



TENDER DOCUMENT
(e-Procurement)

Tender No: IISc/Tender-ELE-1/2021-22

For
"Upgradation of HV, LV Switchgears & Transformers in SERC Substation at IISc Campus, 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**

Website : <https://IISc.ac.in/business-with-IISc/tenders/>

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1. Tender Notification

Tender No: IISc/Tender-ELE-1/2021-22

Scope of Work	Upgradation of HV, LV Switchgears & Transformers in SERC Substation at IISc Campus, Bangalore
Estimated Value of work	Rs. 3,88,89,337
Period of Work Completion	7 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 2020/2203/2765 e-Mail: office.ccmd@iisc.ac.in
Tender Fee	As per e-procurement portal
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	Not applicable
Last date and Time for online submission (uploading) of tender	09.08.2021 at 18.00 hrs.
Date and Time of opening of Tender (Technical Bid)	11.08.2021 at 15:30 hrs.
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	26.07.2021 at 15.30 hrs. Pre bid meeting will be held on Teams App (Video conference mode). The web link is as below.

https://teams.microsoft.com/l/meetup-join/19%3ameeting_ZTg5MmY5NmMtNDZiZS00MGI0LTkwZTQtMjg0ODRhZmU4ZjU5%40thread.v2/0?context=%7b%22Tid%22%3a%226f15cd97-f6a7-41e3-b2c5-ad4193976476%22%2c%22Oid%22%3a%22f95f068c-dee7-437c-b9ed-ea908bc827af%22%7d

2. Notice Inviting Tender

The Registrar, Indian Institute of Science invites tenders in two bid (Technical and Financial) system from eligible Bidders, for "**Upgradation of HV, LV Switchgears & Transformers in SERC Substation at IISc Campus, 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 certificate copies of PAN, GST, Contractor's Registration certificate in technical bid, **failing which the tender will be rejected**. If necessary, bidder shall produce all the original documents for verification.
- 2.3 If the rate quoted by the Contractor for each category of works is below the estimated value of the work, the contractor should pay the difference of amount in favour of The Registrar, IISc in the form of DD or Pay order or FDR (Fixed deposit receipt) or Bank Guarantee as an additional security deposit before entering into Agreement. The same will be refunded only after satisfactory completion of the work.
- 2.4 The work shall be carried out as per the directions of the Project Engineer cum Estate Officer.
- 2.5 Blacklisted contractors in State / Central Govt. Departments / BBMP / PSU/ Central PSUs/ Autonomous bodies / Institutions are not eligible to quote, if found such tenders will be rejected. The contractors who are penalized due to delay in completion of the previous works will be rejected.
- 2.6 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.
- 2.7 The material shall be got approved by the Project Engineer cum Estate Officer, IISc before execution of the work.
- 2.8 Further details of the work can be obtained from this office.
- 2.9 The rates quoted should reflect all taxes separately. However, 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.
- 2.10 The work shall be commenced with all men and machinery within 10 days from the date of work order, 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.
- 2.11 Conditional tenders will not be accepted and is liable for rejection.
- 2.12 Bidders who meet the above specified minimum qualifying criteria, shall be eligible.

2.13 Even though the Bidders meet the above criteria, 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.

To give prospective Bidders reasonable time in which to take corrigendum/ addendum into account in preparing.

2.19 Documents comprising the Tender

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

- a) Earnest Money Deposit & Tender fee 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 and Tender fee:

The Bidders are exempted for paying the Earnest Money Deposit (EMD) as per the GoI guidelines. The bidder has to submit the BID SECURITY DECLARATION as per the enclosure. However, the bidder has to pay the tender fee. The Bidder has to pay the Tender fee 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 DD has to be submitted along with the 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.

2.22 Provisions for Micro, Small and Medium Enterprises (MSME) :

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

Policy is meant for procurement of only goods produced and services rendered by MSMEs. 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 thro' 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 by e-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 2.31, 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 as per 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 2.37, 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 2.36, 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 Further Security deposit (FSD)

Further percentage on the running bills and final bill in addition to Earnest Money Deposit shall be levied from the contractor. When the FSD deducted from R.A Bills of the contractor @ 3% 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 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 The rates to be quoted including all taxes with GST and inclusive of all statutory Levies like cess, royalty etc., and shall not be quoted above 125% and below 75% of the prevailing rates. Otherwise above 125% and below 75% of the amount will be treated as unbalanced amount which will be accounted for security deposit.

2.40 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.

2.41 Payment Terms

70% against the supply of material and 30% after installation, testing and commissioning, subject to the provisions of the tender document.

2.42 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.

3. (a) Declaration of Tenderer

Name of Work: Upgradation of HV, LV Switchgears & Transformers in SERC Substation at IISc Campus, 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.

(b) Bid Security Declaration

(To be submitted by all bidders in their letter head as the part of Technical Bid)
To,
The Registrar,
Indian Institute of Science,
Bangalore- 560012

Subject: Bid Security Declaration
Reference: Tender No: IISc/Tender-ELE-1/2021-22

I/we hereby understand and accept that if I/we withdraw or modify my/ our bids during the period of validity, or if I/we are awarded the contract and on being called upon to submit the performance security/ Security Deposit, fail to submit the performance security/ Security Deposit, before the deadline defined in the request for bid document/ Notice Inviting tender, I/we shall be debarred from exemption of submitting Bid Security/ Earnest Money Deposit and performance security/ Security deposit for a period of 6 (six) months, from the date I/we are declared disqualified from exemption from submission of EMD/SD, for all tenders for procurement of goods/works/services/consultancy etc. issued by any unit of Indian Institute of Science published during this period.

Bidder:

Signature

Name of the Authorized Signatory.....

Designation:
Company Seal
Date:

4. Eligibility Criteria

Technical Criteria:

4.1 The bidder should have satisfactorily completed as a Prime contractor during the last seven years, ending March 2021 in PWD/CPWD/Railways/BSNL/MES//Central PSUs or any Government Department.

- a) Three similar works each costing not less than 40% (forty percent) of the estimated cost i.e. Rs. 1,57,00,000 or completed two similar works each costing not less than 60% (sixty percent) of the estimated cost i.e. Rs. 2,36,00,000 or completed one similar work costing not less than 80% (eighty percent) of the estimated cost i.e. Rs. 3,14,00,000.
- b) Work completion certificate for having completed work of similar nature of contract certified from the competent authority not below the Rank of Executive Engineer or equivalent shall be uploaded. The work completion certificate shall mention the nature of work, items of work executed, the agreement number & date, the value of work, the date of commencement, the stipulated date of completion, the actual date of completion of the work and reason for delay (if any).

4.2 The bidder should be a valid CLASS-I registered contractor in PWD/CPWD/Railways/BSNL/MES//Central PSUs or any Government Department.

4.3 The bidder should have valid CLASS I (ELECTRICAL) Licence issued by State Electrical Licencing Authority.

Financial Criteria

- 4.4 The bidder should have registered for a minimum period of Ten years.
- 4.5 The average annual financial gross turnover should be 30% of estimated cost in that last five years.
- 4.6 The minimum annual financial turnover for the two consecutive years should be 30% of estimated cost.
- 4.7 The bidder should have not incurred any loss in more than two years.
- 4.8 The bidder should submit the solvency certificate from the bank for 30% of estimated cost.
- 4.9 The average net worth of the bidder as of **2020-21** should be not less than 25% of estimated cost. Necessary certificate by the Chartered Accountant shall be submitted.
- 4.10 The bidder should have not been blacklisted by any State / Central Govt. Departments / BBMP / PSU/ Central PSUs/ Autonomous bodies / Institutions.
- 4.11 The bidding capacity of the bidder should be 75% or more of the estimated cost.
- 4.12 Information on works for which tenders have been submitted and on going works as on the date of this Tender.

(A) Existing commitments and on-going works:

Description of work	Place & State	Contract number & date	Name & address of the 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 Tenders already submitted:

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

4.13 Certificate from Charted Account stating turn over for the last five years is also to be uploaded.

Sl.No	Year	Turn over amount	Remark
1	2016-17		
2	2017-18		
3	2018-19		
4	2019-20		
5	2020-21		

Litigation and Arbitral Issues:

4.14 Net pending litigations should not be more than 50% of bidder's net worth.

4.15 No consistent history of court/arbitral award decisions against the bidder for the last five years.

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 1.50% 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 / PWD specifications shall be followed and in the absence of specification for any item, materials and 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 Employer 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 his risk and cost.
- 5.13 The contractor shall vacate the campus premises with all his men/ materials immediately after completion of the project.
- 5.14 The equipment data sheet as per the technical specification to be filled by the bidder and uploaded along with the technical bid eligibility documents.**

6. GENERAL CONDITIONS

6.1 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.

6.2 Institute shall mean the "Indian Institute of Science, Bangalore".

6.3 "Office" shall refer to the Office of the Project Engineer cum Estate officer.

6.4 "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.

6.5 "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.

6.6 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.

6.7 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.

6.8 The Engineer in charge shall mean the Project Engineer cum Estate officer directly in charge of the work or his duly authorized assistants.

6.9 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.

6.10 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.

6.11 "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.

6.12 "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.

6.13 "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.

6.14 "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.

6.15 "Month" shall mean a Calendar month.

6.16 "Prime contractor" means 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 undertaking. Words used in singular shall also include the plural & vice-versa where the context so demands.

6.17 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. .

6.18 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.

6.19 SETTING OUT:

The Contractor shall set out the building in accordance with the plans. All grid/center 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 benchmark at the intersection of all main walls, columns, etc., in order that the lines and levels may be accurately checked at all times.

