance with the recommendation of the suspension clamp manufacturer.

4.4 Compression Type Dead End Clamps

The compression type dead end clamp shall be made of mild steel or stainless steel suitable for use on galvanized steel stranded overhead steel ground wire and shall have a steel clevis or oval eye end. Each compression type dead end clamp, if equipped with clevis, shall be furnished complete with bolt and cotter pin. Each compression type dead end clamp shall be capable of developing not less than 95% of rated ultimate strength of the overhead ground wire.

4.5 Miscellaneous Materials

Materials not specifically covered herein by detailed specifications shall be of standard commercial quality suitable for the intended use.

4.6 Galvanizing

Unless otherwise specified, all ferrous metal shall be galvanized in accordance with the relevant standard indicated in Data Sheet-A. All metal shall be free from burrs, sharp edges, lumps and dross, and shall be smooth so that interconnecting parts will fit properly and so that the parts may be assembled and disassembled readily. Bolts and nuts shall be galvanized after being threaded and excessive zinc shall be removed and shall run freely (hand fit) for the entire length of the thread.

4.7 Tests

All routine and sample tests shall be carried out in the presence of PURCHASER's representative. Tests for hardware and fittings shall be accordance with the applicable standard indicated in Data Sheet –A.

5.0 LINE ACCESSORIES

5.1 General

All line accessories to be furnished shall be made of aluminium alloy, malleable iron or steel.All ferrous metals (except stainless steel) shall be galvanized by hot dip process.

5.2 Conductor Connection and Repair

5.2.1 Tension Sleeves

a) The tension sleeves for ACSR conductor shall consist of steel compression sleeve for the steel core, an aluminium alloy compression sleeve for the complete conductor and aluminium plugs for sealing holes in aluminium compression sleeve through which an aluminium joint compound is to be injected.

b) Each tension sleeve shall capable for developing not less than 95% of the rated ultimate strength of the conductor and shall have a conductivity of not less than that of the conductor.

5.2.2 Repair Sleeves

The compression type repair sleeves for conductor shall be aluminium or aluminium alloy sleeve, and suitable for use on the ACSR conductor and each shall consist of aluminium

or aluminium alloy sleeve body or keeper.

5.3 Overhead Ground Wire Connection

a) The overhead ground wire connection shall be suitable for use on galvanized overhead steel ground wire.

b) The tension sleeves for the overhead ground wire shall be made of mild steel sleeve. Each compression joint shall be capable of developing not less than 95% of the rated ultimate strength of the overhead ground wire.

5.4 Armour Rods for conductor

a) The armour rods shall be of the performed type, made of aluminium alloy and suitable to use on conductor. The armour rods shall be smooth, free from corrosion, split, crack or any defects. Armour rods shall be designed in such a manner so as to protect effectively the conductor from fatigue caused by vibration.

5.5 Vibration Dampers

The vibration dampers shall be of the Stockbridge type suitable for use on the conductor or overhead ground wire.Dampers for use on the ACSR conductor shall have aluminium clamps compressed on the steel messenger between the weights and suitable for attachment to the conductor. The damper clamp shall be designed to permit installation and removal by the use of hot line tools. Each damper weight shall be provided with one drain hole positioned to be at the bottom of the weight when the damper is installed in the vertical plane. Damper weights shall be made of cast iron or steel, to compress the messenger strand, and shall be hot-dip galvanized.

5.6 Aluminium Joint Compound

The compound shall be applicable for both aluminium to aluminium and aluminium to copper jointing accessories. The compound shall be free from oxide compound, and shall be chemically insert of a higher electrical efficiency and having zinc chromate as oxide inhibitor. It shall remain workable through a temperature range from 8 deg to 50 deg. It shall be non-toxic and insoluble in water.

6.0 DANGER, NUMBER AND PHASE PLATES :

6.1 Each tower shall be fitted with a number plate and danger plate. Each tension tower shall be fitted with phase plates also. These shall be provided at appropriate level from the ground (about 3.15 metres from ground level) so that the man standing on the ground will be able to clearly identify the same. These plates shall be 2 mm thick and vitreous enamelled on the back and front.

6.2 The letters, figures and the conventional skull and bones on danger plates shall be signal red on the front side. The danger boards shall confirm to IS-2551.

6.3 The letters on number plates shall be in red against white background. The number plate shall confirm to Figure 5. of IS:5613 (Part-II/ Sec.-1).

7.0 BIRD GUARD :

7.1 Bird guard shall be provided to prevent birds perching immediately above the suspension insulator strings on the holes provided on the cross arm for this purpose.

6.12.2 Substation Accessories-Datasheets

DATA SHEET A1					
Sl. No.		**Description**		**Unit**	**Data**
1.0 GENERAL	1.1	Post insulators			For details, refer attached switchyard plan and sections
	1.2	Highest system voltage		kV (rms)	72.5
	1.3	Classification			Bus post Insulator
	1.34	System neutral earthing			Effectively earthed system
	1.5	Insulation levels (For use on effectively/non-effectively earth systems as applicable)			
		i) Visible discharge voltage		kV (rms)	53
		ii) One minute power frequency (Dry/Wet)		kV (rms)	140/140
		iii) Power frequency puncture withstand		kV (rms)	1.3 times the actual dry flashover voltage of the unit
		iv) Impulse voltage withstand		kV (Peak)	325
	1.6	Creepage distance	Total	mm	1812.5
			Protected	mm	906.25
2.0 OUTDOOR CYLINDRICAL POST INSULATORS	2.1	Designation			C8-325
	2.2	Number of units		No.	As per switchyard layout
	2.3	Mechanical characteristics			
		i) Strength class			8
		ii) Minimum failing load			
		Bending		N	8000
		Torsion		Nm	3000
		Tension		N	50000
		Compression		N	100000 **(Refer Note)**
	2.4	Dimensions			
		i) Overall height		mm	770±1
		ii) Maximum diameter of the insulating part		mm	220
		iii) Top metal fitting	Pitch circle dia.	mm	127
			No. & dia. of tapped holes	No. mm	4 16
		iv) Bottom metal fitting	Pitch circle dia.	mm	127
			No. & dia. of tapped holes	No. mm	4 16

Note:

1 Bidder shall furnish cantilever strength calculation.

DATA SHEET – A2					
Sl. No.		**Description**		**Unit**	**Data**
	1.0	**INSULATORS FOR OVERHEAD POWER LINES**			NOT APPLICABLE
1.0 GENERAL	1.1	Highest system voltage		kV (rms)	
	1.2	System neutral earthing			
	1.3	Classification Type			
	1.4	Insulation levels			
	1.5	Dimension and number of units in each string			
		i) Visible discharge voltage		kV (rms)	
		ii) Wet power frequency		kV (rms)	
		iii) Power frequency puncture withstand		kV (rms)	
		iv) Impulse voltage withstand		kV (rms)	
	1.6	Minimum failing loads for			
		i) Pin Insulators		kN	
		ii) Post Insulators		kN	
		iii) String Insulators		kN	
	1.7	Pin ball shank diameter for string insulator		mm	
		Creepage distance	Total	mm	
			Protected	mm	
2.0 INSULATOR FITTINGS FOR OVERHEAD POWER LINES	2.1	Material			
	2.2	Type of fittings required			
	2.3	Size of power line conductor			
	2.4	Suitability for hot line washing			
	2.5	Bolted type / compression type			

DATA SHEET – A3				
CLAMPS AND CONNECTORS				
Sl. No.	**Description**		**Unit**	**Data**
1.0	Name of Manufacturer			By Bidder
2.0	Details of connectors/accessories			
3.0	Material	a) For connecting ACSR conductor to ACSR conductor		NA
		b) For connecting Equipment terminal made of Cu or Brass to ACSR conductor/ Al tube		Bi-metallic connectors made from Al alloy casting with 4mm thick cast copper alloy liver
		c) For connecting GI shield wire		Malleable Iron Casting
		d) Bolts, Nuts and Plain/ Spring Washers		Hot dip galvanised steel
4.0	Type			Bolted / Crimped.
5.0	Compliance with standard			As stipulated
6.0	Rated current		A	800A
7.0	Diameter and number of armour rods to be used on specified sizes of conductors			Suitable for 2”/2.5” IPS Al tube as per switchyard layout
8.0	Bolt tightening torque		kg m	By bidder

DATA SHEET – A4					
ALUMINIUM TUBE					
Sl. No.		**Description**	**Unit**	**Data**	
1.0 GENERAL	1	Application			
	2	Tubular bus conductor material		Aluminium	
	3	Size: outside diameter	mm	60.53	73.02
	4	Standard pipe size		IPS 2" (Bay Bus)	IPS 2.5" (Main Bus)
	5	Pipe wall thickness	mm	3.9	5.15
	6	Dimensional tolerance			
	a)	Mean thickness	mm	-0, +0.3	
	b)	Straightness (deviation in 10 m length)	mm	18	
	c)	Roundness	mm	1.0	
	d)	Length	mm	-0,+0.30	
	7	Atmosphere corrosive	Yes/No	No	
	8	If yes type of corrosive atmosphere Salt laden/ ammonia		NA	
	9	Quantity	m	As per BOQ (Section-7.1)	
2.0 RATING	1	Voltage rating	kV	66	
	2	Number of phases		3	
	3	Current rating	A	By Bidder	
	4	Frequency	Hz	50	
	5	Short circuit current	kA	31.5	
	6	Duration of fault	Sec	3	
3.0 DESIGN DATA	1	Wind velocity			
	a)	Maximum	m/ Sec		
	b)	Minimum	m/ Sec		
	2	Maximum ambient temperature	^{o}C	45	
	3	Temperature rise of conductor when carrying rated current	K	40	
4.0 CONFIGURATION	1	Phase spacing	m	2 to 4	
	2	Mounting		Horizontal	
	3	Span	m	2.5 to 4.5	

DATA SHEET –A5		
APPLICABLE STANDARDS		
Porcelain post insulators		IS 2544 BS 3297 IEC 60273
Insulators for overhead power lines		IS 731 EN 60383-2 EN 60305 IEC 60305, 60433
Fittings for overhead power lines		IS 2486 BS 3288
Dimensions of indoor and outdoor porcelain post insulators and post insulator units		IS 5350
Conductors and earth wire accessories for overhead power lines		IS 2121 BS 3288
Electric power connectors		IS 5561 BS 3288
AAC, ACSR Conductors		IS: 398
Copper conductors		IS: 7391
Galvanisation of steel wires		IS: 4826
Reels and drums for bare wire		IS: 1778
Aluminium/ Aluminium bars, rods, tubes, sections for electrical purpose		IS 5082
Note: Unless otherwise stipulated, insulators and insulator fittings shall conform to relevant Indian Standards		

DATA SHEET -B1 (To be filled in by the BIDDER and enclosed with the bid)				
(INSULATORS)				
Sl. No.	**Description**	**Unit**	**Bidder's Data**	
1.	Name of manufacturer			
	a) Post Insulators			
	b) Insulators for O/H power line			
	c) Fittings			
2.	Applicable Standards			
	a) Post Insulators			
	b) Insulators for O/H power line			
	c) Fittings			
3.	Weight		Post insulator	Disc Insulator
	a) Insulator	kg.		
	b) Complete stack/string W/O fittings	kg.		
	c) Complete string with fittings	kg.		
4.	Overall dimensions		Post insulator	Disc Insulator
	a) Stack	mm		
	b) String including fittings at either end	mm		
5.	Creepage Distance			
	a) Stack	mm		
	b) String	mm		
6.	Drawings			
6.1	Overall dimensional drawings for			
	a) Insulator units		Ref. Drg. No.	
	b) Fittings		Ref. Drg. No.	
	c) Stack/String		Ref. Drg. No.	
	Note : Drawings as above and technical catalogues need to be enclosed with the bid highlighting therein actual type/model offered. Confirm whether drawings and catalogues enclosed/not enclosed.			

DATA SHEET-B2 (To be filled in by the BIDDER and enclosed with the bid)			
(CLAMPS AND CONNECTORS)			
Sl. No.	**Description**	**Unit**	**Bidder's Data**
1	Name of manufacturer		
	a) For Power connectors		
	b) For Accessories		
2	Dimensional drawings giving weight of each power connectors/accessory need to be made available with the bid		
	Confirm whether drawings enclosed/ not enclosed		
4	Visible discharge voltage for		
	a) Power connectors	kV	
	b) Accessories	kV	

6.13.1 Addendum to Earthing & Lightning Protection

ADDENDUM TO DOCUMENT No: Section 6.13.2

1. Clause Nos. 6.0. This clause is not applicable for this tender including Sub Cluase.(6.1-6.9)
2. Clause No.3.0. Sub-Clause Nos. (3.2),(4.10) are not applicable for this tender.
3. Clause No.4.0. Sub-Clause Nos. (4.3) - "lightning protection and earthing" shall be read as Earthing (Means lightning Protection not applicable for this tender)
4. Clause No.4.0. Sub-Clause Nos. 4.10 is not applicable for this tender.

6.13.2 Earthing & Lightning Protection

1.0 SCOPE

1.1 This specification covers the requirement of installation, testing and commissioning of earthing and lightning protection systems. The work shall be carried out in accordance with relevant project layout drawings enclosed.

2.0 CODES AND STANDARDS

2.1 The earthing and lightning protection systems shall comply with all currently applicable standards regulations and safety codes of the locality where the installation is to be carried out. Nothing in this specification shall be constructed to relieve the CONTRACTOR of this responsibility.

2.2 The installation work shall conform to the latest applicable electricity rules, standards and codes of practice for earthing and lightning protection system.

3.0 SCOPE OF SUPPLY

3.1 The earthing and lightning protection conductors and earth electrodes shall be supplied by the CONTRACTOR when specifically indicated in layout drawings and bill of quantity (Section-3.1). Conductors shall be free from rust scale and other electrical and mechanical defects and all materials used shall conform to relevant standards or approved by the

PURCHASER. The sizes, materials and quantity shall be as listed in layout drawings and bill of quantity (Section-3.1).

3.2 Test links in suitable weather proof enclosures as shown in enclosed drawing shall be supplied by the CONTRACTOR for connection between each lightning conductor down comer and earth electrode.

4.0 SCOPE OF INSTALLATION WORK

4.1 The installation work shall include unloading, storing, laying, fixing, and jointing/termination, testing and commissioning associated with the safety earthing system of the plant and lightning protection system for switchyard/substation. All welding/brazing equipment, necessary tools and testing equipment shall be furnished by the CONTRACTOR.

4.2 The CONTRACTOR shall be responsible for any installation materials which are lost or damaged during installation. All damages and thefts shall be made good by the CONTRACTOR till the installation is handed over to the PURCHASER.

4.3 The CONTRACTOR shall carryout the lightning protection and earthing of all structures as indicated in the PURCHASER'S drawings.

4.4 The CONTRACTOR shall install bare conductors, braids, etc., required for system and individual equipment earthing. All work such as cutting, bending, supporting, painting, coating, drilling, brazing soldering, welding, clamping, bolting and connecting onto structures, equipment frames, terminals, rails or other devices shall be in the CONTRACTOR'S scope of work. All incidental hardware and consumables such as fixing cleats/clamps anchor fasteners, lugs, bolts nuts washers, bitumen compound, adhesive, anti-corrosive paint as required for the complete work shall be deemed to be included by the CONTRACTOR as part of the installation work.

4.5 The quantities sizes, and material of earthing conductors and electrodes to be installed shall be as indicated in layout drawings and bill of quantity (Section-3.1), and routes of the conductors and locations of electrodes shall be shown on the project drawings. The alignments of conductors are approximately shown in the earthing drawings and these may be suitably shifted / finalized in consultation with the site ENGINEER / PURCHASER to avoid any interference. If earth connection to any device is not shown specifically in the relevant earthing drawings, it shall be field routed.

4.6 The tap connections (earthing leads) from the floor embedded main earthing grid to the equipment of more than 500mm long shall be embedded in floor by the CONTRACTOR where required, together with associated civil work such as excavation/chasing, concreting and surfacing, if not already done by the civil contractor. The concrete cover over the conductor shall not be less than 50mm.

4.7 The depth of burial of earth conductors in outdoor areas shall be as per data sheet A1 and project drawings. The scope of installation of earth conductors in outdoor areas, buried in ground shall include excavation in earth up to 600mm deep and 450mm wide (unless otherwise stated), laying of conductor at 600mm depth (unless stated otherwise), brazing / welding as required of main grid conductor joints as well as risers of 50mm length above ground at required locations and backfilling. Back filling material to be placed over buried conductor shall be free from stones and other harmful mixtures. Backfill shall be placed in layers of 150mm uniformly spread along the ditch, and tampered utilizing pneumatic tampers or other approved means. If the excavated soil is found unsuitable for backfilling, the CONTRACTOR shall arrange for suitable soil from outside.

4.8 The scope of installation of earth connection leads on steel structures/walls shall include laying the conductors, welding/cleating at specified intervals, welding/brazing to the main earth grids risers, coating welded/brazed joints by bituminous paint.

4.9 The scope of installation of electrodes shall include installation of these electrodes as indicated in layout drawings, specification (Section-6.3.1) and BOQ (Section-3.1) and connecting to main buried earth grid, as per enclosed drawings / relevant standards. The scope of work shall include excavation, construction of the earth pits including all materials

required for construction of the earth pits, placing the pipe, providing and fixing test links on those pipes in test pits and connecting to main earth grid conductors.

4.10 The scope of installation of lightning Protection Conductors on the roofs of buildings shall include laying, anchoring, fastening and cleating of horizontal conductors, grouting of vertical rods where necessary, laying, fastening /cleating/welding of the down comers on the walls/columns of the building and connection to the test links above ground level.

4.11 Support Cleats used for roof conductors at tiled roof area shall be fixed to the tiles using water proof adhesive as the same cannot be fixed by screws.

4.12 The scope of installation of the test links shall include mounting of the same at specified height on wall/column by suitable brackets and connections of the test link to the earth electrode.

4.13 All earth pits shall be interconnected using buried ground grid conductor.

5.0 EARTHING SYSTEM:

5.1 The installation work shall be carried out in accordance with the following specification:-

Earthing and lightning protection system – Installation notes.

5.2 Wherever main earthing conductor crosses cable trenches, they shall be buried below the trench floor.

5.3 Suitable earth risers approved by the PURCHASER shall be provided above finished floor/ground level, if the equipment is not available at the time of laying of the main earth conductors. The minimum length of such riser inside the building shall be 200mm and outdoors shall be 500mm above ground level. The risers to be provided shall be marked in project drawings.

5.4 Wherever earthing conductor passes through walls, galvanized iron sleeves shall be provided for the passage of the earthing conductor. The pipe ends shall be sealed by the CONTRACTOR by suitable water proof compound.

5.5 Water stops shall be provided wherever earthing conductor enters the building form outside below grade level. Water stops and above mentioned sleeved shall be provided by the civil contractor.

5.6 Metallic conduits and pipes shall be connected to the earthing system unless specified otherwise.

5.7 Earth Electrodes

a) The type of earth electrodes shall be as indicated in Data sheet A1

b) Electrodes shall as far as practicable, be embedded below permanent moisture level

c) Some electrodes shall be housed in test pits with concrete covers for periodic testing of earth resistivity. Installation of rod/pipe/plate electrodes in test pits shall be convenient for inspection, testing and watering.

d) Earth pits shall be treated with salt and charcoal if average resistivity of soil is more than 20 ohm. Metre.

6.0 LIGHTNING PROTECTION SYSTEM:

6.1 The installation work shall be carried out in accordance with the specification mentioned in Para 5.1.

6.2 The material, type, size and quantities of components shall be as mentioned in layout drawings and BOQ (Section-3.1).

6.3 The methods of lightning protection system to be adopted are:

a) By horizontal roof conductors and down conductors

b) By down conductors for Metal roof structures where the minimum thickness of sheet metal used for roofing is in accordance with the applicable standard.

c) By shield wires supported on poles/ masts

The particular method of protection depends on dimensions of the structure protected aesthetics and convenience.

6.4 Air Termination System

a) Horizontal air terminations comprising of horizontal roof conductors shall be used for all buildings.

b) A few vertical air terminations shall be provided, wherever necessary and GS rods of 20mm dia. and 1m long shall be used.

6.5 Down Conductors:

6.5.1 Air termination system shall be connected to the earth by down comers fixed along the outer surface of building/structure. Each down comer shall be terminated to a separate Treated test earth electrode. The material of down conductors will be as specified in BOQ and layout drawings. There shall not be any sharp bends and turns in the down conductors.

6.5.2 The number of down conductors shall be provided in accordance with the applicable standards.

6.5.3 Lightning protection system down conductors shall not be connected to other earthing conductors above ground level. Also no intermediate earthing connection shall be made to lightning arrester, transformer and CVT earthing leads which shall be directly connected to pipe/plate/rod electrode.

6.6 Test Links:

Each down comer shall be provided with a link one meter above ground level for dismantling the electrodes and taking measurements. The links shall be made up of aluminium and housed in PVC or glass filled nylon enclosure box to prevent corrosion.

6.7 Termination And Joints:

a) All joints in the horizontal roof conductors shall be of welded type. Where it is likely to damage the roof material like asbestos or sheet steel, riveted joints shall be used.

b) Connection between roof conductors and down comers shall be of welded type. Where it is likely to damage the roof material like asbestos or sheet steel, riveted joints shall be used.

c) Down Comers shall be connected to test links by bolted connections

d) The lead from test link to earth electrodes shall have bolted connection at both ends.

e) Individual earth electrodes in turn shall be connected to station earthing system by welded joint at grid and bolted joint at electrodes.

f) All pipes carrying hazardous materials shall be bonded at the joints couplings and shall be earthed.

6.8 Earth pits of Lightning protection system shall be interconnected to the plant ground grid below ground level.

6.9 The lightning protection of special structures as mentioned below shall be carried in accordance with applicable standards

a) Tall structures exceeding 30 meter in height.

b) Structures with roofs of high flammability.

c) Buildings with explosive or highly flammable contents.

7.0 TESTING OF EARTHING SYSTEM

7.1 The CONTRACTOR shall ensure the continuity of all conductors and joints. The CONTRACTOR shall carry out earth continuity tests, earth resistance measurements and other tests which in his opinion are necessary to prove that the system is in accordance with the design specifications, code of practice and Electricity Rules. The CONTRACTOR shall have to bear the cost of all such tests.

8.0 CONTRACTOR'S LICENCE

8.1 It will be the responsibility of the CONTRACTOR to obtain necessary License/Authorization permit for work from the Licensing Board of the locality/state where the installation is to be carried out. The persons deputed by the CONTRACTOR'S firm shall also hold valid permits issued or recognized by the Licensing Board of the Locality/State where the work is to be carried out.

9.0 WORKMANSHIP

9.1 The CONTRACTOR shall ensure workmanship of good quality and shall assign qualified supervisors/engineers and competent welders/labour who are skilled, careful and experienced in their traders. The PURCHASER's ENGINEER shall reserve the right to reject non competent persons employed by the CONTRACTOR, if the workmanship is not of good order.

10.0 SAFETY

10.1 The CONTRACTOR shall ensure adherence to all safety norms such as use of Safety Shoes, Belts, Helmets, Gloves etc. and sign acceptance of OWNER's Safety Conditions for work at site.

6.14.1 Addendum to Electrical Contract Works

ADDENDUM TO DOCUMENT No: Section 6.14.2

1. Clause No.7.0: This clause is not applicable for this tender.
2. Clause No.8.3, 8.8, 8.11,8.12: These clauses are not applicable for this tender.
3. Clause No.6.0: The clause Earthing and Lightnng Protection shall be read as Earthing System (Lightning protection is not applicable for this tender)
4. Clause No.8.1: The clause shall be read as "All checks and tests as per the MANUFACTURE'S drawings/manuals, relevant code of installation and the enclosed commissioning checks as listed here under for various types of equipment e.g. Transformers, HV & MV switchgear, Outdoor Circuit Breaker, isolators, CTs, PTs, LAs, Control and Relay panels, Relays and Meters, Cables, etc., shall be carried out by the CONTRACTOR as part of the installation work.

6.14.2 Electrical Contract Works

1.0 SCOPE

1.1 This specification covers the requirements of supply and/or Installation of any or all the following equipment/systems:-

a) Installation, Testing and commissioning of equipment to be supplied by the owner.

b) Supply, Installation, Testing and Commissioning of equipment to be supplied by the contractor.

c) Supply, Installation, Testing and Commissioning of cabling system including supply of cable trays and all other cable carriers, cable laying and termination accessories.

d) Supply, Installation, Testing and Commissioning of Earthing and Lightning Protection systems.

e) Supply, Installation, Testing and Commissioning of Lighting system.

1.2 The exact requirements shall be as specified under Section-6.3.1 of this specification, other relevant specifications and data sheets under Section-6.4 to Section 6.18 and price schedule.

1.3 This specification details the broad guidelines for installation, testing and commissioning of electrical equipment. The work shall, however, at all times be carried out strictly as per the instructions of the OWNER/ENGINEER/MANUFACTURER.

2.0 CODES AND STANDARDS

2.1 The electrical installation work shall comply with the latest applicable standards, Regulations, Electricity Rules and Safety Codes of the locality where the installation is carried out. Nothing in this specification shall be construed to relieve the CONTRACTOR of this responsibility.

2.2 Applicable standards for installation and testing of equipment and systems are indicated in Data Sheet A2. However, this list is not intended to be comprehensive. Any other relevant codes and standards shall also be applicable.

3.0 GENERAL SCOPE

3.1 The CONTRACTOR shall take the equipments to be erected from the storage yard/stores/sheds/railway siding, transport the equipment where required in actual position, erect, assemble all parts of the equipment and test and commission the same.

3.2 The CONTRACTOR shall furnish all tools. Welding equipment, rigging materials, testing equipment, test connections etc., required for complete installation, testing and commissioning of the items included in the contract work.

3.3 The OWNER may engage specialist engineers from the equipment MANUFACTURERS to supervise the installation, testing and commissioning of their equipment. The CONTRACTOR shall extend full co-operation to these engineers and carry out the works as per their instructions. The CONTRACTOR'S work shall include minor rewiring/modifications as may be necessitated during commissioning. Providing such assistance shall be deemed to be included in the CONTRACTOR'S basic scope.

3.4 The CONTRACTOR shall co-operate through the OWNER/ENGINEER with other contractors at site, in all matters of common interest, so as not to obstruct operation of others and to ensure the safety of all personnel and works covered under this specification.

3.5 It will be the CONTRACTOR's responsibility to obtain approval /clearance from local statutory authorities including Electrical Inspector, wherever applicable, for conducting of any work or for installation carried out which comes under the purview of such authorities.

3.6 The work shall be carried out strictly as per the instructions and layout drawings of the OWNER/MANUFACTURER. In case of any doubt/misunderstanding as to correct interpretation of the drawings or instructions, necessary clarifications shall be obtained from the OWNER/ENGINEER. The CONTRACTOR shall be held responsible for any damage to the equipment consequent to not following the MANUFACTURER'S instructions correctly. All necessary drawings, MANUFACTURER'S equipment manuals shall be obtained by the successful bidder who after completion of work must submit the same to the OWNER/ENGINEER.

3.7 All thefts of equipment/component parts, after taken over by the CONTRACTOR, until the installation is handed over to the OWNER, shall be made good by the CONTRACTOR.

3.8 The CONTRACTOR shall have a separate cleaning gang to clean all equipment under erection and as well as the work area and the project site at regular intervals to the satisfaction of the OWNER/ENGINEER. In case the cleaning is not to the OWNER'S satisfaction, he will have the right to carry out the cleaning operations and any expenditure incurred by the OWNER in this regard will be to the CONTRACTOR'S account.

3.9 In order to avoid hazards to personnel moving around the equipment such as switchgear/switchyard equipments etc., which is kept, charged after installation before commissioning, they should be suitably cordoned off to prevent anyone accidentally going near it.

3.10 The CONTRACTOR shall carry out touch-up painting on any equipment indicated by the OWNER/ENGINEER, if the finish paint on the equipment is soiled or marred during installation handling. The paint will be supplied by the OWNER.

3.11 The CONTRACTOR shall ensure workmanship of good quality and shall assign qualified supervisors/engineers and competent labourers who are skilled, careful and experienced in their several trades in similar works. The OWNER/ENGINEER shall reserve the right to reject non-competent persons employed by the CONTRACTOR, if the workmanship is not of good order.

3.12 It shall be the responsibility of the CONTRACTOR to obtain necessary License/ Authorisation/ permit for work from the Licensing Board of the locality/state where the CONTRACTOR's firm should also hold valid permits issued or recognised by the Licensing Board of the locality/state where the work is to be carried out.

4.0 EQUIPMENT INSTALLATION WORK

4.1 The CONTRACTOR shall supply, install, test and commission all the equipment as per scope. The quantities, approximate sizes and weights of the equipment shall be indicated in relevant data sheets and BOQ Section 7.1 & 7.2

4.2 Equipment shall be installed in a neat, workmanlike manner so that it is level, plumb, square and properly aligned and oriented. Tolerances shall be as established in the MANUFACTURER's drawings or as stipulated by the ENGINEER. No equipment shall be permanently bolted down to foundation or Structure until the alignment has been checked and found acceptable by the OWNER/ENGINEER.

4.3 Care shall be exercised in handling to avoid distortion to stationary structures, the marring of finish, or damaging of delicate instruments or other electrical parts. Adjustments shall be made as necessary to the stationary structures for plump and level, for the sake of appearance or to avoid twisting of frames, binding of hinged members, etc.

4.4 The CONTRACTOR shall move all equipment into the respective buildings through the regular doors or floor openings provided specifically for lifting the equipment. The CONTRACTOR shall make his own arrangement for lifting heavy equipment and materials. The CONTRACTOR shall move the equipment from storage site to the crane, attach to the crane hook to the points(s) provided specifically for handling and install in final location. Operation of the crane shall be by qualified personnel only. No part of the structure shall be utilised to lift or erect any equipment without prior permission of the OWNER/ENGINEER.

4.5 Foundation work for all transformers, switchgear, motors, control panels, switchyard equipments, desks and minor modifications to foundations, wherever found necessary for proper installation will be carried out by the CONTRACTOR.

4.6 All external cabling including end connections and earthing will be carried out separately under cabling and earthing works respectively.

4.7 **Transformers**

4.7.1 Supply, Inspection, storage, installation, testing and commissioning of transformers shall be in accordance with the specified code of practice and MANUFACTURER'S instructions.

4.7.2 Whenever stated in Data Sheet A1, transformers will be delivered without oil, filled with inert gas and without bushings and externally mounted accessories. As applicable, the CONTRACTOR shall:

(a) Assemble the transformers with all Fittings such as bushings, cooler banks radiators, conservators, values, piping, Cable boxes, marshalling boxes, OLTC, cooling fans/pumps, etc.,

(b) Arrange for Oil filtration before filling.

(c) Provide wedges/clamps to rigidly station all Transformers on rails.

(d) Connect the transformer's terminals

(e) Lay and terminate the cables/conduits between all the accessories mounted on the transformer tank/cooler and transformer marshalling Kiosk.

(f) The oil-filtration equipment shall be arranged by the CONTRACTOR.

4.7.3 Care shall be taken during handling of insulating oil to prevent ingress of moisture or foreign matter. In the testing, circulating, filtering or otherwise handling of oil, rubber hoses shall not be used. Circulation and filtering of oil, the heating of oil by regulated short-circuit current during drying runs and sampling and testing of oil shall be in accordance with the MANUFACTURE'S instructions and specified Code of Practice.

4.8 **Switchgear, control/relay panels**

4.8.1 Switchgear and control relay panel/desks shall be supplied and installed in accordance with specified Code of Practice and the MANUFACTURER'S instructions. The switchgear/ panels shall be installed on finished surfaces, concrete, or steel sills. The CONTRACTOR shall be required to install and assign any channel sills, which form part of the foundations. In joining shipping sections of the switchgear/ panels/ control centres together, adjacent housing or panel sections provided shall be bolted together after alignment has been completed. Power bus, enclosures, ground and control splices of conventional nature shall be cleaned and bolted together, being drawn up with torque wrench of proper size or by other approved means. Tape or compound shall be applied where called for by the MANUFACTURER'S drawings.

4.8.2 The CONTRACTOR shall take utmost care in handling instruments, relays and other delicate mechanisms. Wherever the instruments and relays are supplied separately, they shall be mounted only after the associated control panels/desks have been erected and aligned. The blocking materials/mechanism employed for the safe transit of the instruments and relays shall be removed after ensuring that the panels/desks have been completely installed and no further movement of the same would be necessary. Any damage to relays and instruments shall be immediately reported to the OWNER/ENGINEER and shall be made good by the CONTRACTOR.

4.8.3 Whenever applicable, the CONTRACTOR shall install compressed air plants associated with the switchgear. The installation shall be complete with compressor sets, receivers, control panels, compressed air pipes, valves and other accessories.

4.9 **Motors**

4.9.1 Unless otherwise specified, the motors will be installed by the respective vendors of the driven equipment. However, the CONTRACTOR under this specification shall undertake the

testing and commissioning of the motor. The installation/ commissioning shall be as per the applicable code of practice and the MANUFACTURER'S instructions.

4.10 **Battery and Chargers**

4.10.1 Installation and testing of battery shall be done in strict compliance with the manufacturer's instructions. Each cell is filled with electrolyte in accordance with the MANUFACTURER'S instructions. Battery shall be set up on racks as soon as possible after receipt, utilising lifting devices supplied by the MANUFACTURER. The cells shall not be lifted by the terminals. Contact surfaces of battery terminals and inter-cell connectors shall be cleaned, coated with protective grease and assembled. Each connection shall be properly tightened. Each cell shall be tested with hydrometer and thermometer and results logged. Freshening charge, if required, shall be added. When turned over to the OWNER, the battery shall be fully charged and electrolyte shall be at full level and have specified specific gravity.

4.11 **Busduct/ Busways**

4.11.1 The CONTRACTOR shall carry-out installation of busduct/ busway as required in the OWNER'S / MANUFACTURER's plan and elevation drawings of Substation showing equipment layout details, etc., equipment connections, (unless otherwise specified), will be supplied by the OWNER. The quantities of all equipment will be indicated in the bill of materials on the drawings and/or Data Sheet A1.

4.11.2 Whenever specified in Section 6.3.1, the CONTRACTOR shall undertake the design, fabrication, supply and installation of busduct support structures as per the OWNER/ENGINEER'S requirements.

4.11.3 Wherever called for, the wall frame assembly for busduct run from outdoor shall be installed by the contractor.

5.0 CABLING SYSTEM INSTALLATION WORK

5.1 Scope of Work

a) Supply and Installation of cables.

b) Supply and installation of the following item:-

i) Cable Carrier System including cable trays and tray covers complete with all accessories necessary such as coupler plates, elbows, tees, bends, reducers, stiffeners and all hardware.

ii) GI rigid and flexible conduits/pipes.

iii) Cable terminations kits, cable glands, lugs, trefoil clamps etc.,

iv) Miscellaneous items like junction/marshalling boxes, push button stations etc.,

c) The cabling system installation work shall include unloading, storing, installation, fixing, jointing/termination, testing and commissioning of complete cabling system items and any other work/items necessary for completing the job.

5.2 The installations work shall be carried out in accordance with the following documents:-

a) Cabling System

b) Cable Installation Notes

5.3 Major civil works are included in the scope of this specification. These include construction of cable trenches, cable tunnels, duct banks etc. The required embedment plates shall be supplied and installed by the contractor at the time of civil construction. Minor civil works such as making holes/grooves in floor slab/wall and patching up in an approved manner any holes made in the walls/floors by the CONTRACTOR, embedment of short lengths of

conduits, plates in floors, walls etc. shall also be deemed to be included in the scope of CONTRACTOR.

5.4 Schedule of Quantities

The material, type, size and quantities of all items shall be as mentioned in schedule of prices (Section-7.1 and 7.2).

6.0 EARTHING AND LIGHTNING PROTECTION SYSTEM INSTALLALTION

6.1 Scope of work

a) Supply and installation of all earthing and lightning conductors, electrodes and accessories as mentioned in the Section-6.3.1 and schedule of prices (Section-7.1 and 7.2).

b) The installation work shall include unloading, storing, laying, fixing, joining/terminations, testing and commissioning of the safety earthing system of the plant and lightning protection system for switchyard, building and allied structures. All welding/brazing equipment, necessary tools and testing equipment shall be furnished by the CONTRACTOR.

6.2 The installation work shall be carried out in accordance with the following specifications:-

a) Earthing and Lightning Protection

b) Earthing and Lightning Protection system Installation Notes.

6.3 The CONTRACTOR shall carry out the lightning protection and earthing of all equipment/panel/structures as indicated in the drawings, specification and BOQ (Section-7.1 and 7.2). Whether specifically shown in drawings or not, building columns, hand rails, miscellaneous items such as junction/marshalling boxes, field switches, cable boxes etc., shall be earthed.

6.4 The CONTRACTOR shall install bare/insulated, copper/aluminium/steel conductors, braids, etc., required for system and individual equipment earthing. All work such as cutting, bending, supporting, painting/coating, drilling, brazing/soldering/welding, clamping, bolting and connection onto structures, equipment frames, terminals, rails or other devices shall be in the CONTRACTOR'S scope of work. All incidental hardware and consumable, such as fixing cleats/clamps, anchor fasteners, lugs, bolts, nuts, washers, bitumastic compound, anti-corrosive paint as required for the complete work shall be deemed to be included by the CONTRACTOR as part of the supply and installation work.

6.5 Schedule of Quantities

The material, type, size and quantities of supply and installation items shall be as mentioned in the specific requirements (Section-6.3.1) and schedule of prices (Section-7.1 and 7.2).

7.0 LIGHTING SYSTEM INSTALLATION WORK

7.1 Scope of work

a) Supply, Installation, testing and commissioning of lighting fixtures with lamps and accessories.

b) Supply and installation of lighting system equipment such as lighting distribution boards (LDB'S), lighting panels(LPs), receptacles, light control switches, ceiling fans, lighting wires, conduits junction boxes, lighting poles, towers, etc., if called for in the scope.

c) The installation work shall include unloading, storing unpacking, fixing of all equipment, routing and laying of conduits/cables, wiring, termination, testing and commissioning of all the equipment of lighting system.

7.2 The supply and installation of all mounting accessories, earthing wires and incidental hardware and consumable like fixing saddles, spacer plates, junction boxes and conduits required for the fitting fixing/suspension points, joint boxes and connectors, jointing, ferrules, all fixing brackets, screws and studs, shall be deemed to be included as a part of work. Mounting accessories like saddles, spacer plates, joint boxes, junction boxes and fixing hardware shall be of galvanised mild steel, black enamelled steel.

7.3 Schedule of quantities

The material, type, size and quantities of all items shall be as mentioned in specific requirements (Section-6.3.1) and schedule of prices (Section-7.1 and 7.2).

8.0 TESTING AND COMMISSIONING

8.1 All checks and tests as per the MANUFACTURE'S drawings/manuals, relevant code of installation and the enclosed commissioning checks as listed here under for various types of equipment e.g. Transformers, Neutral Grounding Resistors, HV & MV switchgear, isolators, CTs, PTs, motors, relays and meters, Battery, Chargers, DCDB, Cables, Busducts, etc., shall be carried out by the CONTRACTOR as part of the installation work.

8.2 Commissioning checklist for switchgear

8.2.1 Preliminary checks

a) Check for physical damage

b) Check for tightness of all bolts, clamps and connecting terminals using torque wrench

c) Check cleanliness of panels, insulators, switchgear

d) Check earthing

e) Check for proper cable tags and ferrules

f) Whether breaker can be inserted properly

g) Breaker contacts should be fixed tightly with fixed contacts

8.2.2 Commissioning checks

a) High voltage test for 415V & 11kV switchgear

b) Insulation resistance test on HV & auxiliary circuits

c) Milli-voltage drop test on busbar joints (Ductor test)

d) Checks on meters

e) Checks on CTs & PTs

f) Functional checks on the auxiliary circuits

g) Contact travel measurements for VCB's

h) Measure the ground clearances for outdoor PCVCB's

i) Check for interlocks

j) Check for electrical and manual operation of Breakers

k) Checks on power cable termination or busduct termination.

l) Calibration of all meters and relays

8.3 Commissioning checklist for busducts

8.3.1 Preliminary checks

a) Check busbar fastener tightness using torque wrench.

b) Check busbar fixing insulators for any damage, crack, chipping etc.,

c) Check CT secondary wiring and fixing support

d) Check ventilation plug

e) Check breather

f) Cleanliness of duct inside enclosure

8.3.2 Commissioning checks

a) Insulation resistance value to be measured for each phase

b) High voltage test on busbar supporting insulators for HT busduct. Test value to be referred from IS

c) Milli-volt drop test on busbar joints(Ductor test)

8.4 Commissioning checklist for CTs & PTs

8.4.1 Preliminary checks

a) Check for physical damage

b) Check for tightness of all bolts, clamps, connecting terminals and drain plug

c) Check cleanliness

d) Check earthing of CT, PT & Junction boxes

e) Check for CT polarity (P1, P2, S1, S2, etc.,) and disconnecting links.

f) Check for correct level of oil and leakages (wherever applicable)

g) Check for proper cable tags and ferrules.

8.4.2 Commissioning checks

a) Dielectric test of oil (wherever applicable)

b) Insulation resistance test for both primary and secondary

c) CT polarity tests

d) Ratio test on all cores

e) Milli-volt drop test on busbar joints

f) Measurement of ground clearances from the primary terminals (wherever applicable)

g) Spare, CT cores, if any, to be shorted and earthed

8.5 Commissioning checklist for Transformer

8.5.1 Preliminary checks

a) Check for physical damage

b) Check for tightness of all bolts, clamps and connecting terminals

c) Check cleanliness

d) Check earthing of Transformer tank, Neutral bushing , marshalling box, cable box, cooling equipment etc.,

e) Check for correct oil level and oil leakage

f) Check for proper cable tags and ferrules.

8.5.2 Commissioning checks

a) Insulation test of windings and PI values

b) Insulation resistance on auxiliary circuits, primary and secondary

c) Milli-volt drop test on busbar joints

d) Functional tests on auxiliary circuits

e) Operational tests on OLTC

f) Measurement of ground clearances from primary terminals

g) BDV testing of insulating oil before and after filtration.

h) Check for operation of all relays, protection devices and interlocks

i) Polarity check

j) Hipot test on 11kV terminations

k) Capacitance and tan delta test of condenser type of bushing before assembly, wherever such bushings are provided

l) Forced cooling system(wherever applicable)

i) Check for operation of valves
ii) Check for operation of flow switches
iii) Check for motor insulation, vibration, directions of rotation
iv) Check for operational test of complete system.

8.6 Commissioning checklist for Isolators

8.6.1 Preliminary checks

a) Check for physical damage

b) Check for tightness of all bolts, clamps and connecting terminals

c) Check cleanliness

d) Check earthing

e) Check for proper cable tags and ferrules.

f) Whether isolator can be operated manually

8.6.2 Commissioning checks

a) Insulation resistance test on auxiliary circuits

b) Milli-voltage drop test on busbar joints

c) Functional checks on the auxiliary circuits

d) Measure the ground clearances

e) Checks for interlocks

8.7 Commissioning checklist for control panels

8.7.1 Preliminary checks

a) Check for physical damages

b) Check cleanliness

c) Check tightness of all clamps and terminal connections

8.7.2 Commissioning checks

a) Check continuity of each wire and connections as per relevant drawings

b) Insulation test of each wire

c) Check on settings of protection relays, timers, alarms, tripping devices etc.,

d) Functional checks of meters

e) Functional checking of all control circuits e.g. closing, tripping, controls, interlock, supervision and alarm circuits.

f) Calibration of all meters and relays

8.8 Commissioning checklist for Battery and Battery charger

8.8.1 Battery

a) Check for physical damages

b) Check for specific gravity during charge and discharge

c) Check for cell voltage during charge and discharge

8.8.2 Battery charger

a) Check for physical damage

b) Insulation test of all circuits

c) Functional check of all controls, alarms and indications

d) Measurement of voltage regulation

e) Voltage and current (both A.C & D.C) at no load and different loads.

8.9 Commissioning checklist for Motors

8.9.1 Preliminary checks

a) Check for physical damage

b) Check for tightness of all bolts, clamps and connecting terminals

c) Check for ground connections of body and terminal boxes

d) Check for clearances inside terminal box

e) Check for bearing lubrication

8.9.2 Commissioning checks

a) Check for continuity of motor windings

b) Insulation testing of motor windings

c) Check for resistance of motor winding in case of large motors

d) Check for continuity of RTD Connections

e) Check for phase sequence and rotation

f) Check for the following parameters:

i) Starting and no load currents
ii) No load operation – observe vibrations, temperature rise of motor body and bearings
iii) On load operation - observe vibrations, temperature rise of motor body and bearings
iv) In case of forced cooling, inlet and outlet temperature of cooling air

g) Check for controls and interlocks

h) Check for overload and short circuit relay/release settings. Also, locked rotor relay settings wherever applicable.

8.10 Commissioning checklist for cable

8.10.1 Preliminary checks

a) Check for physical damages

8.10.2 Commissioning checks

a) High voltage test for HV cables(3.3kV and above)

b) Insulation test for 1100 Volt power and control cables between each core and to armour/sheath

c) Check for continuity

d) Check for proper connections

8.11 Commissioning checklist for Earthing & Lightning protection system

8.11.1 Preliminary checks

a) Check for physical damages

b) Check for tightness of all bolts, clamps and connecting terminals

c) Check for proper markings

d) Check for proper treatment of all welded joints

8.11.2 Commissioning checks

a) Measurement of earth grid resistivity of the system as well as at selected earth pits.

8.12 **Commissioning checklist for lighting system**

8.12.1 Preliminary checks

a) Check for physical damages

b) Check for tightness of all bolts, clamps and connecting terminals

c) Check for proper markings

d) Check for operation of all fittings.

8.12.2 Commissioning checks

a) Measurement of earth leakage current in each circuit

b) Lux measurement at identified areas.

6.15.1 Addendum to Cabling System

ADDENDUM TO DOCUMENT No: Section 6.15.2

1. Clause No. 3.2.5: This clause is not applicable for this tender.
2. Clause No.3.7.4: The following sentence may be treated as deleted. “Fire proof sealing shall be done for pipe inserts in floor slabs, in walls of pressurised rooms and hazardous area and wherever indicated in project drawings.”

6.15.2 Cabling System

1.0 SCOPE:

1.1. This specification covers the requirements of cabling system installation work. The installation, testing and commissioning of the complete cabling system shall be carried out in accordance with the enclosed cable installation notes OWNER’S/ENGINEER’S typical and specific project drawings, and as stipulated in this specification. Supply items shall be quoted separately against specification; however, the installation of all items shall be quoted for in this specification.

2.0 CODES AND STANDARDS:

2.1. The cabling system installation work shall comply with the latest applicable Standards, Regulations and Safety Codes of the locality where the installation is carried out. Nothing in this specification shall be construed to relieve the CONTRACTOR of this responsibility.

2.2. The installation work shall conform to the latest applicable Codes of Practices, Electricity Rules, Fire Insurance Regulations and Standards.

3.0 INSTALLATION WORK SCOPE:

3.1. **General Scope:**

3.1.1. The installation work shall include unloading, storing, laying, fixing, jointing/termination, testing, commissioning and any other work items necessary for completing the job.

3.1.2. The CONTRACTOR shall furnish all supervision, labour, tools, welding equipment, tackles and testing equipment as required for installation work. All incidental hardware and miscellaneous items such as saddles, spacers, nuts/bolts/washers, anchor fasteners, cable route and joint markers and protective covers for buried cables, cable identification tags and ferrules, nylon cord/GI wire, earthing as required for the cabling installation shall be deemed to be included by the CONTRACTOR as part of installation work.

3.1.3. Civil works for construction of cable trenches/tunnels/duct banks, cable carrier supports on main pipe rack structure, provision of embedded conduits/pipes in RCC/masonry structures & across roads/railway tracks shall be included from the cable installation CONTRACTOR'S scope unless otherwise specified in Section-6.3.3 or Project Drawings. Minor civil works such as patching up in an approved manner any holes made in the walls by the CONTRACTOR, embedment of short lengths of conduits in floors, walls, etc. shall be deemed to be included in the CONTRACTOR'S scope of work. The CONTRACTOR shall work in co-ordination with the other Contractors at site.

3.1.4. Any changes in routes of cables which are required to be made to suite site conditions shall be carried out by the CONTRACTOR in consultation with the ENGINEER/OWNER and after his approval. All such changes shall be marked by the CONTRACTOR on respective project drawings/ cable & conduit schedule for finalisation by the OWNER/CONSULTANT'S/Design Office.

3.1.5. The MANUFACTURER'S/OWNER'S/ENGINEER'S drawings, cable schedules, instructions & recommendations shall be correctly followed by the CONTRACTOR in handling, laying, testing and commissioning of the cabling system. In case of any doubt/misunderstanding as to correct interpretation of drawings/instructions, necessary clarifications shall be obtained by the CONTRACTOR from the ENGINEER/OWNER.

3.1.6. CONTRACTOR shall make good all thefts and damage of cables or equipment, to which cables are to be connected, till the installation is handed over to the OWNER.

3.1.7. The CONTRACTOR shall arrange suitable means to clear the areas/routes/trenches to facilitate and proceed with cable laying work without any obstruction. It will be the responsibility of the CONTRACTOR to clean the trenches/tunnels, remove cable drums, surplus/waste materials and all other similar items after the installation work is complete.

3.2. **Cable Laying:**

3.2.1. The Contractor shall install, test and commission power and control cables, Instrumentation cables. The quantities, sizes and types of cables shall be as indicated in BOQ.

3.2.2. The cables shall be laid in cable trays, trenches, directly buried, in vertical raceways, clamped on structures/walls/ceiling, pulled through pipes and conduits etc., as per the relevant cable installation practices notes and typical/project drawings.

3.2.3. The cable installation shall generally conform to enclosed specification section no. 6.17.1: Cable Installation Notes.

3.2.4. The scope of cable laying shall include laying, pulling cables as above, proper dressing of cables on cable trays, racks, vertical raceways and supply & installation of cable fixing saddles, spacers & nylon cord for tying as required. Supply of special trefoil and wooden clamps for 1 core cables shall be quoted separately. However, the installation of trefoil/wooden clamps for clamping the cables shall be included in the installation cost of relevant cables.

3.2.5. The work of excavation, back filling etc., associated with direct buried of cables shall be separately indicated.

3.3. **Cable Termination:**

3.3.1. All cables that will be laid by the CONTRACTOR shall be connected at both ends to switchgear, panels, equipment, local push buttons, and instruments of junction / marshalling boxes terminals as the case may be.

3.3.2. The scope of termination at each end shall include dressing and connection of all the cores of the cables. The following shall be included in the scope of work:

Making the requisite holes in the bottom/gland plate of the switchgear for cable boxes/glands, fixing the cable boxes/glands, terminating the cables in the cable boxes/glands, earthing the cable armour, crimping the cable lugs on each core (for XLPE/PVC cables, the bare conductor from cable box shall be taped up to the lug) neatly clamping the cables inside switchgear/panels' cable alleys, wiring troughs & connecting to correct terminals as per the OWNER's/ MANUFACTURER's wiring diagrams & cable schedules. The cable and core identifying lugs & ferrules respectively shall be supplied & installed by the CONTRACTOR as part of cable termination work.

3.3.3. All cable terminations shall be solder less crimping type. The CONTRACTOR shall use proper crimping tools of Dowel or equivalent make. The crimping tools used shall be subject to the OWNER's/ ENGINEER's approval.

3.3.4. Supply of lugs, glands, cable boxes, junction boxes shall be indicated separately as per specification.

3.3.5. Spare cores of control cables shall be connected to spare terminal blocks, where available, with appropriate ferrules. If there are no spare terminal blocks, the spare cores shall be bunched together & shall be neatly kept inside the panel.

3.3.6. Copper-Aluminium bimetallic strips shall be provided between Copper and Aluminium connections.

3.4. **Cable Trays Installation:**

3.4.1. The CONTRACTOR shall install the type & sizes of cable trays as indicated in the specification/BOQ.

3.4.2. The trays & accessories details shall be as per enclosed specification section no 6.17.1 and drawings referred to therein.

3.4.3. The scope of cable trays installation shall include the installation of the associated accessories like coupler plates, elbows, drop-outs, tees & bends as required in Project layout drawings. The CONTRACTOR shall also include earthing of the cable trays at distances not exceeding 10 M length by means of min. size 25 x 3 mm GS flat (unless otherwise noted).

3.4.4. Supply of cable trays and accessories shall be indicated separately as per Specification.

3.5. **Cable Tray Covers Installation:**

3.5.1. Vertical raceways/trays & outdoor trays shall be covered by 16 gauge painted/galvanised MS sheet covers as indicated in the Project drawings.

3.5.2. The estimated lengths & widths of these covers shall be as indicated in specification/BOQ. The scope of work shall include the installation of these covers including necessary screws when required for fixing to vertical raceways.

3.5.3. Supply shall be indicated separately as per Specification.

3.6. **Cable Tray Mounting Arrangements, Vertical Raceways & Cable Carrier Structures:**

3.6.1. The CONTRACTOR shall fabricate, install & paint the following as per enclosed specification no. section no 6.17.1, drawings referred to therein and project drawings:

a) Mounting arrangements for cable trays. Any cable trays junction bends, which are non-standard, shall be fabricated as racks to suit installation drawings.

b) Vertical cable raceways & steel accessories (angles & plates) required to seal the floor openings in the case of indoor raceways.

c) Cable carrier structures (racks) for cable trenches and tunnels.

d) Supporting steel for junction/marshalling boxes, push buttons, vertical structures for clamping trefoil cables cable-boxes if mounted below switchgear etc., as required.

3.6.2. The above mounting structures/cable racks shall be fabricated from standard structural steel members as indicated on enclosed drawings (channels, plates, angles & flats). The estimated quantity of steel shall be as indicated in BOQ. The supply of steel if required to be furnished by the CONTRACTOR will be indicated in specification/ BOQ and the rate for the same shall be stated separately by him in this quotation.

3.6.3. The scope of installation of structural steel shall include fabrication, installation, painting earthing to system grid of all vertical raceways & cable carrier structures in tunnels/trenches by min. size 25x3 mm GS flat (unless noted otherwise), as indicated in enclosed drawings/notes, supply of incidental accessories like anchor fasteners, bolts, nuts, washers, welding works as required for fabrication & installation. Contractor will do all floor plate inserts/steel embedments in walls required for welding the cable support structures to the same. If any extra floor plates are required in certain locations for convenience of cable fasteners the same shall be supplied and installed by the Contractor.

3.6.4. All structural steel shall be painted as per instructions given in enclosed drawings/notes on cable tray mountings, trenches, tunnels & cabling practices. Where any cuts or holes are made or welding is done on painted/galvanised steel work/cable-trays these shall be painted in the original manner.

3.7. **Conduits/Pipes Installation:**

3.7.1. The CONTRACTOR shall install all conduits/pipes required for the cable work as per enclosed drawings/notes. The sizes & quantities shall be as indicated in BOQ.

3.7.2. The conduit and pipe installation shall be generally in accordance with the enclosed specification section no 6.17.1

3.7.3. Conduits/pipes shall be laid buried in ground, laid along the walls/structural members, along floors & ceilings. Conduits & pipe sleeves which are required to be embedded in walls, roof slabs, floors trench & tunnel walls, under roads and tracks etc., will in general be furnished in place wherever necessary by the CONTRACTOR for the portion of civil. The CONTRACTOR shall install conduit/pipe sleeves in place wherever necessary by breaking walls/floors as required by the OWNER/ ENGINEER to his satisfaction. All conduits/pipes shall have their ends closed by caps until cables are pulled.

3.7.4. Water proof sealing shall be done for all outdoor to indoor conduit/pipe inserts by means of bell mouth termination pieces & bitumen based cold set water proof compound. Fireproof sealing shall be done for pipe inserts in floor slabs, in walls of pressurised rooms & hazardous area and wherever indicated in project drawings. The supply rates of the necessary water-proof/fire-proof sealing compounds shall be separately indicated by the CONTRACTOR.

3.7.5. The scope of installation of conduits/pipes shall include supply & installation of all accessories like tees, elbows, pull-boxes, conduit end plugs, bell-mounts, GS wire for cable pulling, GS saddles, spacers, screws, nuts & bolts.

3.8. **Sealing of Floor Openings:**

3.8.1. All floor openings for vertical cable trays/raceways shall be sealed by fireproof compound with one hour withstand rating fireproof materials.

3.8.2. The scope of work shall include preparing & laying of the compound. The supply rate for the compound shall be indicated separately by the CONTRACTOR & the installation of steel accessories required for closing the opening shall be as indicated in Clause 3.6.

3.9. **Cable Joints:**

3.9.1. The CONTRACTOR shall supply and carry out Cable jointing wherever necessary & approved by the ENGINEER. The work shall be carried out as per the cable & jointing kit Manufacturer's instructions furnished to the CONTRACTOR.

3.9.2. The scope of jointing of various sizes & type of power cables shall include all necessary special tools & incidental accessories and HV pressure testing of the joints.

3.10. **Junction/Marshalling Boxes/Push-Button Station Installation:**

3.10.1. The CONTRACTOR shall supply and install the junction/marshalling boxes wherever indicated in the Project drawings for the convenience of marshalling several cables at a local point near equipment or central to various field mounted equipment. The estimated sizes & quantity of these boxes shall be indicated in Data Sheet/BOQ.

3.10.2. Unless otherwise specified, the CONTRACTOR shall install the push-button stations local to motors as per relevant enclosed typical cabling practices drawings. The quantity of these push-button stations shall be indicated in the Data Sheet/BOQ.

3.10.3. The scope of installation of junction/marshalling boxes & push-button stations shall be mounting on walls, columns, structures, including bolts, nuts, screws & welding work as necessary.

4.0 WORK DETAILS:

4.1. The installation, testing and commissioning of Cabling System shall be carried out in accordance with specification section no 6.17.1, drawings referred to therein and project drawings.

4.2. Cable shall be protected at all times from mechanical injury and from absorption of moisture at unprotected ends. Damaged cables shall be replaced at the CONTRACTOR's expense.

4.3. Additional requirements for any specific installation which are not covered by these specifications will be detailed in the relevant project layout drawings.

5.0 CONTRACTOR'S LICENSE:

It shall be the responsibility of the CONTRACTOR to obtain necessary license/Authorisation/permit for work from the Licensing Board of the locality/State where the work is to be carried out. The persons deputed by the CONTRACTOR'S firm should also hold valid permits issued or recognised by the Licensing Board of the Locality/State where the work is to be carried out.

6.0 WORKMANSHIP:

The CONTRACTOR shall ensure workmanship of good quality & shall assign qualified Supervisor/Engineers and competent labour who are skilled, careful and experienced in their several trades in similar works. The OWNER/ENGINEER shall reserve the right to reject non-competent persons employed by the CONTRACTORS, if the workmanship is not of good order.

7.0 SAFETY:

The contractor shall ensure adherence to all safety norms such as use of safety shoes, belts, helmets, gloves etc., and sign OWNER's safety conditions for work at site.

6.16.1 Addendum to Earthing & Lightning Protection

ADDENDUM TO DOCUMENT No: Section 6.16.2

5. Clause Nos. 7.0. These clauses are not applicable for this tender include sub cluases (7.1 - 7.5)

6. Clause Nos. 11.0. These clauses are not applicable for this tender.

7. Clause Nos. 8.1, 8.2, 8.3, These clauses are not applicable for this tender.

6.16.2 Earthing & Lightning Protection System Installation Notes

1.0. GENERAL

1.1 These notes shall be read and construed in conjunction with Lightning Protection and Earthing drawings and specifications. In case of conflict between these notes and drawings/ specifications, the later shall prevail.

1.2 Earthing conductor layout is shown diagrammatically. Exact location of earthing conductors, earth electrodes and test pits, and earthing connections may be changed to suit the site conditions. Major modifications should be referred to OWNER/ENGINEER for clearance.

1.3 Neutral points of systems of different voltages, metallic enclosures and frame works associated with current carrying equipment and extraneous metal works associated with electric systems shall be connected to a single earthing system unless stipulated otherwise.

1.4 Earthing and lightning protection system installation shall be in strict accordance with the latest editions of Indian Electricity Rules, relevant Indian Standards and Codes of Practice and Regulations existing in the locality where the system is installed.

a)	Code of practice for earthing	IS:3043
b)	Code of practice for the protection of Buildings and allied structures against lightning	IS: 2309
c)	Indian Electricity Rules, 1956	
d)	Protection of Structures against lightning	IEC 61024 / 61312
e)	IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems.	IEEE Std 142-1991
f)	IEEE Recommended Practice for Powering and Grounding Electronic Equipment	IEEE Std 1100-1999
g)	IEEE Guide for Safety in AC Substation Grounding	IEEE Std 80-2000
h)	IEEE Guide for Direct Lightning Stroke Shielding of Substations	IEEE Std 998-1996 (R2002)

2.0. EARTHING CONDUCTOR LAYOUT

2.1 Earthing conductors in outdoor areas shall be buried 600mm below finished grade level unless stated otherwise stated in Data sheet A1.

2.2 Minimum 6000mm spacing between rod/pipe electrodes and 8000 mm spacing between plate electrodes shall be provided unless stipulated otherwise.

2.3 Earthing conductor around the building shall be buried in earth at a min. distance of 1500 mm from outer boundary of the building. In case high temperature is encountered at some location, the earthing conductor shall be laid min. 1500 mm away from such location.

2.4 Earthing conductors embedded in the concrete floor of the building shall have approximately 50 mm concrete cover.

2.5 Earthing conductors along their run on columns, walls etc., shall be supported by suitable welding/cleating at intervals of 1000 mm and 750 mm respectively.

2.6 Tap connections from the floor earthing grid to the equipment/structure to be earthed shall be terminated on the earthing terminals of the equipment, if the equipment is available at the same time of laying the grid. Otherwise, 'earth insert' with temporary wooden cover of 'earth riser' as shown in the drawing shall be provided near the equipment foundation/pedestal for future connections of the equipment earthing terminals.

2.7 In outdoor areas, buried conductors shall be brought 500 mm above ground level for tap connections to equipment.

2.8 Earthing conductors crossing the road shall be either installed in hume pipes or laid at greater depth to suit the site conditions.

2.9 Wherever earthing conductor cross u/g service ducts, pipes, trenches, tunnels, railway tracts etc., it shall be laid min. 300 mm below them. The earthing conductor shall be re-routed in case it fouls with equipment foundations.

2.10 Wherever earthing conductor passes through walls, floors, etc., galvanised conduit sleeves shall be provided for the passage of the conductor. Both ends of the sleeve shall be sealed to prevent the passage of water through the sleeves.

2.11 Water stops shall be provided wherever earth conductor enters the building from outside, below ground level.

3.0. EQUIPMENT AND STRUCTURE EARTHING

3.1 Earthing pads/terminals shall be provided by the SUPPLIER of the apparatus/equipment at accessible positions. The connection between earthing pads/terminals and the earthing grid shall be made by short and direct earthing leads free from kinks and splices.

3.2 Whether specifically shown in drawings or not, steel/RCC columns, metallic stairs, handrails, etc., of the building housing electrical equipment shall be connected to the nearby earthing grid conductor by the earthing lead. Electrical continuity shall be ensured by bonding the different sections of hand rails and metallic stairs.

3.3 Electrical conduits, pipes and cable tray sections shall be bonded to ensure electrical continuity and connected to earthing conductors at regular intervals. Apart from intermediate connections, end and beginning points shall also be connected to earthing system.

3.4 Metallic conduits and pipes shall not be used as earth continuity conductor.

3.5 A separate earthing conductor shall be provided for earthing lighting fixtures, receptacles, switches, junction boxes, lighting conduits, poles, etc. This conductor in turn will be connected to the main earth.

3.6 When an earthing conductor crosses or runs at less than 300 mm distance along metallic structures such as gas, water and steam, conduits/pipes and steel reinforcement in concrete, it shall be bonded to the same.

3.7 Street lighting poles, junction boxes on the poles, flood light supporting structures etc., shall be connected to the earthing conductor running along with the supply cable and, in turn, shall be connected to earthing grid conductor at minimum two points.

3.8 Railway tracks within plant area shall be bonded across fish plates and connected to earthing grid at several locations. At the point where the track leaves the plant area, the rail section shall be provided with insulated joint at both ends.

3.9 Buried earthing conductor shall be run 1000 mm outside the switchyard fence. Every alternate post of the fence shall be connected to earthing grid by one lead and gates by flexible braid of the earthed post.

3.10 Miscellaneous items such as junction boxes, field switches, cable ends, boxes/glands, fittings and fixtures shall be earthed whether specifically shown or not.

3.11 Flexible earthing connections shall be provided where flexible conduits are connected to rigid conduits to ensure continuity.

3.12 Auxiliary earth mat of 150mmX150mm spacing at a depth of 300mm from FGL, to be provided in front of outdoor HV isolator/ earth switch operating mechanism boxes, covering an area of 1000mmX1000mm. The auxiliary earth mat shall be connected to the switchyard main earth mat at minimum two points. The size of auxiliary earth mat conductor shall be as detailed at the construction drawing. Operating handle shall be bonded to earthing structure by flexible conductor.

4.0. JOINTS

4.1 Earthing connections to equipment earthing pads/ terminals shall be bolted type with GI bolts and nuts. Contact surfaces shall be free from scale, paint, enamel, grease, rust or dirt. Two bolts shall be provided for making each connection. Equipment bolted connections after being checked and tested, shall be painted with anti-corrosive /compound.

4.2 Connection between equipment earthing lead and main earthing conductors and between main earthing conductors shall be welded/brazed type. For rust protection, the welds should be treated with red lead and afterwards thickly coated with bitumen compound to prevent corrosion.

4.3 Steel to copper connections shall be brazed type.

4.4 Resistance of the joint shall not be more than the resistance of the equivalent length of the conductor.

4.5 Welding/brazing surfaces shall be cleaned and made free of all oxide films, grease, oil or any foreign material. However, the jointing surfaces should not be made too smooth/highly polished to prevent the jointing metal from flowing away.

4.6 The items to be welded/brazed shall not be clamped/tied tightly (at the same time clearance should not be excessive), to allow the flux/alloy to run freely through the joint and alloy itself with the surface to be joined together.

4.7 All brazing shall be done by oxy-acetylene torch flame.

4.8 All welded connections shall be made by electric arc welding. All welded joints shall be allowed to cool down gradually to atmospheric temperature before putting any load on it. Artificial cooling shall not be allowed.

4.9 Bending of large dia rod/thick conductors shall be done preferably by gas heating.

4.10 All arc welding with large dia. conductors shall be done with low hydrogen contact electrodes.

4.11 For brazing, alloys of silicon bronze/ phosphorus copper/phosphorus-silver-copper shall be used.

5.0. CABLE EARTHING

5.1 Metallic sheaths, screens and armour of all multi core cables shall be earthed at both equipment and switchgear ends.

5.2 Sheath and armour of single core power cables shall be earthed at switchgear end only.

6.0. TESTING OF EARTHING SYSTEM

6.1 The CONTRACTOR shall ensure the continuity of all conductors and joints. The contractor shall carry out earth continuity tests, earth resistance measurements and other tests which are necessary to prove that the system is in accordance with the design specifications, code of practice and Electricity Rules. The CONTRACTOR shall bear the cost of all such tests.

7.0. LIGHTNING PROTECTION SYSTEM:

7.1 The methods of lightning protection system to be adopted are:

d) By Horizontal Roof Conductors and down comers

e) By down comers for metal roof structures

f) By Shield wires supported on poles/mast

The particular method of protection depends on dimensions of the structure protected aesthetics and convenience

7.2 **Horizontal Air Terminations :**

Horizontal air terminations comprising of horizontal roof conductors shall be used for all buildings.

7.3 **Down Conductors:**

a) Air termination system shall be connected to the earth by down comers fixed along the outer surface of building / structure. Each down comer shall be terminated to a separate treated test earth electrode. The material of down conductors will be same as that of Horizontal roof conductors. There shall not be any sharp bends, turns and joints in the down conductors.

b) The down comers shall not be connected to any other earthing conductors above ground level.

7.4 **Test Links:**

Each down comers will be provided with a link one meter above ground level for dismantling the electrodes and taking measurements. The links shall be made up of aluminium and housed in PVC or glass filled nylon enclosure box to prevent corrosion.

7.5 **Component Sizes:**

The following material and size of conductors and earth electrodes shall be used unless otherwise mentioned in Data sheet A1.

a.	Horizontal Air Termination	AL. strip	25 x 3mm
b.	Down comer	AL strip	25 x 3mm
c.	Test link to grid connection	GS strip	25 x 6mm
d.	Earth electrode	Rod/CI pipe/Plate	As per drawings and BOQ

8.0. MODE OF TERMINATION AND JOINTS:

8.1 All joints in the horizontal roof conductors shall be of welded type. Where it is likely to damage the roof material like asbestos or sheet steel, riveted joints will be used.

8.2 Connection between roof conductors and down comers shall be of welded type. Where it is likely to damage the roof material like asbestos or sheet steel, riveted joints shall be used.

8.3 Connection between metal roof and down comer shall be bolted type using 2 Nos. M10 bolt and nuts.

8.4 Down Comers will be connected to test links by bolted connections

8.5 The lead from test link to Pipe electrodes shall have bolted connection at both ends.

8.6 Individual pipe electrodes in turn shall be connected to station earthing system by welded joint at grid and bolted joint at electrodes.

8.7 Welding/brazing surfaces shall be cleaned and made free of all oxide films, grease, oil or any foreign material. However, the jointing surfaces should not be made too smooth/highly polished to prevent the jointing metal from flowing always.

8.8 The items to be welded/brazed shall not be clamped/tied tightly (at the same time clearance should not be excessive), to allow the flux/alloy to run freely through the joint and alloy itself with the surface to be joined together.

8.9 All brazing shall be done oxy-acetylene torch flame.

8.10 All welded connections shall be made by electric arc welding. All welded joints shall be allowed to cool down gradually to atmospheric temperature before putting any load on it. Artificial cooling shall not be allowed.

9.0. LAYING:

9.1 Precautions shall be taken such as providing an up stand and using PVC or glass filled nylon clamps, so that contact with cement mortar is avoided. When the roof conductors are closer to beams less than 2M. Bonding between the beam columns and down comer shall be provided to prevent side flashing.

9.2 Pipes carrying hazardous substances shall be protected by suitable steel wire or lightning conductors at a height to provide total protection against lightning. Joint in these pipe lines shall be bonded by a copper flexible with copper clamps on either side of the joints. Pipe line shall be earthed at both ends. Either isolation shall be provided by keeping the lightning conductor 2M away or they shall be bonded if they are close to each other.

9.3 Routing of lightning conductors down comer shall be done in such a way that they do not run parallel with power control and instrumentation cable. They shall be taken by crossing at 90^{O}C. If parallel routing is unavoidable minimum distance of 2m shall be ensured.

10.0. SURGE ARRESTORS:

10.1 All important circuits catering to expensive appliances shall be protected by 415/240V, TPN/SPN, 40/10kA surge arrestors to protect the equipment from transferred surges. This shall include TV/Video circuits, EPABX, Computers, PLC etc. Unit rates shall be quoted for supply and installation of these surge arrestors as required by OWNER.

11.0. EARTHING SYSTEM:

11.1 The proposed Lightning Protection System earth pits shall be interconnected to the station Earth grid. Connection from test link to earth grid shall be by GS flat of size as indicated in BOQ and layout drawings.

6.17.1 Cable Installation Notes

1.0 SCOPE:

1.1. These notes cover specific requirements for cabling system installation work and shall be read and construed in conjunction with the specification for cabling system and OWNER's/ENGINEER's cable layout drawings and typical installation drawings.

2.0 GENERAL REQUIREMENTS:

2.1. Standard cable grips & reels shall be utilized for cable pulling. Maximum pull tension shall not exceed recommended value for the cable measured by tension dynamometer. In general, any lubricant that does not injure the overall covering & does not set up undesirable conditions of electrostatic stress or electrostatic charge may be used in pulling insulated cables in conduits & ducts. In particular soap shall not be used as lubricant. After pulling cable, the CONTRACTOR shall record cable identification & date pulled, neatly

with waterproof ink on linen tags at all cable ends. This is in addition to the cable identification tags to be tied by GI wire at each end of the cable.

2.2. Cable take-off from drums shall be so planned as to avoid using joints & splices in the run of the cable. Cable splices shall be made only after obtaining permission of the ENGINEER. Splice shall be made by the CONTRACTOR for each type of wire or cable in accordance with the instructions issued by the cable MANUFACTURER and the Engineer.

2.3. When power cables are laid in the proximity of communication cables, minimum separation between power & communication cables shall be not less than 460mm for single-core cables & 300 for multi-core cables. Power & communication cables shall, as far as possible cross at right angles to each other.

2.4. Un-armoured cables shall be protected in conduits up to 2.5m from floor level.

2.5. The CONTRACTOR shall make connections to small electrically operated devices on equipment installed as accessories to, or assembled with other equipment & requiring 2 wire or 3 wire connections. Connections to recording instruments, float switches, limit switches, pressure switches, thermocouples, thermostats & other miscellaneous equipment shall be done as per the MANUFACTURER's/ENGINEER's drawings and schedules.

2.6. The CONTRACTOR shall be responsible for correct phasing of the motor power connections & shall interchange connections at the motor terminal box, if necessary, after each motor is test run.

2.7. The CONTRACTOR shall make terminations for each type of wire or cable in accordance with instructions issued by cable MANUFACTURER and the ENGINEER.

2.8. Control cable terminations shall be made in accordance with wiring diagrams/cable interconnection diagram & cable schedules furnished to the CONTRACTOR for this purpose. Where on testing, reversal or other rearrangement of connections turns out to be necessary, additional work of reconnecting and testing shall be performed by the CONTRACTOR at no extra cost to the OWNER.

2.9. Jointing of cables shall be carried out in accordance with relevant Standard Codes of practice & the MANUFACTURER's special instructions. The CONTRACTOR shall supply hardware like clips & clamps and tools required for cable jointing work. Cables shall be firmly clamped on either sides of a straight through joint at not more than 300 mm away from the joints. Identification tags shall be provided at each joint & at all cable terminations. Single core cable joints shall be marked so that phase identity at each joint shall be determined easily. The joints shall be located at the most suitable places. There shall be sufficient overlap of cables to allow for the removal of cable ends, which may have been damaged.

2.10. Where cables are to be installed at temperatures below 3 ^{o}C, they shall be heated to about 10 ^{o}C for not less than 24 hours (in a heated building or in a tent with protective coverings of the cables). The cable laying must be carried out swiftly so as not to allow the cable to cool down too much.

3.0 OUTDOOR CABLE INSTALLATION

3.1. Directly buried cables shall be laid as per project cable layout drawings. The cables shall be laid on a bedding of minimum 75mm sand at the bottom of the trench and covering it with additional sand of minimum 75mm and protecting it by means of tiles, bricks or slabs. HV cables shall be protected by concrete slab. Cable route markers shall be put at 15 metre intervals. At least one marker shall be provided if the length of the buried cable is less than 15 metres. Bends shall be identified by route markers at both ends. Buried cables in trefoil formation shall be bound by plastic tapes or 3 mm dia. Nylon cord every 750 mm.

3.2. The minimum depth of laying from ground surface to the top of cable shall be as follows unless otherwise shown in cable layout drawings:-

a) High voltage cables, 3.3 kV to 11 kV 900 mm

b) High voltage cables, 22 kV and 33 kV 1050 mm

c) Medium voltage and Low voltage cables 750 mm

d) Control cables 750 mm

3.3. Joints in directly buried cables shall be identified by joint markers at each joint location.

3.4. In each outdoor cable run greater than 60m, some extra cable length shall be kept at a suitable point to enable a straight through joint to be made should the cable develop fault at a later date.

3.5. Where cables cross roads and water, oil, gas or sewage pipes, the cables shall be laid in Hume or steel pipes. For road crossings, the pipe for the cable shall be buried at not less than 1000 mm unless otherwise noted in the drawings. Hume pipes shall be preferred to steel pipes from the point of view of corrosion.

3.6. Control cables and small power cables in trenches and tunnels shall be run in ladder type cable trays (maximum tray width 600 mm) supported on trench/tunnel carrier arms. The cables shall be tied to tray rungs by means of 3 mm dia. Nylon cord at an interval of 5000 mm and also at bends.

3.7. For good sealing arrangement at entry points, suitable pipe sleeves, adequate in number and of adequate sizes shall be provided in building walls/slabs for passage of cable into a building from cable trays/racks/cable trenches located outside the buildings. Details of sleeves and exact locations of such entry points will be available on relevant project drawings

4.0 CABLE TRAY INSTALLATION

4.1. The type & sizes of cable trays shall be as indicated in the specification, drawings and BOQ.

4.2. Cable trays shall be run in concrete trenches or run overhead supported from building steel, floor slab, pipe rack etc.,

4.3. Vertical trays/race ways shall be covered by removable 16 gauge MS/GS sheet covers wherever shown in project drawings.

4.4. Cable tray installation shall comply with the following requirements:

a) Cable trays shall be supported at an interval of not exceeding 1000 mm for horizontal and straight runs, unless otherwise specified.

b) Embedded parts of cable trays, if any, shall be painted with 2 coats of bitumen paint. All site fabricated metal work such as cable tray supports, mounting brackets etc, used in buildings/areas classified as chemically CORROSIVE shall be cleaned for removal of rust, and scale & shall be given 2 coats of corrosion resistant epoxy paint. Any cuts and holes drilled in the galvanised and epoxy finished metal work shall be given two coats of epoxy paint.

c) The length of tray supporting members will depend on the number of tray tiers required at a particular section. The details shown in the drawings for various tray sections are typical only.

d) Minimum vertical clearance between the bottom of the lowest cable tray tier and any other obstruction shall be 300 mm unless otherwise shown in project drawings.

e) Minimum vertical clearance between the top most tray tier and any structural member shall be 300 mm. Wherever, cable tray passes vertically through floors, platforms, it shall be made totally enclosed by covering with 16 SWG. Galvanised sheet covers.

f) When cable trays are installed in tiers, the minimum vertical clearance between tiers shall be 275 mm, unless otherwise indicated in the drawing.

g) Working space of 600 mm min. shall be maintained on one side of each Cable tray or where grouped in rows adjacent to each other, a min. working space to 800 mm shall be maintained over each cable tray.

h) All cable trays and vertical cable raceways shall have identification designation, as per ENGINEER's drawing painted at each end of the tray and raceways. For long lengths of trays, the identification shall be painted at intermediate points also.