6.20 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.

6.21 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.

6.22 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.

6.23 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.

6.24 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.

6.25 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.

6.26 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.

6.27 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.

6.28 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.

6.29 SAMPLE APPROVAL:

Before ordering materials, the Contractor shall get the samples approved from the Project Engineer cum estate officer well in time.

6.30 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.

6.31 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.

6.32 PROJECT PROGRAMME OF WORKS AND WEEKLY PROGRESS REPORT:

a) Organization 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 (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 milestone 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.

6.33 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.

6.34 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.

6.35 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.

6.36 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.

6.37 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.

6.38 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.

6.39 All the works shall be carried out as per specifications prescribed by BIS, National Building code, CPWD / KPWD specifications, relevant IS codes or as directed by the Project Engineer in the absence thereof.

6.40 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.

6.41 All the materials shall be got approved by the Project Engineer cum Estate officer before use.

6.42 The rates quoted for 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.

6.43 Necessary pillars shall be constructed by the Contractor for benchmark at no extra cost as directed by the Project Engineer.

6.44 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.

6.45 In the work spot the contractor shall provide suitable temporary office with a covered area of 1000 sq.ft 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.

6.46 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.

- 6.47 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.
- 6.48 The contractor shall furnish weekly medical report showing number of persons ill or incapacitated and nature of their illness, to the Project Engineer.
- 6.49 The contractor shall furnish a report of any accident which may occur, within 24 hours of its occurrence to the Project Engineer.
- 6.50 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.
- 6.51 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.
- 6.52 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.
- 6.53 The Engineer shall have the right to direct the contractor to progress the various items of works in the manner prescribed by him.
- 6.54 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.
- 6.55 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.
- 6.56 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.
- 6.57 The contractor has to make his own arrangements in regard to power supply and water required for construction and drinking water facilities.
- 6.58 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.

6.59 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.

6.60 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 bill.

6.61 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.

6.62 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.

6.63 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.

6.64 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.

6.65 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.

6.66 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.

6.67 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.

6.68 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.

6.69 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.

6.70 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.

6.71 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.

6.72 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.

6.73 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.

6.74 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.

6.75 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.

6.76 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.

6.77 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.

6.78 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.

6.79 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 sub-agency 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 be borne 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 subagencies including supervision on the quality of materials and workmanship and to ensure that the sub agencies 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.

6.80 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.

6.81 Dust nuisance to neighbor shall be minimized by providing and erecting screens to the required height as per direction of Project Engineer cum Estate officer with Aluminum 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.

6.82 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.

6.83 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 or any other cause whatsoever, in any way connected with the carrying out the construction/dismantling/demolition.

The contractor shall take required insurance cover with an approved insurance company as provided in the contract and deposit with the Institute well before commencement of construction/ demolition / dismantling.

6.84 **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 Engineer-in charge.

6.85 **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 carryout the work in accordance with such working drawings and working details.

6.86 **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.

6.87 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.

6.88 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.

6.89 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.

6.90 Labour Statistics:

The contractor shall submit daily reports on the following:

- (a) Total No. of labour employed in the working area.

6.91 Execution of work during night time:

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.

6.92 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 of contamination by poisonous materials epidemic causing infections bacteria etc., by maintaining the source and system under adequate hygienic conditions.
- r) Notwithstanding the above clauses, there is nothing in this to exempt the contractor to exclude the operations of any other Act or Rules in force of the Central Govt., State Govt.

6.93 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.

6.94 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.

6.95 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.

6.96 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-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 the contractor shall ensure that the dimensional details of the equipment fit into the allotted space provided in the building.

6.97 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.

6.98 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.

6.99 RATE ANALYSIS

At any time 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.

6.100 The Project Engineer reserves the rights to delete any item from the contractor's scope of works.

7. CONTRACTOR'S LABOUR REGULATIONS

ANNEXURE - I

7.1 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:

Labour means 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.

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.

Contractors shall include every person whether a sub-contractor head or agent employing labour on the work taken contract.

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.

7.2 WORKING HOURS:

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.

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.

Every worker shall be given a paid weekly holiday normally on Sunday.

7.3 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.

7.4 PAYMENT OF WAGES:

Wages due to every worker shall be paid to him direct.

7.5 FIXATION OF WAGES PERIODS:

The contractor shall fix the wages period of which the wages shall be payable.

Wages of every worker employed on the contract shall be paid.

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. 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

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.

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.

7.6 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 deductions:

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.

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.

Deduction for recovery of advance or for adjustment of over payment of wages, advance granted shall be entered in a register.

And other deductions which the Institute may from time to time allow.

7.7 Fines:

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.

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.

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.

No fine imposed on any worker shall be recovered from him by instalments or after the expiry of sixty days from the date which it was imposed.

Every fine shall be deemed to have imposed on a day of the act or omission in respect of which it was imposed.

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.

7.8 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.

7.9 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.

7.10 REGISTER OF FINES ETC.

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.

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.

7.11 SUBMISSION OF RETURNS:

The contractor shall submit periodical returns as may be specified from time to time.

7.12 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.

ANNEXURE -II

7.13 Labour Clause

No labourers below the age of 15 years shall be employed on the work.

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-fulfilment 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 contractor 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.

7.14 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.

7.15 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.

7.16 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.

7.17 Maternity benefit rules for female workers employed by contractor, leave and pay during leave shall be regulated as follows:

(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.

7.18 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.

8. CONDITIONS OF CONTRACT

Clause 1. Security Deposit

Estimated cost of the work put to tender	E.M.D. Percentage	F.S.D. Percentage
(i)	(ii)	(iii)
Rs. 3,88,89,337	0%	3%
Note : EMD + FSD to be limited to 3.0% of the contract value		

(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 to 3% of the contract value.

E.M.D - Earnest Money Deposit

F.S.D - Further Security Deposit

No Interest will be paid on EMD / Further / Additional 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.

a) EMD paid along with the tender shall be refunded only after the completion of the defect liability period without any interest.

b) 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 3% 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 **eighteen 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. PENALTY FOR DELAY

(f) 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.

(g) 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.

(h) 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 Centre for campus management and Development.

The Centre 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 Centre 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 Centre 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 instalment 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.

a) 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.

b) 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.

c) 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.

d) 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.

- e) 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. ISSUE OF FINAL CERTIFICATE - 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 bathrooms, 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 unskilful 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 :

(i) 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.

(j) **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.

(k) 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.

(l) 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, this detailed specification shall be strictly adhered to, supplemented by relevant provisions of 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 alterations 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: -
 - iii)** Increase or decrease the quantity of any work included in the contract.
 - iv)** Omit any such work.
 - v)** Change the character or quality or kind of any such work,
 - vi)** Change the levels, lines, positions and dimensions of any part of the work,
 - vii)** Execute additional work of any kind necessary for the completion of the works and
 - viii)** 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 CCMD 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, CCMD 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, CCMD and shall be binding on the contractor.

Clause 11. TIME LIMITS UNFORSEEN CLAIMS

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. NO CLAIM TO ANY PAYMENT OR COMPENSATION FOR DELETION OF 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 unskilful 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 materials 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;
- (iii) Three qualified Graduate Engineer & Six qualified Diploma Engineer, when the cost of the work to be executed above 10 crores;
- (iv) 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 Centre for Campus Management 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 entertained.

(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 or abandonment thereof, the dispute shall, in the first place, be referred to the Centre for campus management and Development who have jurisdiction over the work specified in the contract. The Centre 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 Centre 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 the 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 15 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.

Clause 34 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

9. 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.

WHEREAS the Employer is desirous of getting the work of "**Upgradation of HV, LV Switchgears & Transformers in SERC Substation at IISc Campus, Bangalore**" (hereinafter called the work) executed by the Contractor at the rates quoted by him amounting to **Rs. 3,88,89,337 (Rupees three crore eighty eight lakhs eighty nine thousand three hundred and thirty-seven only)** which is the estimated amount put to tender.

AND 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.

AND WHEREAS the contractor has deposited a sum of **Rs Nil (Rupees Zero)** with Employer as security for the due performance of this Contract.

NOW it is hereby agreed and declared by and between the parties hereto 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 **7 Months** starting after 10 days of issuance of work order or from the date of handing over of site, whichever is later.
2. The Employer 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 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 as compensation an amount equal to one percent, or such smaller amount, as the Director, Indian Institute of Science (whose decision in writing 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 proper dates.

4. The contractor shall 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 Architects/ 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 writing 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 (7 ½) percent of the estimated cost of the work as shown in the tender.

5 The Director of the Indian Institute of Science, without prejudice to his 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.
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 labour 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 labour 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.

6. The schedules above mentioned including the General Rules and Directions to Contractors and the following documents, viz.,

- i) Letter of Intent
- ii) Conditions of Contract – Volume I
- iii) Contractor's Bid – Bill of Quantities – Volume II
- iv) Technical Specifications – Volume III
- v) Drawings
- vi) The pre-Bid meeting proceedings and corrigendum
- vii) 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.

7. 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.

8. This agreement comprises the work afore said and all subsidiary works connected therewith even though such works may not be shown on the schedule appended hereto.
9. Notwithstanding anything contained in the tender submitted by the contractor, all the clauses of this agreement shall be binding on both the parties.
10. 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.
11. In the event the contract is terminated by the Employer due to any afore mentioned 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.
12. The Employer 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 Employer on account of any negligence, carelessness, acts of omissions, commissions of contractors, his 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, lawsuits, penalties imposed by any State or Central Government Department or statutory body or by a third party for reasons of violation of any of statutory provisions or requirements by the contractor. The Employer 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 Employer shall be completely indemnified accordingly.
13. In case of disputes 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.