5.0 CABLES IN TRAYS/ON RACKS

5.1. Different voltage grade cables shall be laid in separate trays when trays are arranged in tiers, HV cables shall be laid in top trays and cables of subsequent voltage grades in lower tiers of trays.

5.2. Control cables shall be run in a separate tray, similarly, Instrument cables shall be run in a separate tray.

5.3. The HV power cables of 3.3kV and above shall be laid in trays/on racks as follows:

a) In single layer only without exception.

b) 3 Crore cables to be laid in touching formation.

c) Single core cables to be laid in trefoil groups with spacing equal to diameter of the cable between edges of the trefoils.

d) Cables in trefoil groups of the same circuit shall be laid as indicated below so as to ensure balanced current distribution:

		Y				Y				Y				Y			
R			B	B			R	R			B	B			R		
(1)				(2)				(3)				(4)				and so on	

5.4. 1100V grade power cables of 120 mm^2 size and above shall normally be laid in single layer in trays/on racks. In exceptional cases, these may be laid in double layer if shown on the drawings or with the permission of the ENGINEER.

5.5. Smaller 1100V grade power cables below 120 mm^2 may be run in double layers, where required, due to space restrictions.

5.6. Control and instrumentation cables can be laid upto a minimum of three layers in each tray/rack.

5.7. Control cables and small power cables on racks shall be run in ladder type cable trays supported on rack carrier arms. The cables shall be tied to tray rung by means of 3 mm dia. nylon cord at an interval of 5 metre and also at bends.

6.0 BENDING RADII FOR CABLES

6.1. The bends radii for various types of cables shall not be less than those specified below, unless specifically approved by the ENGINEER:

Type and voltage Grade of Cable	**Minimum bending radius**		
	Single core	**Multi-core**	
		Armoured	**Un-armoured**
a) XLPE insulated upto 11 kV	20D	15D	15D
b) XLPE insulated upto 22 kV	20D	15D	15D
c) XLPE insulated upto 33 kV	20D	20D	20D
d) PVC insulated 1.1 kV	15D	15D	15D
e) XLPE insulated 1.1 kV	15D	15D	15D
f) Rubber insulated 600 V	-	8D	10D
g) Mineral insulated 300 kV	-	8D	-

Where D is overall diameter of Cable

(For High voltage XLPE insulated cables, recommendation of MANUFACTURERs shall be checked and followed if higher values are recommended).

6.2. The above values may be reduced to 70% when making only one bend such as in Case of installing an end termination.

7.0 TERMINATION, CLAMPING AND MISCELLANEOUS DETAILS

7.1. Cable entry to motors, push button stations and other electrical devices shall be from the bottom as far as possible or from the sides. Top entry shall be avoided particularly for outdoor equipment.

7.2. Identification tags made from aluminium sheet shall be attached to each end of each cable by means of GI binding wire. Tags shall be additionally put at an interval of 30 meters on long runs of cables and in pull boxes.

7.3. Cable glands

7.3.1. The cable glands shall be made from solid drawn brass rods, machined for smooth finish, Cadmium, Nickel plated and passivated to protect against corrosion.

7.3.2. Cable glands for armoured cables shall be double seal cone grip compression (Double compression) type unless otherwise stated. The cone and clamping ring for armour shall be suitable to accommodate armouring wire/strip/tape.

7.3.3. Cable glands for unarmoured cables shall be single seal compression type similar to above but without the cone and clamping ring for the armour.

7.4. Cable lugs

7.4.1. Cable lugs shall be tinned copper for both copper and Aluminium cables. For Aluminium cables, bi-metallic paste shall be applied.

7.4.2. All cable terminations shall be solder less crimping type. Whenever lugs are required to be supplied, adequate size crimping lugs of approved make shall be used by the CONTRACTOR. The crimping tools shall be adequate for the lugs sizes.

7.5. Saddle type clamps to suit number of cables to be clamped at a particular location shall be used to clamping cables running along walls, ceilings, structures, etc. The interval between adjacent clamps shall be shown on the relevant project drawings.

7.6. Single core power cables for 3 phase AC circuits laid in trays/racks/trenches in trefoil groups shall be held in trefoil clamps placed at an interval of 3metre. The details of trefoil clamp shall be as shown in project drawing. The trefoil groups of cables shall be additionally tied by means of 3 mm dia, Nylon cord as follows:

a) At an interval of 1metre when laid in cable trays/racks.

b) At an interval of 750 mm when laid in trenches without cable trays.

7.7. Wooden cleats when required for vertically supporting one or more single core cables per phase, such as on vertical framework near transformer cable boxes, shall be made out of well seasoned wood and given two coats of fire retarding paint of approved quality.

8.0 CONDUIT AND PIPE INSTALLATION

8.1. All conduit/pipe sleeves shall be sealed at both ends against ingress of water after the cables have been pulled.

8.2. All conduit/pipes sleeves shall be extended at least 50 mm on both sides of wall/floor/ceiling.

8.3. Exposed conduit/pipe runs shall be adequately clamped at an interval of 2metre.

8.4. All installed conduits/pipes shall have their ends temporarily closed by caps or other approved means until cable in pulled.

8.5. When two lengths of conduits are joined together through a coupling, running threads more than twice the length of coupling shall be provided on any one length to facilitate easy dismantling of the two conduits. Threads shall be painted with zinc rich paint.

8.6. GI pull wires of adequate size shall be laid in all conduits before installation.

8.7. After the installation of all the cables, the unused pipe inserts (spares/future) shall be cut to the floor level and plugged flush with brass plug.

9.0 TESTING AND COMMISSIONING OF CABLES

9.1. Cables shall be checked for insulation resistance before and after jointing. The voltage rating of the meggars for cables of different voltage grades shall be as indicated below:

Voltage grade of cable	Meggar rating
1.1 kV	500 V
3.3 kV, 6.6 kV and 11 kV	1000 V
22 kV and 33 kV	2.5 kV motorized meggar

9.2. High Voltage Testing

9.2.1. All cables of 1.1kV grade 400 mm^2 and above and all HV cables shall be subjected to DC or AC high voltage test after jointing and terminating but before commissioning as per the relevant standards. Testing with DC voltages should be preferred, as test equipment required is compact, easily portable and requires low power. The DC test voltages applicable in India shall be as per Table 4 in IS 1255. The cable cores must be discharged on completion of DC high voltage test and cable shall be kept earthed until it is put into service.

9.2.2. DC test voltage for old cables should be 1.5 times rated voltage or less depending upon the age of cables, repair or nature of jointing work carried out.

9.2.3. In each test, the metallic sheath/screen/armour should be connected to earth.

9.3. Continuity of all the cores, correctness of all connections, as per wiring diagrams, correctness of polarity and phasing of power cables and proper earth connection of cable gland, cable boxes, armour and metallic sheath shall be checked.

10.0 EARTHING

10.1. Earthing of cables

10.1.1. Metallic sheaths, screens and armour of all multi-core cables shall be earthed at both equipment and switchgear end.

10.1.2. Sheath and armour of single core power cables shall be earthed at switchgear end only. If specifically indicated in project specification/drawings, for long lengths of cables multiple earthing may have to be adopted to safeguard against the presence of standing voltages under normal as well as fault conditions.

10.1.3. Earthing of power cable with core balance CT shall be as shown in the project drawings.

10.2. Earthing of CT neutral lead shall be at one end only, as indicated in respective control wiring drawings.

10.3. Earthing of cable trays

Each cable tray section including elbows, tees, etc., shall be bonded together to form a continuous circuit for the flow of fault current. Cable trays shall be connected to the nearest main earthing grids at intervals of 10 metre along the run of the tray.

10.4. Earthing of Conduits and pipes

Conduit runs shall be permanently connected to earth by means of approved type of earthing clamp effectively fastened to the conduit. The conduit systems shall be checked for electrical continuity.

11.0 PAINTING

11.1. Whenever MS items are to be supplied by the CONTRACTOR as indicated in installation specification, these shall be painted as follows:

a) For indoor installations- one shop coat of red oxide zinc chromate primer and two site coats of aluminium alkyd paint as specified.

b) For outdoor and corrosive atmosphere indoors/outdoors painting with a two pack epoxy coating.

11.2. Where any cuts or holes are made on the finished steelwork or welding is done, the affected portions of steelwork shall be painted as stated above. Galvanized structures, if damaged during welding, cutting etc., shall be touched up with two coats of zinc-rich paint.

12.0 DATA TO BE FURNISHED BY THE CONTRACTOR AFTER AWARD OF CONTRACT

12.1. The CONTRACTOR shall furnish sketches/marked up prints of the PURCHASER's project drawings indicating any changes in the cable routing and or cable carrier system arrangement.

12.2. Test certificates of cables tested at site.

12.3. Catalogue/material specification of the type of fireproof compound used.

6.18.1 SCADA

1.0 SCOPE

1.1 This specification covers design, material, construction features, manufacture, performance and testing at VENDOR'S/SUB-VENDOR'S works and delivery to site of 'SUPERVISORY CONTROL AND DATA ACQUISITION' (SCADA) System for electrical power systems networks.

1.2 The system/equipment furnished to this specification shall conform to the requirements herein, unless modified by specification in Section-6.3.3.

2.0 CODES AND STANDARDS

2.1 The design, manufacture, performance and testing of all equipment, system, software and services covered under this specification shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment will be installed. The equipment and systems shall also conform to the latest applicable standards. If such standards do not exist for any equipment or system, the same shall comply with the applicable recommendations of the following professional institutes:

a) National Electricity Manufacturers Association (NEMA).

b) The institute of Electrical and Electronic Engineers (IEEE).

c) Instrument Society of America (ISA).

d) American National Standards Institute (ANSI).

e) Deutsche Industries Norman (DIN).

f) International Electrotechnical Commission (IEC).

g) International Consultative Committee on Telephone and Telegraphy (CCITT).

h) Verin Deutschar Eisecnhuttenleute (VDE).

Nothing in this specification shall be construed to relieve the VENDOR of this responsibility.

2.2 Standards not indicated in the specification are acceptable (subject to approval by the ENGINEER/PURCHASER) if they are established to be equal or superior to the standards indicated in the specification. The VENDOR shall furnish along with his bid English translation of all such standards to which the equipment and systems offered conform.

2.3 In the event of any conflict between the codes and standards referred to in this specification and the requirements of this specification, the requirements of this specification shall govern.

3.0 SYSTEM CONFIGURATION

3.1 Details of system configuration are provided in clause 2.2 of section 6.3.3.

This DWG clearly indicates the existing system and the new system, The bidders are advised to visit the site and ensure the scope of work.

4.0 SYSTEM DESCRIPTION

4.1 The proposed System / Equipment need to be interfaced with present Microprocessor Based Supervisory Control and Data Acquisition (SCADA) System.

4.2 Microprocessor based SCADA system shall comprise any or all the following subsystems and the equipment as specified in section 6.3.3.

a) Data Acquisition & Monitoring System (DAMS)

b) Communication System (CS) shall perform the function of communication among RTUs, monitoring equipment, maintenance engineer's monitor for operator’s structuring and also within RTU. Communication system shall employ the means of signal transmission by a redundant data bus system complete with local bus within RTU, communication controller and main redundant data bus system. Digital communication interface shall perform the function of integrating microprocessor based SCADA system with external computer system.

4.3 The SCADA System shall have sequence of Events Recorder (SER) also. with a resolution of 1 millisecond.

5.0 GENERAL REQUIREMENT for SCADA:

5.1 The design, manufacture, testing and performance of all equipment shall comply in all respects with the requirements of the latest edition of the applicable standards and codes.

5.2 The scope includes supply, unloading storage at site, erection, testing, commissioning and coordination with Substation vendor, the supplier of existing SCADA system and with other new equipment suppliers.

5.3 Refer to the SCADA system architecture drawing number PCPL-2329-5-SK-001 and PCPL-2329-5-SK-002. This drawing clearly identifies the existing system and the new SCADA requirements for the Proposed Transformer#1 bay.

5.4 The new SCADA system shall be interfaced with following panels/system supplied by others and enable complete monitoring and control from Proposed and existing Servers and Monitors.

h) Transformer control and relay panel.

i) Remote tap changer panel.

j) Existing SCADA integration.

k) Transformer marshalling box.

l) Multifunction / Power Quality meters (MFM/PQM) and other IED relays.

m) 11kV Incomer feeders

n) Existing communication main bus, SCADA system components, operating devices and peripherals.

o) Existing and Proposed 66kV CB/isolator control & relay panel

Hard wired signal cables from these panels will be connected to the I/O modules.

5.5 A new SCADA SYSTEM is proposed to cater to Proposed 66kV Transformer #1 bay control and monitoring. This system will accept signals from Field equipment through IED as the case may be. This system will be hooked up to main communication data bus (redundant) enabling operation (control) and monitoring of 66kV Substation from Proposed and existing Servers and Monitors. The BCU/BPU and EFS units and necessary SCADA hardware will be included as a part of CRP Panels supplies and Refurbish work of Existing SCADA Panel need to be added as Scope this Tender.

5.6 The new SCADA equipment need to be synchronized with the Proposed GPS receiver unit.

5.7 Necessary communication buses, cables and hardware to complete the system need to be supplied as a part of SCADA vendor scope.

g) Fiber optic cables, conduits and installation materials.

h) Ethernet Fiber switches.

i) CAT6 Armored/Shied Cable and Patch cords, conduits and installation materials.

j) Fiber Optic Patch cords

k) RS485 to RJ45 LAN Converter

l) Start up spares.

m) 2 years maintenance spares.

n) Necessary software for the intelligent devices supplied under the contract.

o) Training of Engineers.

5.8 Additional input modules need to be provided to link it with existing system to scan the inputs to the resolution of one millisecond and communicate with present sequence of event recording system.

5.9 Necessary communication buses, cables and hardware to complete the system need to be supplied as a part of SCADA vendor scope.

5.10 The vendor shall co-ordinate with all equipment supplier in getting the I/O list, consolidate the same and configure in SCADA with specific reference to control relay panel supplier.

6.0 DESIGN REQUIRMENTS OF SCADA SYSTEM

6.1 General requirements.

a) The system / equipment shall be state-of the art suitable for interfacing with existing SCADA system and operation under electrical environment and follow the latest engineering practice.

b) The system design shall be such that personnel without any background knowledge of micro processor based technology will be able to operate the system. The operator interface shall be such that the personnel can operate it easily after having received some basic training.

6.2 Software Structure:

a) The software package shall be structured according to the existing SCADA system.

b) An extension of the station shall be possible with lowest possible efforts. Maintenance, modification or an extension of components of any switch gear shall not force a shutdown of the parts of the system which are not affected by the system adaption.

6.3 Man Machine interface:

a) The new system shall be suitably interfaced with present man machine and peripheral devices.

6.4 System Operation:

Operation of the system by the operator from the SCADA shall take place via industry standard existing MMI (Man Machine Interface) subsystem consisting of graphic colour VDU, a standard keyboard and a cursor pointing device (mouse).

6.5 Criteria Governing Design Requirements

Design requirements of the system shall take into consideration following criteria as applicable for new equipment.

a) Fail Safe Design

b) System Availability

c) Equipment Reliability

d) Expandability

e) User friendliness

f) Fault Monitoring and Diagnostic Capability

g) Redundancy Requirement.

h) Time synchronization

The above requirements are elaborated further as follows:

6.5.1 Fail Safe Design

The hardware and software modules, subsystems and total system shall be designed so as to be fail safe and shall take into account IEC defined interference levels which are normally present in power system network. In no case, shall a device or software failure or a combination of failures jeopardise the integrity of the power system or the safety of personnel. Failure of any cards/ system / sub-system shall be annunciated.

6.5.2 System Availability Requirements as applicable for new system components.

The SCADA shall be designed so that the failure of any single component, processor, or device shall not render the system unavailable.

a) All equipment and systems covered in this specification shall be designed for maximum reliability and availability.

b) All equipment and systems shall be of proven design using material with well established physical and chemical properties and as appropriate to the service intended.

c) Adequate redundancy shall be built in at various levels to increase the system availability and reliability.

d) The system shall be designed with extensive self-diagnostics and troubleshooting features. Adequate facility shall be provided for quick repair/maintenance and on-line replacement of faulty modules. This shall not result in spurious trips.

e) Components used in the equipment and systems shall be designed with higher rating than required for the normal operating conditions in order to have higher availability of the system.

f) Control system failure shall avoid system upsets and subsequent loss of application.

g) Easy access shall be provided for all components in the equipment and systems offered to reduce the maintenance period.

6.5.3 Equipment Reliability as applicable for new system component

All equipment furnished shall be of good manufacturing quality and of high reliability. Equipment showing poor reliability record during system development and prior to final acceptance should be replaced.

The SCADA shall be designed to satisfy the very high demand for reliability and availability concerning:

a) Mechanical and electrical design

b) Security against electrical interface (EMI)

c) High quality components and boards

d) Modular, well-tested hardware

e) Thoroughly developed and tested modular software.

f) Easy to understand programming languages for application programming

g) Detailed graphical documentation and application software

h) Built in supervision and diagnostic functions

i) Security

6.5.4 Fault Monitoring and Diagnostic Capability

a) All equipment shall continuously monitor itself for internal faults.

b) Every Individual system shall have a self-checking facility for the reliable operation of its components.

c) A comprehensive fault monitoring system shall be provided to signal individually all types of internal faults of the control equipment at card level.

d) Signalling and indication of faults shall include common alarms and individual alarms including interlock signals.

6.5.5 Redundancy Requirement

Redundancy shall be provided at the communication levels.

i) Power Supply system

Power supply modules and distribution of auxiliary power supply to various equipment shall be fully redundant.

6.5.6 Time Synchronisation

a) The SCADA and all its components will be synchronised from a GPS time referenced clock receiver, the time synchronisation equipment. A timing accuracy of better than one (1) millisecond will be achieved for all the devices within the substation Automation System (SAS).

b) Power Fail Auto Restart (PFAR) facility with automatic time synchronisation for GPS time will be provided.

c) Two digital clocks one each at SCADA ROOM and CONTROL ROOM driven by GPS receiver shall be provided, if it is not provided in existing System.

6.5.7 Expandability

The new System/Equipment shall have provision to cater to another 11kV transformer bay. No hardwares will be presently included.

7.0 FUNCTIONAL REQUIREMENT OF REMOTE TERMINAL UNITS

7.1 Each remote terminal unit shall perform the following two functions:

a) Acquisition and monitoring (measurement) of both analog and digital inputs pertaining to one or more circuits/equipment of the power system network.

b) Control of one or more circuit (s) /equipment(s) of power system network.

7.1.1 Data Acquisition and Monitoring systems shall process following types of information available as its inputs

a) Analog values measured through transducers such as current, voltage, active power, reactive power and frequency and parameters measures through sensor such as temperature, etc.,

b) Digital commands signals such as

i) Commands to operational equipment to take a definite position such as open/close.

ii) Commands to positioning devices to advance in steps in the required direction like transformer on load tap changers.

iii) Check commands.

c) Indication signals of the following type:

i) Single state indications such as alarm and relay operation.

ii) Two state indications such as information about the status of devices/operational equipment.

iii) Numeric values such as indications regarding the position of transformers tap or setting value of relays used in protection system.

iv) Derived messages such as exceeding set values which are generated by software during monitoring and processing of process information.

v) Alarms generated within the system.

7.1.2 Sensors /Transducers

a) The field interrogation shall be 110V DC.

b) Interfacing Relays

Interfacing relays shall be provided for converting the operating devices ON/OFF or OPEN/CLOSE command outputs from RTUs to actuate the closing and opening coils of equipment like circuit breakers, isolators or earth switches. Rating of operating coils of interfacing relays and their contacts shall be suitable for interfacing between two different voltage levels, viz, SCADA system voltage and switchgear control voltage. All interfacing relays related to a particular circuit shall be housed along with the I/O cards for the particular circuit. Also all interconnecting cabling between drive control modules and interfacing relays shall be provided.

7.1.3 Functional Requirements Of Data Acquisition & Monitoring System

7.1.3.1 Signal Conditioning & Monitoring

a) Analogue signal Conditioning

i) Galvanic isolation of inputs and output signals.

ii) Inputs filtering and non filtering for attenuation of noise level.

iii) Amplification of low level signals.

iv) Signal distribution for back-up control panel instruments/ other systems (if specified).

v) Cold junction compensation.

b) Analogue signal Monitoring

i) Power supply failure monitoring due to lose plug connection, short circuit, wire break and voltage interruption.

ii) Transducer monitoring for party, wire break, live zero and end limit values.

iii) A/D conversion.

iv) Cable monitoring for open circuit.

v) Communication monitoring.

c) Binary Signal Conditioning

i) Galvanic isolation of input and output signals.

ii) Inputs filtering for attenuation of noise level.

iii) Signal distribution for back-up control panel instrumentation/ annunciation system/other systems.

iv) Power supply to the sensors.

d) Binary Signal Monitoring

i) Contact monitoring.

ii) Contact bounce.

iii) Power supply failure.

iv) Fail safe condition on failure of card/channel.

v) Communication monitoring.

vi) Cable monitoring.

e) Pulse Input Monitoring

Pulse counter overflow indication.

f) Correction

Correction for measured signals will be applied as applicable.

g) Signal compatibility between various equipment shall be ensured. All necessary conditioning and monitoring hardware required for the same shall be provided.

7.1.3.2 Signal Processing (Software)

The data acquisition and control processor in remote terminal unit (RTU) shall perform the following functions:

a) Scanning of process inputs at the preset scan frequency and acquire data by driving its I/O system.

b) Engineering unit conversion, i.e., relating the analog input signals to the actual value and units.

c) Validation of the acquired input signals, i.e.

   i) Checking whether the measured value is within high and low limits.

   ii) Mathematical and logical checking (e.g. correlating current and voltage with kW/KVAR and kVA).

d) Storing the input data after validation/processed data in the local memory (RAM) of RTU with battery back-up.

e) Digital filtering of all input signals.

f) Generation of alarm messages and storing them in local memory.

g) All analog input/output and calculated values, digital & pulse input/output and Boolean points shall be provided with following attributes:

   i) Point identification No. (PID)

   ii) Point description

   iii) Engineering units

   iv) Contract status indicator

   v) Input status and quality indicators namely-

   - 'Bad' input point,
   - Input deleted from scanning/processing
   - Value substituted by control engineer
   - 'Suspect' value
   - Alarm inhibited
   - Point in alarm (HI, LO, HIHI, LOLO).

   These input attributes shall be common through-out the SCADA System.

7.1.3.3 Alarm Detection

Alarm monitoring shall be done for process variables, equipment malfunctions and control deviations. The following features shall be provided.

a) Operating limits, viz., high limit, low limit or both high and low limits shall be assigned to specified analog inputs and calculated variables. The system shall check for violation of these limits to detect alarm conditions. Provision shall be made for variable alarm limits also.

b) In addition to the above operating limits, specified variables shall be assigned with trip limits, viz., high-high limit, low-low limit or both high-high and low-low limits.

c) One or the states (0 or 1) of all high resolution digital inputs and specified low resolution digital inputs and Boolean variables shall be designated as the alarm state. Status change for digital inputs shall be checked at each scan and that of Boolean variables shall be checked as and when they are generated to detect alarm condition.

d) Return to normal state from alarm condition shall also be detected. For analog variables (case (a) and (b)) dead-band feature shall be provided to avoid cyclic alarms.

e) Manual and automatic inhibition of alarms shall be provided. Manual inhibition shall be through console under keylock. Inputs which are detected as 'bad' or which originate from equipment which are 'out-of-service', shall be automatically inhibited from limit checking.

f) The alarms shall be classified as follows:

i) Major alarms: All high resolution digital inputs and all analog inputs with HI-HI and LO-LO limits.

ii) Minor alarms: Analog inputs with HI and LO limits and low resolution digital inputs to be alarmed.

8.0 DESIGN AND PERFORMANCE REQUIREMENTS OF DATA ACQUISITION AND MONTORING SYSTEM

Each Remote Terminal unit shall consist of the following function blocks:

a) Data acquisition and control processor.

b) Communication processor with associated hardware interface with the data highway.

c) Local memory to store dynamic plant data, control programs and self-diagnostic routines.

d) Process input/output modules.

e) Power supply module.

8.1 The system shall have sufficient operating speed, computing capability and input/output requirements.

8.2 The system shall be easy to operate and maintain and extendable in future.

8.3 Use of different types of cards shall be restricted to a minimum, in order to optimise the inventory of spare cards.

8.4 The system shall provide for easy configuration control function or control algorithms through display of logic diagrams/ladder diagrams on MMIs. There shall not be any need for the user to have any in-depth knowledge of programming. The system shall be user friendly.

8.5 Provision shall be made to assure that loss of power in any part of the system does not result in loss of memory so that the system can be reconfigured on restoration of power.

8.6 The process input/output modules shall include analog input modules and digital input/output modules. They shall be interfaced to the data acquisition and control processor through suitable I/O bus. The process I/O modules shall be designed to reduce loading on RTU processor to the extent possible.

8.7 Requirements of I/O Modules

8.7.1 Analogue Input Modules

i) The analog input (AI) module shall be of solid state type. The following features shall be provided:

a) The decoding logic shall ensure that no two channels are selected simultaneously.

b) Cross talk attenuation between selected and unselected channel shall be more than 80 dB.

ii) The Analog-to-Digital Converter (ADC) shall preferably be of successive approximation type. The following features shall be provided.

a) Guarded input section to ensure large common mode noise rejection.

b) Provision for ADC overflow detection.

c) Repeatability shall be better than 0.025%

iii) Necessary signal conditioning prior to A/D conversion for analog inputs signals from commercially available transducers shall be determined and provided by VENDOR. The following hardware shall be included:

a) Programmable gain amplifier for low level signals.

b) Attenuators for high level signals (if any)

c) Filters for noise rejection.

iv) The following design features shall be provided to offer protection to analog input modules.

a) Protection for continuous overload up to 200 percent of all inputs ranges. Such overload on any analog input point shall not affect the accuracy of the next analog inputs in the same range.

b) Features to ensure that power line voltage variations upto ±10% and line frequency variation upto ±5% do not affect the accuracy of the system.

c) Provision for isolating failed channels and for ensuring that such partial failures do not affect remaining healthy channels.

d) Modular design to enable easy field expandability.

e) Provision for too high accuracy reference voltages to be used for checking the accuracy of the ADC for linearity, zero drift and gain. The reference voltage shall be set at equal intervals with respect to the ADC range. This check shall be made automatically at periodic intervals not to exceed six seconds, and shall be alarmed, if conversion is out of tolerance.

f) On line replacement of individual modules in case of failure.

g) Surge with stand capability as per IEEE standards.

h) Provision of suitable circuits for detecting any possible multiple selection or non-selection and indicating the error.

8.7.2 Digital Input Modules

The digital input (DI) modules shall be provided for the periodic scanning of both low resolution and high resolution digital inputs. The following design features shall be provided:

a) Internal voltage source to convert contact state of potential free contacts, either change-over or ON-OFF into logic level signals. Possibility of surface film or contaminates on the contacts shall be considered while selecting this sources.

b) Voltage level sensing units, with non-zero values for the binary status output.

c) Differential input circuit to offer common mode isolation.

d) Choice of polarity and threshold range.

e) Buffer registers.

f) Filtering to protect against contact bounce or electrical noise on input lines.

g) Detection of card power supply failure.

h) Surge withstand capability as per IEEE standards.

i) Self-checking features for detecting faulty operation.

j) Status indicating LEDs for each input.

k) On-line replacement of individual modules in case of failure.

l) Simulation facility.

8.7.3 Pulse Input Modules

The pulse input modules shall have the following features:

a) Pulse accumulation in pulse accumulators/storage registers which are sufficiently large, so that they do not overflow when accumulating pulses which occur at the rate indicated in Date Sheet for a period equal to the maximum scan class interval.

b) Suitable buffering of the accumulators/storage registers to enable scanning without affecting the counting operation.

c) On-line replacement of individual modules in case of failure.

8.7.4 Digital Output Modules

The digital output module shall provide contact closure output by driving relays. The features to be provided are as follows:

a) On-line replacement of individual modules in case of failure.

i) Long life, bounce free, high speed mercury wetted or dry reed relays.

ii) Surge with stand capability as per IEEE standards.

8.8 The system shall have 20% spare capacity for all types of process input/output modules.

8.9 The power supply for the RTU shall be redundant type with suitable auto-changeover facility.

9.0 SCADA SYSTEM FUNCTIONS

The following SCADA system functions which are already existing in the present system shall be augmented for the new system / equipment.

9.1 Status supervision

a) The status of each equipment such as circuit breaker, isolator, earth switch etc shall be supervised continuously. Every detected change of position shall be immediately displayed on the MMI screen and recorded in the event list.

b) The status of 66kV breakers, isolators and earth switches shall be monitored by two auxiliary switches, Normally Open (NO) and Normally Closed (NC) which shall give ambivalent signals. An alarm shall be initiated if these position indications are inconsistent or if the time required for operating mechanism to change position exceeds a predefined limit.

9.2 Measurements

a) All the analogue inputs shall be connected to the RTU through the intermediate transducers.

b) The measured values shall be displayed on the MMI screens.

c) The analogue values shall be updated every 2 seconds.

9.3 Events and Alarm functions

a) Events and alarms shall be generated by RTUs, protection IEDs or the local panels.

b) Alarms shall be recorded in a separate alarm list.

c) All or a freely selectable group of events and alarms shall also be printed out on an event printer.

d) The alarm signals shall be time tagged at 250 ms and events signals shall be time tagged at 1ms resolution.

e) It shall be possible to access the alarms and events displayed on the screen.

f) An acoustic buzzer shall indicate abnormalities.

g) All operators actions shall be logged.

9.4 Displays

The following pictures shall be displayed from the MMI:-

a) Single line diagrams of switchyard, showing the switching equipment status and measured values.

b) Alarm list – Switchyard and power house equipment.

c) Event list – station and plant section wise.

9.5 Event logger

9.5.1 The event logger shall be used:-

a) For logging Trip Signals and causes of trip signals.

b) To record open and closed status of each switching equipment

c) To record change in digital events. When changes occur, a display as well as print out on the printer shall be made.

9.5.2 The event logger shall meet the following requirements:-

a) The time resolution shall be 1ms.

b) Cope with up to 40 changes in any one 10ms interval.

c) The date and time shall be printed to the nearest 1 ms.

d) Events occurring whilst a previous event is in process of being printed shall be stored to await printing. It shall be possible to store 100 such events.

9.6 Event List

9.6.1 Each event shall be displayed with its associated time of occurrence at 1ms resolution.

9.6.2 The operator shall be able to call up the chronological event list on the monitor for the whole system or particular plant section.

9.6.3 It shall be possible to store all events for at least one month.

9.6.4 The chronological event list shall contain.

a) Change in status of switching devices

b) Indication of protective relay operations

c) Fault signals

d) Indication when the analogue measured values cross the specified upper or lower values

e) Loss of communication.

9.6.5 It shall be possible to get selected list of a certain type or group of events such as

a) Date and time

b) Plant section

c) Device

d) Function (Trip, alarm etc.)

9.7 Alarm List

a) The alarm list shall constitute an evaluation of all alarms.

b) The alarm list shall display the present alarm situation and each alarm shall be reported with the following details:-

i) Date and time

ii) Description of the alarm

iii) Acknowledgement state

c) The list shall indicate unacknowledged alarms and persisting faults.

d) Whenever an alarm condition occurs, the alarm condition shall be displayed in a flashing state along with an audible alarm. After acknowledgement of the alarm. It shall appear in a steady state and the audible alarm shall stop.

e) The alarm shall disappear if the cause has physically ceased and the operator has reset the alarm.

f) The state of the alarm shall be shown in the alarm list with the following details.

i) Acknowledged/ unacknowledged

ii) Ceased /persistent

9.8 Reports

9.8.1 The reports shall provide time – related follow ups of measured and calculated values. The data displayed shall include:-

a) Trend reports for day/Month/semi-annual/yearly

b) Historical reports of selected analogue values for:-

- Day
- Week
- Month
- Year

9.8.2 It shall be possible to have the following print outs from the printer on demand:-

a) Daily voltage and frequency curves during 24 hours duration

b) Weekly trend curves for real and derived analogue values

c) Maximum and minimum values for each analogue parameter of each circuit and frequency of occurrence and duration of these during a 24 hours period.

d) Information about each breaker status such as number of operations with date and time.

9.8.3 IED parameter setting

It shall be possible to access all protection relays for reading parameters (settings) from the SCADA system. The setting of parameters or the activation of parameters shall be secured by a password. The necessary software for interfacing with the protective relays shall be provided.

10.0 FUNCTIONAL REQUIREMENTS OF CONTROL ENGINEER'S (OPERATION ENGINEER) COMMIUNICATION AND MONITORING SYSTEM (CCMS).

10.1 The following functional requirements are be implemented for the new system / equipment.

10.2 The existing control Engineer's communication and monitoring system performs following functions through Control Engineer's interface equipment:

a) Control function for open loop control through control display from MMI and key board.

b) Display of mimic diagrams.

c) Alarm display and alarm acknowledgement.

d) Display of individual points data.

e) Generation & display of trend plots.

f) Generation/display/printing of various summaries.

g) Generation/printing of various logs and reports.

10.3 The existing control Engineer's communication and monitoring system satisfy the following requirements. All these requirements shall be met for new system / equipment.

a) It provides the means for communication between the main data bus system and control engineer’s equipment (i.e. MMI and Printers). This means of communication is fully redundant.

b) It is possible to operate and control the plant equipment by use of control MMI and associated key boards / touch screen.

c) The process information shall be made available to control engineer in the form of various display and printout, either automatically or on demand by the Control engineer.

d) The display selection process shall be optimized so that the desired display can be selected by the barest minimum of key strokes by the control engineer. Mouse /keyboard facility shall be provided for curser control purposes.

e) It shall be possible to delete any input from scanning/processing or to return it to scanning/processing on demand by control engineer through control MMI. This action shall be logged on printer.

f) Existing system provides safety tagging to all equipment released for maintenance. A record of release orders, work permits and safety tags issued clearance of release orders and removal of safety tags, etc. are stored in memory and automatically logged in printer, No operation shall be possible on any equipment during the time safety tags are in place, this feature need to be tested for new system / equipment.

10.4 Functions of CCMS:

Present facility shall be utilized to satisfy these functions as applicable for new system / equipment.

10.4.1 Control displays

10.4.2 Control Display for open Loop Control

10.4.3 Mimic Diagrams

10.4.4 Alarm Displays

The following facilities are provided:

a) Audible chime annunciation. The chime shall be discontinued after acknowledgement.

b) Push buttons on control engineer's console for alarm acknowledgement.

c) Display of alarm messages and return to normal messages on MMI.

d) Printing of alarm messages on printer on occurrence of fault or on demand.

e) Alarm messages shall appear on the screen in the order of occurrence until the page is full.

f) On occurrence of an alarm, an operator guidance message for accessing the alarm message in alarm display shall appear on the reserved space on the screen along with audible chime annunciation.

g) An alarm display shall contain the latest 20 alarms with the older alarms (backlog) stored in memory as an additional page. Storage for minimum 5 pages of alarm shall be provided.

h) It shall be possible to display backlog pages on demand. Should an older page be on display on MMI and a new alarm occurs, the most recent alarm page shall re-appear automatically.

i) All return top normal messages shall be removed by pressing 'Alarm Reset' key on control engineer's keyboard.

j) 'Bad' inputs shall also be displayed on MMI in the area reserved for control engineer guidance messages.

k) Any software and hardware faults detected by self-diagnostic check shall also be displayed on MMI.

10.4.5 Alarm Message Format

The present alarm message format shall be followed.

10.4.6 Alarm Printing

Alarm printing shall be as per the present system.

10.4.7 Individual Point Data

10.4.8 The display of digital inputs.

10.4.9 The display of digital outputs.

10.4.10 Time and Frequency Display

The time and power frequency shall always be displayed similar to the existing one.

10.4.11 Trend Plots

10.4.12 Summaries

The system shall provide for composing the summaries of points with similar status. On the control engineer's command, a summary could be displayed/printed. The following type of summaries shall be included:

i Summary of existing alarms,

ii 'Bad point' summary,

iii Points out of scan summary,

iv Summary of alarm limit changes for the day,

v Summary of substituted values,

vi Summary of SCADA System faults.

10.4.13 Logs/Reports

All alarms and abnormal system conditions in the process shall be recorded on the hard copy device. Software shall generate the following reports in the required formats and shall be approved by PURCHESER/CONSULTANT.

a) Periodic Logs

The system shall store values of specified parameters at hourly or half-hourly intervals in different groups (exact group will be identified later). Logs shall be printed out periodically.

b) Shift Report

The system shall generate and print the following shift reports at the end of each shifts:

i) Summary of active alarm including 'bad input' summary.

ii) Status changes (breaker/isolator)

iii) Alarm limit changes by the operator.

c) Daily Report

The system shall generate and print-out following daily reports at the end of each day:

i) Daily maximum and minimum values with time for frequency, voltage, input(generation) flow and transfer flow.

ii) Summary of predefined important alarms.

d) Monthly Report

i) Monthly reports shall include.

ii) Daily maximum and minimum values with date and time.

iii) Monthly maximum and minimum values with date and time.

iv) The above reports shall be prepared for the following parameters:

v) System demand.

vi) Line flows.

vii) System generation

viii) Energy consumption

ix) Calculated losses.

e) SCADA System Fault Log

The system shall printout any fault detected in the system e. g. card failures, any processor failure peripheral failures, etc. immediately on occurrence of the same on printer.

f) Power System Equipment Service Log

The following logs shall be provided:

i) Number of manual operations and fault clearances per circuit breaker.

ii) Hours logged in service and out of service per circuit breaker.

11.0 COMMUNICATION SYSTEM (CS)

11.1 Functional Requirement

11.1.1 The existing communication system has a main data bus for communication between RTU, IED relays, control engineer's communication and monitoring system and maintenance engineer's equipment. It includes cubicle buses which are local. It also performs the function of integrating SCADA system with external computer system through a digital communication interface. The system has the following features:

a) Redundant data busses shall be provided. The failure is annunciated.

b) The data bus system is independent of the various equipment/modules connected it.

c) It shall be possible to carry out on line replacement of new distributed modules as applicable. This shall not result in spurious trips.

11.2 Design And Performance Requirements

a) The data bus system shall be designed such that the information available at any of the RTUs will be accessible to any other RTU interfaces to the data bus.

b) The data integrity shall be protected under the plant environmental conditions.

c) The data bus system shall support a standard protocol with extensive error checking and error recovery features.

d) The system shall have extensive self-diagnostic checks for detection and indication of failures.

e) The data traffic in cubicle bus (local bus) shall not affect the main data bus loading.

f) Communication controller between main data bus and cubical data bus of each RTU shall be redundant, hot back-up type.

11.3 Signal power and communication cables:

The specification of signal, power and data bus communication cables are given under data sheets.