IN WITNESS WHEREOF the parties hereto have set their respective hands the day and the year here in above written.

In the presence of:	Signed by for and on behalf of the said Contractor.
In the presence of:	Signed by for and on behalf of the said Employer.

REGISTRAR
INDIAN INSTITUTE OF SCIENCE
BANGALORE-12

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.

MEMORANDUM OF WORK

1.	GENERAL DESCRIPTION	Upgradation of HV, LV Switchgears & Transformers in SERC Substation at IISc Campus, Bangalore
2.	ESTIMATED COST	Rs. 3,88,89,337
3.	EARNEST MONEY DEPOSIT	Rs. NIL
4.	FURTHER SECURITY DEPOSIT	3% on the running account bills and final bill in addition to Earnest Money Deposit. When the F.S.D. deducted from the RA bills of the Contractor @ 3% of the bill amount exceeds Rs.1.00 lakh, 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 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.
5.	TIME ALLOWED FOR THE COMPLETION OF WORK IN ALL RESPECTS FROM THE DATE OF COMMENCEMENT OF WORK	7 Months
6	BILLS OF QUANTITIES	Enclosed
7.	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 agree to abide by and fulfil 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. Nil (Rupees Zero 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

OCCUPATION

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	Upgradation of HV, LV Switchgears & Transformers in SERC Substation at IISc Campus, Bangalore
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	7 Months
4.Frequency of interim Certificate and payment	Once in every month.
5.Further Security deposit	3% on the running bills and final bill in addition to earnest money deposit. When the F.S.D. deducted from the R.A. Bills of the contractor @ 3% of the bill amount exceeds Rs.1.00 Lakhs, the amount in excess of Ra.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 1/2 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.

10. REFERENCES
I.S. STANDARDS OF ELECTRICAL WORKS

Sl.No	STANDARDS	TITLE
	Code of Practice / Guide	
1	IS : 732 – 1989	Code of Practice for Electrical wiring installations.
2	IS : 4648 – 1968	Guide for Electrical layout in residential buildings
3	IS : 80614 – 1976	Code of Practice for Design, installation and maintenance of service lines up to and including 650V.
4	IS : 7752 (Part-1) - 1976	Code of Practice for interior illumination : General requirements and recommendations for welding interiors.
5	IS : 4347 – 1967	Code of Practice for hospital lighting
6	IS : 6665 – 1972	Code of Practice for industrial lighting
7	IS : 2672 – 1966	Code of Practice for Library lighting
8	IS : 10118 (Part-1) - 1982	Code of Practice for selection, installation and maintenance of switcher and Control gear : Installation.
9	IS : 4146 – 1983	Application guide for voltage transformers.
10	IS : 3043 – 1987	Code of practice for earthing.
11	IS : 5216 (Part-2) - 1982	Guide for safety procedures and practices in electrical work : General.
12	IS : 4237 – 1982	General requirements for switchgear and control gear for voltages not exceeding 1000 V AC or 1200 V DC.
13	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.
14	IS : 10027 – 2000	Composite units of Air-Break switches and rewirable type fuses for voltages not exceeding 650 V AC.
15	IS : 4064 (Part-1) - 1978	Composite units of Air-Break disconnector, Air-Break switch disconnector and fuse- combination units for voltages not exceeding 1000 V AC or 120 V DC : General requirements.
16	IS : 8828 – 1996	Electrical accessories - circuit breakers for over current protection for household and similar installation.
17	IS : 2516 (Part-1/Sec01)- 1985	Circuit-Breaks : Requirements and tests : Voltages not exceeding 100 V AC or 1200 V DC.
18	IS : 5039 – 1983	Distribution pillars for Voltages not

		exceeding 1000 V AC or 1200 V DC.
19	IS : 8544 (Part-4) - 1979	Motor starters for voltages not exceeding 1000 V : Reduced voltage AC starters, two- step auto transformer starters.
20	IS : 9537 (Part-1) - 1980	Conduits for electrical installations General requirements
21	IS : 9537 (Part-4) - 1983	Conduits for electrical installations : Pliable self recovering conduits of insulating materials.
22	IS : 3854 – 1997	Switches for domestic and similar purposes.
23	IS : 1293 – 1988	Plugs and sockets outlets of rated voltage up to and including 250 Volts and current up to and including 16 Amperes.
24	IS : 2418 (Part-1) - 1977	Tubular Fluorescent lamps for general lighting services : Requirements and tests.
25	IS : 9900 (Part-1) - 1981	High pressure mercury vapor lamps : Requirements and tests.
26	IS : 1913 (Part-1) - 1978	General and safety requirements for luminaries : Tubular fluorescent lamps.
27	IS : 10322 (Part-1) - 1982	Luminaries : General requirements
28	IS : 302 (Part-1) - 1979	General and safety requirements for household and similar electrical appliances.
29	IS : 6236 – 1971	Direct recording electrical measuring instruments.
30	IS : 2705 (Part-1) - 1992	Current transformers : General requirements.
31	IS : 2448 (Part-1) - 1963	Adhesive insulating tapes for electrical purposes : Tapes with cotton textile substrates.
32	IS: 8130-1984	Code for Conductor Construction
33	IS: 5831-1984	Code for Insulation & sheath material
34	IS:694-1990	PVC insulated Flexible Single Core Wire/ Unarmoured Multicore/ Flat Cables. For working voltage upto & including 1100V.
35	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.
36	IS:3975-1990	Code for Number of Strips in armouring construction.
37	IS: 7098/II/85	XLPE insulated HT & AB Cables. For working voltage 6.35/11KV.
38	IS:14255-1995	Code for Aerial Bunched Cables. For working voltage up to 1.1KV.
39	IS:13573/VDE 0278/IEC 60502/HD 629.1.S2 CENELEC	Code of Type tests for HT termination jointing kit.
40	IS 7569:1987	Cast Acrylic Sheets for use in Luminaires
41	IS 8030:1976	Specifications for Luminaires for Hospitals
42	IS 10242: Part 3: Sec 6: 1986	Electrical installations in ships: Part 3 Equipment, Section 6 Luminaires & accessories
43	IS 10322: Part 2 1982	Specification for Luminaires - Part 2: Constructional Requirements
44	IS 10322: Part 3 1984	Specification for Luminaires - Part 3: Screw & Screw Less Terminals
45	IS 10322: Part 4 1984	Specification for Luminaires - Part 4: Method of Tests
46	IS 10322: Part 5: Sec 1: 2012	Luminaires: Part 5 Particulars requirements, Sec 1 General Purpose Luminaires
47	IS 10322: Part 5: Sec2: 2012	Specifications for Luminaires - Part 5 : Particular Requirements - Section 2: Recessed Luminaires
48	IS 10322: Part 5: Sec4: 1987	Luminaires: Part 5 Particulars requirements, Section 4 Portable general-purpose luminaires
49	IS 13383: Part 1 : 1992	Photometry of Luminaires - Method of Measurement - Part 1: Luminaires for use in interior Lighting
50	IS 13383: Part 2 : 1992	Methods of Photometry of luminaires: Part 2 Luminaires for road & street lighting
51	IS 13383: Part 3 : 1992	Photometry of Luminaires - Method of Measurement - Part 3: Luminaires for Floodlighting
52	BSEN 10025 Grade 5, 355JO (or) ASTM A 572-50	Steel sheet thickness
53	IS 875 Part 3	Wind Velocity

54	IS 2062 (or) ASTM A 572-50	Base Plate
55	BSEN ISO 1461 (or) ASTM A123 (or) IS 2629	Galvanized in single hot dip / With Average 70 Microns
56	BS 5135	Welded Single L-Seam Joint
57	AISI 304 Grade	Stainless Steel Wire Rope (Factor of Safety: TR No. 7)
58	IS 1239	Maximum Load Carrying Capacity (Lantern)
59	IS 9595 (or) IS 10178 AWS	Single Section & Single Joint welded
60	ASTM - A 123 and 153	Hot dip Galvanized in Single dipping with not less than 65 Microns

11. TECHNICAL SPECIFICATION

The work shall be carried out as per the Specification as detailed below /CPWD Specification and relevant IS codes. In case of discrepancy between technical specification and BOQ, the BOQ prevails.

11.1 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 **Upgradation of HV & MV switchgears, 11/0.433kV 1x2500kVA Transformer and 1x1500kVA Transformers, power cables and associated works, SCADA system including all civil works at SERC S/S in 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 of SERC S/S 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	75x12 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	240V 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.

11.3.1 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 in SERC substation and has planned to upgrade the same and increase its capacity.
1. 3 The present power demand is 1.5MVA and SERC S/S is drawing power from MUSS.
1. 4 IISc would like to enhance the power from 1.5 MVA contract demand to 4 MVA as load requirement is expected to rise over the next 2 to 3 years.
1. 5 The SERC Substation at IISc is 11/ 0.433 kV substation comprising of two Feeders from MUSS cum three numbers of transformer of 2 x 500 kVA and 1 x 1000kVA capacity.
1. 6 IISc intends to upgrade the existing two feeder cables, 3 nos. of Transformers, 1 no. of HT IOCG panel & Main LT panel to meet the above requirements.
1. 7 The existing Transformers of of 2 x 500 kVA and 1 x 1000 kVA capacity will be removed and replaced by 1 x 2500 kVA and 1 x 1500 kVA transformers.
1. 8 As part of this project, 11 kV Substation equipment will have to be procured under this scope of work and erected and commissioned.

2. 0 SCOPE OF WORK

2. 1 The scope of work shall include Design, Engineering, Manufacture, Testing at the VENDOR/SUB VENDOR'S works. Inspection, Packing for shipment, Delivery to site, Receipt and Storage at site, Installation, Testing at site, Commissioning, Liasoning with KPTCL, BESCOM and any other Statutory body for approvals, Performance testing and Handing over to IISc all the equipment and systems included in this specification.
2. 2 All related activities whether specifically mentioned or not shall be included in the scope of work.
2. 3 Nature of work being Refurbishment / Replacement / Augmentation of existing system, in order to ensure the un-interrupted power and to minimise the down time to SERC facility, the execution shall be taken up in the pre-determined sequence.
2. 4 Actual site work and dismantling of existing equipment shall start only after the Factory Acceptance Tests have been completed and all the equipments have arrived at site.

Below is the general sequence of work which involves the following:

- a) Dismantling of existing Feeder cables from MUSS to SERC S/S.
- b) Laying of proposed feeder cables from MUSS to SERC S/S.
- c) Dismantling of Existing HT & LT switchgear panels.
- d) Erection, Testing & commissioning of proposed HT & LT panels including busducts.
- e) Dismantling of Existing (2 x 500 kVA) & (1 x 1000 kVA) transformers.
- f) Installation of Earthmat including the Civil Works for 2.5 MVA transformer.

- g) Installation of New 2.5 MVA Transformer with all equipments including foundation and support structure.
- h) Cabling from equipment to SAS System, HT panel & Main LT panel.
- i) Cabling from HT switchgear panel OG feeder to 2.5 MVA transformer.
- j) Testing & commissioning of 2.5 MVA transformer.
- k) Installation of Earthmat including the Civil Works for 1.5 MVA transformer.
- l) Installation of New 1.5 MVA Transformer with all equipments including foundation and support structure.
- m) Cabling from equipment to SAS System, HT panel & Main LT panel.
- n) Cabling from HT switchgear panel OG feeder to 1.5MVA transformer.
- o) Testing & commissioning of 1.5MVA transformer.
- p) Existing Cabling to be removed and laid again in new Hume pipes from DG AMF panel to Main LT Panel.
- q) Termination of feeder cables from old Main LT panel to Proposed Main LT panel and SDB.
- r) Liasoning / Approvals & Charging
- s) Handover to IISc.

2. 5 The sequence of work list above in clause-2.3 is indicative. Successful bidder to study the site conditions and furnish the proposed Sequence of work in discussion with IISc.

2. 6 The following is the scope of supply, unloading and storage at site, erection, testing and commissioning for the project:

Sl. No.	Item Description	Quantity
11 kV Feeder cables		
1	11 kV Unearthed Grade (UE), stranded Aluminium conductor, XLPE insulated, three core, Steel strip armoured, extruded PVC inner and outer sheathed Cable of size 1R x 3C x 400 Sq.mm.	(Refer BOQ)
2	11 kV Unearthed Grade (UE), stranded Aluminium conductor, XLPE insulated, three core, Steel strip armoured, extruded PVC inner and outer sheathed Cable of size 1R x 3C x 185 Sq.mm.	(Refer BOQ)
415 V Busways / LT cables		
3	0.415 kV, 4000A AL BUSWAY	1 Set
4	0.415 kV, 2500A AL BUSWAY	1 Set
5	0.415 kV, 2500A AL BUSWAY	1 Set
Control Room Equipment		
6	11kV HT Indoor Single Bus bar Switchgear	1 No.
7	415V LT Indoor Single Bus bar Switchgear panel with two bus sections	1 No
8	415V LT Indoor Sub Distribution Board	1 No
9	Battery and Battery charger with integral DCDB	1 No.
10	Capacitor Panel / APFC Panel	2 No.
11	SCADA System	1 Lot
12	Power and control Cables	1 Lot

Sl. No.	Item Description	Quantity
13	Cabling, Earthing and Lightning Protection	1 Lot
Oil Filled Transformer		
14	11/0.433kV, 2500 kVA ONAN Cooled Power Transformer with vector group Dyn11, Z= 8% with OCTC	1 No.
15	OCTC with Tap Range: (-) 5 to (+) 5 in steps of each 2.5% for the above Transformer	1 No.
16	First fill of oil along with 2 Drums (400 litre) or 10% spare extra oil whichever higher in sealed non returnable containers.	1 Lot
17	10 litre of paint (finish shade) in non returnable containers for site touch-up after erection.	1 Lot
18	Oil filtration at the time of installation, testing and commissioning of transformer	1 Lot
19	50 x 8mm Copper Busbar from transformer LV neutral bushing shall be brought to ground supported by 1.1 kV class insulator at every 500mm on the tank.	1 Lot
20	11/0.433kV, 1500 kVA ONAN Cooled Power Transformer with vector group Dyn11, Z= 6.0% with OCTC	1 No.
21	OCTC with Tap Range: (-) 5 to (+) 5 in steps of each 2.5% for the above Transformer	1 No.
22	First fill of oil along with 2 Drums (400 litre) or 10% spare extra oil whichever higher extra oil in sealed non returnable containers.	1 Lot
23	10 litre of paint (finish shade) in non returnable containers for site touch-up after erection.	1 Lot
24	Oil filtration at the time of installation, testing and commissioning of transformer	1 Lot
25	50 x 8mm Copper Busbar from transformer LV neutral bushing shall be brought to ground supported by 1.1 kV class insulator at every 500mm on the tank.	1 Lot
Miscellaneous Items		
26	Supply and installation / laying of RC Hume Pipe NP3 class for Re-laying of existing LT cables from DG synchronisation panel to Main LT panel	(Refer BOQ)
27	Miscellaneous works	(Refer BOQ)
28	Temporary Power Supply	(Refer BOQ)
29	DG Synchronisation Panel Outgoing feeder Revamping	(Refer BOQ)
30	Civil Works	(Refer BOQ)
31	Supply and installation / laying of RCC Hume Pipe NP3 class at road crossing, building wall for cable entry, complete with wall opening and sealing of pipe ends	(Refer BOQ)
32	Civil Works pertaining to the above work including excavation of earth, PCC bed around hume pipe inserts and back filling, compacting the earth as per specification and making good to original condition including asphalting/concreting at road crossings.	Refer BOQ)
33	Civil works pertaining to above electrical works, including chipping of wall, through holes etc and making good with plastering	Refer BOQ)
34	Fire stop compound for wall opening sealing	(Refer BOQ)
35	Supply and installation / laying of GI Pipe from transformer drain	(Refer BOQ)

Sl. No.	Item Description	Quantity
	valve to oil sump including valve chamber, civil works for excavation etc.	
Buy Back List		
36	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. 3C x 185 sq mm	130m
37	11kV HT Indoor Single Bus bar Switchgear	1 Nos
38	500kVA, 11kV/380-400-433V Power Transformer, Z=5.47%, with OCTC	1 Nos
39	500kVA, 11kV/380-400-433V Power Transformer, Z=4.61%, with OCTC	1 Nos
40	1000kVA, 11/0.433 kV Power Transformer, Z=5.33%, with OCTC	1 Nos
41	0.415 kV, 1600A AL BUSWAY	(Refer BOQ)
42	3C x 300 sq mm PVC AL ARM. LT CABLE	
43	415V LT Indoor Double Bus bar panel	1 Nos
44	Capacitor Panel	3 Nos.
45	500kVA Auxiliary Transformer (OLTC panel)	1 Nos.
46	Unused Cables Al conductor after identification by Engineer in charge (IISc)	(Refer BOQ)
47	Unused Cables Copper conductor after identification by Engineer in charge (IISc)	(Refer BOQ)
48	Iron/Steel Scrap Materials after identification by Engineer in charge (IISc)	(Refer BOQ)

2. 7 The highlighted equipments in Drg. No : PCPL-2013-4-GA-001 will be replaced with new ones.
2. 8 The work shall be carried out in accordance with drawings, specifications, installation notes, data sheets and price schedule enclosed with this document.
2. 9 The supply and installation of all equipment and systems shall conform to 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. 10 The CONTRACTOR shall furnish all the tools, welding equipment, rigging materials, testing equipment and test connections as required for complete installation, testing and commissioning of all the equipment in the specification.
2. 11 The contractor shall be responsible for obtaining statutory clearances from the concerned authorities including approval of drawings and documents from CEIG/ CEA and to obtain the safety certificate for charging the substation. Statutory fees and processing fees shall be reimbursed by Institute on production of Receipts.
2. 12 The CONTRACTOR shall be responsible for obtaining KPTCL's approval wherever required.
2. 13 Reference drawings enclosed as Bid document are as given below:

Drawing No.	Rev No	Title
PCPL-2013-4-GA-001	P0	General arrangement-Existing Key Plan

PCPL-2013-4-GA-002	P0	General arrangement-Proposed Key Plan
PCPL-2013-4-GA-003	P0	General arrangement-Proposed LV, HV & Transformers section
PCPL-2013-4-SLD-001	P0	Proposed Single Line Diagram
PCPL-2013-4-CT-001	P0	General Arrangement-Existing cable trench
PCPL-2013-4-CT-002	P0	General Arrangement-Proposed cable trench
PCPL-2013-4-GL-001	P0	SERC electrical room Earthing layout
PCPL-2013-4-LP-001	P0	SERC electrical room Lightning protection layout
PCPL-2013-C-RC-001	P0	Scheme for extension of building
PCPL-2013-4-SK-001	P0	SCADA Architecture

2. 14 EXCLUSIONS

- 2. 14. 1 Control Room Building Lighting -Interior and Exterior, Lighting Distribution.
- 2. 14. 2 Control Room Building Painting -Interior and Exterior
- 2. 14. 3 415 V DG Set and DG Switchgear augmentation.
- 2. 14. 4 Downstream loads such as UPS and HVAC fed from 415 V Main LV Panel and Sub Distribution Boards (These works are carried out under separate contract by C-DAC, only information is shared for the purpose of engineering)
- 2. 14. 5 Other items & scope not explicitly mentioned in this tender.