12.0 OPERATOR STRUCTURING SYSTEM (OSS)

12.1 Functional Requirements

12.1.1 The existing OSS has following functions. These shall be utilized for implementation as applicable for new systems.

a) Data base generation and maintenance. However, the process control functions shall be under key-lock control.

b) Development and testing of software to perform the functions specified in this section for the function of SCADA System.

c) It shall be possible to down load the software and data base from this console to the various RTU, either through the data bus or any alternative way.

d) ENTER/CHANGE function for all the attributes of analog and digital I/O points, calculation and Boolean variables and constants (e.g., scan class, process range, etc.).

e) ASSIGN/DELETE function for all the following :

i) Scanning of inputs.

ii) Alarming of inputs.

f) Display and printing of complete data base including I/0 points.

g) Generations of graphics for mimic diagrams, control displays

h) In addition, it shall be possible to perform all the functions specified for control engineer's MMIs.

i) Testing, configuring/re-configuring of process interface cards /modules.

j) The software utility for generation of control software shall allow software development through ladder or logic diagrams. The utility shall be user friendly and shall not require any knowledge of programming by the user.

k) System shall have facility to analyse downtimes and time to repair SCADA system equipment faults.

12.1.2 It shall be possible to display and print the system operational status including data buses and all the processing modules/peripherals connected to it. The following features shall be provided:

a) Over view of total system,

b) Status of each modules,

c) Status of peripherals /components connected to each module (e.g. MMIs., printers, I/O boards),

d) Status of communication system,

e) Faults detected in system through self-diagnostics. It shall also be possible to run off-line self diagnostic programmes.

12.2 Design And Performance Requirements

Design and performance requirements of OSS shall be same as control engineer's communication and monitoring system (CCMS) and control engineer's interface equipment.

13.0 GENERAL PERFORMANCE REQUIREMENTS OF SCADA SYSTEM

The following requirements need to be met for the new system.

a) Signal Acquisition

Signal acquisition for analog, digital and pulse inputs shall have the following features:

i) All analog inputs used for monitoring only, shall be acquired with a maximum scan interval of 1 second.

ii) All low resolution digital inputs shall be acquired every 10 ms and high resolution input scanned by independent SER having a resolution of 1 ms.

iii) All hardware counters accumulating pulse inputs shall be scanned every one second.

iv) Analog and digital inputs shall be time tagged as per requirement, e.g. for alarm monitoring, report generation etc.

b) Response Time

The response time of the system under worst loading conditions shall be as follows:

i) The updating of dynamic data on displays shall be done at least every 5 sec.

ii) The keyboard command to field equipment shall be executed in less than 1 sec.

iii) The response for control engineer's request from key board for any display shall be less than 2 seconds and the display shall be completed in 3 seconds.

c) Spare Capacity

Each processor shall have sufficient capacity for modification or extension during commissioning.

d) Worst Loading Conditions

For Distributed Control system, the worst loading condition shall include the following tasks:

i) All process inputs scanning and processing is in progress and all the data is transmitted over the main data bus every one second.

ii) All open loop controls in operation.

iii) All output devices are in operation with rated performance / speed.

iv) Control / information request is initiated on all control MMIs.

v) In burst mode operation 100 digital alarms are generated per second for a period of 10 seconds.

e) All components shall be subjected to a burn in test before they are assembled. Completely assembled units (PCBs) shall be subjected to dry heat test (elevated temperature test) and Damp heat cyclic test as per IS-9000, part III & Part V. Completely assembled system shall be subjected to working test under simulated working condition at shop for a period 14 days and of which at least 72 hours shall be continuous operation performing all specified functions.

f) Detailed calculations with the help of a schematic of various sub-systems connected in series or parallel as the case may be and the MTBF and MTTR values for the various equipments shall show that required availability is possible. The method of calculation shall be as specified in IEEE standard - P1046 or equivalent. In case a standard other than IEEE is used, a copy of the relevant portions of the standard shall also be furnished.

14.0 SEQUENCE OF EVENTS RECORDER (SER)

14.1 Functional Requirements

14.1.1 The SER system is microprocessor based system.and part of BCU supplied under transformer control and relay panel. The SER shall be connected to SCADA data bus with a redundant communication link for data transfer between SER and data bus. SER input signals shall be from the source devices and not from the multiplied contacts through relays.

14.1.2 The SER system shall have the following digital input monitoring facilities:

a) Galvanic isolation

b) Input filtering for noise level.

c) Contact bounce protection

d) Power supply and supply failure protection.

e) ON - line testing

f) Communication monitoring

g) Cable monitoring

14.1.3 The status changes (also called as events) for high resolution digital inputs, which are scanned as described below, shall be reported through the dedicated sequence of events recorder. The following features shall be provided:

a) Status change in any one of the high resolution digital inputs to a specified state shall initiate sequence-of events recording. All status changes shall be immediately transmitted along with the time of occurrence to the data bus for annunciation on alarm CRT.

b) For the initiating event, time shall be recorded in year, month, date, hours, minutes, seconds and milliseconds. For subsequent events, time interval shall be recorded in elapsed milliseconds, relative to the initiating event.

c) Time resolution of at least one millisecond shall be provided for time tagging the events.

d) SER shall be time synchronised periodically (30 minutes) with SCADA system.

e) After a time interval of 30 seconds from the initiating event, it shall be assumed that one sequence of events (SOE) is over and the sequence of event record shall be transferred to a storage buffer for further processing and printing. This facility shall be reset for further data collection after the data has been transferred to the buffer mentioned above for monitoring the next SOE record.

f) Data for minimum 5 events to be stored in a cyclic manner in the memory and should be available for printing on demand.

g) All the high resolution digital inputs to be automatically scanned on SER restart. This scanning shall be also available on demand, to update the status of all the inputs.

h) The sequence of events (SOE) log shall contain the following:

i) Time of occurrence as described in (b) above.

ii) Point of identification

iii) Point description

iv) Status description code.

i) The SOE log shall be printed automatically on a dedicated printer.

j) The SOE log shall be printed / displayed in a format approved by the PURCHASER / CONSULTANT

14.2 Design And Performance Requirements

This log shall be printed automatically in the existing log printer. This system shall have the following design features:

a) All the high resolution digital inputs shall be hardwired to the process I/O system of the SER directly without any inter stage contact multiplication.

b) Self-checking and automatic diagnostic features shall be provided.

c) SER shall be capable of accepting an external time synchronisation pulse and synchronise its internal clock with the pulse.

15.0 FUNCTIONAL REQUIREMENT OF CONTROL DESK, BACK-UP CONTROL PANEL AND CABINETS (CD / CP / C)

15.1 Control Desk / Panels

There is no control desk or control panel required. The new BCU unit will be mounted and wired in the New TR#1 CRP panel.

16.0 DESIGN AND PERFORMANCE REQUIREMENTS OF SOFTWARE

a) The software shall consist of various utilities as required by the system.

b) Existing SCADA software database need to be upgraded to make compatible for Proposed Transformer#1 Bay.

c) The online Real Time Operating System (RTOS) supplied shall be proven for similar application and shall be able to support all the equipment / peripherals.

d) The background executive shall enable software development in background time sharing mode by two or more programmes simultaneously. It shall be possible to run / test any program without making it into an online program.

e) Compiler if used shall generate an optimised machine language code.

f) The file handling utility shall allow copying of one file in part or whole into another, copying from one medium to another medium and typing the file contents or MMI without entering edit mode.

g) The utility for copying of files shall have capability to read / write in both ASCII/EBCDIC modes. It shall also have capability to read from one medium in any one mode and write on another medium in different mode. It shall also have the capability to do a backup.

h) The debugging utility shall allow for online debugging of programmes.

i) The display generation utility shall be of interactive type. There shall be no need to write programmes for generation and maintenance of displays.

j) It shall be possible to make the system backup copy and programme changes while the system is online. There shall be no need to take the system in standalone mode for making the backup copy and programme changes.

k) Test programmes shall be provided for hardware testing of CPU and other equipment. It shall be possible to test the equipment, except CPU and disks, without taking the system in standalone mode. Online error checking and diagnostic message facility for CPUs various equipment shall be provided.

l) It shall be possible to do the system generation at site after any addition or deletion in memory and peripherals.

m) Utility shall be provided for generation and maintenance of plant input data base. The plant input data base implemented in SCADA system shall be the master data base.

n) The data acquisition, processing and alarm monitoring / reporting software resident in each RTU shall enable processing of raw process data including engineering unit conversion and process alarm limit checking.

o) The communication package shall enable data transfer between the distributed modules though the data bus system.

p) The operator interface software shall enable the operator to call up displays and to control the process through VDU/keyboard.

q) The control language shall be a user oriented language to formulate control systems.

r) Report /display generator shall facilitate creation of reports and graphic displays in user definable formats.

s) The report processor shall assess the plant database for necessary data and initiate printing of log and report.

t) The diagnostic package shall enable online or off-line testing of all distributed modules as well as the data base communication system. The online diagnostics shall run during the normal functioning of distributed modules without interfering with the real time performance of the system. If any malfunction is detected in a module, it shall be disabled automatically and an alarm message shall be reported to the maintenance engineer.

u) The downloading utility shall enable down loading of all programmes developed at maintenance engineer's work station to the respective distributed modules.

v) Suitable communication software protocol for the communication link for communication between SCADA System and other computer system shall be provided.

17.0 DESIGN AND PERFORMANCE REQUIREMENTS OF INTERFACING RELAYS

a) Interfacing relays shall be two element relays having suitable number of contacts for each element.

b) Interfacing relays should be compact in size.

c) The relay shall be compatible in all respects with respect to I/O boards microprocessor based SCADA system with which it shall be interfaced.

18.0 MAINTENANCE AND TESTING REQUIREMENTS OF VARIOUS MODULES OF SCADA SYSTEM

18.1 Maintenance Requirements

All equipment shall be designed for ease of maintenance to help achieve a high mean time between failures. All equipment shall be of modular design to assure a short mean time to repair. The following provisions shall be made:

a) The vendor shall furnish the details of the maintenance requirements of each equipment, indicating list of parts which require regular maintenance and frequency of maintenance for these parts. Based on VENDOR's experience, documentation giving a recommended maintenance program to achieve a high MTBF for the system shall be furnished.

b) The VENDOR shall furnish sufficient documentation to ensure efficient maintenance and trouble shooting of equipment and modules. This shall include point-to-point wiring diagrams and schematic diagrams of all electronic assemblies supplemented with concise description of theory of operation of individual sub-systems. Expected faults, troubleshooting hints, check-out lists and a list of sub-components prone to failure shall also be provided.

c) All equipment shall have extensive self-diagnostic features, test points and clearly labelled error indication lamps which will help in speedy identification of faulty modules.

d) Provision shall be made for isolating sub-systems/modules which are identified to be faulty, thus enabling on-line replacement without taking equipment off-line.

e) Adequate number of test equipment like test sockets, test cables, digital voltmeters, 3-pen recorders, signal generators, card extenders, etc. shall be provided to facilitate ease in maintenance.

f) Necessary maintenance equipment tools and special erection tools which are not specifically mentioned in the specification but are normally required for ease of maintenance and to have minimum down time, shall be supplied.

g) Components of same function shall be as far as possible interchangeable.

h) Standardisation concept shall be used in selecting the components for the system.

i) All the documentation shall be in English language.

j) All the documentation shall be provided on soft copy in addition to the printed documents.

k) During guaranteed availability period the contractor shall take continual action to ensure the guaranteed availability and shall make available all the necessary resources such as the specialist personal, spare parts, tools, test devices etc for replacement or repair of all defective parts and shall have prime responsibility for keeping the system operational

18.2 QUALITY CONTROL, INSPECTION AND TESTING

18.2.1 General

a) The equipment covered by this contract shall be subjected to inspection and testing.

b) The supplier shall perform his internal inspection/ testing before offering the equipment for purchaser's inspection. Only after ensuring that his inspection/ test results are satisfactory, the supplier shall offer the equipment for purchaser's inspection. However, in case of such tests which are required to be done only once in the lifetime of the equipment, the test shall be carried out in the presence of Purchase's representative

18.2.2 I/O Modules

a) The analogue input module shall be tested as follows:

i) Checks using simulated inputs to represent each type of input.

ii) Tests to determine analog input module operability, addressing capability, scan rate, linearity, repeatability and stability over a 24 hour period.

iii) Tests to determine the reproducibility of a known analog input (mid-range value).

b) The digital input module shall be tested for addressing, signal level, input delay, noise rejection and interrupt recognition time.

c) The pulse input module shall be tested for counting accuracy and capacity of the accumulator.

d) The digital output module shall be tested to check addressing, power failure status, signal level and output delay.

18.2.3 Central Processing Unit (If applicable)

a) VENDOR shall submit in writing for PURCHASER's review and approval a detailed description of the test procedures and programs at least two months prior to start of the system test. The tests indicated in the following paragraphs shall be included:

b) Main memory test of twelve (12) hours duration to demonstrate the capability of memory read - write function under worst pattern at various voltage levels.

c) Main memory parity detection test of 12 hours duration to demonstrate that parity detection feature performs properly to the PURCHASER's satisfaction.

d) Logic tests of 12 hours duration to demonstrate the hardware commands, interrupt structures and hardware failure detection.

e) Count-down registers and pulse counter test of eight (8) hours duration to demonstrate the accuracy of all time count-down registers.

f) Bulk memory data transfer test of thirty-six (36) hours duration to demonstrate possible combinations of transfer from/to bulk memory including checks for illegal writing, reading and wrong transfer indications. Voltage and speed variation checks shall also be performed.

g) Bulk memory parity detection test of 12 hours duration to demonstrate the proper functioning of the parity detection feature.

18.2.4 Test during inspection:

The manufacturer shall list all the factory, routine, type and acceptance tests clearly in the QA Plan identifying the details of agencies witnessing the same.

18.2.5 Also the details of stage inspections shall be furnished by the manufacturer in the QA plan. The QA plan is to be submitted for approval before taking up the manufacture of the equipment.

18.2.6 Approval or passing of any such inspection by the purchaser or his authorized representative shall not, however, prejudice the right of the Purchaser to reject the equipment if it does not comply with the specification or give complete satisfaction in service when erected

18.2.7 Type Test

a) All the equipments to be supplied shall be of type tested quality. The manufacturer shall submit for Purchasers approval the reports of all the type tests as per relevant standards and codes and carried out within last five years from the date of the bid.

b) In case the manufacturer is not able to submit report of the type test(s) or in case the type test report(s) are not found to be meeting the specification requirements, the supplier shall conduct all such tests under this contract without any time and price implication and submit the reports for approval.

c) The type tests to be compulsorily repeated by the manufacturer as per IEC/IS shall be indicated during detailed engineering.

19.0 SPARES:

19.1 Consumables

All consumables such as papers, cartridges shall be supplied by the contractors till the SCADA is taken over by the owner.

19.2 Availability spare:

a) In addition to mandatory spares as listed elsewhere, the bidder is required to list the spares, which may be required for ensuring the guaranteed availability during the guaranteed availability period.

b) During the guaranteed availability period, the spare parts supplied by the contractor shall be made available to the contractor for usage subject to replenishment at the earliest.

c) Thus at the end of availability period the inventory of spares with the purchaser shall be fully replenished by the contractor.

6.18.2 SCADA System Datasheets

DATA SHEET-B1 **(Bidder shall submit duly filled in Data Sheet-B along with the complete Bids)**			
Sl. No.	**Description**	**Unit**	**Bidder's Data**
1.0	System Response Times		
1.1	Updating of dynamic data on display		
1.2	Key board command to field equipment execution time		
1.3	Key board command for display presentation execution time		
1.4	Key board command to display presentation completion		
	REMOTE TERMINAL UNIT		
1.0	Make and model No.		
2.0	No. of unites		
3.0	***Data Acquisition & Control Processor***		
3.1	Model No.		
3.2	Word length		
3.3	Floating point arithmetic	Yes/No	
3.4	Provision for configuring in hot back up	Yes/No	

DATA SHEET-B1 (Bidder shall submit duly filled in Data Sheet-B along with the complete Bids)			
Sl. No.	**Description**	**Unit**	**Bidder's Data**
	mode		
3.5	Capability to continue data acquisition & control functions in the absence of data highway	Yes/No	
3.6	Input / Output capacity		
	a) Analog inputs		
	b) Digital inputs		
	i Low resolution		
	ii High resolution		
	c) Pulse inputs		
	d) Digital outputs		
3.7	Binary control	Yes/No	
4.0	Dedicated Communication Processor	Yes/No	
4.1	Network standard number		
5.0	Local Memory		
5.1	Volatile memory		
	a) Type		
	b) Memory cycle time		
	c) Capacity		
	d) Type of back up		
	e) Duration of battery backup		
5.2	Non-volatile memory type		
6.0	Process Input / Output Modules		
6.1	Capacity offered (Total)		
6.2	Spare capacity (proposed to be implemented)		
6.3	Maximum capacity (Furnish limitations for different combinations of I/O capacity)		
6.4.3	Scan cycle		
6.4.4	Cross talk upto		
6.4.5	Normal mode rejection ratio		
6.4.6	Common mode rejection ratio		
6.4.7	Common mode voltage (DC & PK to PK)		
6.4.8	Analog to digital converter (ADC)		
	a) Type		
	b) Make and Model No.		
	c) No. of ADCs		
	d) No. of Inputs/ADC		
	e) Resolution (No. of bits)		
	f) Overall accuracy		
	g) Linearity		
	h) Repeatability		
	i) Input impedance		
	j) ADC overflow detection		
	k) Speed of Conversion (No. Of pts/Sec)		
	l) Expandability		
6.4.9	Short circuit detection for analog signals		
6.4.10	Provision of optical isolation		
6.4.11	Surge withstand capability		
	a) Low resolution digital input		
	b) High resolution digital inputs		
6.5	Digital Input Module		

DATA SHEET-B1 **(Bidder shall submit duly filled in Data Sheet-B along with the complete Bids)**			
Sl. No.	**Description**	**Unit**	**Bidder's Data**
6.5.1	Card/Model No.		
	a) Low resolution digital input		
	b) High resolution digital inputs		
6.5.2	No. of cards/No. of inputs per card :		
	a) Low resolution digital inputs		
	b) High resolution digital inputs		
6.5.3	Scan cycle for low resolution digital inputs		
6.5.4	Contact bounce protection	Yes/No	
6.5.5	Noise rejection	Yes/No	
6.5.6	Sense voltage across contact		
6.5.7	Differential input circuit	Yes/No	
6.5.8	Choice of polarity and threshold range	Yes/No	
6.5.9	Buffer registers	Yes/No	
6.5.10	Detection of power supply failure	Yes/No	
6.5.11	Surge withstand capability		
6.5.12	Provision of Optical isolation	Yes/No	
6.5.13	Status indicating LED's for each input	Yes/No	
6.6	Pulse Input Module		
6.6.1	Card/Model No.		
6.6.2	No. of cards/No. of inputs per card		
6.6.3	Counter / register length		
6.6.4	Overflow protection	Yes/No	
6.6.5	Read interlock	Yes/No	
6.6.6	Buffer register	Yes/No	
6.6.7	Common mode voltage (PK to PK/DC)		
6.6.8	Optical isolation	Yes/No	
6.7	Digital Output Module		
6.7.1	Card/Model No.		
6.7.2	No. of cards/No. of inputs per card		
6.7.3	Multiplexed/Non-multiplexed		
6.7.4	Necessary power supply provided	Yes/No	
6.7.5	Output cycle		
7.0	Online replacement of cards in case of failure	Yes/No	
8.0	Provision of Power supply units for all modules in RTU with redundancy	Yes/No	
9.0	Degree of protection as per IS : 2147		
10.0	Reliability Factors		
10.1	MTBF:		
	a) Processor		
	b) Local memory		
	c) Process I/O cards		
	d) Power supply		
10.2	MTTR		
	a) Processor		
	b) Local memory		
	c) Process I / O cards		
	d) Power supply		
11.0	Technical literature		

DATA SHEET-B2 **(Bidder shall submit duly filled in Data Sheet-B along with the completed Bids)**			
Sl. No.	**Description**	**Unit**	**Bidder's Data**
1.0	**SYSTEM ARCHITECTURE FOR CCMS & OSS**		
1.1	If centralized architecture, processor level redundancy for CCMS provided? (for system quoted)	Yes/No	
2.0	Display Capabilities		
2.1	No. of plant overview display pages		
2.2	No. of group display pages/ No. of points per page		
2.3	No. of plant mimic display pages		
2.4	No. of bar chart display pages/No. of display pages/No. of displays per page		
2.5	No. of individual point displays		
2.6	No. of alarm summary display pages/No. of alarms per page		
2.7	No. of trend display pages/ No. of trend display per page.		
2.8	No. of operator guidance message display pages		
3.0	CENTRAL PROCESSING UNIT (if applicable)		
3.1	Make and model No.		
3.2	No. of CPUs		
3.3	Provision for configuring in hot back up mode		
3.4	Processing capacity		
3.5	Reserve capacity		
3.6	Word length		
3.7	Arithmetic processor with floating point capability		
3.8	ROM bootstrop		
3.9	Maximum logical address space		
3.10	Max. physical address space		
3.11	Memory addressing range		
3.12	Memory addressing modes		
3.13	Programmable rear time clock		
3.14	Watch dog timer		
3.15	Auto restart		
3.16	Heat dissipation, Kcal/hr		
3.17	Reliability factors		
	a) MTBF		
	b) MTTR		
3.18	Technical literature		
4.0	MAIN MEMORY		
4.1	Type		
4.2	Word size		
4.3	Error correction feature		
4.4	Memory cycle time		
4.5	Offered memory size		
4.6	Memory expandability		
4.7	Module size for expansion		
4.8	Maximum expansion capability		
4.9	Battery backup	Yes/No	

DATA SHEET-B2 **(Bidder shall submit duly filled in Data Sheet-B along with the completed Bids)**			
Sl. No.	**Description**	**Unit**	**Bidder's Data**
4.9.1	Type		
4.9.2	Duration		
4.10	Cache memory provided	Yes/No	
4.11	If yes,		
	a) Cache memory type		
	b) Capacity offered		
	c) Memory cycle time		
4.12	Real time clocks		
	a) Model No.		
	b) Type		
	c) Clock resolution		
4.13	Reliability factors		
	a) MTBF		
	b) MTTR		
4.14	Technical literature		
5.0	INPUT-OUTPUT SYSTEM		
5.1	Type of I/O bus		
5.2	Capacity (No. of devices) offered		
5.3	Maximum capacity		
5.4	No. of DMA channels		
5.5	DMA transfer rate		
5.6	No. of interrupts		
5.7	No. of interrupt priority levels		

DATA SHEET-B4 **(Bidder shall submit duly filled in Data Sheet-B along with the completed Bids)**			
Sl. No.	**Description**	**Unit**	**Bidder's Data**
1.0	**MAIN DATA BUS SYSTEM (As applicable)**		
1.1	Type & Specification of Cable used		
1.2	Length of data bus offered		
1.3	Max. length of data bus without repeaters		
1.4	Network topology		
1.5	No. of distributed modules connected		
1.6	Maximum No. of distributed modules it can support		
1.7	If coaxial type, atmosphere conditions for coaxial taps (relative humidity and temperature range)		
1.8	Type of communication protocol		
1.9	Maximum allowable distance between modules		
1.10	No. of communication processors		
1.11	Redundant data bus	Yes/No	
1.12	Self-diagnostic features	Yes/No	
1.13	Type of error detection and recovery features		Bidder to state
1.14	Method of communication		
1.15	If exception reporting, no. of exception reporting dead bands		
1.16	Data bus transmission rate		
1.17	Bus controller required?	Yes/No	
1.18	Data bus loading with proposed configuration (furnish data bus loading calculations)		
1.19	Node bypass switch provided	Yes/No	
1.20	Reliability factors		
1.20.1	MTBF		
1.20.2	MTTR		
1.21.	Technical literature		
2.0	COMMUNICATION LINK FOR COMMUNICATION WITH EXTERNAL SYSTEM		
2.1	Type of communication link		
2.2	Maximum allowable length		
2.3	Data transfer rate		
2.2	Maximum allowable length		
2.3	Data transfer rate		
2.4	Protocol used		
1.0	SEQUENCE OF EVENTS RECORDER		
1.1	Make and model No.		
1.2	No. of units		
1.3	CPU		
1.3.1	Processing capacity		
1.3.2	World length		
1.3.3	Programmable real time clock	Yes/No	
1.3.4	Watch dog timer	Yes/No	
1.3.5	Auto restart	Yes/No	
1.3.6	Time synchronization	Yes/No	
1.4	PROCESS INPUT SYSTEM		

DATA SHEET-B4 (Bidder shall submit duly filled in Data Sheet-B along with the completed Bids)			
Sl. No.	**Description**	**Unit**	**Bidder's Data**
1.4.1	No. of high resolution inputs		
1.4.2	Resolution		
1.5	PRINTER		
1.5.1	Make and model No.		
1.5.2	No. of Units		
1.5.3	Type		
1.5.4	Printing speed		
1.5.5	No. of Character/line		
1.5.6	Sound proof enclosure	Yes/No	
1.5.7	Noise level		
1.6	Mounting dimensions	HxWxD mm	
1.7	Weight	Kg	
1.8	Heat dissipation	Kcal/hr	
1.9	Redundant communication link for data transfer to SCADA bus	Yes/No	
1.10	Reliability factors		
1.10.1	MTBF		
1.10.2	MTTR		
1.11	Technical literature		

6.18.3 Instrumentation Cables Datasheets

DATA SHEET-A			
Sl. No.	**Description**	**Data**	
	GENERAL		
1	APPLICATION	DIGITAL SIGNAL (CONTROL)	POWER SUPPLY
2	NO. OF PAIRS / QUANTITY (kM)	1 PAIR	2 Core (NOTE 4)
3	TWISTED PAIRS / OVER LAY	MIN.-10 TWIST PER METER / YES	
4	AREA CLASSIFICATION	NON HAZARDOUS AREA	NON-HAZARDOUS AREA
5	INDIVIDUAL PAIR SHIELDING / MATL.	NOT APPLICABLE	NOT APPLICABLE
6	OVERALL SHIELD / MATL.	YES / AL. MYLAR TAPE, 0.05MM THK	YES / AL. MYLAR TAPE, 0.05MM THK
7	TYPE OF SCREENING	100% COVERAGE WITH 25% OVERLAP	100% COVERAGE WITH 25% OVERLAP
	CONDUCTOR		
8	CONDUCTOR MATL. / TYPE	TINNED COPPER / STRANDED	TINNED COPPER / CORE
9	CONDUCTOR STANDARD	IS-8130	IS-8130
10	CONSTRUCTION	STRANDED 7 X 0.43 mm Dia (approx.)	SOLID
11	CONDUCTOR CROSS SECTION	1.5mm²	2.5mm²

DATA SHEET-A			
Sl. No.	**Description**	**Data**	
12	CONDUCTOR INSULATION / STANDARD	LDPE / IS 6474	LDPE / IS 6474
13	INSULATION COLOR	BLACK (+VE) & LIGHT BLUE (-VE)	BLACK, LIGHT BLUE & BROWN
14	INSULATION THICKNESS	NOT LESS THAN 0.25mm	
	CONSTRUCTION		
15	INNER SHEATH / COLOUR	FRLS XLPE / BLACK (ST-2-IS5831 / IEC-502)	FRLS XLPE / BLACK (ST-2-IS5831 / IEC-502)
16	OUTER SHEATH / COLOUR	FRLS XLPE 1.4mm THK / BLACK (ST-2-IS5831 / IEC-502)	FRLS XLPE 1.4mm THK / BLACK (ST-2-IS5831 / IEC-502)
17	DRAIN WIRE MATL. & SIZE (UNDER SHIELD)	TINNED COPPER 7 X 0.3 mm Dia	TINNED COPPER 7 X 0.3 mm Dia
18	COMMUNICATION	NOT APPLICABLE	NOT APPLICABLE
19	RIP CORD	REQUIRED BELOW INNER SHEATH	REQUIRED BELOW INNER SHEATH
20	ARMOUR TYPE	GALVANISED STEE WIRE 1.4mm Dia	GALVANISED STEE WIRE 1.4mm Dia
21	CORE IDENTIFICATION / NUMBERING	EVERY 50mm	EVERY 50mm
	ELECTRICAL CHARACTERISTICS		
22	INSULATION RESISTANCE OHM / KM	>5000 OHM / Km AT 20 Deg. C. AS PER BS - 5308	>5000 MEGA OHM / Km AT 20 Deg. C. AS PER BS -5308
23	FLAME RETARDANCE	IEC 332 PART III CAT. A	IEC 332 PART III CAT. A
24	VOLTAGE GRADE (volts)	300V / 500V	300V / 500V
25	ELECTROSTATIC NOISE REJECTION	> 76 db	> 76 db
26	CONDUCTOR RESISTANCE ohm / km @ 20 Deg. C.	18.3 ohms / Km (max)	12.3 ohms / Km (max)
27	MUTUAL CAPACITANCE max.		
28	(a) BETWEEN CORE TO CORE	75pF / M	75pF / M
29	(b) BETWEEN CORE TO SCREEN	400 Pf / M at 1 KHZ	400 Pf / M at 1 KHZ
30	INDUCTANCE AT 1 Khz MH/Km max	<1	<1
31	L /R RATIO microH / OHM max	<25	<40
	TESTS		
32	DIELECTRIC TEST VOLTAGE	AS PER BS 5308 PART II	AS PER BS 5308 PART II
	(a) CORE TO CORE		
	(b) CORE TO SHIELD		

DATA SHEET-A			
Sl. No.	**Description**	**Data**	
	(c) ARMOUR TO SHIELD		
	(d) SHIELD TO SHIELD		
	(e) SPARK TEST DURING PRODUCTION		
33	OXYGEN INDEX (%)	>30 AS PER ASTM D 2863	>30 AS PER ASTM D 2863
34	TEMPERATURE INDEX (OC)	>250 Deg. C. AS PPER ASTM D 2863	>250 Deg. C. AS PPER ASTM D 2863
35	ACID GAS EMISSION (%)	AS PER IEC-754-1	AS PER IEC-754-1
36	SMOKE INDEX (% ABSORBANCE)	AS PER ASTM D 2843	AS PER ASTM D 2843

NOTE:

1. All cables shall be Water, Oil & Ultraviolet resistant, Gas & Vapour tight.
2. The drain wire shall be in contineous contact with the side of the shield.
3. Embossing marking per meter of the cable shall be clear & prominent. Running length of cable shall be printed at least every 5 meter interval.
4. The Power cables requirement from client's source to UPS is included. The power cable from UPS to Bidders equipment should be provided by VENDOR.

FIBER OPTICAL - PATCH CORDS

	GENERAL	
1	Cable Type	FIBER OPTICS- Patch Cords
2	Application	Substation Automation-Indoor, High Speed Data Transmission
3	Type	Multi-Mode (NOTE:3)
4	Configuration	Duplex (NOTE:3)
5	Connector Type	ST Coupler at both end (NOTE:4)
6	Compliance	UL Certified, IEC 61754/TIA/EIA
7	Area Classification	Non- Hazardous
8	Speed	1000 Base - SX / 100 Gbites
	Specification	
9	FIBER Conductor Size	3mm / 4mm (OM3/OM4)
10	Insertion Loss	Typical <=0.2 dB, Max.0.3 dB
11	Return Loss	<=25 dB, (MM)
12	Color	With refer to Configuration
13	Working Temperature Range	-20 to 70 Deg
14	Working Distance	Above 500 meter (without any Repeaters)
	CONSTRUCTION / Mechanical Properties	

15	Insulation	LSZH (Low smoke-Zero Halozon)
16	Repeatablity	<=0.2 dB 200 times mating cycles
17	Connector Ferrule	Ceramic

NOTES :

1) All cables shall be Water, Oil &Ultraviolet resistant,Gas & Vapour tight.
2) Embossing marking per meter of the cable shall be clear & prominent. Running length of cable shall be printed at least every 5 meter interval.
3) SCADA Vendor shall be confirmed a type of **configuration Duplex/ Multi-mode.**
4) SCADA Vendor shall be confirmed a type of connector **SC/ST/LC/FC/MTRJ** which is going to be use. The coupling connector must suitable to IED, EFS, SNTP Server and other SCADA accessories. Also **Combination of connectors shall be chosen (If system requires SC-ST, ST-LC, SC-LC etc.,)**

TWISTED PAIR - LAN PATCH CARDS

	GENERAL	
1	Cable Type	Twisted Pair LAN Patch Cords
2	Application	Substation Automation-Indoor, High Speed Data Transmission, NON-PoE
3	Type	CAT6
4	Configuration	4 Pair -- Twisted Pair
5	Connection	RJ45 Connector at Both the Ends
6	Compliance	UL Certified, TIA/EIA 568C.2
7	Area Classification	Non- Hazardous
8	Speed	100 base TX Fast Ethernet /1000 Base T
	Specification	
8	Type of Conductor	24 AWG, Multi strand
9	Conductor metal	Bare Copper
10	Type of Connector	Modular connector / Plug
11	Insertion cycle	>500 Times
12	Heat Resistance	>50 Deg
13	Terminal	Gold Platted
14	Temperature Range	-20 to 75 Deg
	CONSTRUCTION / Mechanical Properties	
15	Insulation	HDPE
16	Outer Jacket	FR-PVC
17	Contact	Copper / Alloy
18	Insulation Resistance	>500Mohms, 1000V DC / Min
19	Dielectric withstand	1000 V DC / Min

NOTES :
All cables shall be Water, Oil &Ultraviolet resistant,Gas & Vapour tight.
Embossing marking per meter of the cable shall be clear & prominent. Running length of cable shall be printed at least every 5 meter interval.

I/O LIST OF ALL IED AND MFM at Proposed TR#1 Bay 66kV sub-stations for SCADA

Sl No	SUB-STATION DESCRIPTION	EFS	OPERATING DEVICES					INPUT/ OUT PUT		SUMMARY	
			BCU	87T	64R	51/51 N	MFM	DI	DO	DI	DO
A.	**Proposed TR#1 SUBSTATION - CRP**									**62**	**44**
1.	TRANSFORMER CRP	1	1					32	16	32	16
				1				16	16	16	16
					1			4	4	4	4
						1		8	6	8	6
							1	2	2	2	2

NOTES:

1 BCU :BAY CONTROL UNIT : MONITORED AND CONTROLLED FROM SCADA. BCU shall be Supplied with CRP as a looase item and it needs to be installed and integrated in existing SAS Panel

87T : TRANSFORMER DIFFERENTIAL RELAY : ONLY MONITORED FROM SCADA

51/51N : BACKUP PROTECTION RELAY : ONLY MONITORED FROM SCADA

PQM/MFM: POWER QUALITY METER/ MUTIFUNCTION METER : ONLY MONITORED FROM SCADA

2. FROM IED TO MAIN SERVER THROUGH EFS, SIGNALS TRANSFER IN TERMS OF IEC 61850.

3 PROTECTION INETRFACING SIGNAL COMMUNICATION WILL BE MADE FOR 87L and 21.

4 IEC 61850 SIGNALS BETWEEN THE IED WILL MADE THROUGH IEC61850 GOOSE PROTOCAL

5 THE INPUTS (BI) AND OUTPUTS (BO) AS CONSIDERED WITH RESPECT TO SITE REQUIREMENT AND 20% SPARE SHALL BE CONSIDERED FOR FUTURE EXPANSION.

7.0 Schedule Of Deviation From Technical Specification

All deviations from the Technical Specifications shall be filled by the BIDDER clause by clause in this schedule.

SECTION	SPECIFICATION NO	CLAUSE NO	DEVIATION

The bidder hereby certifies that the above mentioned are the only deviations from the PURCHASER's Technical Specifications for the enquiry. The BIDDER further confirms that in the event any other data and information presented in the BIDDER's proposal and accompanying documents including drawings, catalogue, etc., are at variance with the specific requirements laid out in the PURCHASER's Technical Specifications, then the latter shall govern and shall be binding on the BIDDER for the quoted price.

COMPANY SEAL

SIGNATURE .....

NAME .....

DESIGNATION .....

COMPANY .....

DATE .....

8. GENERAL CONDITIONS

7.1 DEFINITIONS OF TERMS

In constituting these conditions and specifications, the following expressions shall have the meaning, therein assigned to them unless there is something repugnant in the subject of context in consisting with such meanings.

7.1.1 Institute shall mean the "Indian Institute of Science, Bangalore".

7.1.2 "Office" shall refer to the Office of the Project Engineer cum Estate officer.

7.1.3 "Contractors" shall mean the tenderer whether a firm, registered company, partnership or any individual whose tender has been accepted by Institute or by an Officer (duly authorized in this behalf) on behalf of the Institute and who has entered into agreement with Institute for due fulfillment of the contract and shall include the legal representatives, successors, heirs and assignees of the tenderer.

7.1.4 "Engineer" shall mean the "Project Engineer cum Estate officer", Indian Institute of Science, Bangalore or such other officer as may be appointed to call as the Project Engineer cum Estate officer for the purpose of the contract and shall also mean and include other officers of equivalent rank directly in charge of the work or any part thereof under administrative control of the Director, IISc, Bangalore-12.

7.1.5 When the Engineer is named as final authority, it includes all the above mentioned officers and in such matters, the contractors shall have the right of appeal against the orders up to the Director, IISc, Bangalore, whose decision shall be final and legally binding on all the parties concerned.

7.1.6 The Project Engineer cum Estate officer named as final authority for any decision taken, shall mean only the Director, IISc, Bangalore or his duly authorized assistant.

7.1.7 The Engineer in charge shall mean the Project Engineer cum Estate officer directly in charge of the work or his duly authorized assistants.

7.1.8 Plant shall mean and include any or all plants, machinery, tools and other implements of all description necessary for the execution of the work in a safe and workmen like manner.

7.1.9 The expression "Works" where used in these conditions shall unless thereby something in the subject or contract repayment to such construction, be construed to mean the work or the works constructed to be executed under or virtue of the contract whether temporary or permanent and whether original, altered, substituted or additional.

7.1.10 "Contract and contract document" shall mean and include the notice inviting tenders, proceedings of the pre bid meeting, the stamped agreement, conditions of contract, specifications and Schedules 'B', drawings and all other connected documents with tender schedule.

7.1.11 The contractor shall be responsible for obtaining statutory clearances from the concerned authorities including approval of drawings and documents from CEIG/ CEA / KPTCL / BESCOM and to obtain the safety certificate for charging the switchyard. Statutory fees and processing fees shall be reimbursed by Institute on production of Receipts.

7.1.12 "Specifications" shall mean the specifications annexed and where these are not specifically mentioned shall be as may be detailed and necessary due to particular nature of work as approved by the Project Engineer cum Estate officer.

7.1.13 "Site" shall mean and include all the area in which operations in respect of the work are carried out. This shall also include materials stacking yards and the area where temporary structures are put up for installing any machinery etc."Tests" shall mean such tests as are required to be carried out either by the contractor or by the Project Engineer cum Estate officer from time to time on completion as detailed in the specifications before the work is certified as being satisfactory and is taken over by the Project Engineer cum Estate officer.

7.1.14 "Month" shall mean a Calendar month.

7.1.15 ***"Prime contractor"*** mean a firm that performs construction work itself and that the work is directly entrusted to the firm by the owner / Government / local body / Quasi Government / Government under taking.

Words used in singular shall also include the plural & vice-versa where the context so demands.

7.1.16 **CONTRACTOR TO INSPECT SITE**:

The contractor shall visit and examine the construction site and satisfy himself as to the nature of the existing roads or other means of communications, the character of the soil for the excavations, the extent and magnitude of the work and facilities for obtaining materials and shall obtain generally his own information on all matters affecting the execution of the work. No extra for charges made in consequence of any misunderstanding or incorrect information on any of these points or on the grounds of insufficient description will be allowed. All expenses incurred by the contractor in connection with obtaining information for submitting this tender including his visits to the site or efforts in compiling the tender shall be borne by the Tenderer and no claims for reimbursement thereof shall be entertained. .