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 most stringent one shall prevail after identified and decided by engineer in-charge of IISc.
- 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 **Power Transformer:**
 - 3.3.1 Power Transformer, Off Circuit Tap Changer (OCTC) and its associated panel, shall conform to enclosed specification Section 6.4.1 and Section 6.4.2 along with Data Sheets.
 - 3.3.2 The transformers shall be SCADA compatible.
 - 3.3.3 All the interconnecting cabling for various instruments mounted on the transformer and Marshalling cabinet, OCTC and its local control cubicle shall be included in the scope of Bidder.
 - 3.3.4 All corresponding components of MB of same rating shall be interchangeable with one another.
 - 3.3.5 The finish shade for the transformer and its accessories shall be 632 of IS 5. The type of paint shall be epoxy coated.
 - 3.3.6 Bidders are required to offer transformer with level-3 losses as specified in IS:1180 standards. Bidder shall declare the Guaranteed losses figure in their bid.
 - 3.3.7 Institute reserves the right to reject the Transformer, if the losses exceed the guaranteed values plus tolerance as per Table-3 & Table-6 of latest IS 1180 (Part-1) / Table-1 of latest IS 2026 (Part-1).

- 3.3.8 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.
- 3.3.9 Valves shall be of gunmetal bodies with gunmetal fittings for all sizes. 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. 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.
- 3.3.10 Two (2) nos. of neutral terminals shall be provided on LV side. One neutral terminal shall be part of phase connection arrangement LV cable-box. Other neutral terminal shall be in a separate box and brought to tank bottom by means of earthing bar of 50x8 mm of copper, supported on 1.1 kV class polymer insulators mounted on transformer tank. The neutral earthing bar brought to the tank bottom for connection to station earth shall be provided with holes and suitable connecting hardware. This earthing bar shall have fork type arrangement at the end. However neutral shall be solidly grounded as per system requirement.
- 3.3.11 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.
- 3.3.12 Neutral CT Bidder to provide neutral bushing CT as per details given in data sheet – A for restricted earth fault protection or standby earth fault protection. In case neutral CT is tank mounted, CT box shall be weather proof having D.O.P. IP: 55. The Neutral CT box shall also be provided with a suitable canopy. CTs shall be cast resin type. All CTs (except WTI) shall be mounted in the turret of bushings, mounting inside the tank is not permitted.
- 3.3.13 Transformer shall be supplied with the essential spares listed at Data Sheet – A under section – 6.4.2.
- 3.3.14 The transformer shall be designed with IS tolerance on the impedance.
- 3.3.15 Flux density in any part of the core & yoke on any tap position with 10% voltage variation from voltage corresponding to the tap shall not exceed 1.9 Wb/m². Transformer shall also withstand following conditions due to combined voltage and frequency variations: Continuous operation for 110% flux density, At least 1 minute operation for 125% flux density and At least 5 sec. operation for 140% flux density
- 3.3.16 Vendor shall ensure availability of spare parts and maintenance support services for the offered equipment for at least 25 years from the date of supply.
- 3.3.17 Vendor shall give a notice of at least one year to the end user of equipment before phasing out the product/spares to enable the end user for placement of order for spares and services.
- 3.3.18 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.
- 3.3.19 Negotiation of technical parameters by Bidder after the bids are opened will not be entertained.
- 3.3.20 The technical bid without the documentation as stated in Clause-5.0 of this section and schedule of deviations for Technical Specification will be considered as incomplete and shall not be part of the Technical Bid evaluation.
- 3.3.21 The vendor shall keep their testing instruments duly calibrated. Calibration certificates shall be made available to the representative of IISc at the time of inspection.

3.4 HV Switchgear

3.4.1 The Switchgear shall conform to enclosed specification in section 6.5.1 for HV Indoor Switchgear along with data sheets in section 6.5.2 and Single Line Diagram as listed below:

SL. NO.	DRAWING NO.	TITLE
1	PCPL-2013-4-SLD-001	Proposed Single Line Diagram

3.4.2 METERING:

Tri-vector Meter (TVM) : 11 kV Switchgear-Incomer Feeder shall be provided with these meter and shall feature the basic parameters (V, A, Hz), Power parameters (kW, kVA, kVAr), Energy (kWh, kVAh, kVArh) parameters with accuracy class of **0.2s** and shall also indicate Maximum Demand and Harmonic Measurements.

Power Quality Meters (PQM): 11 kV Switchgear-Outgoing Feeder shall be provided with these meter and shall feature the basic parameters (V, A, Hz), Power parameters (kW, kVA, kVAr), Energy (kWh, kVAh, kVArh) parameters with accuracy class of **0.2** with Harmonic Measurements.

Harmonics Measurements capability of all the above meters shall be up to 32nd Harmonic.

All the TVM/LM/PQM mentioned above shall have Modbus-TCP/IP communication port to be interfaced with SCADA.

3.4.3 All the interconnecting cabling for various instruments mounted on the switchgear panel shall be included in the scope of BIDDER.

3.4.4 Bidders shall offer horizontal isolation and horizontal draw out indoor type breaker.

3.4.5 The offered switchgear shall be complete with suitably sized copper bus bars with HV insulated heat shrink sleeves of Raychem make throughout the length of the panels.

3.4.6 The bus bar chamber of each panel shall have a partition plate with seal off bushing to arrest arc and smoke travel to other panel in case of an insulation failure.

3.4.7 The panels shall be provided with 50x6 mm GS earth bus throughout the length of the switchboards for connecting to earth grid.

3.4.8 The panel shall be internal arc tested as per IS/IEC 62271-200 requirements for full short circuit current and for a duration of 1 second (minimum) and shall be qualified to comply with all the 5 criteria as per IS/IEC 62271-200. The panel shall also be AFLR tested as per IS/IEC 62271-200 requirements.

3.4.9 Safety barriers / shutters shall be provided to permit personnel to work safely within an empty compartment with the bus bars energised. Loss of Service Continuity (LSC) category of the switchgear shall be LSC2B as per IS/IEC-62271-200.

3.4.10 The panel shall be provided with Surge arresters as shown in the Single Line Diagram. The surge arrester shall be of Line Discharge Class 2 as per IS/IEC 60099, Rated Voltage (V_r) not less than 10kV, Continuous Operating Voltage (V_c) not less than 8kV and Single Impulse Energy capability not less than 5.5kJ/kV of rated voltage.

3. 4. 11 Cable sizes have been mentioned to size the cable termination chamber. Cable sealing kits will be supplied by BIDDER. Suitable cable clamping arrangement shall be provided in the cable chamber. The minimum height of cable termination points from Bottom of the panel shall be 750 mm. If OEM is unable to maintain 750mm, then a cable pan shall be considered.
3. 4. 12 BIDDER shall include the cost of one breaker transport trolley in their quoted price as per BOQ.
3. 4. 13 Protective equipments such as MCB's / RCBOs of suitable rating shall be used in the control circuits (AC/ DC).
3. 4. 14 One earthing truck each for cable side earthing and busbar earthing for specified breaker rating shall be quoted as per BOQ. The earthing truck shall consist of a voltage transformer, quick making earth switch, a buzzer and indicating lamps to warn the operator before the earth switch is closed in the event of presence of potential on the cable/bus to be earthed.
3. 4. 15 The indicating lamps shall be cluster type LED of suitable colour depending on the functions.
3. 4. 16 All control wiring for CT and other circuits shall be of minimum size 2.5 Sq mm flexible multi-stranded copper wire, FRLS-PVC insulated preferably of LAPP Cables.
3. 4. 17 Each panel shall be provided with danger sign label as per IS 2551, both at front and rear.
3. 4. 18 Each panel shall have name plate on both front and rear side with the letter size of minimum 25mm. Cable size shall be painted on each cable box chamber.
3. 4. 19 The switchgear shall be SCADA compatible. The circuit breakers and meters shall have facility for communication / interfacing with SCADA. The interface equipment for SCADA shall be suitable for MODBUS / OPEN Protocol.
3. 4. 20 The status of equipments like Circuit Breaker, Local/ Remote switches, Circuit Breaker Alarm and Trip Indications, Circuit Breaker operation commands, Supply Fail Indications, Circuit Breaker healthiness etc shall be made available to/from SCADA by providing necessary RTUs and any other necessary hardware required in the HV Switchgear.
3. 4. 21 Contact multiplication for the auxiliary contacts shall be achieved only through bi-stable auxiliary relay and not by means of air break contactors or mono-stable relays.
3. 4. 22 All corresponding components of cubicles of same rating shall be interchangeable with one another.
3. 4. 23 Breakers of identical ratings shall be interchangeable.
3. 4. 24 All secondary and auxiliary wiring terminals shall be of stud type.
3. 4. 25 20% spare terminal blocks shall be made available in each terminal block location for purchaser's use.
3. 4. 26 All unused terminals of all meters, instrumentation shall be wired out to the terminal blocks.
3. 4. 27 CT terminal blocks shall be of shorting link type.
3. 4. 28 Switchgear shall be extendable on both sides to add additional feeders later.
3. 4. 29 Front doors of all the panels shall be provided with padlocking facility.
3. 4. 30 No live parts shall be accessible on opening the panel door.
3. 4. 31 Necessary measurement shall be carried out by the successful bidder for existing panel dimensions.

3. 4. 32 The IEC 61850 compatible Relay make and model to be (a) Siemens -7SR1206 (b) GE- P141 (c) C&S - CSEZEN F-550 (d) ABB-REJ601

3. 4. 33 Bidder shall exclude Arc flash protection sensors and its associated relays. However,

3. 5 **MV Switchgear**

3. 5. 1 The MV switchgear shall conform to enclosed specification in section 6.6.1 along with data sheets in section 6.6.2.

3. 5. 2 MV Switchgear shall be 3 Phase, 415V, 50Hz, 4W, single front floor mounted type. The panels shall be of compartmentalised design conforming to Form 3b of IEC-61439.

3. 5. 3 METERING:

Power Quality Meters (PQM): Main LV Panel-Incoming Feeder shall be provided with these meter and shall feature the basic parameters (V, A, Hz), Power parameters (kW, kVA, kVAr), Energy (kWh, kVAh, kVAh) parameters with accuracy class of **0.2** with Harmonic Measurements.

Load Manager (LM) : Main LV Panel-outgoing and other feeders in SDB/AFPC Panel shall be provided with these meter and shall feature all the basic parameters (V, A, Hz), Power parameters (kW, kVA, kVAr), Energy (kWh, kVAh, kVAh) parameters with accuracy class of 0.5 and Harmonic Measurements.

Harmonics Measurements capability of all the above meters shall be up to 32nd Harmonic.

All the TVM/LM/PQM mentioned above shall have Modbus-TCP/IP communication port to be interfaced with SCADA.

3. 5. 4 Suitable sleeving of busbars shall be done with phase identification marking.

3. 5. 5 The incomer shall be Four Pole, fixed type, electrical operated EDO; spring charged Air Circuit Breaker (ACB).

3. 5. 6 ACB shall be provided with micro processor based over current, short circuit and earth fault protection (LSING) with independently adjustable current and time settings and also shall have communication ports.

3. 5. 7 ACB shall be electrically operated, motor assisted spring charged and electrically closing type.

3. 5. 8 All outgoings shall be Four Pole, fixed type, manually operated Air Circuit Breaker (ACB) / Moulded Case Circuit Breaker (MCCB).

3. 5. 9 MCCBs shall be manually operated, spring charged and manually closing type.

3. 5. 10MCCBs shall be provided with microprocessor based releases for overload, short circuit and earth fault protection (LSING) with independently adjustable current and time settings and also shall have communication ports.

3. 5. 11Electrical interlocking shall be provided as indicated in the single line diagram to prevent parallel operation.

3. 5. 12Current Transformers, Local / Remote selector switch, TNC switch and lockable type Emergency Push Buttons shall be provided on the incoming / outgoing feeders as indicated in SLD.

3. 5. 13ON, OFF, Auto Trip and R Y B indications shall be provided on the incoming / outgoing feeders as indicated in SLD. Other indicating lamps as indicated in SLD shall also be provided.
3. 5. 14ACB's and MCCB's shall be complete with integral phase barriers and terminal covers (supplied by switchgear manufacturer) for shrouding the live parts. No FRP sheets should be used for ACB/MCCB live part shrouding inside the switchgear compartment.
3. 5. 15In the event of non-availability of sufficient numbers of auxiliary contacts for MCCB / ACB, to meet the requirements of control & interlocking schemes, bidder shall use bi-stable relay for multiplication of contacts.
3. 5. 16Panel shall be provided with 10mm wide MIMIC diagram of colour violet (IS-5) on the front side of the panel.
3. 5. 17Switchgear panel shall be extendable on both sides to add additional panel later.
3. 5. 18 All corresponding components of cubicles of same rating shall be interchangeable with one another.
3. 5. 19 Breakers of identical ratings shall be interchangeable.
3. 5. 20All the meters shall be provided with communication port.
3. 5. 21Communication Cables for all meters as applicable shall be looped inside the panel and terminated at one place.
3. 5. 22Panel mounted indicating lamps shall be of cluster LED type.
3. 5. 23The entire control & power network have to be designed as a fuse less system. Hence, no control fuses shall be used in control circuits. MCBs / RCBOs of suitable rating are to be used for control circuits and PT secondary circuits in place of fuses.
3. 5. 24All control wiring shall be of minimum 2.5 Sq.mm FRLS PVC insulated stranded copper wire.
3. 5. 25All exposed live parts shall be provided with proper shrouding.
3. 5. 26All incoming and outgoing terminations shall be finger touch proof of suitable rating.
3. 5. 27All control terminal blocks shall be of push on cage type with a minimum size of 6sq.mm. CT terminal blocks shall be of shorting link type. Minimum 15% spare terminal blocks shall be provided.
3. 5. 28Inter panel barriers shall be provided in the bus-bar chamber.
3. 5. 29Control and instrument cables shall run in separate raceways.
3. 5. 30Suitable type and size of lugs shall be provided for end termination of wires depending upon the type of terminal ends.
3. 5. 31Terminal rubber boots of suitable size shall be provided for power cable terminations.
3. 5. 32All ACB and MCCB handles shall be pad lockable in OFF position. In addition to this, respective module door shall be interlocked with switch handle.
3. 5. 33The panel door shall be provided with single cylindrical key operated door locks.
3. 5. 34The panel rear cover shall be bolted type with module identification labels.
3. 5. 35All busbar and cable alley shall be identified with respective label at the front and rear side of the panel.
3. 5. 36“LIVE BUSBAR” sticker shall be provided on front and rear side of Busbar Alley.

3. 5. 37 All components of the Panel shall have identification tags.
3. 5. 38 All panel doors shall be earthed using 6 sq.mm flexible copper braid / 6 sq. mm flexible copper wire (green with yellow strip) to the panel frame.
3. 5. 39 Each section of the Panel shall be provided with 16A, 3-pin Switched Socket Outlet in Cable Alley.
3. 5. 40 Each cable alley shall be provided with Panel illumination lamp controlled by door limit switch.
3. 5. 41 The panel shall have external and internal finish as specified in Data Sheet A.
3. 5. 42 Panel shall be provided with danger plate on the front side as per relevant IS-2551 and complete with warning and voltage level in 3 languages (English, Hindi and Kannada). Details shall be furnished by the successful bidder.
3. 5. 43 The switchboard shall be supplied with the essential spares required for trouble free operation for 3 years.
3. 5. 44 Milli Volt Drop Test on all busbar joints shall be carried out for this panel.
3. 5. 45 All the interconnecting cabling for various instruments mounted on the switchgear shall be included in the scope of Bidder.
3. 5. 46 All CT terminals shall be wired through shorting type terminal blocks.
3. 5. 47 Metering: Incomer feeder shall be provided with digital multi function display meter type EM 6400NG of Schneider or equivalent.
3. 5. 48 The finish shade for the switchgear and its accessories shall be RAL 7032. The type of paint shall be powder coated.
3. 5. 49 The current ratings indicated for all the ACB's and MCCB's shall be in-panel rating and NOT FREE AIR RATING. Successful Bidder shall furnish type test certificates for all these equipment in support of rating selection.
3. 5. 50 Safety: All ACB and MCCB handles shall be pad lockable in OFF position.
3. 5. 51 Protection: The ACB / MCCBs shall be provided with short circuit, overload and earth fault protections with independently adjustable current and time settings. The ACB / MCCBs shall have microprocessor based releases.
3. 5. 52 The MV panel shall be provided with 75 x 10 mm GS earth bus throughout the length of the panel for connections to Purchaser's earth grid.

3. 6 Air Insulated Non Segregated Phase Bus Ducts (NSPBD)

3. 6. 1 The NSPBD shall conform to enclosed specification in section 6.9.1 along with data sheets in section 6.9.2.
3. 6. 2 The bus duct shall be installed partly outdoor and partly indoor. Wall frame assembly with seal off bushing shall be supplied.
3. 6. 3 The busduct shall be Air Insulated type, Metal enclosed 415 V, 4000A, 65kA, 3Phase +Neutral.
3. 6. 4 The enclosure shall be made out of minimum of 3mm thick non-magnetic Aluminium alloy or CRCA Sheet steel rectangular in shape.

3.6.5 The Enclosure shall be IP-54/IP-66 based weatherproof construction for Indoor/Outdoor respectively with automatically controlled space heaters.

3.6.6 The exterior finish of enclosure shall be RAL-7032 & black matt finish for interiors.

3.7 **Battery and Battery charger cum DCDB**

3.7.1 The Battery shall conform to enclosed specification in section 6.10.1 along with data sheets in section 6.10.2.

3.7.2 The Battery charger cum DCBC shall conform to enclosed specification in section 6.11.1 along with data sheets in section 6.11.2.

3.7.3 Battery charger shall be SMPS based Dual Float cum Boost Battery Charger Panel (Dual FCBC) Microprocess based Controller, LCD Display, with minimum of 120Ah Capacity 12V SMF Battery Bank along with Mild steel duly painted Battery Stand, Battery MCCB Junction Box, Interconnection DC Cabling work.