7.1.17 **ACCESS TO SITE**:

The Contractor is to include in his rates for forming access to the site, with all temporary roads and gangways required for the works.

7.1.18 **SETTING OUT**:

The Contractor shall set out the building in accordance with the plans. All grid/centre lines shall be pegged out to the satisfaction of the Engineer. The Contractor shall be responsible for the correctness of the lining out and any inaccuracies are to be rectified at his own expense. He will be responsible for taking ground levels of the site before setting out and recording them without any extra charge.

The Contractor shall construct and maintain proper bench mark at the intersection of all main walls, columns, etc., in order that the lines and levels may be accurately checked at all times.

7.1.19 **TREASURE TROVE**:

Should any treasure, fossils, minerals, or works of art of antique interest be found during excavation or while carrying out the works, the Contractor shall give immediate notice to the Engineer of any such discovery and shall make over such finds to the Institute.

7.1.20 **ACCESS FOR INSPECTION**;

The Contractor is to provide at all times during the progress of the works and the maintenance period proper means of access, with ladders, gangways etc., and the necessary attendants to move and adapt as directed for the inspection of measurement of the works by the Engineer or their representatives.

7.1.21 **ATTENDANCE UPON ALL TRADERS**:

The Contractor shall be required to permit tradesmen/ Specialized agencies appointed by the employer to execute works like water supply, Sanitary, Electrical installation, lifts, air conditioning, hardware and other specialized works. The contractor shall also permit the above mentioned agencies to use his scaffolding and retain the scaffolding till such works are completed. The rates quoted by the contractor shall be inclusive of the above facility.

7.1.22 **GATEKEEPER AND WATCHMAN**:

The Contractor from the time of being placed in possession of the site must make arrangements for watching, lighting and protecting the work, all materials, workmen and the public by round the clock on all days including Sundays and holidays at his own risk and cost.

7.1.23 **STORAGE OF MATERIALS**:

The Contractor shall provide for necessary sheds of adequate dimension for storage and protection of materials like cement, steel, lime, timber and such other materials including tools and equipment which are likely to deteriorate by the action of sun, wind, rain or other natural causes due to exposure in the open. The cement storage site shall be leak proof and shall hold at least 4 months requirement. All such sheds shall be cleared away and the whole area left in good order on completion of the contract to the satisfaction of the Engineer.

All materials which are stored on the site such as bricks, aggregates etc., shall be stacked in such a manner as to facilitate rapid and easy checking of quantities of such materials.

7.1.24 **COST OF TRANSPORTING**:

The Contractor shall allow in his cost for all transporting, unloading, stacking and storing of supplies of goods and materials for this work on the site and in the places approved from time to time by the Engineer. The Contractor shall allow in his price for transport of all materials controlled or otherwise to the site.

7.1.25 **W.C. AND SANITARY ACCOMMODATION AND OFFICE ACCESSORIES AND ACCOMMODATION**:

The contractor shall provide at his own cost and expense adequate closet and sanitary accommodation complying in every respect to the rules and regulations in force of the local authorities and other public bodies, for his workmen, for the workmen of nominated sub-contractors and other contractors / specified agencies working in the building, the Project Engineer of works and other Institute agents connected with this building project and maintain the same in good working order.

The Contractor shall also provide at his own expense adequate office accommodation for the Project Engineer of works preferably contiguous to his office and shall maintain the same in a satisfactory condition and shall provide light, fan and attendant etc., for the same and shall remove them after completion of the works. He shall arrange to provide latest survey Instruments and at all times maintain the same in good working order at site, to enable the Project Engineer of works or other representative of Institute to check the lines and levels of the work.

7.1.26 **MATERIALS**:

Materials shall be of approved quality and the best of their kind available and shall conform to I.S. specifications. The Contractor shall order all the materials required for the execution of work as early as necessary and ensure that such materials are on site well ahead of requirement for use in the work. The work-involved calls for high standard of workmanship combined with speed and to the entire satisfaction of the Project Engineer.

7.1.27 **TO ASCERTAIN FROM CONTRACTORS FOR THE OTHER TRADES**.

The Contractor shall ascertain from all agencies / Sub-contractors all particulars relating to their work with regard to the order of its execution and the position in which chases, holes and similar items will be required; before the work is taken in hand as no patch works shall be allowed for cutting away work already executed in consequence of any neglect to ascertain these particulars before hand.

7.1.28 **SAMPLE APPROVAL**:

Before ordering materials, the Contractor shall get the samples approved from the Project Engineer cum estate officer well in time.

7.1.29 **TESTING OF WORK AND MATERIAL**:

The Contractor shall, if required by the Engineer arrange to test materials and/or portions of the works at his own cost in order to prove their soundness and efficiency. If after any such test the work or portion of works is found in the opinion of the Engineer to be defective or unsound, the Contractor shall pull down and redo the same at his own cost. Defective materials shall immediately be removed from the site at his own cost.

7.1.30 MECHANICAL PLANT:

The Contractor will be required to provide and maintain in working order the following power-driven equipment's during the construction-work and number of equipment's shall depend on the volume of work involved pertaining to this project as and when required.

1. Concrete mixers of required capacity.
2. Concrete pumps.
3. Vibrators
4. Concrete testing equipment.
5. Stone cutting machines.
6. Jack Hammers.
7. Pumps with required capacity.
8. Air compressors with required capacity.
9. Diesel Generators.
10. Welding, cutting and bending equipment.
11. Builders hoist.
12. Tipper/Dumper.
13. Tractor with Trailer.
14. Earth Compactor.
15. Earth rammer
16. Steel tubular scaffolding.
17. Slab shuttering
18. Floor polishing machines.
19. Surveying instruments with total station.
20. Any other machinery required during the execution of work.

7.1.31 FOREMAN AND TRADESMEN:

All Tradesmen shall be experienced men properly equipped with suitable tools for carrying out the work of carpentry and joinery and other specialist trades in a first class manner and where the Engineer deem necessary, the Contractor shall provide such tools which are considered necessary for carrying out of the work in a proper manner.

All such tradesmen shall work under an experienced and properly trained Foreman, who shall be capable of reading and understanding all drawings, pertaining to this work and the contractor shall also comply with other conditions set out in different clauses of the conditions of the contract.

7.1.32 **PROJECT PROGRAMME OF WORKS AND WEEKLY PROGRESS REPORT**:

a) Organisation chart:

The contractor should submit the proposed organization chart for the project including the details of staff to be deployed full time on site to the approval of Project Engineer , where the PROJECT ENGINEER raises any objection to either the qualification or experience or required professionalism of any of the staff deployed by the contractor, the same shall be replaced by suitably competent person to the approval of PROJECT ENGINEER within 7 days.

b) Program chart:

The Contractor shall furnish the detailed programme of execution for timely completion of the project within 24 months (inclusive of rainy season). Such a detailed program of works prepared using Industry Standard Scheduling Software like **MS Project 2000 or Primavera** shall be submitted by the Contractor within ten days after receiving communication of tender acceptance. As per the detailed drawings and schedule of quantities; the contractor shall work out concurrent activities with start and finish times, integrating of all tasks with interface and mile stone event drawn and to evaluate for reduction in total project duration through improved over lapping of tasks and activities where feasible. The Contractor shall plan for improved planning and scheduling of activities and forecasting of resource requirements, ability to use the Computer effectively to produce timely valid information for Project Management purpose. Accordingly, PERT; CPM Networking shall be drawn. GANNT charts shall also be furnished. The Contractor shall also furnish necessary particulars to the Project Engineer of works for compiling weekly progress reports in the form furnished by the Institute. A monthly financial programme shall also be submitted.

7.1.33 **CLEARING OF SITE**:

The contractor shall after completion of the work clear the site of all debris and left over materials at his own expense to the entire satisfaction of the Institute. The same should be carted out of the Institute at his own cost.

The contractor shall also clear the labour camp/RMC plant of all types of permanent/temporary structures, soak pits, sump, septic tanks or any other such installations as identified by the PROJECT ENGINEER to the entire satisfaction of the Institute. The debris/excess stuff shall be carted out of the Institute at his own risk and cost.

7.1.34 **PHOTOGRAPHS**:

The Contractor shall at his own expense supply to the Institute photographs in duplicate copies not less than 25 cm x 20 cm. (10" x 8") along with soft copy, of the works taken from all the portions of the building at intervals of not more than one week during the progress of the work, or at every important stage of construction, as directed by the Project Engineer of work.

7.1.35 **PROVISION OF NOTICE BOARD**:

The Contractor shall provide a notice board on proper supports 3m x 2m (10' x 6') in a position approved by the Engineer. He shall allow for painting and lettering stating name of work; name of Architects; Structural Consultants; General Contractor and Sub-Contractors. All letters except that of the name of the work shall be in letters not exceeding 5 cm. in height and all to the approval of the Engineer. Proper barricading shall be erected all-round the site before commencement of the work.

7.1.36 PROTECTION:

The contractor shall properly cover up and protect all work throughout the duration of work until completion, particularly masonry, moldings, steps, terrazzo or floor finishes, staircases and balustrades, doors and window frames, plaster angles corners lighting and sanitary fittings, glass, paint work and all finishing.

7.1.37 PREPARATION OF BUILDING FOR OCCUPATION AND USE ON COMPLETION:

The whole of the work shall be thoroughly inspected by the Contractors and all deficiencies and defects set right. On completion of such inspection, the Contractor shall inform the Engineer in writing that he has finished the work and it is ready for the Engineer's inspection.

On completion, the Contractor shall clean all windows and doors and all glass panes, including cleaning of all floors, staircases and every part of the building including oiling of all hardware. He will leave the entire building neat and clean and ready for immediate occupation and to the satisfaction of the Engineer.

7.1.38 The tenderer must understand clearly that the rates quoted are for complete items of works including charges due to materials, labour, all lead and lift, HOM of plant and machineries, scaffolding, supervision, service works, power, all types of royalties, sales tax, labor cess, all types of taxes payable to the Govt and local bodies, over head charges, etc., and includes all extra to cover the cost of night work if and when required and no claim for additional payment beyond the prices or rates quoted will be entertained for payment subsequently towards any claims on the grounds of misrepresentation or on point that he was supplied with information given by promise or guarantee by the Institute, or by any person whether member of or employee in Institute will not be entertained. Failure on the contractor's part to obtain all necessary information for the purpose of submitting his tender and quoting rates therein shall not absolve him of any risk or liability consequent upon the submission for tender.

7.1.39 All the works shall be carried out as per specifications prescribed by BIS, National Building code, KPWD specifications, relevant IS codes or as directed by the Project Engineer in the absence thereof.

7.1.40 In case there is any conflict in the specifications and drawings the decision of the Project Engineer cum Estate officer shall be final and binding on the contractor.

7.1.41 All the materials shall be got approved by the Project Engineer cum Estate officer before use.

7.1.42 The rates quoted for in individual items shall include labour, cost of materials conveyance and lift charges for all materials required for successful completion of work and all taxes payable to any authority as per rules in vogue from time to time.

7.1.43 Necessary pillars shall be constructed by the Contractor for benchmark at no extra cost as directed by the Project Engineer.

7.1.44 Site order book shall be maintained in the work spot and the contractor shall sign in the order book in token of having gone through the instructions issued by the inspecting officers and carryout the instructions promptly.

7.1.45 In the work spot the contractor shall provide suitable temporary office with a covered area of 1000 sft matching that of the Contractor's office with necessary furniture for use of Institute as directed by the Project Engineer for which no extra payment or compensation shall be claimed. The furniture however will after completion of the work, be the property of the contractor and shall remove them at the close of the contract.

7.1.46 The contractor shall take all precautions against damage from accident. No compensation will be allowed to the contractors for their tools and plant materials lost or damaged from any cause. The contractor is liable to make good the structure or plants damaged by any other cause at his own cost. The Institute will not pay the contractor for corrections or repairing any damaged portion of work done during construction.

7.1.47 The contractor shall employ adequate no. of skilled & unskilled labours required for successful timely execution of work. He shall submit daily reports to the Engineer in charge regarding the strength of labour employed both skilled and unskilled.

7.1.48 The contractor shall furnish weekly medical report showing number of persons ill or incapacitated and nature of their illness, to the Project Engineer.

7.1.49 The contractor shall furnish a report of any accident which may occur, within 24 hours of its occurrence to the Project Engineer.

7.1.50 The contractor shall keep on site of work a qualified Engineer as required as per rules of registration as their authorized representative who will receive all instructions given from the Institute officers.The representative shall have permanent office at site of work where communications can be sent and notices can be served by the Project Engineer throughout the duration of work.

7.1.51 Prior approval should be obtained from the Project Engineer for the construction and location of the temporary site office, store sheds and labour quarters, within the premises of the site, similarly the contractor shall get approval of the Project Engineer regarding the areas to be

utilized for stacking the materials etc., for the work.

7.1.52 Reference to detailed specifications are indicated against the items contained in the Schedule 'B', in case there is any item for which no detailed specifications is indicated, it shall be carried out as per specifications intimated by the Project Engineer. The contractor shall not be entitled for any extra claims or compensation on this account. In case of additional or extra items not covered by the Schedule 'B', the contractor shall carry out the work as per specifications intimated by the Project Engineer.

7.1.53 The Engineer shall have the right to direct the contractor to progress the various items of works in the manner prescribed by him.

7.1.54 Failure to adhere to any of the above will be sufficient cause for taking action under clause (2) or clause (3) or both along with their sub clauses of conditions of contract.

7.1.55 Contractor shall make arrangements at his own cost to construct approach road for conveyance of materials etc., preferably on the alignment accepted by the Institute to procure land etc. for housing, staff and workmen near the site of the work.

7.1.56 It is not possible for the Institute to release any quarry (metal and sand etc.,) for this work. The contractor has to make his own arrangements. No claim regarding leads and lift will be accepted.

7.1.57 The contractor has to make his own arrangements in regard to power supply and water required for construction and drinking water facilities.

7.1.58 Tool, Tax, Octroi, Royalty for collecting earth, gravel, sand, stone, excise duty, sales tax, labour cess or any other tax payable on account of this contract shall be met by Contractor.

7.1.59 The contractor shall be entirely responsible for sufficiency of the scaffolding, timbering, machinery, tools, implement and generally of all means used for fulfillment of the work. Whether such means may not be approved or recommended by the Project Engineer, the contractor must accept at his own cost all risks of accidents or damages.

7.1.60 ***After completion of the work, service drawings as per actual execution in Auto CAD should be submitted by the agency for services such as Electrical, Water supply and Sanitary before submission of final***

7.1.61 Extra care shall be taken regarding the laborers by providing waist belt, Helmets scaffolding etc at your own cost and supervision and shall be carried out as per the directions of the Project Engineer.

7.1.62 **WORKMANSHIP AND LABOUR**:

The quality of all materials, tools, operators and labour used on the work

shall be subject to the approval of the Project Engineer cum Estate officer or his authorized agent who shall have power to order immediate removal by the contractor any of the above that may not meet with his approval.

In case of failure to carry out orders of removal within the time specified, the Project Engineer or
his authorized agents shall get the same removed at the contractor's expense.

7.1.63 KEEPING DRY AND PUMPING:

Unless otherwise provided for in the contract, the contractor will at his own expense keep all portions of the work free from undue water, whether due to springs, soakage or inclement weather and will use his own implements and machinery for this purpose.

BAILING OUT OR DEWATERING:

Adequate arrangements shall be made by the contractor for dewatering the foundation trenches and excavation and keeping the same dry while the masonry or concrete work is in progress and till the Project Engineer considers that the mortar is sufficiently set.

The rates for the various items include the cost of shoring, strutting, coffer dam, channels or other incidental devices necessary for diverting the water met within foundation. The cofferdam and the diversion channel shall, however, be maintained in good and working condition till the completion of the structure or until such time, as in the opinion of the Project Engineer till the coffer dam or/and diversion channel is no longer necessary. Bailing out water necessitated by the failure to maintain the cofferdam and diversion channel will not be paid for separately under any conditions.

No extra rate shall be paid for removing any stuff outside, which might find excess due to rains or for reasons whatsoever from the sides or bottom of the foundation trenches and excavation or from also where when the dewatering operations are in progress.

The contractor must assure himself by making the necessary investigation regarding the depths to which foundations are likely to go. If any work is ordered to be done beyond dimensions or deviations marked in the drawings, no extra rate other than the rate for the Undertaking of work quoted by the contractor be paid.

The contractor will make himself arrangements for necessary plant such as Pump, engines, and other materials required in this connection.

7.1.64 FACILITIES FOR INSPECTION:

The work at all times be open for inspection by the Project Engineer or his duly authorized Assistant and the contractor shall arrange easy access to every part of the work and shall provide such ladders, scaffolding and lifts

for this purpose as necessary at his own cost.

7.1.65 DELIVERY OF WORKS:

The final bill will be prepared after the work is handed over to the Project Engineer or his duly authorized representative in a thoroughly complete, clean, sound and workman like state.

7.1.66 EXTRA ITEM:

Whenever the contractor is ordered by the Project Engineer or the person duly authorized by him to execute any item of work, which is not in his tender, it shall be the contractors duty to see that the order is duly entered in the order book on the work, unless a separate communication to this effect is received by him, it shall be his duty to get the rates sanctioned for the item by the appropriate authority. For any extra item of work not thus ordered either by any entry in the order book or separate communication, the contractor shall have no claim to payment.

7.1.67 COMPLIANCE WITH BYELAWS AND PROTECTIONS AGAINST ACCIDENTS, ETC:

Contractor is responsible for complying with all acts, bye-laws, Municipal and other regulations for the provision and maintenance of lights during nights, barricading, providing any other protection that may be necessary and will be liable for all claims that may arise from accidents of nuisance caused by works.

7.1.68 DISPUTES:

Disputes on the points between the Project Engineer and the contractors shall be referred to the Center for campus management and Development, whose decision shall be given in writing and shall be final and binding on the contractor.

7.1.69 TOOLS ETC.,

The contractor shall unless otherwise specially stated in the contract, be responsible for the payment of all import duties, octroi duties, sales tax, quarry fees etc., on all materials and articles brought to site.

7.1.70 CLEARANCE OF SITE:

The site described and shown on the plan is to be cleared of all obstruction, loose stones and materials, rubbish of all kinds of shrubs and brushwood, the roots being entirely removed.

The products of the cleaning to be stacked in such a place and manner as ordered by the Project Engineer.

In jungle clearing all trees not marked for preservation, jungle wood and brushwood shall be cut down and their roots entirely removed up. All wood and materials from the clearings will be property of the Institute and should be stacked as the Engineer in charge directs. **Trees shall not be cut**

without prior permission of the Institute.

All holes or hollow, whether originally existing or produced by digging up roots, shall be carefully filled up with earth well rammed to the required density and leveled off, as may be directed.

7.1.71 LINE OUT:

The contractor shall use necessary measuring instruments, theodolite, workstation and other materials like flags, strings, pegs, nails, pillars, paints, etc., and also Labour required for ascertaining of the initial ground levels at the different stages of excavation and construction of masonry or other structures at his own cost. Any dispute in regard to the accuracy of the measuring instruments and the device shall be subjected to the final decision of the Engineer-in charge of the work.

7.1.72 MACHINERY: All the machinery that will be employed on the work shall be approved, efficient and thoroughly, complying with the specifications of each machine or parts and shall have been manufactured by reputed and qualified firms. All the machinery employed on the work shall be open to inspection at all working hours, by the Project Engineer and any defect shall be rectified, repaired, replaced, renewed or remodeled so that its performance in the opinion of the Project Engineer is satisfactory. Any defective part of the machine, which requires replacement, shall be promptly replaced, failing which the Engineer-in-charge, shall be at liberty to cause the defective fittings removed from site of work at the cost of the contractor. ALL MATERIALS SHALL CONFORM TO BIS SPECIFICATION

7.1.73 OPERATORS: The machines shall be in charge of efficient and trained operators, which terms shall include drivers, mechanics or other personnel who are actually operating the machines. The Engineer in-charge has the right to test operators, etc., as deemed necessary by him for the class of machinery, which he is to operate and shall drive out such of the operators who fail in the tests.

7.1.74 SAFETY PRECAUTION: All reasonable safety precautions for the safety of workers shall be taken. The contractors shall be responsible for the maintenance of all regulations under the Factory Act, workmen's compensation. Minimum wages act and other act for the safety and welfare of the workers employed by him. In addition, the contractors shall provide adequate protection to all workers employed by him against natural elements such as rain, sun, wind etc., during working hours and provide free, pure protected drinking water during working hours.

7.1.75 NON-STOP OPERATION: In the continuous or non-stop operations suitable shifts or working hours for each shift shall be maintained. The contractor is liable for all reasonable extra payment for all extra hours of work done by the workers employed by him.

7.1.76 TESTS: The Project Engineer cum Estate officer or his authorized representatives shall have full scope and right of entry at all times to examine and test, measure, count, weigh, take bores, or in any manner satisfy himself that the work executed is according to the specifications and required strength. Any portion of work got disturbed, during such tests, shall be made good by the

contractors, without extra cost. The Engineer in charge has the right to change the design proportions, mixes within reasonable limits to ensure requisite strength of the structure. Laboratory for requisite tests shall be established by the Contractor at site only, at his own cost.

7.1.77 ADEQUATE ARRANGEMENTS TO ACHIEVE PROGRESS: The Project Engineer shall have the right to advise the contractor on the strength, quality and nature of labour to be employed on work to maintain progress on the work, commensurate with the strength of structure. Similarly, he shall advise the contractor on the nature and adequacy of the machinery that are required on the work.

7.1.78 DETAILS TO BE FURNISHED FOR ENGAGING SUB-CONTRACTOR FOR SPECIALISED WORKS:

The tenderer shall be required to engage agencies of standing and repute who have experience in executing works of similar nature and magnitude. Such specialized trades cover electrical installation (HT/LT), Lifts, A.C. sanitary and water supply works, firefighting installation and any such other trades as may be directed by the Institute. The successful tenderer shall be required to engage Sub-agencies for such specialized trades only with the prior written approval of the Project Engineer cum Estate officer after giving an opportunity to the Project Engineer cum Estate officer to evaluate the experience and competence of the sub-agency for each trade. In order to ensure implementation of this requirement, it is required that each tenderer shall submit along with his tender, names of three sub-agencies for each trade amongst whom tenderer proposes to engage if successful in the tender. Along with names of sub-agencies for each trade, the tenderer shall furnish in detail the following particulars in respect of each subagency.in the format furnished in Technical Bid.

All such information concerning sub-agencies shall be furnished along with the tender. Any tender containing insufficient information in this regard is liable for rejection. In the event of non-compliance of this requirement, the Institute shall have the right to nominate any sub-agency who in their opinion meets the selection criteria. In such event it would be incumbent on the successful tenderer, to accept and appoint then nominated sub-agency without demur and on this account, if there is any additional cost, such cost shall beborne by the successful tenderer. The Institute shall have no liability on this account. The Institute has the right to evaluate the experience, reputation etc., of such sub-agencies and on their approval in writing to the successful tenderer, successful tenderer shall be required to engage only such approved agencies for execution.

If the Institute is not satisfied with the performance or capability of the names in the panel furnished by the tenderer, the successful tenderer shall be required to engage an agency nominated by Institute. In all these matters, there shall be no additional financial implication to the Institute. The successful tenderer shall be required to execute works within the accepted rates only and no claim will be accepted due to the Institute, insistence on engaging any sub-agency. The Institute further reserves the right to instruct the successful tenderer to terminate the work of sub-agency at any time during the contract, if the performance is found unsatisfactory. In such case, the successful tenderer shall be required to furnish a further panel of names from whom a similar selection can be made by the Institute In this instance also, the Institute is not liable for any additional cost. Responsibility for the delay occurred in this process, if any shall rest with the successful tenderer.

It is the responsibility of the successful tenderer to ensure that the sub-agencies engaged in the work comply with all the clauses in the agreement between the Institute and the successful tender. It shall be responsibility of the successful tenderer to exercise first line supervision on the works executed by his sub agencies including supervision on the quality of materials and workmanship and to ensure that the subagencies comply with the technical specifications, drawings and bill of quantities. The successful tenderer shall also establish competent site organization technically and administratively to ensure that the works of various sub-agencies are supervised and well co-ordinate to ensure proper sequencing of construction and finishing works and to ensure that the overall time schedule is fully complied with.
The detailed construction programme schedule to be furnished by successful tenderer shall include action plan for procurement of materials and execution of works at site for each of the sub-agency and the detailed construction programme schedule shall reflect proper integration of each component of the building to ensure well-coordinated execution so as to complete the project including services within the stipulated time schedule.

Existing service lines such as electrical, water supply, sewer lines, telephone lines etc., shall be carefully protected and preserved before commencement and during excavation, dismantling /demolition operations. Details of UG facilities shall be provided to the successful tenderer. Any damage caused to the aforesaid service lines, etc., during excavation, demolition/dismantling shall be made good at Contractor's own expense/cost. Restoration of any service lines, which needs to be shifted and found in the proposed site, is the responsibility of the contractor and the agency shall carry out the work as per the direction of Project Engineer the cost of such work will be borne by the Institute.

Dust nuisance to neighbour shall be minimized by providing and erecting screens to the required height as per direction of Project Engineer cum Estate officer with Aluminium sheets or canvas or other suitable material before commencement of the work. The site shall be cleared off such protection arrangement after virtual completion of work. All the operations shall be carried out strictly in accordance to regulations of municipal and other local authorities and shall be restricted to normal working hours.

No debris or materials got from dismantlement/demolition the building(s) shall be thrown in the public road causing inconvenience to the traffic and any fine or penalty imposed by local authority for non-compliance of this provision shall be borne by the contractor.

The Contractor shall be responsible for any injury to persons, animals, or things and for all structural damage to property which may arise from the operation or neglect of himself and or any nominated sub-contractors, contractor's Employees and or third party whether such injury or damage arising from carelessness, accident orany other cause whatsoever, in any way connected with the carrying out the construction/dismantling/demolition.
Preservation of trees: The contractor shall preserve all existing trees in and adjacent to
the site which does not interfere with the construction as determined by the Engineerin charge.

Drawings and working Details: The work shall be carried out strictly in

accordance with the approved plans and estimates and specifications and as per the instructions of the Engineer-in-charge, and no deviations or changes are permitted without the written order of the Engineer. The designs and drawings enclosed with the tender documents are only typical and tentative. The working drawings and the working details of the several components of works will be prepared and made available at the time of execution and the contractor shall carry out the work in accordance with such working drawings and working details.

Omissions and discrepancies in drawings and instructions: In all cases of omissions, doubts or discrepancies in the dimensions or discrepancies in the drawings and item of work, a reference shall be made to the Project Engineer cum Estate officer, whose elucidation and elaboration shall be considered as authorized. The Contractor shall be held responsible for any error that may occur in the work through lack of such reference and precautions.
The contractor shall be responsible for accuracy for all shapes, dimensions, and Alignments both vertical and horizontal etc., of all the components of the work.

Lands for the use of the Contractors Camp: The contractor shall have to make his own arrangements at his own cost for construction of living accommodation outside the IISc premises. The Employee shall not provide any space / building for labour camp.

Undesirable Person to be removed from site: The contractor shall not employ on site any person who is undesirable, if in the opinion of the Project Engineer the person or persons at site of work employed on behalf of the contractor is/are considered undesirable. The Project Engineer shall notify the contractor to this effect and the contractor will be bound by the decision of the Project Engineer to remove such person or persons from the site of work and from the labour camp. The contractor shall not be entitled to any damage or loss on this account. On the contrary, the contractor shall be liable to compensate the Institute for any loss or damage to the Institute property caused by the employment of such person.
Labour Statistics:
The contractor shall submit daily reports on the following:
(a) Total No. of labour employed in the working area.

Execution of work during night times: The work shall normally be carried out between 08.00 hours and 17.00 hours with a break of one hour and when permitted during night period, the second shift shall be between 17.00 hours and 00 hours with a break of half an hour during night. When ordered to work at night, adequate provision for lighting the working area should be made by the contractor at his cost and got approved by Engineer. The agency shall not be paid extra for the works executed during night.

Safety code:

a) The Contractor at a prominent place at work spot should bring these safety provisions to the notice of all concerned by display on notice board. The persons responsible for compliance of the safety code shall be named therein by the contractor.

b) To ensure effective enforcement of the rules relating to safety precautions, the arrangement made by the contractor shall be open to inspection by the

Labour Officer, Engineer or his representatives.

c) All necessary personal safety equipment's as considered adequate by the Engineer should be kept available for immediate use of persons employed at the site and maintained in the good condition and the contractor should take adequate steps to ensure proper use of equipment by those concerned.

d) Workers employed on mixing concrete, cement grout, cement mortar shall be provided with protective footwear protective goggles and protective gloves. Those engaged in mixing or stacking cement or any materials injurious to the eye, nose and mouth shall be provided with a face mask and protective cover free of cost by the contractor.

e) Those engaged in welding work shall be provided with welder's protective eye Shield and gloves. Stonebreakers shall be provided with protective goggle and protective clothing and seated at sufficiently safe intervals.

f) Those engaged in binding and fabricating steel shall be provided with protective gloves.

g) Those engaged in deep cuts, large rock excavation shall be provided with helmets.

h) All labour / persons at work shall wear helmet compulsorily.

i) When the work is near any place where there is risk of drowning all necessary equipment's shall be kept ready for use and all necessary steps taken for prompt rescue of any person in danger and adequate provisions should be made for prompt first aid treatment of all injuries likely to be sustained during the course of work.

j) Adequate and suitable caution and danger signal boards shall be prominently exhibited at road/high tension overhead line/where heavy electrical machines are working where overhead cranes or hoist; derricks, winches are working where blasting zone is demarcated. The content of the board shall be in English and the local language for easy identification.

k) All scaffolding, ladder, stairways, gangways, staging, centering, form work and temporary support and safety devices etc., shall be sound in strength and constructed and maintained as such throughout its use. The agency shall obtain approval from Project Engineer cum Estate officer for scaffolding, formwork etc., before commencement of work.

l) No materials on any site of work shall be so stacked as to cause danger or inconvenience to any persons or public.

m) The Contractor shall provide all necessary fencing and lighting to protect the

public/working men from accident and shall be bound to bear the expense of defense of every suit action or other proceedings of law that may be brought by any person for injury sustained owing to neglect of the above precautions and to pay any damages and cost, which may be awarded in any such suit action or proceedings to any such persons or which may with consent of the contractor be paid to compensate any claims by any such person.

n) No electric cables or apparatus, which is liable to be a source of danger to persons, employed shall remain electrically charged unless a caution Board is put into that effect and close approach to the same is prohibited.

o) All practical steps shall be taken to prevent danger to persons employed from risk of fire or explosives. No floor, roof or other portion of any building used for residence shall be so over-loaded with debris or materials so as to render it unsafe.

p) The final disposal of water used for work or removed from work spot as well as the supply used for domestic consumption shall be as directed by the Engineer. The contractor shall make his own arrangement for purification of domestic water supply used by his staff and labour colony and used on the site of work to the satisfaction of the Engineer.

q) The source of drinking water supply/distribution system in workers colony shall be protected from chances ofcontamination by poisonous materials epidemic causing infections bacteria etc., by maintaining the source andsystem under adequate hygienic conditions.

r) Notwithstanding the above clauses, there is nothing in this to exempt the contractor to excludethe operations of any other Act or Rules in force of the Central Govt., State Govt.

AWARENESS OF SITE CONDITIONS AND CARRYING OUT OF SITE INSPECTION PRIOR TO TENDERSUBMISSION:

Prior to the preparation and submission of his Tender, the Contractor shall make visits to the siteand carry out all the necessary inspections and investigations in order to obtain all informationand to make his own assessment of the conditions and constraints at site, including the means ofaccess to it. The Contractor shall make himself aware of all the features of the site and the working conditions and space and shall, in general, be responsible for obtaining all the necessary and requisite information needed for him to prepare and submit his Tender.

Should the Contractor require any clarifications he shall seek these in writing from

the Project Engineer before submitting his Tender. At no stage will any extra claims be entertained or allowed on any matter or for any reason arising from or as a consequence of the Contractor's failure to comply with all the requirements stipulated in this Clause.

WORK AND WORKMANSHIP

To determine the acceptable standard of workmanship, the Project Engineer may order the Contractor to execute certain portions of works and services under the close supervision of the Project Engineer. On approval, they shall label these items as guiding samples so that further works are executed to conform to these samples.

TEST CERTIFICATES:

The contractor shall submit copy of test certificates for all the major electrical equipment such as circuit breakers, CTs, PTs, instruments, relays, busducts, rising mains, busbars, cables etc., and panel as a whole, confirming to relevant IS/BIS standards issued by manufacturers.

SAMPLES AND CATALOGUES:

Before ordering the material necessary for these installations, the contractor shall submit to the Engineer-in-Charge/Consultants for approval, a sample of every kind of material such as cables, conductors, conduits, switches, socket outlets, circuit breakers, lighting fixtures, boxes etc., along with the catalogues with their dimensional details.

For major items such as sub lighting panels distribution boards, the submission of drawings/catalogues along with technical details shall be enough. Prior to ordering any electrical equipment/material/system, the contractor shall submit to the Engineer-inCharge/Consultants the catalogues, along with the samples, where applicable, from the approved manufacturer. The contractor shall arrange inspection and testing at the manufacturer's factory or assembly shop for final approval. No material shall be procured prior to the approval of the Engineer-in-Charge/Consultant.

Also, the contractor shall ensure that the dimensional details of the equipment fit into the allotted space provided in the building.

COMPLETION CERTIFICATE:

On completion of the electrical installation a certificate shall be furnished by the contractor countersigned by the licensed supervisor, under whose direct supervision the installation was carried out.

PERFORMANCE GUARANTEE

The contractor shall indemnify the Institute against defective materials and workmanship for a period of one year after completion of the work. The contractor shall also hold himself fully responsible during that period for reinstallation or replacement at free of cost to institute, the following:

Any defective work or material supplied by the Contractor.

Any material or equipment damaged or destroyed as a result of defective workmanship by the contractor.

RATE ANALYSIS

At anytime and at the request of the Project Engineer the contractor shall provide details or break down of costs and prices of any part or parts of the works.

The Project Engineer cum estate officer of IISc reserves the rights to delete any item from the contractor's scope of work.

CEMENT CONCRETE:

The material used, i.e., water, cement and aggregate shall be of approved quality and the grading of the aggregate shall be as specified at the time of concreting.

The design of concrete mix shall be done by trial mix and testing. The same has to be approved by the Project Engineer cum Estate officer before adopting at site.

PLACING CONCRETE:

Concrete shall be placed only in locations where authorized and no concrete or mortar shall be placed until formwork, installation of embedded parts, preparation of surface and necessary cleanup has been done and checked to be in conformity with specification and drawings. Earth foundation, on which concrete is to be laid shall be firm, drained soil free from any soft and other objectionable materials and on which there is no standing or running water. Rock surface or rigid masonry or concrete surface upon or against which, concrete is to be placed, shall be prepared in the same manner as rock foundation or old masonry or concrete surface over old masonry. All concrete shall be placed directly in its final position within 30 minutes after it is mixed. Concrete shall not be dropped from excessive distance and the free fall should be kept to a minimum to avoid segregation, air entertainment and damage to form work.

RATE OF PLACE:

Concreting shall be continued without interruption when it is unavoidable until the structure or section is completed or until satisfactory construction joint can be made. Concrete shall not be placed faster than the placing crew can compact it properly. The difference in elevation between adjacent block shall not exceed 15" inches.

CONSOLIDATION OF CONCRETE:

Each layer of concrete, where smooth surface are required and for all surfaces which will be permanently exposed to the weather, and for all surface next to embedded metal work, the concrete shall be worked, or vibrated to obtain concrete of maximum density and imperviousness and to assure proper contact of the concrete with the form and reinforcement bed. Ordinary hand methods consisting of ramming, tamping and skiing with suitable tools and tamping shall be permitted only in situation where it is impracticable to use power vibrators. Excessive vibrations sufficient to cause segregation tending to bring in excess of finer particles to the surface shall be avoided. Vibrators shall be inserted to lower course that has commenced final set.

CHIPPING AND ROUGHENING CONCRETE SURFACE:

Surface upon or against which additional concrete is to be placed shall be chipped and roughened to a depth not greater than one inch on the surface. The roughening shall be performed by chipping or other satisfactory method and in such a manner as not to loosen, crack or shatter any part of the concrete beyond roughened surface. After being roughened the surface of concrete shall be cleaned well thoroughly of all loose fragments, dirt and other objectionable substances and shall be sound and hard and in such conditions as to ensure good mechanical bond between old and new concrete. The old prepared surface shall be treated with epoxy and cured before concreting.

CURING AND PROTECTION:

All concrete shall be protected against injury until final acceptance. Concrete shall be kept continuously moist for not less than 21 days. Construction joint shall be cured. Separate labors to be engaged 24 x 7 exclusively for curing the concrete works.

MACHINERY:

All the machinery that will be employed on the work shall be approved, efficient and thoroughly, complying with the specifications of each machine or parts and shall have been manufactured by reputed and qualified firms. All the machinery employed on the work shall be open to inspection at all working hours, by the Project Engineer and any defect shall be rectified, repaired, replaced, renewed or remodeled so that its performance in the opinion of the Project Engineer is satisfactory. Any defective part of the machine, which requires replacement, shall be promptly replaced, failing which the Engineer-in-charge, shall be at liberty to cause the defective

fittings removed from site of work at the cost of the contractor.

OPERATORS:

The machines shall be in charge of efficient and trained operators, which terms shall include drivers, mechanics or other personnel who are actually operating the machines. The Engineer in-charge has the right to test operators, etc., as deemed necessary by him for the class of machinery, which he is to operate and shall drive out such of the operators who fail in the tests.

SAFETY PRECAUTION :

All reasonable safety precautions for the safety of workers shall be taken. The contractors shall be
responsible for the maintenance of all regulations under the Factory Act, workmen's compensation. Minimum wages act and other act for the safety and welfare of the workers employed by him. In addition, the contractors shall provide adequate protection to all workers employed by him against natural elements such as rain, sun, wind etc., during working hours and provide free, pure protected drinking water during working hours.

NON-STOP OPERATION:

In the continuous or non-stop operations suitable shifts or working hours for each shift shall be maintained. The contractor is liable for all reasonable extra payment for all extra hours of work done by the workers employed by him.

TESTS:

The Project Engineer cum Estate officer or his authorized representatives shall have full scope and right of entry at all times to examine and test, measure, count, weigh, take bores, or in any manner satisfy himself that the work executed is according to the specifications and required strength. Any portion of work got disturbed, during such tests, shall be made good by the contractors, without extra cost. The Engineer in charge has the right to change the design proportions, mixes within reasonable limits to ensure requisite strength of the structure**. Laboratory for requisite tests shall be established by the Contractor at site only, at his own cost.**

ADEQUATE ARRANGEMENTS TO ACHIEVE PROGRESS:

The Project Engineer shall have the right to advise the contractor on the strength, quality and nature of labour to be employed on work to maintain progress on the work, commensurate with the strength of structure. Similarly, he shall advise the contractor on the nature and adequacy of the machinery that are required on the work.

MEASUREMENTS:

Estimates of quantities contained in the attached schedule of work are based on the use of standard

methods of measurements applicable to the various items. The methods of measurements for some items are briefly described below.

EXCAVATION: All excavation shall be measured as the original volume in undisturbed condition in site.

DRILLING: The drilling holes shall be measured as the actual number of linear feet of holes drilled including linear feet drilled through concrete or masonry. The drilling holes for blasting shall be considered as the part of the excavation operation and no separate measurements of such holes will be made.

CONCRETE: Concrete shall be measured as the volume of concrete in place of the structure. This item shall include all materials in all forms, form lining and fixture, framing and scaffolding and all operations in connection with mixing, conveying, placing and curing of concrete. It shall also include batching and finishing operations except where finishing as defined in the specifications is required. In measuring concrete the **volume of openings, embedded pipes and metal work except reinforced bars and anchor bolts and bars will be deducted.**

REINFORCEMENT: Reinforcement shall be linearly measured and paid in terms of weight of steel reinforcement placed in the structure calculated as per IS Standards. It shall also include weight of metal chair supporters, clips used to set and fix reinforcement in place. Laps and wastage shall not be measured and paid.

CEMENT POINTING: The exposed faces shall be measured in superficial area.

8 CONDITIONS FOR ELECTRICAL WORK:

8.1 GENERAL

These conditions are meant to amplify the specifications and General Conditions of Contract. If any discrepancy is noticed between these conditions, Specifications, Bills of Quantities and Drawings**, the most stringent of the above shall apply for execution of the work.**

The materials, design and workmanship shall satisfy the specifications contained herein and Codes Referred to. Where the technical specifications stipulate the requirement in addition to those contained in the Standard Codes and specifications, those additional requirements shall also be satisfied. In the absence of any Standard/ Specifications covering any part of the work covered in this tender document, the instruction/ directions of Project Engineer will be binding on the contractor.

The scope of this section is to describe materials and systems for complete electrical installations of building which form together with the project documents, a complete volume of work and quality description. All electrical installation shall be of high quality, safe, complete and fully operational including all necessary items and accessories whether or not specified in detail. All electrical work shall be completed in accordance with the regulations and standards to the satisfaction of the Project Engineer. The general provisions, provisions and general requirements apply to the entire installation.

The work shall be carried out simultaneously with building work and shall be continued till it is completed satisfactorily along with the completion of essential portions of the building works.

During the progress of work, completed portion of the building may be occupied and be put to use by the owner but the contractor shall remain fully responsible for the maintenance of electrical installations till the entire work covered by this contract is satisfactorily completed by him and handed over to the institute.

8.2 SCOPE OF WORK:

8.2.1 The scope under this contract shall include the internal electrical installation for the work. The work to be carried out under this contract shall cover the supply, installation, testing and commissioning of the complete electrical installation as detailed herein under and shown in the drawings and specifications.

In general the work to be performed under this contract shall comprise of the following:

a) Supply, installation, testing and commissioning of All Main Lighting panels, distribution panels and other miscellaneous panels.

b) Supply, installation, testing and commissioning of mains and sub

mains, distribution cables and cable trays etc.

c) Supply, installation, testing & commissioning of all wiring/cabling for lights, fans and power outlets including point and circuit wiring along with wiring accessories etc.

d) Supplying and drawing of cables/wires for telephone system including installation of terminal boxes etc.

e) Supply, Installation, testing and commissioning of light fixtures as indicated in the BOQ and installation, testing and commissioning of lighting fixtures supplied by the owner, if any.

f) Supply, installation, testing and commissioning of external lighting poles, cables lighting fittings panels/feeder pillars etc.

g) By only licensed Electrical Contractor holding valid 'A' grade license issued by Electrical
Inspector to Govt. of Karnataka.

Contractor shall carry out and complete the said work under this contract in every respect in conformity with the current rules and regulations of the local electricity authority. The contractor shall furnish all labour and install all materials, appliances, equipment, necessary for the complete provision and testing of the whole electrical installation as specified herein and shown on the drawings. This also includes any materials, appliances, equipment not specifically mentioned herein or noted on the drawings as being furnished or installed but which are necessary and customary to make complete installation with all outlets for power, light, telephone conduits and other electrical systems/& Extra low voltage systems shown on the schedule and described herein, properly connected and in working condition.

The work shall include all incidental jobs connected with electrical installation such as excavation in trenches and back filling, cutting/drilling and grouting for fixing of fixtures, equipment, making good the damages etc.

8.3 RATES:

8.3.1.0 The rates quoted shall be deemed to allow for all minor extras and constructional details which are not specifically shown on drawings or given in the specifications but are essential in the opinion of the Project Engineer to the execution of works to conform to good workmanship and sound engineering practice. The Project Engineer reserve the right to make any minor changes during the execution without any extra payment.

8.3.1.1 The Project Engineer decision to clarify any item under minor changes, minor extras and constructional details shall be final, conclusive and binding on the Contractor.

8.3.1.2 The rates quoted by the Contractor shall be net so as to include all requirements described in the contract agreement and no claim

whatsoever due to fluctuations in the price of material and labour will be entertained.

8.3.1.3 The rates quoted by the Contractor shall include for supplying material and labour necessary for completing the work in the best and most workmanship like manner to the satisfaction of the Project Engineer. The rates shall be complete in all respects including cost of materials, erection, fabrication, labour, supervision, tools and plant, transport, sales and other taxes, royalties, duties and materials, contingencies, breakage, wastage, sundries, scaffoldings, etc. on the basis of works contract. The rates quoted shall include all taxes, duties, transport, insurances, octroi, or any other levies applicable under the statute.

8.3.1.4 In case the rates of identical items under different sub-heads/parts are different, the lowest of these will be taken for the purpose of making the payments.

8.3.1.5 The rates for different items are for all heights, depths, widths and positions, unless otherwise specified against the item. No claim in respect of any leads/lifts for any item specified in the Schedule of Quantities, for which separate items for lead/lift do not exist in that schedule, will be entertained.

8.3.1.6 The work shall be executed as per the programme drawn or approved by the Project Engineer and it shall be so arranged as to have full co-ordination with any other agency employed at site. No claim for idle labour shall be entertained nor shall any claim on account of delay in the completion of the work be tenable except extension of time secured by the contractor on request to be submitted to the Engineer-in-Charges.

8.3.1.7 **The Contractor shall permit free access and afford normal facilities and usual convenience to other agencies or departmental workmen to carry out connected work or other services under separate arrangements. The Contractor will not be allowed any extra payment on this account.**

8.3.1.8 The contractor shall provide all equipment's, instruments, labour and such other assistance required by the Project Engineer for measurement of the works, materials etc.

8.3.1.9 Even though the payment shall be effected under different items in the schedule of quantities, the various items in the schedule of quantities shall be deemed to cover all aspects of the work for the completion of the work as per drawings, from excavation to the finishing not withstanding any space adjustment possible omission in the description of the item and specifications thereof regarding incidental items of work, without which the whole work cannot be deemed to have been included under the scope of the different items of the schedule of quantities. The Contractor is advised to keep this in mind while quoting rates as no claims in this regard shall be entertained.

8.4 AWARENESS OF SITE CONDITIONS AND CARRYING OUT OF SITE INSPECTION PRIOR TO TENDER SUBMISSION

Prior to the preparation and submission of his Tender, the Contractor shall make visits to the site and carry out all the necessary inspections and investigations in order to obtain all information and to make his own assessment of the conditions and constraints at site, including the means of access to it. The Contractor shall make himself aware of all the features of the site and the working conditions and space and shall, in general, be responsible for obtaining all the necessary and requisite information needed for him to prepare and submit his Tender.

Should the Contractor require any clarifications he shall seek these in writing from the Project Engineer before submitting his Tender. At no stage will any extra claims be entertained or allowed on any matter or for any reason arising from or as a consequence of the Contractor's failure to comply with all the requirements stipulated in this Clause.

8.5 WORK AND WORKMANSHIP

8.5.1 To determine the acceptable standard of workmanship, the Project Engineer may order the Contractor to execute certain portions of works and services under the close supervision of the Project Engineer. On approval, they shall label these items as guiding samples so that further works are executed to conform to these samples.

8.6 TEST CERTIFICATES

The contractor shall submit copy of test certificates for all the major electrical equipment such as circuit breakers, CTs, PTs, instruments, relays, busducts, rising mains, busbars, cables etc., and panel as a whole, confirming to relevant IS/BIS standards issued by manufacturers.

8.7 SAMPLES AND CATALOGUES

Before ordering the material necessary for these installations, the contractor shall submit to the Engineer-in-Charge/Consultants for approval, a sample of every kind of material such as cables, conductors, conduits, switches, socket outlets, circuit breakers, lighting fixtures, boxes etc., alongwith the catalogues with their dimensional details.

For major items such as sub lighting panels distribution boards, the submission of drawings/catalogues along with technical details shall be enough. Prior to ordering any electrical equipment/material/system, the contractor shall submit to the Engineer-in-Charge/Consultants the catalogues, along with the samples, where applicable, from the approved manufacturer. The contractor shall arrange inspection and testing at the manufacturer's factory or assembly shop for final approval. No material shall be procured prior to the approval of the Engineer-in-Charge/Consultant.

Also contractor shall ensure that the dimensional details of the equipment fit into the allotted space provided in the building.

8.8 COMPLETION CERTIFICATE

On completion of the electrical installation a certificate shall be furnished by the contractor countersigned by the licensed supervisor, under whose direct supervision the installation was carried out.

8.9 PERFORMANCE GUARANTEE

The contractor shall indemnify the Institute against defective materials and workmanship for a period of one year after completion of the work. The contractor shall also hold himself fully responsible during that period for reinstallation or replacement at free of cost to institute, the following :

8.9.1 Any defective work or material supplied by the Contractor.

8.9.2 Any material or equipment damaged or destroyed as a result of defective workmanship by the contractor.

8.10 RATE ANALYSIS

At anytime and at the request of the Project Engineer the contractor shall provide details or breakdown of costs and prices of any part or parts of the works.

8.11 The Project Engineer reserves the rights to delete any item from the contractor’s scope of works.

9. CONTRACTOR'S LABOUR REGULATIONS

1.1 DEFINITION:

In these regulations unless otherwise, expressed or indicated the following words and expressions shall have the meaning hereby assigned respectively that is to say:

1.1.1 Labour mea ns workers employed by the contractor or the Institute directly or indirectly through sub- contractor or any other person, or any agent on his behalf on a payment as per prevailing Karnataka State labour regulations and will not include supervisory staff like overseers etc.

1.1.2 Fair wages means whether for item or place of work notified at the time of inviting tenders for the work and where such wages have not been so notified, the wages prescribed by the Karnataka Public Works Department for the district in which the work is done.

1.1.3 Contractors shall include every person whether a sub-contractor head or agent employing labour on the work taken contract.

1.1.4 The relevant orders of Government of Karnataka in regard to payment of wages as amended from time to time shall be followed by the contractor.

1.2 WORKING HOURS:

1.2.1 Normally working hours of a labour employed should not exceed 8 hours a day. The working day shall be so arranged that inclusive of interval for rest if any, it shall not spread over more than 12 hours on any day.

1.2.2 When a worker is made to work for more than 8 hours on a day or for more than 48 hours in any week, he is entitled to double the ordinary rate of wages. Children shall not be made to work.

1.2.3 Every worker shall be given a paid weekly holiday normally on Sunday.

1.3 DISPLAY OF NOTICE REGARDING WAGES ETC.

The contractor shall (a) before he commences his work on contract, display and correctly maintain in a clean legible condition in conspicuous places on the work, notices in English and in the local language spoken by the majority of the workers, giving the rate of wages which have been certified by the Regional Labour Commissioner, as fair wages and the hours of work which such wages are earned, and a copy of such notices shall be sent to the certifying officers.

1.4 PAYMENT OF WAGES:

Wages due to every worker shall be paid to him direct.

1.5 **FIXATION OF WAGES PERIODS**:

1.5.1 The contractor shall fix the wages period of which the wages shall be payable.

1.5.2 Wages of every worker employed on the contract shall be paid.

1.5.2.1 In case of establishments in which the wage period is one week, within three days from the end of the wage period wages shall be paid.

1.5.2.2 In the case of other establishment before the expiry of the 7th day or 10th day from the end of the wage period according to the numbers of the workers employed in such establishment does not exceed 100 or exceeds 1000.

1.5.3 When the employment of any workers is terminated by or on behalf of the contractor the wages earned by him shall be paid before the expiry of the days succeeding the one which his employment is terminated.

1.5.3.1 All payment of wages shall be made on a working day except when the work is completed before the expiry of the wages period in which case final payment shall be made within 48 hours of the last working day at work site and during the time.

NOTE: The term working day means a day on which the labour is employed and the work is in progress.

1.6 FINES AND DEDUCTIONS WHICH MAY BE MADE FROM WAGES:

The Wages of workers shall be paid to him without any deductions of any kind except the following:

1.6.1 Deductions:

9.6.1.1 Deductions for absence for duty i.e., from the place or the places whereby the terms of his employment he is required to work. The amount of deductions shall be in proportion to the period for which he was absent.

9.6.1.2 Deductions for damage or loss of goods expressly entrusted to the employed person for custody or for loss of money or any other deduction which he is required to account, where such damage or loss is directly attributable to neglect or default.

9.6.1.3 Deduction for recovery of advance or for adjustment of over payment of wages, advance granted shall be entered in a register.

9.6.1.4 And other deductions which the Institute may from time to time allow.

1.6.2 Fines:

1.6.2.1 No fine shall be imposed on any worker save in respect of such acts and the Commissioner of Labour has approved omissions on his part as.

1.6.2.2 No fine shall be imposed on a worker and no deduction for damage or loss be made from his wages until the worker has been given an opportunity.

Undertaking of showing cause against such fines or deductions.

1.6.2.3 The total amount of fines which may be imposed in any one wage period on a worker shall not exceed an amount equal to the wages payable to him in respect of that wage period.

1.6.2.4 No fine imposed on any worker shall be recovered from him by installments or after the expiry of sixty days from the date which it was imposed.

1.6.2.5 Every fine shall be deemed to have imposed on a day of the act or omission in respect of which it was imposed.

1.6.3 The contractor shall issue an employment card in Form III to each worker on the day of the worker's entry into the employment. If the worker has already any such card with him for the previous employment of contractor, he shall merely endorse that employment card with relevant entries. On termination of employment, the employment card shall again be endorsed by the contractor and returned to the worker.

1.7 REGISTER OF UNPAID WAGES:

The contractor should maintain a register of unpaid wages in such a form as may be convenient at the place of work but same shall include the following particulars:

- Full particulars of the laborer's whose wages have not been paid.
- Reference number of the muster roll and wage register
- Rate of wages
- The period
- Total amount not paid
- Reasons for not making payment
- How the amount of unpaid wages was utilized
- Acquaintance with dates.

9.8 REGISTER OF ACCIDENTS:

The contractor shall maintain a register of accidents in such form as may be convenient at the work place but the same shall include the following particulars.

- Full particulars of the laborers who met with accidents.
- Rate of wages
- Sex
- Age
- Nature of accidents and cause of accident
- Time and date of accidents
- Date and time when admitted in Hospital
- Date of discharge from the Hospital.

The agency shall alone be liable to pay compensation for any damage/death /injury sustained by the personnel or any other members of the agency in the course of their work/duty at the Institute during the contract period. Govt. of India issued guidelines on payment of compensation in cases of death / permanent incapacitation of person due to unintended/ unforeseen occurrences during maintenance, operation and provisioning of public services. Under these guidelines, the agency has to pay an amount of Rs.

10 Lakhs as compensation in the cases where a person is died and up to Rs. 7.5 Lakhs in the case of disabled based on loss of earning capacity. Institute has the right to recover further penalty in the cases where the incidents have happened with the negligence of the agency.

9.9 REGISTER OF FINES ETC.

9.9.1 The contractor shall maintain a register of fines and a register of deductions for damages or loss in form Nos. I and II respectively which shall be kept at the place of work.

9.9.2 The contractor shall maintain both in English and local language a list approved by Commissioner for labour clearly stating the acts and commissions for which penalty or fine may be imposed on a workmen and display it in a good condition in conspicuous place on the work.

9.10 SUBMISSION OF RETURNS:

The contractor shall submit periodical returns as may be specified from time to time.

9.11 AMENDMENTS:

The Government of Karnataka may from time to time add to or amend the regulations and on may question as to the application interpretation on effect if these regulations the decision of the Commissioner of Labour or Deputy Commissioner for Labour to Govt. in that behalf shall be final.

Labour Clause

Clause 12 A No labourers below the age of 15

years shall be employed on the work. Clause 12 B

Payments of wages of labourers.

The contractor shall pay not less than fair wage of labourers engaged by him on the work.

EXPLANATION:

(a) The contractor shall notwithstanding the provision of any contract to the contrary cause to be paid wages to labourers indirectly engaged for the work including any labour engaged by his sub-contractors in connection with the same works if the labourers have been immediately employed by him.

(b) In respect of all labours directly or indirectly employed in the works for the performance of the contractor's part of this agreement, the contractor shall comply with or cause to be complied with Karnataka Public Works Department Contractors Labour Regulations from time to time, in regard to payment of wages. Wage period, deductions from wages recovery of wages not paid and deductions unauthorized made, maintenance of wage book, wage slips, publication of scale of

wage and other terms of employment, inspection and submission of periodical returns and all other matter of a like nature.

The Project Engineer cum Estate officer or In-charge Engineer concerned shall have the right to deduct from the money due to the contractors any sum required for making good the loss suffered by a worker or workers by reason of non-fulfillment of the conditions of the contract for the benefit of the workers, non-payment of wages or of deductions made from his or her wages which are not justified by their terms of the contract or non-observance of the regulations.

(c) For payment of minimum wages the Contractor is bound to follow the relevant orders of Govt. of Karnataka from time to time.

(d) Vis-à-vis the Institute the contractor shall be primarily liable for all payments to be made under and for the observance of the regulations aforesaid without prejudice to his right to claim indemnity from his sub- contractors. The regulations aforesaid shall be deemed to be part of this contract, and any breach thereof shall be deemed to be a breach of this.

Clause 12(C): In respect of all labour directly or indirectly employed in the work for the performance of the contractor's part of this agreements the contractor shall at his own expense arrange for the safety provisions as per Karnataka P.W.D. safety code framed from time to time and shall at his own expense provide for all facilities in arrangements and provide necessary facilities as aforesaid he shall be liable to pay penalty of Rs. 50/- for each default and in addition the Project Engineer cum Estate officer in charge shall be at liberty to make arrangements and provide facilities as aforesaid, and recover the cost incurred in that behalf from the contractor.

Clause 12(d): The contractor shall submit by the 4th and 19th of every month to the Project Engineer of true statement showing in respect of the second half of the preceding month and the first half of the current month respectively (1) the name of labourers employed by him on the work (2) their working hours, (3) the wages paid to them, (4) the accidents that occurred during the said fortnight showing the circumstances under which they happened and the extent of damage and injury caused to them and (5) the number of female workers who have been allowed, maternity benefit according to clause 19F and the amount paid to them, failing which the contractor shall be liable to pay the Institute a sum of not exceeding Rs. 50/- for each default or materially incorrect statement by deduction from any bill due to the contractor and amount levied as fine.

Clause 12(e): In respect of all labour directly or indirectly employed in the works for the performance of the contractor's part of this agreement, the contractor shall comply with or cause to be complied with all the rules framed by Institute from time to time for the protection of health and sanitary arrangements for workers employed by the Indian Institute of Science and its contractors.

Clause 12(f): Maternity benefit rules for female workers employed by contractor, leave and pay during leave shall be regulated as follows:

Leave (i) in case of delivery: Leave during maternity leave not exceeding 8 weeks up to and including the day of delivery and 4 weeks following that day.
(ii) In case of miscarriage, up to 3 weeks from the date of miscarriage.

9.13 Pay:

i) In case of delivery: Leave pay during maternity leave will be at the rate of women's average daily earning calculated on the total wages earned on the days when full time work was done during the period of three months immediately preceding the date on which she gives notice that she expects to be confined.

ii) In case of miscarriages: Leave pay at the rate of average daily earnings calculated on the total wages earned on the day's full time works was due during a period of 3 months immediately preceding the date of miscarriage.

iii) Conditions for the grant of maternity leave: No maternity leave benefit shall be admissible to a woman unless she has been employed for a total period of not less than 6 months immediately preceding the date of delivery /miscarriage.

10. CONDITIONS OF CONTRACT

Clause 1. Security Deposit

(a) Clause -1(a) The person/persons whose tender may be accepted (hereinafter called the contractor which expression shall unless the context otherwise requires, include his heirs, executors, administrators and assigns) shall pay Earnest Money Deposit indicated in Column (ii) of the table given below and shall permit Institute (a) to deduct FSD at the percentage mentioned in Column (iii) of the table given below of all moneys payable of work done under the Contract, at the time of making such payments to him/them and (b) to hold such deductions as further Security Deposit. The EMD + FSD will be limited to7.5% of the contract value.

Estimated cost of the work put to Tender	E.M.D. Percentage	F.S.D. Percentage
(i)	(ii)	(iii)
Rs. **3,95,67,380.00**	1.5%	6.0%
Note : EMD + FSD to be limited to 7.5% of the contract value		

E.M.D. - Earnest Money Deposit
F.S.D. - Further Security Deposit

No Interest will be paid on EMD / Security deposit.

(b) Additional or Reduction in Security Deposit.

The EMD for the tendered work and additional amount of Security Deposit at the rates mentioned in **Sub-clause 1(a)** above should be, paid by the contractor. The Project Engineer cum Estate officer may allow if a portion of the work is withdrawn from the Contractor under the provisions of Clause 12(a) a proportionate reduction in the amount of security Deposit.

(1) ***EMD paid along with the tender shall be refunded only after the completion of the defect liability period without any interest.***

(2) ***1% labour cess towards workers Welfare Fund on the works expenditure will be recovered from RA bills for depositing the same to the welfare board as per Karnataka Govt. Order. Rates quoted should be inclusive of cess.***

(c) However if the Contractor desires, agency may furnish a BG issued by the Public Sector Undertaking Bank / Scheduled commercial Bank / Nationalized Bank in favour of the Registrar, Indian Institute of Science, payable at Bangalore amounting to 7.50% of the total contract value valid up to completion of defect liability period in which case EMD deposited by them will be refunded and no recoveries towards security deposit will be effected in the running account bills.

(d) Dues to Institute, to be set off against Security Deposit.

All compensation or other sums of money payable by the Contractor to Institute under the terms of this contract may be realized or deducted from any Security Deposit payable to him or from any sums which may be due or may become due by Institute to the Contractor on any account whatsoever and

in the event of his security deposit being reduced by reason of any such realization or deduction as aforesaid, the Contractor shall, within ten days thereafter, make good in cash any sum or sums which have been deducted from his security deposit or any part thereof. Otherwise the amount will be treated as outstanding due from the agency.

(e) Refund of Security Deposit (EMD & FSD):

i) EMD paid by the contractor at the time of tendering and FSD deducted from the R.A. bills at the prescribed rates shall be refunded to the contractor immediately after the virtual completion of the work against production of bank guarantee for an equal amount from any of the Public Sector Undertaking Bank/Scheduled commercial Bank/Nationalized Bank valid for a period as mentioned in clause (ii) below.

ii) The bank guarantee received as stipulated in (i) above, will be treated as performance guarantee and shall be returned to the contractor after the final bill is paid or after **Twenty Four months including monsoon period** from the date of virtual completion of the work during which period the work should be maintained by the contractor in good order, whichever is later. The validity of the bank guarantee shall be maintained for the above period.

iii) In case of BG's furnished towards security deposit same shall be returned after completion of the defect liability period.

Clause 2. <u>PENALTY FOR DELAY</u>

(a) Written Order to Commence Work

After acceptance of the tender, the Project Engineer cum Estate officer shall issue a written order to the successful tenderer to commence the work. The Contractor shall enter upon or commence any portion of work only with the written authority and instructions of the Project Engineer cum Estate officer. Without such instructions the Contractor shall have no claim to demand for measurements of or payment for, work done by him.

(b) Programme of work

The time allowed for carrying out the work as entered in the tender shall be strictly observed by the contractor. It shall be reckoned from the date of handing over the site to the Contractor not less than 75 percent of work site area comprising a continuous block. The work shall throughout the stipulated period of the contract be proceeded with, all due diligence (time being deemed to be the essence of the contract on the part of the Contractor). To ensure good progress during the execution of the work, the contractor shall be bound (in all cases in which the time allowed for any work exceeds one month) to comply with the time schedule according to the programme of execution of the work as agreed upon and enclosed by the contractor during execution of agreement.

(c) Review of progress and responsibility for delay etc.,

The Project Engineer cum Estate officer shall review the progress of all works with the contractor at least once every month. Such a review shall take into account the programme fixed for the previous week, obligations on the part of the Institute for issue of drawings etc, and also the obligations on the part of the Contractor. The review shall also examine the accumulated delays

by the contractor if any and mitigation measures proposed by the contractor to overcome the delay.

Apportioning of responsibility for delay between Contractor and Institute.

In case the progress achieved falls short by more than 25 percent of the cumulative programme, the reasons for such shortfall shall be examined and a record made thereof apportioning the responsibilities for the delay between the contractor and the Institute. This record should be signed in full and dated both by the Project Engineer cum Estate officer and the Contractor. If the contractor refuses to sign the said record, approval of the reasons for delay may be submitted to **CENTER FOR CAMPUS MANAGEMENT AND DEVELOPMENT (CCMD**) for approval and such approval is binding on the contractor.

Shortfall in progress made up subsequently.

To the extent the shortfall is assessed, as due to the delay on the part of the contractor, a notice shall be issued to him by the Project Engineer cum Estate officer to make up the shortfall. If the shortfall is not made up before the progress of the work is reviewed during the second month succeeding the month in which the shortfall was observed, the Contractor shall be liable to pay penalty as indicated in **Clause 2(d)** below.

Grant of extension of time.

If the delay is attributable to reasons beyond the control of the Contractor, requisite extension of time shall be granted by the Project Engineer cum Estate officer in accordance with **Clause 5** after obtaining the approval of his higher authorities, wherever necessary.

Review of progress by Center for campus management and Development.

The Center for campus management and Development shall review the progress periodically, preferably more number of times as required. These reviews are in addition to the monthly reviews required to be done by the Project Engineer cum Estate officer. The results of such review by the CENTER FOR CAMPUS MANAGEMENT AND DEVELOPMENT (CCMD) shall, wherever necessary, be incorporated in the next review of the Project Engineer cum Estate officer.

If the Contractor stops the work for 45 days when no stoppage of work is shown on the current

Program and the stoppage has not been authorized by the Employer then The Employer may terminate the Contract at the risk and cost of the contractor.

Settlement of dispute regarding shortfall in progress.

In case of dispute between the Project Engineer cum Estate officer and Contractor regarding the responsibility for the shortfall in progress, the matter shall be referred to the Center for campus management and Development who shall thereupon give a decision within fifteen days from the

date of receipt of reference. The decision of the Center for campus management and Development shall be final and binding on the contractor and the Project Engineer cum Estate officer.

(d) Penalty for delay

In respect of the shortfall in progress, assessed as due to the delay on the part of contractor as per **Clause 2(b)** and **2 (c)**, the contractor shall be liable to pay as penalty an amount equal to half percent of the contract value of the balance work assessed according to the programme, for every week that the due quantity of work remains incomplete; provided always that the total amount of penalty to be paid under the provisions of this clause subjected to a maximum of 10 percent of the contract value of the entire work as shown in the tender, provided further that in the event of the contractor making up the shortfall in progress within the stipulated or extended time of completion, the penalty so recovered may be refunded on an application in writing by the contractor.

Note: *If the Project Engineer cum Estate officer considers it necessary he shall be entitled to take action as indicated in* ***Clause 3 (d)*** *also.*

d.1 Liquidated damages

The Contractor shall pay liquidated damages to the Employer at the rate per day stated in the Contract Data for each day that the Completion Date is later than the Intended Completion Date (for the whole of the works or the milestone as stated in the Contract Data). The total amount of liquidated damages shall not exceed the amount defined in the Contract Data. The Employer may deduct liquidated damages from payments due to the Contractor. Payment of liquidated damages does not affect the Contractor's liabilities.

If the Intended Completion Date is extended after liquidated damages have been paid, the Employer shall correct any overpayment of liquidated damages by the Contractor by adjusting the next payment of bill.

(e) Adjustment of excess/over payments.

Excess/over payments as soon as they are discovered should be adjusted in the next running account bill of the contractor and in case the final bill has already been paid, the excess/over payment made shall be recovered from the Security Deposit of the contractor together with interest at such percentages as Institute may decide from time to time, from the date of such excess or over payment to the date of recovery.

ACTION WHEN WHOLE OF SECURITY DEPOSIT IS FORFEITED

Clause 3. In any case in which under any clause or clauses of this contract the contractor shall have rendered himself liable to pay compensation and/or penalty amounting to the whole of his security deposit including the amount deducted in installment from his bills as Further Security Deposit,

the Project Engineer cum Estate officer on behalf of the Director, IISc shall have power to adopt any of the following courses as he may deem best suited in the interest of Institute.

(a) **Forfeiture of Security Deposit**

Without prejudice to Institute's right to recover any loss from the Contractor under **sub-clauses (b)** and **(c) of Clause 3** of the Contract, to rescind the contract (of which rescission notice in writing to the contractor under the hand of the Project Engineer cum Estate officer shall be conclusive evidence). And in that case, the security deposit of the contractor including whole or part of the lump sum deposited by him and also the amount deducted from his bills as Further Security Deposit, shall stand forfeited and be absolutely at the disposal of the Institute.

(b) **Debiting cost of labour and materials supplied.**

To employ labour paid by the Institute and to supply materials to carry out the work or any part of the work, debiting the contractor with the cost of the labour and the price of the materials (as to the correctness of which cost and price the certificate of the Project Engineer cum Estate officer shall be final and conclusive against the contractor) and crediting him with the value of the work done; in all respects in the same manner and at the same rates as if it had been carried out by the contractor under terms of this contract, and in that case the certificate of the Project Engineer cum Estate officer as to the value of the work done shall be final and conclusive against the contractor.

(c) **Recovery of extra cost on unexecuted work**

To measure up the work of the contractor and to take such part thereof as is remaining unexecuted out of his hands and to give it to another contractor to complete it in which case any expenses which may be incurred in excess of the sum which would have been paid to the original contractor, if the whole work had been executed by him (as to the amount of which excess expenses the certificate in writing of the Project Engineer cum Estate officer shall be final and conclusive) shall be borne and paid by the original contractor and shall be deducted from any money due to him by Institute Otherwise the amount will be treated as outstanding due from the agency.

(d) **Action against unsatisfactory progress**

If the contractor does not maintain the rate of progress as required under **Clause 2** and if the progress of any particular portion of work is unsatisfactory even after taking action under **Clause 2(c)** and **2(d)**, the Project Engineer cum Estate officer shall be entitled to take action under **Clause 3(b)** or **3(c)** at his discretion in order to maintain the rate of progress after giving the contractor 10 days notice in writing whereupon the contractor will have no claim for any loss sustained by him owing to such actions.

(e) **No compensation for loss sustained on advance action**

In the event of any of the above courses being adopted by the Project Engineer

cum Estate officer, the contractor shall have no claim to compensation for any loss sustained by him by reason of his having purchased, or procured any materials, entered into any agreements or made any advances on account of, or with a view to the execution of the work or the performance of the contract. And in case the contract shall be rescinded under the provision aforesaid the contractor shall not be entitled to recover or be paid any sum for any work thereof actually performed by him under his contract, unless and until the Project Engineer cum Estate officer shall have certified in writing the performance of such work and the amount payable in respect thereof, and he shall only be entitled to be paid the amount so certified.

(f) Recovery of 1% of the contract value towards the laborers welfare fund created by the Government of Karnataka will be effected in the running account bills of the contractor.

Clause 4. CONTRACTOR TO REMAIN LIABLE TO PAY COMPENSATION IF ACTION IS NOT TAKEN UNDER CLAUSE-3.

In any case in which any of the powers conferred upon the Project Engineer cum Estate officer by **Clause 3** thereof shall have become exercisable and the same shall not have been exercised, the non-exercise thereof shall not constitute a waiver of any of the conditions hereof and such powers shall notwithstanding be exercisable in the event of any future case of default by the contractor for which under any clause hereof he is declared liable to pay compensation or penalty amounting to the whole of his security deposit and the liability of the contractor for past and future compensation or penalty shall remain unaffected.

Power to take possession of or require removal of or sell contractor's properties.

In the event of the Project Engineer cum Estate officer taking action under **sub-clause (a)** or **(c) of Clause 3**, he may, if he so desires, take possession of all or any tools, plant, materials and stores, in or upon works or the site

thereof or belonging to the contractor, or procured by him and intended to be used for the execution of the work or any part thereof, paying or allowing for the same in account at the contract rates; or in the case of contract rates not being applicable, at current market rates, to be certified by the Project Engineer cum Estate officer whose certificate thereof shall be final. In the alternative, the Project Engineer cum Estate officer may after giving notice in writing to the contractor or his clerk of the works, foreman or other authorised agent, require him to remove such tools, plant, materials or stores from the premises within a time to be specified in such notice; and in the event of the contractor, failing to comply with any such requisition, the Project Engineer cum Estate officer may remove them at the contractor's expense or sell them by auction or private sale on account of the contractor and at his risk in all respect, and the certificate of the Project Engineer cum Estate officer as to the expense of any such removal; and the amount of the proceeds and expense of any such sale shall be final and conclusive against the contractor.

Clause 5. GRANT OF EXTENSION OF TIME

(a) If the contractor shall desire an extension of the time for completion of the work, he shall apply in writing to the Project Engineer cum Estate officer before the expiry of the period stipulated in the tender or before the expiry of 30 days from the date on which he was hindered as aforesaid or on which the cause for asking for extension occurred, whichever is earlier and the Project Engineer cum Estate officer or other competent authority may if in his opinion, there are reasonable grounds for granting an extension, grant such extension as he thinks necessary or proper. The decision of such competent authority in this matter shall be final.

(b) The time limit for completion of the work shall be extended commensurate with its increase in cost occasioned by alterations or additions and the certificate of the Project Engineer cum Estate officer or other competent authority as to such proportion shall be conclusive.

Clause 6. <u>ISSUE OF FINAL CERTIFICATE</u> – CONDITIONS REGARDING

On completion of the work the contractor shall report in writing to the Project Engineer cum Estate officer the completion of the work. Then he shall be furnished with a certificate by the Project Engineer cum Estate officer of such completion, but no such certificate shall be given nor shall the work be considered to be complete until the contractor shall have removed from the premises on which the work shall have been executed, all scaffolding, surplus materials and rubbish, and shall have cleaned thoroughly all wood work, doors, windows, wall, floor or other parts of any building, in or upon which the work has been executed, or of which he may have had possession for the purpose of executing the work, nor until the works shall have been measured by the Project Engineer cum Estate officer or other competent authority, or where the measurements have been taken by his Project Engineer until they have received the approval of the Project Engineer cum Estate officer or other competent authority, the said measurements being binding and conclusive against the contractor. If the contractor shall fail to comply with the requirements of this clause as to the removal of scaffolding, surplus materials and rubbish, and cleaning on or before the date fixed for

the completion of the work the Project Engineer cum Estate officer or other competent authority may, at the expense of the contractor, remove such scaffolding, surplus materials and rubbish, and dispose of the same as he think fit and clean off such dirt etc., as aforesaid and contractor shall be liable to pay the amount of all expenses incurred but shall have no claim in respect of any such scaffolding or surplus materials as aforesaid except for any sum actually realized by the sale thereof.

Note: CLOSURE OF CONTRACT PENDING COMPLETION OF MINOR ITEMS.

In cases where it is not desirable to keep the building contract open for minor items, such as flooring in the bath rooms, etc., which can be carried out only after installation of sanitary work the main contract may be finalized after getting a supplementary agreement executed in the prescribed form by the same contractor for doing the residual work.

Clause 7. Contractor to submit bills monthly in printed form

(a) A bill shall be submitted by the contractor on or before 15th of each month for all items of work executed in the previous month as required by IISc. The Running account bills will be paid within **three weeks** from the date of submission of the bill in complete acceptable form after duly checked and certified by concerned Engineer, under normal circumstances.

All bills shall be prepared in the prescribed printed and electronic form in PDF format in quadruplicate and handed over to the Project Engineer in charge of the work/ Project Engineer cum Estate officer's Office and acknowledgment obtained.

The charges to be made in the bills shall always be entered at the rates specified in the tender in full or in part as the case may be, in the case of any extra work ordered in pursuance of these conditions, and not mentioned or provided for in the tender, the charges in the bills shall be entered at the rates hereinafter provided for such work.

(b) **Scrutiny of Bills and measurement of work**

The details furnished by the Contractor in the bill will be completely scrutinized and the said work will be measured by the Project Engineer in the presence of the Contractor or his duly authorized agent. The countersignature of the contractor or the said agent in the measurement book shall be sufficient proof to the correctness of the measurements, along with the Test certificates to be produced with the bill ,which shall be binding on the contractor in all respects.

(c) One copy of the passed bill shall be given to the Contractor without any charge.

Clause 8. PAYMENT PROPORTIONATE TO WORK APPROVED AND PASSED.

No payment shall be made for any work estimated to cost rupees five thousand or less until after the whole of the work shall have been completed and certificates of completion given. But in the case of works estimated to cost more than Rs. 5,000 the contractor shall on submitting the bill and

after due verification by the Project Engineer as per **Clause 7(b)** entitled to necessary Payment proportionate to the part of the work then approved and passed by the Project Engineer cum Estate officer or other competent authority whose certificate of such approval and passing of the sum so payable shall be final and conclusive against the contractor i.e. part payment of submitted RA bills is admissible to contractor. Any such reduced payment amount is admissible for adjustment in the successive RA Bills or Final Bill.

Payment at reduced rates

The rates for several items of works agreed to within shall be valid only when the items concerned are accepted as having been completed fully in accordance with the stipulated specifications. In cases where the items of work are not accepted as so completed, The Project Engineer cum Estate officer or other competent authority may make payment on account of such items at such reduced rates as he may consider reasonable in the preparation of final or on account bills.

Payment or intermediate certificates be regarded as advances:

All such intermediate payments shall be regarded as payments by way of advance against the final payments only and not as payments for work actually done and completed, and shall not preclude the Project Engineer cum Estate officer or other competent authority from requiring any bad, unsound imperfect or unskillful work to be removed or taken away and reconstructed or re-erected nor shall any such payment be considered as an admission for the due performance of the Contract or any part thereof in any respect or the accruing of any claim, nor shall it conclude determine or affect in any other way the powers of the Project Engineer cum Estate officer or other competent authority as to the final settlement and adjustment of the accounts, or otherwise or in any other way vary or affect the contract.

Submission of Final bill and its settlement

The contractor shall submit the final bill within one month from the date of actual completion of the work in all respects. His claims shall be settled within five months from the date of submission of the bill in complete acceptable form after duly checked and certified by concerned Engineer, under normal circumstances.

Disputed items

Note: The contractor shall submit a list of the disputed items within 30 days from the disallowance thereof and if he fails to do this, his claim shall be deemed to have been fully waived and absolutely extinguished.

Clause 9. Definition of Work :

(a) The expression `Work' or 'Works' where used in these conditions, shall unless there be something in the subject or context repugnant to such construction, be construed to mean the work or works contracted to be executed under or in virtue of the contract, whether temporary or permanent and whether original, altered, substituted or additional.