3.7.4 Integral DC Distribution Board with minimum of 12Nos 16A DP MCB so as feed panel loads shall be part of Battery charger.

3.8 **Supply and Installation of Cables**

3.8.1 HV Power Cables:

- a) The cables shall be 11kV, Un-Earthing grade, XLPE insulated, screened, armoured, PVC sheathed and shall conform to enclosed specification Section 6.7.1 and associated data sheets.
- b) The cable sizes and quantities shall be as furnished in Section-7.1.
- c) Heat shrinkable type straight through joints shall be supplied wherever mentioned in Section-7.1.
- d) Heat shrinkable type cable termination kits shall be supplied as furnished in Section-7.1.

3.8.2 MV Power Cables:

- a) The Cables shall be 1100 Volt grade, XLPE insulated, FRLS-PVC sheathed and shall conform to enclosed specification Section 6.8.1 and associated data sheets.
- b) The cable sizes and quantities shall be as furnished in Section-7.1.
- c) The cable termination shall be as furnished in Section-7.1.

3.8.3 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.

3. 8. 4 Cable size and cable number shall be marked near cable termination.
3. 8. 5 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).
3. 8. 6 Cable carrier system sizing shall be carried out considering 20% empty space for addition of future cables.
3. 8. 7 The installation of the cabling system shall be in accordance with the following specifications:
 - a) Section 6.15.2: Cabling system.
 - b) Section 6.17.1: Cable Installation Notes.
3. 8. 8 All cable schedules and interconnection schedules shall be submitted for approval.
3. 8. 9 The following formats will be furnished by Institute during detailed engineering for Contractor to fill in and submit for Institute's reference and records:
 - a) Cable schedule.
 - b) 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. 9 Equipment Marshalling Boxes

3. 9. 1 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.
3. 9. 2 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.
3. 9. 3 The indicating lamps shall be cluster LED type of suitable colour depending on the functions.
3. 9. 4 All control wiring 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.
3. 9. 5 All power & control cabling shall be with finger touch proof terminations. The instrumentation, meters, switches, etc., used shall have terminal shrouding for human safety.
3. 9. 6 Contact multiplication for the auxiliary contacts to be achieved only through bi-stable relay and not by means of air break contactors.
3. 9. 7 All un-used terminals of all relays, meters, instrumentation shall be wired out to the terminal blocks

3. 10 Earthing And Lightning Protection System

3. 10. 1 All the materials required for the system earthing and lightning protection system shall be supplied, installed and commissioned.

3. 10. 2 The installation work shall include unloading, storing, laying, fixing, joining/terminations, testing and commissioning of the safety earthing system and lightning protection system for substation, building and allied structures. All welding/brazing equipment, necessary tools and testing equipment shall be furnished by the CONTRACTOR.
3. 10. 3 Existing earthing and lightning protection 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.
3. 10. 4 The supply and installation work shall be carried out in accordance with the following specification:
 - i) Section 6.13.2: Earthing and Lightning protection.
 - ii) Section 6.16.2: Earthing and Lightning protection system installation notes.
3. 10. 5 Lightning protection layout if required will be furnished to the successful bidder.
3. 10. 6 The bidder shall quote for the earthing and lightning protection materials required for the substation as per the quantity indicated in Section-7.1.
3. 10. 7 Successful bidder shall carryout the soil resistivity measurements before commencement of site works and carryout the earthing design based on the measured soil resistivity and submit for purchasers approval.
3. 10. 8 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). 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.
3. 10. 9 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.

3. 11 SERC Electrical room Equipment

- a) 11KV Main HT panel
- b) 415V Main LT panel
- c) 415V Sub Distribution Board
- d) 415V Automatic Power Factor Correction (APFC) Panel -1 (765 KVar)
- e) 415V Automatic Power Factor Correction (APFC) Panel -2 (465 KVar)
- f) 110V Battery, Battery charger and DCDB board
- g) Panels/equipment dedicated for Supervisory Control and Data Acquisition system (SCADA)

New panels/equipment as per SLD Drg. No. PCPL-2013-4-SLD-001 and description in section 7.1

3. 12 Erection, testing and commissioning

3. 12. 1 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.
3. 12. 2 All checks and tests as per manufacturer'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.
3. 12. 3 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. 13 Civil Works

3. 13. 1 The following works shall be included in the scope of Electrical Contractor :
 - a) Civil works for foundations for all equipments.
 - b) Civil works for installation of earthing, lightning protection and lighting systems.
 - c) Civil works associated with the electrical installation work.
 - d) Civil works for cable trenches, Duct banks and buried cables
 - e) Civil works for burnt oil tank, fire resistant walls for transformers and sump tank.
 - f) Civil works for Road crossings for cable trench and for Hume pipes of cable laying.
 - g) Other works as specified in Document "Specific Technical Requirement (Civil)
3. 13. 2 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.
3. 13. 3 Detailed scope/requirement for civil works for the project has been furnished in Specific Technical Requirement-Civil Works (Section 6.3.2).

3. 14 SCADA System

3. 14. 1 The Supervisory Control and Data Acquisition System (SCADA) shall conform to enclosed specifications Section 6.3.3 and Section 6.18.1.along with Data Sheets.
3. 14. 2 The SCADA shall also conform to with the drawings and data sheets listed in the specification.

3. 15 Temporary Power Supply

3. 15. 1 Providing Compact RMU Substation with 11kV VCB, Transformer and 415V Outgoing Feeders as a Temporary Power Supply arrangement to IISc SERC Building and other Critical loads identified by Engineer In Charge and making all temporary cabling interconnection for the duration as required for project re-vamping. Power at 11kV level shall be provided at one place by IISc. The load list shall be collected from IISc SERC for arriving at the ratings of CSS.

4. 0 APPROVED MAKES:

Sl. No.	Equipment	Preferred makes
1.	Distribution Transformer	Tesla/Kirloskar/INDOTECH Transformers / IMP Powers / Toshiba T&D/Transformers & Rectifiers / Bharat Bijlee
2.	Transformer Bushings	CJI/Bangalore Transformers
3.	Buchholz Relay	Atvus/ Sukrut/ Press-N-Forge
4.	WTI/ OTI	Atvus/ Sukrut/ Press-N-Forge/Precimeasure
5.	PRD	Atvus/ Sukrut/ Press-N-Forge
6.	Relays (IEC 61850 compatible)	a. Siemens (Model no.7SR1206) b. GE (Model no.P141) c. C&S (Model no CSEZEN F-550)
7.	Interposing transformers, Auxiliary instrument transformers & Control transformers.	Intrans/ Kappa/ Prayog/ Kalpa
8.	Selector Switches, Push buttons, actuators Ind. Lamps	Kaycee /Areva/ Siemens/ Schneider
9.	Meters & Instruments,	Siemens/ Schneider/ AE
10.	Annunciation Facia type	Alan/Procon/ Digicont/ Aplab/ Larsen & Toubro
11.	Terminal Blocks	Phoenix/ Wago/Elemex/Connectwell
12.	MCB, RCBO, ELCB, Contactors	Siemens/ ABB/ Schneider/ MDS Legrand
13.	Enclosure	Rittal/ Schneider/ Siemens/ Abb/ EI Steel/ Hensel (For Outdoor)
14.	Cable Trays	Profab/ MDS Legrand
15.	Switches & sockets	MDS Legrand/ MK Germany/ Clipsal
16.	Panel space heaters	Rittal
17.	Hygrostat	Rittal
18.	11KV UG Cable	Polycab / KEC RPG/ Universal/ Ravin/ CCI / NICCO
19.	11kV Class termination and jointing kits	Raychem RPG/ Compaq International/BBS Cellpack
20.	415V Power and Control, Instrument Cables	RR Kabel / LAPP / KEI / Havells
21.	Cable Glands	Baliga/ Comet
22.	Cable lugs	Dowell/ Amp
23.	Lighting	Philips/ CGL Wipro
24.	11KV HT panel with VCBs	Schneider/ Siemens
25.	Air Circuit Breaker	Schneider / Siemens
26.	MCCB/MCB/ELCB	Schneider / Siemens
27.	Power & Aux Contactor	Schneider / Siemens / ABB
28.	Wall mounted DBs	MDS Legrand / Siemens / Schneider / ABB
29.	Switches / Sockets / Boxes	ABB / Siemens / Legrand / Schneider
30.	Terminal connectors / Glands	Wago / Phoenix / Connectwell
31.	Indicating Lamps / Push buttons	Siemens / ABB/ Schneider / Teknic
32.	Bushings / Insulators	Modem / BHEL / WSI / Jayashree / IEC
33.	Trivector Meter	L&T / Secure Meters
34.	Analog & Digital meters	Siemens / Schneider (Digital) / AE (Analog)
35.	Battery Set	Amara Raja / Exide / HBL Power Sys

Sl. No.	Equipment	Preferred makes
36.	Battery Charger	Amara Raja / HBL Power Sys / Caldyne
37.	Instrument Transformers	Kappa / Pragathi / Kalpa
38.	Capacitor Bank	Epcos/Shreem Capacitors/Universal/Abb/Schneider
39.	ACDB & DCDB	Banavathy Power Systems, Svg Control Systems, Lakshmi Control & Instrument, Selmount Power Systems, Khoday Control Systems
40.	Steel	SAIL/ VSP / TISCO/ESSAR
41.	RMU	Schneider / Eaton / Siemens
42.	MS Conduits & Accessoires, Cable lugs	AMP / Dowells
43.	Temp. Scanner	Masibus/Precimeasure
44.	Insulation	Dupont /3M
45.	Fasteners	TVS / Internationally reputed
46.	Glass wool	Twaiga / Lloyd / eqt.
47.	SCADA Software	SCHNEIDER/SIEMENS/GE/Inductive Automation.
48.	Small Power UPS for SCADA	APC/Emerson (Vertiv)/Socomec.
49.	PC Workstation and Printer	DELL /HP
50.	19 Inch Rack for SCADA	Rittal/Hoffman/MPP

Note: Makes of the component shall be same across equipments.