(b) **Work to be executed in accordance with specifications, drawings, orders etc.**

The contractor shall execute the whole and every part of the work in the most sound and substantial and workmanlike manner, and in strict accordance with the specifications both as regards materials and workmanship. The contractor shall also conform exactly, fully and faithfully to the designs, drawings and instructions in writing relating to the work signed by the Project Engineer cum Estate officer or other competent authority and lodged in his office and to which the contractor shall be entitled to have access at such office, or on the site of the work for the purpose of inspection during office hours. The contractor shall also be responsible for the delivery of structure in sound conditions and the execution of the work strictly in accordance with the specifications of the work.

(c) **Action where there is no specification**

In the case of any class of work for which there is no such specification, then in such a case of the work shall be carried out in all respects in accordance with the instructions and requirements of the Project Engineer cum Estate officer or other competent authority.

(d) **Work as per Specifications and IS Codes.**

The detailed specification, which forms a part of contract, accompanies the tender document. In carrying out the various items of work as described in Schedule B of the tender documents and the additional, substituted, altered items of work these detailed specification shall be strictly adhered to, supplemented by relevant provisions of the Indian standard specifications, the code of practice; etc., The Indian standard specification, National Building Code and the code of practice to be followed shall be the latest versions of those listed in the detailed technical specifications. Any class of work, not covered by the detailed technical specifications, shall be executed in accordance with the instructions and requirements of the Project Engineer cum Estate officer and the relevant provisions of the Indian standard specifications.

Clause 10. Alteration in quantity of work, specifications and designs, Additional work, deletion of work

(i) The Project Engineer cum Estate officer shall have power to make any alternations in, omissions from additions to or substitutions for the original specification, drawings, designs and instructions that may appear to him to be necessary or advisable during the progress of the work. For that purpose or if 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 or all the following: -

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

(b) Omit any such work.

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

(d) Change the levels, lines, positions and dimensions of any part of the work,

(e) Execute additional work of any kind necessary for the completion of the works and

(f) change in any specified sequence, methods or timing of construction of any part of the work.

Contractor bound by Project Engineer cum Estate officer's instructions

The Contractor shall be bound to carry out the work in accordance with any instructions in this connection which may be given to him in writing signed by the Project Engineer cum Estate officer or other competent authority and such alteration shall not in any way vitiate or invalidate the contract.

Standard Quantity Take-off (SQT)

Contractor within **14 days** of Issue of LOI to submit the Project Manager & seek approval for the Standard quantity Take-off sheets for all the items mentioned in the Tender BOQ, after due referencing the Tender/ GFC drawings and the Technical Specification. Upon approval, the SQT shall remain the base document for initiating any change orders/ variation in accordance to Clause 31, tracking the daily project progress, and for the measurement sheets.

Orders for variations to be in writing

(ii) No such variations shall be made by the Contractor without an order in writing of the Project Engineer cum Estate officer; 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 the result of the quantities exceeding or being less than those stated in the 'Schedule B' provided also that if for any reason the Project Engineer cum Estate officer shall consider it desirable to give any such order verbally, the Contractor shall comply with such order without any confirmation in writing of such verbal order given by the Project Engineer cum Estate officer, whether before or after the carrying out of the order, shall be deemed to be an order in writing within the meaning of the clause; provided further that if the Contractor shall within seven days confirm in writing to the Project Engineer cum Estate officer and if such confirmation is not contradicted in writing within fourteen days by the Project Engineer cum Estate officer, it shall be deemed to be an order in writing by the Project Engineer cum Estate officer.

(iii) **a)** Any additional work which the contractor may be directed to do in the manner above specified as part of the work shall be carried out by the Contractor on same conditions in all respects on which he agreed to do the main work and same rates as are specified in the tender for the main work. However, change in the Undertaking rates tendered and accepted shall be considered in respect of items under which the quantity of work performed exceeds tendered quantity by more than 25 percent and this actual change in rate will be restricted only to such excess quantity (i.e. beyond 125 percent of the tendered quantity).

(b) **Rate for excess quantity beyond 125 percent of tendered quantity**

The Additional quantity which exceeds 125 percent of the tendered quantity shall be paid at the rates entered in or derived from Schedule of Rates

prevalent at the time of executing additions and alterations plus or minus the overall percentage of the original tendered rates over the current Schedule of Rates (KPWD) of the year in which the tender is accepted (as per the comparative Statement prepared at the time of acceptance of the tender).

(c) Rates for additional, substituted, altered items of work

If the additional, substituted or altered work includes any class of work for which no rate is specified in the contract, then such work shall be carried out at the rates specified for or derived from similar item of work in the agreement. In the absence of similar items in agreement, rate shall be as specified for or derived from similar items in the schedule of rates of KPWD prevalent at the time of execution of such additional substituted or altered items of works, plus or minus the overall percentage of original tendered rates over the current schedule of rates of (KPWD) the year in which tender is accepted as mentioned in sub clause (b) above. With regard to the question whether the additional, substituted or altered item/items of work/works is / are similar or not, to that/those in the agreement / in the Schedule of Rates of KPWD and the decision of the Center for campus management and Development shall be final and binding on the contractor.

(D) Determination of rates for items not found in Estimate or Schedule of Rates

If the rates for additional, substituted or altered work cannot be determined in the manner specified in sub **clauses (b)** and **(c)** above, then the contractor shall within 7 days of the date of receipt by him of the order to carry out the work, inform the Project Engineer cum Estate officer of the rates which it is his intention to charge for such class or work, supported by analysis of the rate or rates claimed. Thereupon the Project Engineer cum Estate officer shall determine the rate or rates on the basis of observed data and failing this, on the basis of prevailing market rates. Under no circumstances the contractor shall suspend the work on the plea of non- settlement of rates for items falling under this clause. In the event of any dispute regarding the rates for such items the decision of Project Engineer cum Estate Officer, Center for campus management and Development shall be final.

Working out the data rates for non SR/ non tendered items shall be based on the procedures laid down in the standard rate analysis format of KPWD Bangalore circle Bangalore. The data rates shall be approved by the Project Engineer cum Estate Officer, Center for campus management and Development and shall be binding on the contractor.

Clause 11. <u>TIME LIMITS UNFORSEEN CLAIMS</u>

Under no circumstances whatever shall the contractor be entitled to any compensation from Institute on any account unless the contractor shall have submitted claim in writing to the Project Engineer cum Estate officer or other competent authority within 30 days of the cause of such claim occurring.

Clause 12. <u>NO CLAIM TO ANY PAYMENT OR COMPENSATION FOR DELETION OF</u>

WHOLE OR PART OF WORK

(a) If at any time after the execution of the contract documents, the Project Engineer cum Estate officer or other competent authority shall, for any reason whatsoever, require the whole or any part of the work as specified in the tender, to be stopped for any period or require the whole or part of the work (i) not to be carried out at all or (ii) not to be carried out by the tendered contractor, he shall give notice in writing of the fact to the contractor who will thereupon suspend or stop the work totally or partially as the case may be. In any such case, except as provided hereunder, the contractor shall have no claim to any payment of compensation whatsoever on account of any profit or advantage which he might have derived from the execution of the work in full but which he did not so derive in consequence of the full amount of the work not having been carried out, or on account of any loss that he may be put on account of materials purchased or agreed to be purchased, or for unemployment of labour recruited by him. He shall not also have any claim for compensation by reason of any alterations having been made in the original specifications, drawings, designs and instructions, which may involve any curtailment of the work, as originally contemplated.

(b) **Payment for materials already purchased or ordered by contractor.**

Where, however, materials have already been purchased or agreed to be purchased by the contractor before receipt by him the said notice the contractor shall be paid for such materials, at the rates determined by the Project Engineer cum Estate officer or other competent authority provided they are not in excess of requirements and are of approved quality, and/or shall be compensated for the loss, if any, that he may be put to, in respect of materials agreed to be purchased by him, the amount of such compensation to be determined by the Project Engineer cum Estate officer or other competent authority whose decision shall be final.

(c) **Labour charges during stoppage of work**

If the contractor suffers any loss on account of his having to pay labour charges during the period during which the stoppage of work has been ordered under this clause, the contractor shall on application, be entitled to such compensation on account of labour charges as the Project Engineer cum Estate officer or other competent authority, whose decision shall be final, may consider reasonable. Provided that the contractor shall not be entitled to any compensation on account of labour charges if in the opinion of the Project Engineer cum Estate officer or other competent authority, the labour could have been employed in the same locality by the contractor for the whole or part of the period during which the stoppage of the work has been ordered as aforesaid.

(d) **Time limit for stoppage of work**

The period of stoppage ordered by the Project Engineer cum Estate officer or other competent authority should not ordinarily exceed six months. Thereafter the portion of works stopped may be treated as deleted from this

agreement if a notice in writing to that effect is given to the Project Engineer cum Estate officer or other competent authority by the contractor within seven days after the expiry of the above period.

Execution of work deleted

The portion of work thus deleted may be got executed from the same contractor on supplemental agreement on mutually agreed rates, which shall not exceed current Schedule of Rates plus or minus tender percentage,

Clause 13. ACTION AND PENALTY IN CASE OF BAD WORK

If at any time before the security deposit is refunded to the contractor, it shall appear to the Project Engineer cum Estate officer or other competent authority that any work has been executed with unsound, imperfect or unskillful workmanship or with materials of inferior quality, or that any materials or articles provided by him for the execution of the work are unsound or of a quality inferior to that contracted for, or are otherwise not in accordance with the contract, it shall be lawful for the Project Engineer cum Estate officer or other competent authority to intimate this fact in writing to the contractor and then notwithstanding the fact that the work, materials or articles complained of may have been paid for, the contractor shall be bound forthwith to rectify, or remove and reconstruct the work so specified on whole or in part as the case may require, or if, so required shall remove the materials or articles at his own charge and cost and in the event of his failing to do so within a period to be specified by the Project Engineer cum Estate officer or the competent authority in the written intimation aforesaid, the contractor shall be liable to pay a penalty not exceeding one percent on the amount of the estimate for every day not exceeding ten days during which the failure, so continues and in the case of any such failure the Project Engineer cum Estate officer or other competent authority may rectify or remove, and re-execute the work or remove and replace the materia1s or articles complained of, as the case may be at the risk and expense in all respects of the contractor should the Project Engineer cum Estate officer or other competent authority for any valid reasons consider that any such inferior work or materials as described above is to be accepted or made use of, it shall be within his discretion to accept the same at such reduced rates he may fix thereof.

Clause 14. WORK TO BE OPEN TO INSPECTION - CONTRACTOR OR RESPONSIBLE AGENT TO BE PRESENT

(a) All works under or in course of execution or executed in pursuance of the contract shall at all time be open to the inspection and supervision of the Project Engineer cum Estate officer or other competent authority and his Engineer-in-charge, and the contractor shall at all times during the usual working hours, and at all other times at which reasonable notice of the intention of the Project Engineer cum Estate officer or other competent authority Project Engineer to visit the work shall have been given to the contractor, either himself be present to receive orders and instructions or have a responsible agent duly accredited in writing present for the purpose. Orders given to the contractor duly authorized agent shall be considered to have the same force and effect as if they had been given to the contractor

himself.

(b) Employment of Minimum technical staff

The Contractor shall employ the following technical staff during execution of this work:

(i) One qualified Graduate Engineer & One qualified Diploma Engineer, when the cost of the work to be executed up to 1 Crore,

(ii) Two qualified Graduate Engineer & Three qualified Diploma Engineer, when the cost of the work to be executed from 1 Crore to 10 crores;

Three qualified Graduate Engineer & Six qualified Diploma Engineer, when the cost of the work to be executed above 10 crores;

(iii) In addition to (i) and (ii) above, the contractor shall employ different types of such technical personnel as may be required and sufficient for execution of work and directed by the Project Engineer cum Estate officer to ensure efficient execution of work.

The technical staff so employed, should be available at site whenever required by Engineer in-charge to take instructions.

(c) If the contractor fails to employ the technical staff as aforesaid, he shall be liable to pay a sum of Rs. 25000 (Rupees Twenty thousand only) for each month of default in the case of Graduate Engineers and Rs. 15000 (Rupees Ten thousand only) for each month of default in case of Diploma Holders.

(d) If the Contractor himself possesses the required qualification and is available at the site for receiving instructions from the Project Engineer cum Estate officer and other competent authority vide **sub-clause (a**) above it will not be necessary for the technical staff to be available at site for receiving instructions.

Clause 15. NOTICE TO BE GIVEN BEFORE WORK IS COVERED UP

The contractor shall give not less than five days' notice in writing to the Project Engineer cum Estate officer or his Project Engineer in charge of the work before covering up or otherwise placing beyond the reach of the measurement any work in order that the same may be measured; and correct dimensions thereof taken before the same is so covered up or placed beyond the reach of measurement, and shall not cover up or place beyond the reach of measurement, and work without the consent in writing of the Project Engineer cum Estate officer or other competent authority or his Project Engineer in charge of work; and if any work shall be covered up or placed beyond the reach of measurement, without such notice having been given or consent obtained, the same shall be uncovered at the contractor's expense, and in default thereof no payment or allowance shall be made for such work or for the materials with which the same was executed.

Clause 16. CONTRACTOR LIABLE FOR DAMAGE DONE, AND FOR

IMPERFECTIONS FOR TWELVE MONTHS AFTER CERTIFICATE OF COMPLETION

If the Contractor or his workmen or servants shall break, deface, injure or destroy any part of a building in which they may be working, or any building, road fence, enclosure or grassland or cultivated ground contiguous to the premises on which the work or any part thereof is being executed, or if any damage shall be done to the work, while it is in progress from any cause whatever or if any imperfections become apparent in it within Twelve months of the grant of a certificate of completion, final or otherwise, by the Project Engineer cum Estate officer or other competent authority the contractor shall make good the same at his own expenses, or in default the Project Engineer cum Estate officer or other competent authority may cause the same to be made good by other workmen, and deduct the expenses (of which the certificate of the Project Engineer cum Estate officer or other competent authority shall be final) from any sums that may be due or may thereafter become due to the contractor, or from his Security Deposit or the proceeds of sale thereof, or of a sufficient portion thereof.

The Defects liability period shall be extended for as long as defects remain to be corrected. Every time notice of a Defect is given, the Contractor shall correct the notified Defect within the length of time specified by the Institute.

Clause 17. CONTRACTOR TO SUPPLY PLANT, LADDERS, SCAFFOLDINGS, ETC., AND IS LIABLE FOR DAMAGES ARISING FROM NON-PROVISION OF LIGHT, FENCING ETC

The contractor shall supply at his own cost all materials, plant, tools, appliance, implements, ladders, scaffolding, and temporary works required for the proper execution of the work whether in the original, altered or substituted form and whether included in the specification, or other documents forming part of the contract or referred to in these conditions or not, and which may be necessary for the purpose of satisfying or complying with the requirements of the Project Engineer cum Estate officer or other competent authority as to any matter as to which under these conditions he is entitled to be satisfied, or which he is entitled to require together with carriage therefore, to and from the work. The contractor shall also supply without charge the requisite number of persons with the means and materials necessary for the purpose of setting out works, and counting, weighing and assisting in the measurement or examination at any time and from time to time of the work or the materials. Failing this, the same may be provided by the Project Engineer cum Estate officer or other competent authority at the expense of the contractor and expense may be deducted from any money due to the contractor under the contract or from his security deposit or the proceeds of sale thereof, or of a sufficient portion thereof. The contractor shall provide necessary fencing and lights required to protect the public from accident, and shall also be bound to bear the expense of defense of every suit, action or other legal proceedings, that maybe brought by any person for injury sustained owing to neglect of the above precautions and to pay any damages and costs which may be awarded in any suit, action or proceedings to any person, or which may with the consent of the contractor be paid for compromising any claim by any such person.

Clause 18. Measures for prevention of fire

The contractor shall not set fire to any standing jungle, trees, brushwood or grass without a written permit from the Project Engineer cum Estate officer. When such permission is given, and also in all cases when destroying cut or dug up trees, brushwood grass, etc., by fire the contractor shall take necessary measures to prevent such fire spreading to or otherwise damaging surrounding property.

Clause 19. Liability of contractor for any damages done in or outside work Area.

Compensation for all damages done by contractor or his men whether in or beyond the limits of Institute property including any damage caused by spreading of fire mentioned in Clause 18 shall be estimated by the Project Engineer cum Estate officer and the estimate of the Project Engineer cum Estate officer, subject to the decision of the Center for campus mangement and Development on appeal shall be final and the contractor shall be bound to pay the amount of the assessed compensation on demand failing which the same will be recovered from the contractor as the damages in the manner prescribed in clause 1(c) or deducted by the Project Engineer cum Estate officer or other competent authority from any sums that may be due or become due from Institute to the contractor under this contract or otherwise.

The contractor shall bear the expenses of defending any action or other legal proceedings that may be brought by any person for injury sustained by him owing to neglect of precautions to prevent the spread of fire and shall pay any damages and cost that may be awarded by the court in consequence.

Clause 20. Work on Notified Holiday

No work shall be done on any notified holiday without the sanction in writing of the Project Engineer cum Estate officer or other competent authority

Clause 21. WORK NOT TO BE SUBLET

(a) The contract shall not be assigned or sublet by the contractor,. However, any specific portion of the work which is of a specialized nature and normally not executable by a general contractor could be got done by the specialized agencies which are executing such works, after obtaining the specific approval of the Project Engineer cum Estate officer in writing in each case. Such consent to sublet the work, if given, shall not relieve the contractor from any liability or obligation under the contract and he shall be responsible for the acts, defaults and neglects of any sub-contractor or his agents, servants or workmate as fully as if they were the acts, defaults or neglects of the contractor, his agents, servants or workmen.

Consequences of subletting work without approval, becoming insolvent, bribing etc., by contractor and action against the contractor.

If the contractor shall assign or sublet his contract or any portion thereof without the specific approval of the Project Engineer cum Estate officer or attempts to do so or become insolvent or commence any proceedings to get himself adjudicated as insolvent or make any composition with his creditors or attempts so to do or if any bribe, gratuity, or indirectly be given, promised or offered by the contractor or any of his servants or agents to any officer or person in the employ of Institute in any way relating to his office or employment or if any such officer or person in the employment or if any such officer or person shall become in any way directly or indirectly interested in the contract, the Project Engineer cum Estate officer or other competent authority may thereupon by notice in writing rescind the contract and the security deposit of the contractor shall thereupon stand forfeited and be absolutely at the disposal of Institute and the same consequences shall ensure as if the contract had been rescinded under Clause 3 here of and in addition, the contractor shall not be entitled to recover or be paid for any work actually performed under contract.

(b) **Recovery of excess payments based on excess measurements and action against contractor.**

Whenever it is noticed that excess payments have been made to the contractor based on excess measurements recorded by the Project Engineer in the measurement book and countersigned by the contractor or his duly authorized agent, action shall be taken to recover the excess payments together with interest immediately. Action may also be taken to remove the name of the contractor from the approved list of contractors and also to black-list him.

Change in classification of excavations accepted not permitted.

Once the measurements mentioning the classification of the excavations are recorded in the measurement book and the same is signed by the contractor or his authorized agent in token of acceptance, no request for reclassification by the contractors shall be entrained.

(c) **Criminal proceedings against IISc Officer and Contractor for the lapses.**

Institute also reserve the right to initiate criminal proceedings against the concerned Institute Officers who are directly responsible for the lapse and the contractors who have colluded with the officers of the Institute in the lapse and fraudulently received amounts not due to them legitimately.

Clause 22. SUM PAYABLE BY WAY OF COMPENSATION TO BE CONSIDERED AS REASONABLE COMPENSATION WITHOUT REFERENCE TO ACTUAL LOSS.

All sums payable by a contractor by way of compensation under any of these conditions shall be considered as reasonable compensation to be applied for the use of Institute without reference to the actual loss or damage sustained and whether any damage has or has not been sustained.

Clause 23. SETTLEMENT OF DISPUTES -TIME LIMIT FOR DECISION

(a) If any dispute or difference of any kind whatsoever were to arise between the Project Engineer cum Estate officer and the contractor regarding the following matters namely,

(i) The meaning of the specification's designs, drawing and instructions herein before mentioned,

(ii) The quality of workmanship or materials used on the work and

(iii) Any other question, claim right, matter, thing whatsoever, in any way arising out of or relating to the contract, designs, drawings, specification, estimates, instructions, or orders, or those conditions, failure to execute the same whether arising during the progress of the work, or after the completion, termination orabandonment thereof, the dispute shall, in the first place, be referred to the Center for campus management and Development who have jurisdiction over the work specified in the contract. The Center for campus management and Development shall within a period of fifteen days from the date of being requested by the Contractor to do so give written notice of its decision to the Contractor.

If the decision of the Center for campus management and Development is not acceptable to the contractor he may approach the **Director, IISc within** a period of 15 days for settlement.

(b) Director's decision final.

Subject to other form of settlement hereafter provided, the Director's decision in respect of every dispute or difference so referred shall be final binding upon the contractor. The said decision shall forthwith be given effect to and contractor shall proceed with the execution of the work with all due diligence.

(c) Remedy when Director's decision is not acceptable to contractor

In case the decision of the Director is not acceptable to the contractor, he may approach the Law Court at Bangalore for settlement of dispute after giving due written notice in this regard to the Director within a period of ninety days from the date of receipt of the written notice of the decision of the Director. Further, the Bangalore courts alone shall have the exclusive jurisdiction.

(d) Time limit for notice to approach Court of law by contractor

If the Director has given written notice of his decision to the contractor and no written notice to approach the law court has been communicated to him by the contractor within a period of ninety days from receipt of such notice, the said decision of Director shall be final and binding upon the contractor.

(e) Time limit for notice to approach law court by contractor when decision is not given by Director, IISc as at (b).

If the Director fails to give notice of his decision within a period of ninety days from the receipt of the contractor's request in writing for settlement of any dispute or difference as aforesaid, the Contractor may within ninety days after the expiry of the first named period of ninety days approach the Law Courts

at Bangalore giving due notice to the Director.

(f) **Contractor to execute and complete work pending settlement of dispute.**

Whether the claim is referred to the Director or to the Law Courts, as the case may be, the contractor shall proceed to execute and complete the works with all due diligence pending settlement of the said dispute or differences.

(g) **Obligations of the Project Engineer cum Estate officer and contractor shall remain unsettled during considerations of dispute.**

The reference of any dispute or difference to the Director or the Law Court may proceed notwithstanding that the works shall then be or be alleged to be complete, provided always that the obligations of the Project Engineer cum Estate officer and the contractor shall not be altered by reason of the said dispute or difference being referred to the Director or the Law Court during the progress of the works.

Clause 24. CONTRACTOR TO PAY COMPENSATION UNDER WORKMEN'S COMPENSATION ACT.

(a) The contractor shall be responsible for and shall pay any compensation to his own workmen payable under the relevant Workmen's Compensation Act for injuries caused to the workmen. If Institute pays such compensation on behalf of the contractor it shall be recoverable by Institute from the contractor under as per relevant clauses.

(b) **Contractor to pay expenses of providing medical aid to workmen.**

The contractor shall be responsible for and shall pay the expenses of providing medical aid to any workman who may suffer a bodily injury as a result of an accident. If Institute incurs such expenses, the same shall be recoverable from the contractor forthwith and be deducted without prejudice to any other remedy of Institute, from any amount due or that may become due to the contractor.

Clause 25. CONTRACTOR TO PROVIDE PERSONAL SAFETY EQUIPMENT FIRST AID APPARATUS, TREATMENT etc.

The contractor shall provide all necessary personal safety equipment and first aid apparatus for the use of the persons employed on the site and shall maintain the same in good condition suitable for immediate use, at any time and shall comply with the following regulations in connection therewith: -

(i) The worker will be required to use the equipment so provided by the contractor and the contractor shall take adequate steps to ensure proper use of the equipment by those concerned.

(ii) When work is carried on in proximity to any place where there is a risk of drowning; all necessary steps shall be taken for the prompt rescue of any person in danger.

(iii) Adequate provision shall be made for prompt first - aid treatment of all injuries likely to be sustained during he course of the work.

Clause 26. Minimum age of persons

employed by contractor (a): No

contractor shall employ

(i) Any person who is under age of 18 years.

(ii) Who does not produce a valid certificate of vaccination against epidemic deceases in respect of himself/ herself as well as all the members of his/her family.

(b) The contractor shall provide potable water facilities to the workers. Similar amenities shall be provided to the workers engaged on large works in urban area.

(c) Removal of persons not satisfying conditions (a) (i) & (ii)

The Project Engineer cum Estate officer or other authority is authorized to direct the removal or to remove through - his own agency, from the work any person referred to in sub-clauses (a) above not satisfying these conditions and no responsibility shall be accepted by the Institute for any delay caused in the completion of the work by such directions for removal.

(d) Payment of fair and reasonable wages by contractor.

The contractor shall pay fair and reasonable wages, which shall not be less than the minimum wages fixed by Govt. of Karnataka from time to time to the workmen employed by him in the contract undertaken by him. In the event of any dispute arising between the contractor, and his workmen on the ground that the wages paid are not fair and reasonable the dispute shall be referred without delay to the Project Engineer cum Estate officer or other competent authority, who shall decide the same. The decision shall not in any way affect the conditions in the contract regarding the payment to be made by Institute at the agreed tender rates.

Clause 27. CONTRACTOR NOT ENTITLED TO ANY CLAIM OR COMPENSATION FOR DELAY IN EXECUTION OF WORK IN BORROW PITS.

The contractor shall not be entitled to claim compensation if there is any delay in the execution of the work on account of water standing in borrow pits and
Compartments. The rates are inclusive for hard or cracked soil, excavation in mud, sub-soil water or water standing in borrow pits and no claim for extra rate shall be entertained, unless otherwise specified.

Clause 28. METHOD OF PAYMENT OF BILLS

Payment to contractors shall be made by cheques drawn by the Institute

Clause 29. SET OFF AGAINST ANY CLAIM OF INSTITUTE

Any sum of money due and payable to the contractor (including the security deposit refundable to him) under this contract may be appropriated by the Institute and set off against any claim of Institute in respect of a payment of a sum of money arising out of or under any other contract made by the contract with the Institute.

Clause 30. RATES INCLUSIVE OF SALES TAX AND LABOUR CESS AND ROYALTY

(a) The rates to be quoted by the contractor shall be inclusive of all taxes like GST , Labour cess, Royalty etc., No extra payment on this account will be made to the contractor. Any statutory levies imposed by the central Government/ state Government/ local body from time to time are to the contractors account only.

(b) When there is a change in existing taxes from time to time i.e. upward or downward is admissible accordingly

(c) All quarry fees, octroi dues levied by the state or any local body or authority and ground rent, if any, charged by the Project Engineer cum Estate officer for stacking materials should be paid by the contractor.

Clause 31. IMPORTANCE OF SAFETY

In addition to Contractor's Contractual Obligations on Safety as per the relevant clauses stated, The
Contractor shall comply with all safety standards to the satisfaction of the Employer's Representative.

In respect of all labour, directly or indirectly employed on the project for the performance and execution of the Contractor's Work under the Contract, the Contractor shall at its own expense arrange for all the safety provisions as listed in (i) Safety codes of C.P.W.D. and Bureau of Indian Standards, (ii) The Electricity Act, (iii) The Mines Act, and Regulations, Rules and Orders made there under and such other acts as applicable. Precautions as stated in the safety clause are the minimum necessary and shall not preclude the Contractor taking additional safety precautions as may be warranted for the particular type of work or situations. Also mere observance of these precautions shall not absolve the Contractor of his liability in case of loss or damage to property or injury to any person including but not limited to the Contractor's labour, the Employer's, Architect's, Employer's Representative's and Project Manager's representatives or any member of the public or resulting in the death of any of these.

The Contractor shall institute and implement to the satisfaction of the Project Manager a construction safety programme, including:

• Preparing a Site-specific written safety programme consistent with the EHS Plan, Indian law and best practices. As a minimum, the programme shall require applicable safety equipment for all workers, use of barriers and barricades around potentially dangerous areas, protection of workers working under elevated conditions, accident reporting, first aid provisions etc.

• Weekly safety reviews and 'risk assessments' shall be carried out in conjunction

with the Project Manager
and the Employer in order to identify potential safety hazards and to mitigate against them.

- Attending weekly or as scheduled safety meetings at site conducted by the site safety representative of
project manager
- The Contractor will be required to provide all personnel entering the Site an Identity and safety rules card and verbal explanation of the safety programme.
- Requiring all Sub-Contractors and other workers under the responsibility of the Contractor (including the Vendors or later phases of the construction of the Project) to adhere to the written safety programme as per approved format.

Experienced safety officers with adequate number of supporting personnel shall be appointed by the Contractor for full time on the site during the Contract period.

NON-COMPLIANCE OF REGULATIONS

If the Project Manager or the Employer's Representative notifies the Contractor of non- compliance with the foregoing regulations, the Contractor shall immediately, if so directed, or in any event not more than eighteen (18) hours after receipt of such notice, make all reasonable efforts to correct such non-compliance. If the Contractor fails to do so, the Employer may suspend all or any part of the Work. When the Contractor has undertaken satisfactory corrective action, Employer shall lift the suspension of the Work. The Contractor shall not claim any extension of time to complete the Work or additional fees due to any such work suspension.

The Client reserves the right to levy penalty if the safety norms such as not wearing helmets, safety gloves/belts/shoes/jackets. etc., even after a written notice by the enforcing authority, a penalty of Rs. 10,000/- per day per event or till the safety norms are adhered to in addition to stopping of work till the safety norms are adhered

Clause 32 Refund of Security Deposit (EMD & FSD):

The Security Deposit lodged/paid by a Contractor shall be refunded to him after the final bill is paid or after the successful completion of defect liability period, during which period the work should be maintained by the Contractor in good order, whichever is later.

Clause 33. PENALTY FOR DELAY

(a) Written Order to Commence Work

After acceptance of the tender, The Project Engineer cum Estate Officer, CCMD shall issue a written order to the successful tenderer to commence the work. The Contractor shall enter upon or commence any portion of work only with the written authority and instructions of The Project Engineer cum Estate

Officer, CCMD. Without such instructions the Contractor shall have no claim to demand for measurements of or payment for, work done by him.

(b) Programme of work

The time allowed for carrying out the work as entered in the tender shall be strictly observed by the contractor. It shall be reckoned from the date of handing over the site to the Contractor not less than 75 percent of work site area comprising a continuous block. The work shall throughout the stipulated period of the contract be proceeded with, all due diligence (time being deemed to be the essence of the contract on the part of the Contractor). To ensure good progress during the execution of the work, the contractor shall be bound (in all cases in which the time allowed for any work exceeds one month) to comply with the time schedule according to the programme of execution of the work as agreed upon and enclosed to the agreement.

(c) Review of progress and responsibility for delay etc.,

The Project Engineer cum Estate Officer, CCMD shall review the progress of all works with the contractor during the first fortnight of every month. Such a review shall take into account the programme fixed for the previous month, obligations on the part of the Contractor.

(d) Apportioning of responsibility for delay between Contractor and Institute.

In case the progress achieved falls short by more than 25 percent of the cumulative programme, the reasons for such shortfall shall be examined and a record made thereof apportioning the responsibilities for the delay between the contractor and the Institute. This record should be signed in full and dated both by The Project Engineer cum Estate Officer, CCMD and the Contractor.

<u>Clause 34</u> BAR CHART / CPM CHART:

BAR chart /CPM chart shall be produced during agreement by the contractor. According to the bar chart work is to be executed otherwise penalty will be levied for the delay of work

THE ARTICLES OF AGREEMENT

This Agreement is made at Bangalore, on this**____day of_____(month)** in the year _____

BY AND BETWEEN

INDIAN INSTITUTE OF SCIENCE, a Trust registered under the Charitable Endowments Act, 1890, a deemed University and an autonomous Institution funded by the Ministry of Human Resource Development, Government of India having its office at **Sir C.V Raman Road, Malleswaram, BANGALORE 560 012**, (hereinafter referred to as the EMPLOYER which expression shall unless repugnant to the context or meaning thereof, mean and include its successors in interest, trustees and permitted assigns) of the ONE PART

AND

_____, hereinafter referred to as the "CONTRACTOR", (which expression shall unless repugnant to the context or meaning thereof, mean and include their partners, their respective heirs, executors, administrators and assigns) on the OTHER PART.

RECITALS

WHEREAS the Employer is desirous of getting the work of **"Design, Supply, Installation of 12.5 MVA Power Transformer and associated works in 66 KV Main Receiving Station (MRS)".** (hereinafter called the work) executed by the Contractor at the rates quoted by him amounting to **Rs. xxxxxxx/- (Rupees xxxxxxxxxx xxxxx xxxxxxx Only)** Inclusive of all Taxes which is xxx% Above/Below the estimated amount put to tender.

WHEREAS the Contractor has agreed to execute the aforesaid work on terms and conditions mentioned herein and subject to Tender Conditions of Contract and in accordance with the particular specifications, general notes and the schedule of quantities, schedule of rates, payment, and penalty condition, to the satisfaction of the IISc, Bangalore

NOW THIS AGREEMENT WITNESSETH AND THE PARTIES HERETO AGREE AND SOLEMNLY AFFIRM AS FOLLOWS:

1. In consideration of the payment to be made to them as hereinafter provided, the contractor shall, subject to the terms, conditions, specifications, schedule of quantities, drawings, etc., more particularly stated in the Schedules aforesaid, execute and complete the work within 10 **(Ten) Months** starting after 10 days of issuance of work order or from the date of handing over of site, whichever is later.

2. IISc shall pay to the contractor such sums as shall become payable hereunder at the time and in the manner specified in the conditions contained in the schedule aforesaid.

3. The time allowed for carrying out the work as entered in the tender Agreement shall be strictly observed by the contractor and shall be deemed to be the essence of the contract on the part of the contractor and shall be reckoned from 10 days after the date on which the work order to commence the work is issued to the Contractor or the date of handing over of site, whichever is later. The work shall throughout the stipulated period of the contract be proceeded with all due diligence and the Contractor shall pay compensation an amount equal to one percent, or such smaller amount, as the Director, Indian Institute of Science (whose decision shall be final) may decide on the amount of estimated cost of the whole work as shown in the tender for every day that the work remains un-commenced or unfinished, after scheduled dates.

4. The contractor shall to ensure good progress during the execution of the work the contractor shall be bound

in all cases in which the time allowed for any work exceeds one month (save for special jobs) to complete one- eighth of the whole work before, one-fourth of the whole time allowed under the contract has elapsed, three- eighths, of the work before one-half of such time has elapsed, and three-fourths of the work before three-fourths of such time has elapsed.

However, for special jobs if a time schedule has been submitted by the contractor and the same has been accepted by the Project Engineer-cum-Estate Officer, CCMD the contractor shall comply with the said schedule. In the event of the Contractor failing to comply with the conditions he shall be liable to pay as compensation an amount equal to one percent or such smallest amount, as the Director, Indian Institute of Science (Whose decision in shall be final), may decide on the said estimated cost of the whole work for every day that the due quantity of work remains incomplete; provided always that the entire amount of compensation to be paid under the provisions of this clause shall not exceed seven and a half (10%) percent of the estimated value of the contract as shown in the tender, provided further that in the event of contractor making up the short fall in progress within the stipulated or extended time of completion, the penalty so recovered may be refunded on an application in writing by the Contractor.

5. The Engineer in charge shall review the progress of all works with the contractor once every week. Such a review shall take into account the programme fixed for the previous week, obligations on the part of the Institute for issue of drawings etc., and also the obligations on the part of the Contractor. The review shall also examine the accumulated delays by the contractor if any and mitigation measures proposed by the contractor to overcome the delay.In case the progress achieved falls short by more than 25 percent of the cumulative programme, the reasons for such shortfall shall be examined and a record made thereof apportioning the responsibilities for the delay between the IISc and the contractor. This record should be signed in full and dated both by the Project Engineer and the Contractor.
6. The Director, Indian Institute of Science, without prejudice to its rights under the contract in any respect of any delay or inferior workmanship or otherwise, or to any claim for damages in respect of any breaches of the Contract and without prejudice to any rights of remedies under any of the provisions of this contract or otherwise and whether the date of completion has or has not elapsed, by notice in writing absolutely determine the contract in any of the following cases: -

   (i) If the contractor having been given by the Architects/Project Engineer-cum-Estate Officer, CCMD a notice in writing to rectify reconstruct or replace any defective work or that the work is being performed in any inefficient or otherwise improper or un workmanlike manner, shall omit to comply with the requirements of such notice for a period of seven days of such notice thereafter or if the contractor shall delay or suspend the execution of the work so that in the judgment of the Project Engineer-cum-Estate Officer, CCMD (which shall be final and binding) either he will be unable to secure completion of the work by the date for completion of the work or he has already failed to complete the work by that date.

   (ii) If the Contractor being a company passes a resolution or if the Court passes an order to wind up the company or if a receiver or a manager is appointed on behalf of the creditors of the company or under circumstances which entitles the Court or the creditors to appoint a receiver or manager which would entitle the Court to make a winding up order.

(iii) If the Contractor commits breach of any of the terms or conditions of this contract;

(iv) If the contractor assigns or sublets without written approval of the Project Engineer-cum-Estate Officer, CCMD or becomes insolvent.

The Director of the Institute shall have following powers:

When the Contractor has made himself liable for action under any of the cases aforesaid, the Project Engineer-cum-Estate Officer, CCMD on behalf of the Director of the Institute shall have powers:

(a) To determine or rescind the Contract as aforesaid (in which termination or recession notice in writing to the Contractor under hand of the Project Engineer-cum-Estate Officer, CCMD shall be conclusive evidence) Upon such determination or recession the security deposit of the Contractor shall be liable to be forfeited and shall absolutely be at the disposal of Institute.

(b) To employ labor paid by the Institute and supply materials to carry out the work or any part of the debiting the Contractor with the cost of the labor and the price of the materials (of the amount of which cost and price certified by the Project Engineer-cum-Estate Officer, CCMD shall be final and conclusive against the Contractor) and crediting him with the value of the work done in all respect on the same manner and at the same rates as if it has been carried out by the contractor under the term of his contract. The certificate of the Project Engineer-cum-Estate Officer, CCMD as to the value of the work done shall be final and conclusive against the contractor, provided always that action under the sub-section shall only be taken after giving notice in writing to the contractor. Provided also that if the expenses incurred by the Institute are less than the amount payable to the contractor at his agreement rates, the difference shall not be paid to the Contractor.

(c) After giving notice to the contractor to measure up the work of the contractor and to take such part thereof as shall be un-executed out of his hands and to give it to another contractor to complete in which case any expenses which may be incurred in excess a sum of which would have been paid to the original contractor if the whole work had been executed by him (of the amount of which excess the certificate in writing of the Project Engineer-cum-Estate Officer, CCMD shall be final and conclusive) shall be borne and paid by the original contractor and may be deducted from any monies due to him from the Institute under this contract or any other account whatsoever, of from his security deposit or the proceeds of sales thereof, or a sufficient part thereof as the case may be.

In the event of any one or more of the above courses being adopted by the Project Engineer-cum-Estate Officer, CCMD, the contractor shall have no claim to compensation for any loss sustained by him by reason of his having purchased or procured any materials or entered into any engagements or made any advances on account or with a view to the execution of the work or the performance of the contract. And in case action is taken under any of the provisions, aforesaid, this contractor shall not be entitled for recover or be paid any sum for work thereto/for actually performed under this contract unless the Architect/ Project Engineer-cum-Estate Officer, CCMD has certified in writing the performance of such work and the value payable in respect thereof and he shall only be entitled to be paid the value so certified.

7. The schedules above mentioned including the General Rules and Directions to Contractors and the following documents, viz.,

- Letter of Intent
- Letter of Acceptance
- Work order
- Conditions of Contract
- Contractor's Bid – Bill of Quantities
- Technical Specifications
- Drawings
- The pre-Bid meeting proceedings and corrigendum
- Any other document listed in the Contract Data as forming part of the contract shall form an integral part of agreement and the decision of the Project Engineer-cum-Estate Officer, CCMD in reference to all matters of dispute as to material and workmanship shall be final and binding on both the parties.

8. The employer reserves to himself the right of altering the drawings of the works and of adding to or omitting any item of work from or of having portions of the same carried out departmentally or otherwise and such alterations or variations shall not vitiate this agreement.

9. This agreement comprises the work aforesaid and all subsidiary works connected therewith even though such works may not be shown on the schedule appended hereto.

10. In the event the contractor or their employees, agents, sub-contractors deface or destroy the property or the establishment belonging to IISc, the same shall be made good by the contractor at their own expenses.

11. The Contractor shall ensure cleanliness at the premises of IISc ensure cleaning of site and removal of debris every week. In any event the contractor ceases to comply the foregoing the IISc shall ensure the site cleaned at the expense of the contractor.

12. The Contractor shall at all time be responsible for the safety of their employees, agents, sub-contractors, and in any event during the commission of work or in their due course of work the IISc shall not be held responsible. The contractor shall defend, indemnify and hold the Institute harmless from any liability or damage, law suits, penalties imposed by any State or Central Government or statutory body or by a third party for reasons of violation of any of statutory provisions or requirements by the contractor.

13. The Contractor shall adhere to the working conditions and its scope strictly and any act not in confirmation with the scope of work which is mutually accepted by both the parties shall only be done after prior approval and acceptance in writing by the Director.

14. The Contractor shall at any time be responsible for the completion of work in time, also the contractor shall be responsible to submit the final bill within one month after completion of the work.

15. Notwithstanding anything contained in the tender submitted by the contractor, all the clauses of this agreement shall be binding on both parties.

16. Where counter terms and conditions, printed or copied, are offered by the

contractor, the same shall not be deemed to have been accepted by the Employer, unless specific written acceptance thereof is furnished by the Employer. Notwithstanding the foregoing, no verbal agreement or inference from conversation with any office members/representatives/employees of the Employer before, during or after the execution of the agreement, shall in any way affect or modify any of the terms/obligations contained herein.

17. In the event the contract is terminated by the Employer due to any aforementioned act/omission on the part of the contractor, or for any reason whatsoever, the Employer shall be entitled to engage the services of any other person, agency or Contractor to meet its requirement, without prejudice to its rights including claim for damages against the Contractor.

18. This agreement can be terminated by IISc with the prior written notice of Seven (7) days in the event of a breach of any of its terms of this agreement and even otherwise this Agreement may be terminated by IISc by giving a minimum of 7 days prior written notice to the Contractor.

19. The IISc shall be indemnified for all losses due to commissions and omissions of persons deployed by the contractor. If any loss or damage is caused to the IISc on account of any negligence, carelessness, acts of omissions. commissions of contractors, its employees or staff, the same shall be made good by the contractor. The contractor shall defend, indemnify and hold the Institute harmless from any liability or damage, law suits, penalties imposed by any State or Central Government or statutory body or by a third party for reasons of violation of any of statutory provisions or requirements by the contractor. The IISc shall not be liable for any damage or compensation payable to any workmen or to any person as a consequence of this work and the IISc shall be completely indemnified accordingly.

20. The contractor shall pay wages directly to its personnel The contractor shall also ensure that no amount by way of commission or otherwise is deducted from the wages of the workmen. The contract labourers deployed by the agency shall not involve in any theft/pilferage/damage to Institute property. After necessary investigations, if proved that the contractor or their personnel are responsible for the incident, the contractor is liable and will be penalized to the extent of the value of the loss and additionally Rs. 50,000/- for each such incident.

21. All terms and conditions, the scope of work, and other conditions as mentioned in the tender document will be diligently complied by the contractor. The terms and conditions, the scope of work, and other conditions mentioned in the tender documents shall form a part and parcel of this agreement.

22. The Contractor hereby agrees and affirms that during or subsequent to the performance of the duties under this Agreement, the Contractor shall maintain confidentiality and shall not divulge, communicate, use or appropriate any of the IISc Information, except to the extent necessary for the Contractor to fulfill his obligations or duties to the IISc under this Agreement. The Contractor shall not cause transmission, removal or transfer of tangible embodiments of, or files from the IISc place of business, without the prior written consent of the IISc and shall not disclose any information of the IISc to any third part .

23. In case of disputes s including all questions relating to the performance of the obligations under this agreement and all the dispute and differences which shall arise either during or after the agreement period or other matters arising out of or relating to this agreement or payments to be made in pursuance thereof shall be decided by the Director of IISc whose decision shall be binding on the contractor. The Contractor hereby agrees to be bound by the decision of the Director IISC.

24. **COURTS:** Courts of appropriate jurisdiction situated in Bangalore City shall have exclusive jurisdiction.Any dispute or difference arising between the parties to the agreement in relation to any of the matters specified herein, shall be settled in the Courts of appropriate jurisdiction situated in Bangalore City which shall have exclusive jurisdiction in regard to any matter arising under or in relation to this agreement. Laws of India and the State of Karnataka, shall be applicable in this regard

25. **GOVERNING LAW** This Contract shall be governed by the Law of India for the time being in force.

IN WITNESS WHEREOF the parties hereto have set their respective hands the day and the year here in above written.

In the presence of:
Witness 1:

Signed by for and on behalf of the said Contractor.

In the presence of:
Witness 2:

Signed by for and on behalf of the said Employer.

REGISTRAR
INDIAN INSTITUTE OF SCIENCE
BANGALORE-12

MEMORANDUM OF WORK

INDIAN INSTITUTE OF SCIENCE, BANGALORE-12

ITEM RATE TENDER FOR WORK

I/We, hereby tender for the execution for the Indian Institute of Science, Bangalore-12 of the works specified in the under mentioned memorandum within the time specified in such memorandum at the rates specified therein and in accordance, in all respects, with the specifications, designs, drawings and instructions in writing which have been read by me/read and explained to me and with such materials as provided for by and in all other respects in accordance with such conditions as for as possible.

1.	GENERAL DESCRIPTION	**Design, Supply, Installation of 12.5 MVA Power Transformer and associated works in 66 KV Main Receiving Station (MRS)**
2.	ESTIMATED COST	Rs. 3,95,67,380/-
3.	EARNEST MONEY	Rs.5,93,510.70 /-
4.	Date of Commencement of work	Within ten days from the date of issue of work order or the date of handing over the site whichever is later
5.	Frequency of interim Certificate and payment	Certificate and payment Once every month.
6.	FURTHER SECURITY DEPOSIT	6% on the running account bills and final bill in addition to Earnest Money Deposit. When the S.D. deducted from the RA bills of the Contractor @ 6% of the bill amount exceeds Rs.1.00 lakhs, the amount in excess of Rs.1.00 lakh may, at the request of the Contractor, be released to him against the production of a bank guarantee issued by a Nationalized Bank only for an equal amount in the prescribed form. The bank guarantee should be valid till the completion of the period mentioned in page 2 of Sl.No.1.
7.	TIME ALOWED FOR THE COMPLETION OF WORK IN ALL RESPECTS FROM THE DATE OF COMMENCEMENT OF WORK	**10 (Ten) Months**
8.	BILLS OF QUANTITIES.	Enclosed.
9.	Defects liability period /release of security deposit.	The security deposit lodged/paid by a contractor shall be refunded to him after the final bill is paid or after Twenty-Four 24 months from the date of completion of the work, during which period the work so executed should be maintained by the contractor in good order, whichever is later.
10.	Period for payment of Running Bill.	Four weeks from the date of submission of each Running account bill by the Contractor.
11.	Period for submitting the final Bill.	One month from the date of virtual completion of the work by the Contractor.
12.	SPECIFICATIONS.	The work shall be carried out strictly in accordance with the enclosed specifications and wherever items are not covered by those specifications in accordance with specifications/drawings/designs/requirements and directions of the Project Engineer-cum-Estate Officer, CCMD or his representatives.

I/We, hereby tender for the execution for the Indian Institute of Science, Bangalore-12 of the works specified in the under mentioned memorandum within the time specified in such memorandum at the rates specified therein and in accordance, in all respects, with the specifications, designs, drawings and instructions in writing which have been read by me/read and explained to me and with such materials as provided for by and in all other respects in accordance with such conditions as for as possible.

I/We hereby agree to abide by and fulfill all the terms and provisions of the conditions contained in the articles of agreement, which have been read by me/us or in default thereof to forfeit and pay to the Registrar, Indian Institute of Science or his successors he sums of monies mentioned in the said conditions

The sum of **Rs.xxxxxxx/-** (**Rupees xxxxxxxxxxxxxxxxxxxxxxxxxxxx only**) has been deposited in cash/Bank draft as Earnest Money the full value which is to be absolutely forfeited to the Registrar or his successors in Office should I/We fail to commence the work specified in the above memorandum and complete the same.

Dated this **.....**

Signature of the Contractor/s

Witness to Contractor/s

Signature: NAME

ADDRESS

OCCUPAT

ION

The above tender is hereby accepted by me on behalf of the Indian Institute of Science, Bangalore-12.

REGISTRAR
INDIANINSTITUTE OF
SICENCE
BANGALORE.

Indian Institute of Science,
Bangalore-12

A P P E N D I X

1.Name of the work	**Design, Supply, Installation of 12.5 MVA Power Transformer and associated works in 66 KV Main Receiving Station (MRS)**
2.Date of commencement of work	Within Ten days from the date of issue of work order or the date of handing over the site whichever is later
3.Time of Completion	**10 (Ten) Months**
4.Frequency of interim Certificate and payment	Once every month.
5.Further Security deposit	6% on the running bills and final bill in addition to earnest money deposit. When the S.D. deducted from the R.A. Bills of the contractor @ 6% of the bill amount exceeds Rs.1.00 Lakhs, the amount in excess of Rs.1.00 Lakh may, at the request of the contractor, be released to him against the production of bank guarantee issued from a Nationalised /Scheduled Bank only for an equal amount in the prescribed form. The bank guarantee should be valid till the completion of the defect liability period.
6. Defects liability period / retention amount from the final bill/release of balance of deposit.	The security deposit lodged/paid by a contractor shall be refunded to him after the final bill is paid or after twelve months from the date of completion of the work, during which period the work so executed should be maintained by the contractor in good order, whichever is later.
7. Penalty for delay	In respect of the shortfall in progress, assessed as due to the delay on the part of contractor as per clause 2(b) and 2(c), the contractor shall be liable to pay as penalty an amount equal to one percent of the estimated cost of the balance work assessed according to the programme, for every day that the due quantity of work remains incomplete, provided always that the total amount of penalty to be paid under the provisions of this clause shall not exceed 7 ½ percent of the estimated cost of the entire work as shown in the tender, provided further that in the event of the contractor making up the shortfall in progress within the stipulated or extended time of completion, the penalty so recovered may be refunded on an application in writing by the contractor.
8. Period for payment of Running Bill.	Three weeks from the date of submission of each Running account bills by the Contractor.
9. Period for submitting the final Bill.	One month from the date of virtual completion of the work by the Contractor.

GENERAL RULES AND DIRECTIONS TO CONTRACTORS

1. A Schedule of Quantities (Bill of Quantities) is attached herewith. It should however, be clearly understood that these quantities are liable to alterations by omission, addition or variation, at the discretion of the Architects/Project Engineer Cum Estate Officer

2. The tenderer shall insert all rates and amounts and the totals in the schedule of quantities. Rate for alternative items, when asked for, shall be entered in red ink and shall not be included in the total.

3. The drawings together with specifications and conditions of contract are enclosed. These should be studied carefully by the intending tenderers. In the absence of specifications for any item of work, material or ingredient in the specifications, PWD specifications shall be followed and in the absence of specification for any item, materials are ingredient shall be fixed in all respects in accordance with the instructions and requirements of the Project Engineer Cum Estate Officer, the work will be the best of the kind.

4. The tenderer is expected to inspect the site and acquaint himself with the local conditions and will be deemed to have so done before submitting the tender.

5. The successful tenderer is required to sign an agreement for the due fulfillment of the contract and start the work immediately on of the acceptance of his tender. A draft of the Articles of the Agreement is enclosed. The Earnest Money referred to in item No.3 of Memorandum contained in the "Item Rate Tender for Works", will be forfeited and at the absolute disposal of the Employer if the Contractor defaults from signing the Agreement of in starting the work.

6. The rates quoted shall be for finished work and shall include for all necessary incidental work. Sales or any other tax on materials in respect of this contract will be payable by the Contractor. The Contractors cannot presume any details regarding the contract.

7. Water supply: The Contractor has to make his own arrangement for water supply. However, if water supply to the site at one convenient point is made available by the Institute, the charges for the consumption of water will be borne by the Contractor at 1.50% of the value of the work.

8. Supply of Electricity-electricity required for construction shall be arranged by the contractor itself. Electricity if supplied to the contractor by the institute will be metered and amounted will be recovered in the bills as per actual at rate fixed by the Institute. Supply of electricity from the institute is not mandatory. Non supply of electricity by the institute cannot be held as reason for short fall in progress.

9. The duration of the work is **10 (Ten) Months.**

10. Institute reserves the right to accept or reject any tender without assigning

reasons thereof. He further reserves the right of deleting any item of work in this contract at his discretion.

11. The tenders are valid for a period of 6 (three) months from the date of opening.

12. This "General Rules and Directions to Contractors" shall also form part of the tender document.

12.1 Cement to be procured by contractor only, adhering to the following conditions.

1. Only 43/53 grade OPC cement is to be used for the projects.
2. The cement shall conform to IS 8119-1976.
3. ACC, L&T, Coromandel, Birla brands only to be used.
4. Test certificate is to be produced for every procurement made for.

13. This contract comprises:
a) General Builders work (Civil works).
b) Water supply and Sanitary installations.
c) Electrical Installations.
d) Sump and overhead tanks.

14. The General Builder should get the water supply and sanitary installations and the Electrical installations executed through licensed sub-contractor having good experience and qualified and competent tradesmen in the respective fields and approved by the Project Engineer Cum Estate Officer.

15. It is entirely the responsibility of the Contractor to arrange for and provide all materials required for successful completion of the work except such special materials that may be supplied if any.

16. The Brand, size and colour of vitrified/ceramic/glazed tiles shall be got approved from the Competent authority before procurement of materials. Brands recommended are Johnson, Naveen, Kazaria.

17. Water supply/Sanitary fixtures like Bibcocks, pillarcocks, Health-faucet, anglecock, bottle traps, EWC, IWC, urinal basins shall be as per approval from competent authority.

18. Tenders determined to be substantially responsive will be checked by the Employer for any arithmetic errors. Errors will be corrected by the Employer as follows
a) Where there is discrepancy between the rates in figures and in words, the lower of the two will be governed and
b) Where there is a discrepancy between the unit rate and the line item total resulting from multiplying the unit rate by the quantity, the unit rate as quoted will be governed.
c) Where there is a discrepancy in entries of unit rate between the Original and Duplicate, the lower will govern.

19. Tol tax, Royalty for collecting earth, gravel, sand stone etc., GST or any other tax payable on account of this contract will have to be met from contractors account.

20. The Contractor should make his own arrangements to cover the all-round

construction area, by providing polyester net/polythene sheet/barricading to avoid inconvenience to other surrounding departments, as directed by the Project Engineer-cum-Estate Officer of the work.

21. The debris arise during the period of construction will have to be cleared then and there to keep the surroundings clean and tidy. Such debris shall, if not cleared, be cleared at his risk and cost.
22. Work done as a sub- contractor under a prime contractor will not be considered for qualification.
23. "Prime Contractor" means a firm that performs a construction work itself and that the work is directly entrusted to the firm by the owner/ government/ local body/ quasi government/ Government undertaking bodies.
24. The contractor shall vacate the campus premises with all his men/ materials immediately after completion of the project.

REFERENCES OF CODE BOOK

I.S. STANDARDS OF ELECTRICAL WORKS

The installation in entirety shall comply with latest codes/standards published by National Building Code of India/ CPWD/KPWD/ National Electric Code (NEC)/ IEEE/ Bureau of Indian Standards (BIS) as well as local regulations from departments like Pollution Control Board/ Electrical inspectorate/ Fire Authorities/ Airport Authority of India (AAI)/ High rise committee/ Indian Electricity rules etc. Some of the standards are mentioned here below for reference:

Sl No	STANDARDS	TITLE
	Code of Practice / Guide	
1	IS : 732 – 1989	Code of Practice for Electrical wiring installations.
2	IS: 2026-1 & 2	Power Transformer General & Temperature rise
3	IS :2705 (1&2) – 1992	Current Transformer Spec & measurements
4	IS 4759- 1968	Galvanizing of structure / tower members
5	IS 1573-1970	spring washers shall be galvanized
6	IS : 9537	Rigid steel conduit for electrical wiring
7	IS : 5216	Recommendations on safety procedure and practice in electrical work.
8	IS : 8309	Compression type tubular terminal ends for aluminium conductors of insulated cables
9	IS : 2633	Methods for testing uniformity of coating zinc coated articles
10	IS : 3043 – 1987	Code of practice for earthing
11	IS : 4237 – 1982	General requirements for switchgear and control gear for voltages not exceeding 1000 V AC or 1200 V DC
12	IS : 8828 – 1996	Electrical accessories - circuit breakers for over current protection for household and similar installation
13	IS : 2516 (Part1/Sec01)-1985	Circuit-Breaks : Requirements and tests : Voltages not exceeding 100 V AC or 1200 V DC.
14	IS : 10027 – 2000	Composite units of Air-Break switches and rewireable type fuses for voltages not exceeding 650 V AC
15	IS : 4146 – 1983	Application guide for voltage transformers.
16	IS : 6875 - (Part-1) - 1973	Control switches (Switching devices for control and auxiliary circuits including 1000 V AC and 1200 V DC : General requirements and tests
17	IS 335:2018	New Insulating oil
18	IS : 2448 (Part-1) - 1963	Adhesive insulating tapes for electrical purposes : Tapes with cotton

		textilesubstrates.
19	IS: 8130-1984	Code for Conductor Construction
20	IS: 5831-1984	Code for Insulation & sheath material
21	IS:694-1990	PVC insulated Flexible Single Core Wire/ Unarmoured Multicore/ Flat Cables. For working voltage upto & including 1100V
22	IS:1554(Part-1)- 1988	Copper or Aluminium Conductor/ PVC insulated/ extruded inner sheathed PVC/ galvanised steel wire/strip armoured/ extruded PVC sheathed LT Control/Power Cable. For working voltage up to & including 1.1KV.
23	IS:3975-1990	Code for Number of Strips in armouring construction
24	IS: 7098/II/85	XLPE insulated HT & AB Cables. For working voltage 6.35/11KV.
25	IS:13573/VDE 0278/IEC 60502/HD 629.1.S2 CENELEC	Code of Type tests for HT termination jointing kit.
26	IS 7569:1987	Cast Acrylic Sheets for use in Luminaires
27	IS 10242: Part 3: Sec 6: 1986	Electrical installations in ships: Part 3 Equipment/ Section 6 Luminaires & accessories
28	IS 10322: Part 4 1984	Specification for Luminaires - Part 4: Method of Tests
29	IS 875 Part 3	Wind Velocity
30	IS 2062 (or) ASTM A 572-50	Base Plate
31	BSEN ISO 1461 (or) ASTM A123 (or) IS 2629	Galvanized in single hot dip / With Average 70 Microns
32	IS-1200 (Part 1)	Method of measurement of building and Civil Engineering Works
33	IS 1200 (Part 1)	Method of measurement of earth work
34	IS 1200 (Part27)	Method of measurement of earth work (by Mechanical Appliances)
35	IS 4988 (Part IV)	Excavators
36	IS 3764	Safety code for excavation work
37	IS 4082	Recommendations of stacking and storage of construction materials at site

ABBREVIATIONS:

The following abbreviations wherever they appear in the specifications, shall have the meaning or implication hereby assigned to them:

Mm	Millimetre
Cm	Centimetre
M	Metre
Km	Kilometre
Mm /sqmm 2	Square Millimetre
Cm /sqcm 2	Square centimetre
Dm /sqdm 2	Square decimetre
M /sqm 2	Square metre
Cm / cubic cm 3	Cubic centimetre
Dm / cubic dm 3	Cubic decimetre
M3/cum 3	Cubic metre
Ml	Millilitre
Kl	Kilolitre
Gm	Gram
Kg	Kilogram
Q	Quintal
T	Tonne
SW	Stone ware
SWG	Standard wire Gauge
GI	Galvanised iron
RCC	Reinforced cement concrete

List of Approved make - Electrical

The following makes of components are acceptable. Any other make if offered shall be subject to Institute/ Project engineer cum Estate officer's approval:

All materials shall have to be got approved from the Project Engineer-cum-Estate Officer before being procured

SL. NO.	EQUIPMENT	PREFERRED MAKES
1.	Power Transformer	TOSHIBA / HITACHI / GE / KEC / ANDREW YULE / KIRLOSKAR
2.	On Load tap changer mechanism and control panel	CTR / OLG/TELK / BHEL
3.	Nitrogen Injection Fire protection System	CTR / SHOOTFIRE / SSCOMP
4.	66 kV SF 6 Circuit breaker	SIEMENS / HITACHI / GE / CGL
5.	66 kV CTs	CGL / SIEMENS / HITACHI / VIDYUT CONTROL / TELK
6.	66 kV Isolators	SIEMENS / HITACHI / CGL / HIVELM / GR POWER / SWITCHGEAR & STRUCTURALS
7.	66 kV PTs	CGL / SIEMENS / HITACHI / VIDYUT CONTROL / TELK
8.	60kV Lightning Arrestors	CGL / OBLUM / HITACHI / RAYCHEM
9.	11Kv Switch gear Panel (New Panel)	SIEMENS / HITACHI / GE / SCHNEIDER
10.	SCADA UPGRADATION	Only GE (Suitable for Existing Substation SCADA)
11.	ACSR Conductors & Shield wire	STERLITE IND ./ GALADA POWER / APARINDUSTRIES / MOHAN / SHARAVATHY CONDUCTORS
12.	Clamps & connectors	TYCO-RAYCHEM / EXALT ENGG / MEGHA IND. /ENERGY ENTERPRISES / SUPREME & CO
13.	Al Tube	INDAL / HINDALCO / BHORUKA / NALCO
14.	Bus post / Solid core/ Disc Insulators	ADITYA BIRLA / MPL / BHEL / MODERN / JSI /INSULATOR & ELECTRICALS
15.	Control & Relay Panels	Only GE (Shall be suitable for Existing SCADA)
16.	Relays	GE / SCHNEIDER (Shall be suitable for Existing SCADA)

17.	Interposing transformers, Auxiliary instrument transformers & Control transformers.	INSTRANS / KAPPA / PRAYOG / KALPA
18.	Switches, Push buttons, actuators Ind.Lamp	KAYCEE / SIEMENS / SCHNEIDER / LK (L&T) / SALZER / SELECTRON

SL. NO.	EQUIPMENT	PREFERRED MAKES
19.	Meters & Instruments	SIEMENS / SCHNEIDER / AE / MECO / RISHAB / SELEC
20.	Annunciation Facia type	PROCON / DIGICONT / APLAB / JVS / MINILEC
21.	Terminals	PHOENIX / WAGO/CONNECTWELL / ELMEX
22.	MCB, RCBO, ELCB, Contactors	SIEMENS/ HITACHI / SCHNEIDER / MDS LEGRAND
23.	Enclosure	RITTAL / SCHNEIDER / SIEMENS / HITACHI/ ELSTEEL / HENSEL (FOR OUTDOOR)
24.	Cable Trays	PROFAB / MDS LEGRAND
25.	Switches & sockets	MDS LEGRAND / MK GERMANY / CLIPSAL/ PANASONIC
26.	Panel space heaters	RITTAL
27.	Humidistat	RITTAL
28.	11kV UG Cable	ASIAN / KEC RPG / UNIVERSAL / POLYCAB / APAR / GEMSCAB
29.	415V UG Cable	ASIAN / KEC RPG / UNIVERSAL / POLYCAB / APAR / GEMSCAB
30.	11kV Class termination and jointing kits	RAYCHEM / COMPAQ INTERNATIONAL
31.	Power and Control Cables	UNIVERSAL / POLYCAB / ASIAN / KEC RPG / GEMSCAB
32.	Cable Glands	BALIGA / COMET / STROKES
33.	Cable lugs	DOWELL / AMP / STROKES
34.	Steel	SAIL / VSP
35.	Safety Accessories (Gloves, Rubber MATetc.,)	3M / RAYCHEM / KARAM

BoQ for the work of Supply, Installation, Testing & Commissioning of the following equipment(s) as per specifications, drawings and data sheets

SL.NO.	DESCRIPTION	UNIT	QTY
	Civil Works		
1.0	Demolishing RCC work manually/by mechanical means including stacking of steel bars and disposal of un serviceable materials within 50 metres lead and as per directions of engineer-in-charge	cum	36.00
2.0	Providing and laying in position cement concrete of specified grade excluding the cost of centering and shuttering - All work up to plinth level : 1:4:8 (1 Cement : 4 coarse sand (zone-III) derived from natural sources : 8 graded stone aggregate 40 mm nominal size derived from natural sources)	cum	6.00
3.0	Providing and laying in position machine batched and machine mixed design Mix M25 grade cement concrete for reinforced cement concrete work ,using cement content as per approved design mix,including pumping of concrete to site of laying but excluding the cost of centering ,shuttering finishing and reinforcement ,including admixtures in recommended proportions as per IS 9103 to accelerate,retard setting of concrete ,improve workability without impairing strength and durability as per directions of Engineer in charge all works upto plinth level Concrete of M25 grade with minimum cement content of 330 kg /cum	cum	31.00
4.0	Centering and shuttering including strutting, propping etc. and removal ofform for Foundations, footings, bases of columns, etc. for mass concrete	Sqm	35.00
5.0	Earth work in excavation by mechanical means (Hydraulic excavator)/ manual means over areas (exceeding 30 cm in depth, 1.5 m in width as well as 10 sqm on plan) including getting out and disposal of excavated earth lead upto 50 m and lift upto 1.5 m, as directed by Engineer-in_x005fcharge. All kinds of soil	cum	100.00
6.0	Steel reinforcement for R.C.C. work including straightening, cutting, bending, placing in position and binding all complete above plinth level.Thermo-Mechanically Treated bars of grade Fe-500D or more.	kg	3000.00
7.0	supply & fixing 90lbs/Yard rails for the transformer foundation	kg	360.00

8.0	Supplying fabricating and erecting Galvanised steel structures	kg	2500.00
9.0	Brick work with common burnt clay machine moulded perforated bricks of class designation 12.5 conforming to IS: 2222 in superstructure above plinth level up to floor five level in cement mortar 1:6 (1 cement : 6 coarse sand) :With F.P.S.(non modular) bricks	cum	3.00
10.0	18 mm cement plaster in two coats under layer 12 mm thick cement plaster 1:5 (1 cement : 5 coarse sand) and a top layer 6 mm thick cement plaster 1:3 (1 cement : 3 coarse sand) finished rough with sponge.	Sqm	44.00
11.0	Providing epoxy painting to plastered / un plastered surface of concrete / brick work	Sqm	35.00
12.0	Providing and filling 40 mm downgraded coarse aggregates in the transformer foundation and in the substation area	cum	60.00
13.0	Dismantling steel work in built up sections in angles, tees, flats and channels including all gusset plates, bolts, nuts, cutting rivets, welding etc. including dismembering and stacking within 50 metres lead.	kg	3886.00
14.0	Backfilling	cum	47.70
1.1.1	**Supply, Installation, Testing & Commissioning of the following equipment(s) as per specifications, drawings and data sheets Electrical Works** **SwitchYard Equipment:** 66kV Three pole Double break, 1250A, 31.5kA for 3 sec Motor operated Isolator with one hand operated Earth Switch along with equipment mounting structure as per specification	Set	1
1.1.2	66kV Class Triple pole, 1250A, 31.5kA for 3 sec Outdoor SF6 Circuit Breaker along with equipment mounting structure as per specification	Set	1
1.1.3	66kV, 3 Core CTs for metering and protection along with equipment mounting structure as per specification	Nos	3
1.1.4	60kV, Station Class Lightning Arrestors along with equipment mounting structure as per specification	Nos	3
1.1.5	66kV Solid Core bus post Insulator along with equipment mounting structure as per specification	Nos	3
1.1.6	66kV Transfermer bay Control And Relay Panel	Set	1
1.1.7.1	66kV TR#1 Bay SCADA Accessories and Integration	Lot	1
1.1.7.2	66kV TR#1 Bay SCADA Software and DataBase Upgradation	Lot	1
1.1.8	Outdoor Bay Marshalling Box	Nos	1
1.1.9.1	**Substation Accessories** 50mm (2.0") IPS SCH-40 Al tube for bay bus	m	100
1.1.9.2	63mm (2.5") IPS SCH-40 Al tube for main bus	m	100

1.1.9.3	Clamps and Connectors suitable for 31.5kA for above Al tubes	Nos	3
1.1.10.1	**<u>Clamps and connectors for AI TUBES connection</u>** Aluminium alloy terminal connector for 66kV CT terminals suitable for 63 mm Al Tube with HORIZONTAL TAKE OFF Fixed Type connector for CT & 63 mm Al Tube	Nos	6
1.1.10.3	Aluminium flexible terminal connector for 66kV CT terminals suitable for 63mm Al Tube with HORIZONTAL TAKE OFF Flexible Type connector for CT & 63mm Al Tube	Nos	6
1.1.10.5	Aluminium alloy terminal connector for 66kV LA terminals(PAD) with VERTICAL TAKE OFF Fixed Type connector for LA -T Type Clamp 50mm	Nos	6
1.1.10.5	Aluminium alloy terminal connector for 66kV Transformer Bushing Expansion Type connector for Bushing Clamp Suitable for 50mm	Nos	6
1.1.10.7	Aluminium alloy terminal connector for 66kV Isolator terminals(PAD) WITH HORIZONTAL TAKE OFF Fixed Type connector for Isolator & 63mm Al Tube	Nos	6
1.1.10.9	Flexible Type connector for Isolator & 63mm Al Tube	Nos	6
1.1.10.10	Aluminium alloy terminal connector for 66kV Circuit Breaker terminals(PAD) WITH HORIZONTAL TAKE OFF Fixed Type connector for circuit breaker & 63mm Al Tube	Nos	6
1.1.10.12	Flexible Type connector for circuit breaker & 63mm Al Tube	Nos	6
1.1.10.13	2.5" IPS SCH-40 "V" Arm & connectors for supporting Main Bus (2.5") to 2.0" IPS SCH-40 Bay Bus	Nos	6
2.1.1.1	**<u>HV POWER CABLES</u>** 11kV Earthed Grade (E), Stranded Aluminium conductor, XLPE insulated, Strip wire armoured, extruded PVC inner and outer sheathed cables laid in cable trench / Cable tray / directly buried with necessary clamps and hardware, cable tags, ferrule numbers etc. and conforming to enclosed specification. 3Rx3C x 240 sq mm	m	400
2.1.2	**Supply and installation of indoor heat shrinkable cable termination kit including double compression brass cable glands, crimping type tinned copper lugs, GS armour binding wires, earth tags, pig tails with lugs, for 11kV Earthed Grade, armoured XLPE insulated Power Cables of following sizes: TR#1 3Rx3C x 240 sq mm, Al, XLPE**	Nos	26

2.1.3	**Supply and Installation of the following Cables as per specification and drawings. (DG Extension)** **2Rx3C x 300 sq mm, Al, XLPE**	m	1000
2.1.4	**Supply and installation of indoor heat shrinkable cable termination kit including double compression brass cable glands, crimping type tinned copper lugs, GS armour binding wires, earth tags, pig tails with lugs, for 11kV Earthed Grade, armoured XLPE insulated Power Cables of following sizes: 2Rx3C x 300 sq mm, Al, XLPE**	Nos	18
2.2.1.1	**MV POWER CABLES** **Supply and Installation of the following Cables as per specification and drawings.** 1.1V Grade, XLPE insulated, PVC innersheath, overall PVC outersheathed, Armoured cables laid in cable trays / buried in trench with necessary clamps and hardware, cable tags, ferrule numbers etc. and conforming to enclosed specification. 3C X 2.5 Sq.mm Cu, Armoured cable	m	500
2.2.1.1.2	3C X 6 Sq.mm Cu, Armoured cable	m	100
2.2.1.1.3	4C X 4 Sq.mm Cu, Armoured cable	m	600
2.2.1.1.4	4C X 25 Sq.mm Cu, Armoured cable	m	50
2.2.2.1	Supply and installation of Cable termination accessories including double compression brass cable glands, crimping type tinned copper lugs, bimetallic strips, GS armour binding wires, earth tags, pig tails with lugs, for 1.1kV grade, armoured XLPE insulated Power Cables of following sizes: 3C X 2.5 sq.mm Cu, Armoured cable	Nos	40
2.2.2.2	3C X 6 sq.mm Cu, Armoured cable	Nos	10
2.2.2.3	4C X 4 sq.mm Cu, Armoured cable	Nos	25
2.2.2.4	4C X 25 sq.mm Cu, Armoured cable	Nos	10
2.3.1.1.1	**MV CONTROL CABLES** **Supply and Installation of the following Cables as per specification and drawings.** 1.1V Grade, Stranded Copper conductor, PVC insulated, Steel Wire armoured, overall FRLS PVC outersheathed control cables laid in cable trays / wire duct with necessary clamps and hardware, cable tags, ferrule numbers etc. and conforming to enclosed specification. 3C X 2.5 sq.mm Cu. cable	m	200
2.3.1.1.2	5C X 2.5 sq.mm Cu. cable	m	300
2.3.1.1.3	5C X 4 sq.mm Cu. cable	m	200
2.3.1.1.4	7C X 2.5 sq.mm Cu. cable	m	150
2.3.1.1.5	12C X 2.5 sq.mm Cu. cable	m	200
2.3.1.1.6	19C X 2.5 sq.mm Cu. cable	m	250
2.3.1.1.7	24C X 2.5 sq.mm Cu. cable	m	300

2.3.2.1	Supply and installation of Cable termination accessories including double compression brass cable glands, crimping type tinned copper lugs, bimetallic strips, GS armour binding wires, earth tags, pig tails with lugs, for 1.1kV grade, armoured PVC insulated Control Cables of following sizes: 3C X 2.5 sq.mm Cu. cable	Nos	12
2.3.2.2	5C X 2.5 sq.mm Cu. cable	Nos	12
2.3.2.3	5C X 4 sq.mm Cu. cable	Nos	12
2.3.2.4	7C X 2.5 sq.mm Cu. cable	Nos	12
2.3.2.5	12C X 2.5 sq.mm Cu. cable	Nos	12
2.3.2.6	19C X 2.5 sq.mm Cu. cable	Nos	12
2.3.2.7	24C X 2.5 sq.mm Cu. cable	Nos	12
3.1.1	**EARTHING** Supply, Installation / laying and termination of the following sizes of earth flats, mats and wires, directly buried / laid in cable trays / drawn through pipe sleeves / run along structures as per specifications and drawings. All joints in the run of conductor shall be welded/ brazed/ fastened/ riveted. 75 x 12 mm GI strip for switchyard buried earth grid	m	300
3.1.1.2	75 x 10 mm GI strip for substation riser to equipment and structural earthing.	m	550
3.1.1.3	50 x 8 mm Cu strip for Transformer neutral earthing.	m	30
3.1.1.4	25 x 6 mm GI Strip for fence earthing.	m	120
3.1.1.5	1C x 6 Sq.mm Cu Flexible Cable (Yellow/green) for DB's/Junction Box/Marshalling Kiosk	m	50
3.1.1.6	Auxiliary earth mat with Copper Mesh size of 150mm x 150mm for isolators (Overall-1200mm x 1200mm)	Nos	6
3.1.2	Supply and erection of Treated Earth pits complete with 100 dia 13 thick Cast Iron Pipe 2.5m long with disconnecting links, chamber, inspection cover, civil works, etc., as per specifications and drawing, and including excavation , salt, charcoal.	Nos	10
4.1.1	**OIL FILLED POWER TRANSFORMER** **Supply, Installation, Testing & Commissioning of the following equipment(s) as per specifications, drawings and data sheets** 12.5MVA, 66/11.6kV, Power Transformer, Z=8.35%, with OLTC +5% to -15%, RTCC, first filling of oil and 10% spare oil as per specifications and Data Sheets	Nos	1
4.1.2	Nitrogen Injected Fire Protection System complete with local control box, remote control panel, signal box, heat detectors and all other accessories as per specification suitable for the above transformer	Set	1

4.1.3	Oill filtration at the time of installation, testing and commissioning of transformer with MAIN TANK + OLTC.	Litres	13000
4.1.4	Oil Sample testing at the time of installation, testing and commissioning of transformer with OLTC.	Nos	4
4.1.5	Essential Spares	LS	1
5.1.1	**HV SWITCHGEAR** **Supply, Installation, Testing & Commissioning of the following equipment(s) as per specifications, drawings and data sheets** 11kV TR#1 Incomer Panel Retrofit (Cable Box Adopter include Bus Bar Extension + New 11kV CT 800-400/1-1-1A -3Nos's)	Set	1
5.1.2	Existing DG incomer Interlock Modification (Interlock Between Buscoupler, DG Incomer, Transformer Incomer)/ Adapter Panel for MCVCB	Set	1
5.1.3	Proposed DG Panel - For Outgoing (DG Room)	Set	1
5.1.4	Proposed DG Panel - For Incoming (11kV Switch Gear Room)	Set	1
5.1.5	Cable side earthing truck with single phase PT, lamp and buzzer	Nos	1
5.1.6	Bus earthing truck with single phase PT, lamp and buzzer	Nos	1
5.1.7	CB Transport trolley	Nos	1
7.1.1	**Supply Installation of Safety items** CO2 Fire Extinguishers - 4.5 kg	Nos	2
7.1.2	Fire bucket with sand	Nos	6
7.1.2	Fire bucket Steel sand (For 3 buckets)	Nos	2
7.1.3	Rubber hand gloves,Branded, Class4	Pair	1
7.1.4	Shock treatment chart, duly framed	Nos.	1
7.1.5	Danger boards as per IS 2551 (150 x 150mm)	Nos.	5
7.1.6	First aid kits	Set	1
7.1.7	Rubber Mats - 1500 mm (W) x 1000 mm (L) x 12 mm (T)	Nos.	7
8.1	**BUYBACK ITEMS**		
8.1.1	66kV Three pole Double break Isolator with one hand operated Earth Switch-supply	Set	1
8.1.2	66kV Class Triple pole Circuit Breaker	Set	2
8.1.3	66kV, 3 Core CTs for metering and protection	Nos	3
8.1.4	Outdoor Junction Box for CT	Nos	1
8.1.5	60kV, Station Class Lightning Arrestors	Nos	3
8.1.6	5MVA, 66/11.6kV, Power Transformer, Z=7.04%, with OLTC +5% to -15%	Nos	1