4.0 INSPECTION AND TESTING:

4.1 General

4.1.1 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.

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

4.2 Test Reports:

4.2.1 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.

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

- A description of the test equipment with diagram showing arrangement of the test instruments and devices.
- Sample computations, wherever necessary to show the test values employed in the equations.
- Curves showing relation of tested quantities.
- Data in tabulated form.
- The comparison of the test results with the guaranteed requirements of the specification and explanation of deviations, if any.

4.4 Shop Tests:

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

4.5 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.

4.6 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.

4.7 Inspection By Project Engineer cum Estate officer

- a) The Project Engineer cum Estate officer will do inspection at the hold points during manufacture as per approved QAP.
- b) The Project Engineer cum Estate officer will witness the type and routine tests as well as other shop tests as per approved QAP.
- c) The Project Engineer cum Estate officer 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.

5.0 DOCUMENTATION:

5.1 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.

5.2 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.

6.0 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.

7.0 QUANTITY VARIATION:

- 7.1 The quantities for supply and installation are furnished at Section-7.0. The bidder shall quote unit rates for all items. The unit rate schedule shall be binding for any quantity variation.
- 7.2 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.
- 7.3 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.
- 7.4 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.

8.0 PERFORMANCE GUARANTEE:

The equipment shall have a warranty of 12 months from the date of commissioning.

11.3.2 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 HV & MV Switchgears, Transformers and power cables in SERC S/S with new ones. The proposed layout is shown in the drawing No. PCPL-2013-4-GA-003 and PCPL-2013-C-RC-001.

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

1.2 Demolition of existing two (2) foundations of transformers.

1.3 Construction of 2 new foundation for 2500 MVA and 1500 MVA transformers.

1.4 Demolition of walls between existing building and proposed extension of building by providing steel beams for supporting the existing roof slab.

1.5 Construction of extended portion of building along with cable trenches.

1.6 Construction of Burnt Oil pit with necessary pipes chambers from transformers.

1.7 All other minor works related to panel foundations, modification of cable trench if required etc.

1.8 Laying of Hume Pipe.

2.0 EARTHWORK SPECIFICATION :

2.1 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.

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

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

2.2.2 IS-3764 - Safety code for excavation works.

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

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

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

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

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

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

2.3 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.

2.4 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.

2.5 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.

2.6 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.

2.7 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.

2.8 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.

2.9 Earthwork is classified under any of the following categories:

2.9.1 Ordinary & Hard Soils: - These include all kinds of soils containing Kankar, sand silt, murru 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.

2.9.2 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.

2.9.3 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.

2.10 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.

2.11 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.

2.12 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 steep 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.

- 2.13 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.
- 2.14 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.
- 2.15 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.
- 2.16 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 murru or earth to fill up the voids and the mixture used for filling.
- 2.17 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.
- 2.18 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.
- 2.19 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.
- 2.20 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.

- 2.21 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.
- 2.22 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.
- 2.23 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.
- 2.24 Filling of the trenches shall be carried simultaneously on both sides of the pipe to avoid unequal pressure on the pipe.
- 2.25 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.
- 2.26 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.
- 2.27 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.
- 2.28 Field compaction test shall be carried out at different stages of filling and also after the fill to the entire height has been completed.
- 2.29 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.
- 2.30 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.
- 2.31 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 area 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.

- 2.32 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.
- 2.33 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.
- 2.34 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.
- 2.35 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.
- 2.36 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.
- 2.37 Actual quantity of consolidated sand filling shall be measured and paid.

3.0 DEWATERING SPECIFICATIONS

- 3.1 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.
- 3.2 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.

4.0 SPECIFICATIONS FOR STRUCTURAL CONCRETE WORKS

4.1 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.

4.2 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.

- 4.2.1 I.S. 269 Specification for ordinary, rapid hardening and low heat Portland cement
- 4.2.2 I.S. 650 Specification for standard sand for testing of cement
- 4.2.3 I.S. 383 Specification for coarse and fine aggregates from natural sources for concrete
- 4.2.4 I.S. 2386 (Part I to VIII) Methods of test for aggregates for concrete.
- 4.2.5 I.S. 516 Methods of test for strength of concrete
- 4.2.6 I.S. 1199 Methods of sampling and analysis of concrete
- 4.2.7 I.S. 3025 Methods of sampling and testing (physical and chemical) water used in industry
- 4.2.8 I.S. 432 (Part I & II) Specification for mild steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement.
- 4.2.9 I.S. 1139 Specification for hot rolled mild steel and medium tensile steel deformed bars for concrete reinforcement
- 4.2.10 I.S. 1566 Specification for plain hard drawn steel wire fabric for concrete reinforcement
- 4.2.11 I.S. 1785 Specification for plain hard drawn steel wire for pre-stressed concrete
- 4.2.12 I.S. 1786 Specification for cold twisted steel bars used in pre-stressed concrete
- 4.2.13 I.S. 2090 Specification for high tensile steel bars used in pre-stressed concrete
- 4.2.14 I.S. 4990 Specification for plywood for concrete Shuttering work
- 4.2.15 I.S. 2645 Specification for integral cement water Proofing compounds
- 4.2.16 I.S. 1791 Specification for batch type of concrete Mixers
- 4.2.17 I.S. 2438 Specification for roller pan mixer
- 4.2.18 I.S. 2505 Specification for concrete vibrators immersion type
- 4.2.19 I.S. 2506 Specification for creed board concrete Vibrators
- 4.2.20 I.S. 2514 Specification for concrete vibrating tables
- 4.2.21 I.S. 3366 Specification for pan vibrators
- 4.2.22 I.S. 4656 Specification for form vibrators of concrete
- 4.2.23 I.S. 2722 Specification for portable swing, weigh-batchers for concrete (single and double bucket type)
- 4.2.24 I.S. 2750 Specification for steel scaffoldings

- 4.2.25 I.S. 456 Code of practice for plain and reinforced concrete.
- 4.2.26 I.S. 1343 Code of practice for pre-stressed concrete
- 4.2.27 I.S. 3370 (Parts I to V) Code of practice for concrete structures for storage of liquids
- 4.2.28 I.S. 3935 Code of practice for composite construction
- 4.2.29 I.S. 34201 Criteria for design & construction of precast concrete trusses
- 4.2.30 I.S. 2204 Code of practice for construction of reinforced shell roof
- 4.2.31 I.S. 2210 Criteria for design of R.C. Shell structures and folded plates
- 4.2.32 I.S. 2751 Code of practice for welding of mild steel bars used for reinforced concrete construction
- 4.2.33 I.S. 2502 Code of practice for bending and fixing of bars for concrete reinforcement
- 4.2.34 I.S. 3558 Code of practice for use of immersion vibrators for consolidating concrete
- 4.2.35 I.S. 3414 Code practice for design and installation of joints in buildings.
- 4.2.36 I.S. 4014 (Parts I & II) Code of practice for steel tubular scaffolding.
- 4.2.37 I.S. 2571 Code of practice for laying in-situ cement concrete flooring
- 4.2.38 I.S. 3696 (Parts I & II) Safety code for scaffolds and ladders
- 4.2.39 I.S. 1200 Method of measurement of building work
- 4.2.40 I.S. 3385 Code of practice for measurement of Civil engineering works

4.3 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.

4.4 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.

4.5 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.

4.6 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.

4.7 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.

4.8 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.

4.9 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.

4.10 Definition of different aggregates:

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

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

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

4.11 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.

4.12 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.

4.13 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.

4.14 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.

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

4.16 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.

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

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

4.18.1 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

4.18.2 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

4.19 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.

4.20 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, 2.36 mm, 1.18 mm, 600 micron, 300 micron, 150 micron and dividing the sum by 100.

4.21 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.

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

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

4.24 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.

4.25 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.

4.26 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.

4.27 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.

4.28 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.

4.29 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 :

4.29.1 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 SO_4)	0.50	20
Alkali, Chlorides (as Cl)	0.01	24

4.30 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.

4.31 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.

4.32 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.

4.33 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.

- 4.34 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.
- 4.35 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.
- 4.36 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.
- 4.37 Erected and secured reinforcement shall be inspected and approved by Owner prior to placement of concrete.
- 4.38 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.
- 4.39 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.
- 4.40 Minimum compressive strength of 15 cm. cubes at 7 and 28 days after mixing, conducted in accordance with IS. 545

Class	Preliminary		Works test		Maximum size of aggregate mm
	Test kg/cm ²		kg/cm ²		
	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.

- 4.41 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.
- 4.42 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.
- 4.43 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.
 - 4.44 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 1 part in 1000 parts.
 - 4.45 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.
 - 4.46 The consistency of each batch of concrete shall be measured immediately after mixing, by the slump test in accordance with I.S.1199.
 - 4.47 Concrete test cubes shall be moulded by placing fresh concrete in the mould and compacted as specified in I.S.516.
 - 4.48 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.
 - 4.49 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.

4.50 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.

4.51 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.

4.52 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.

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

4.54 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.

4.55 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.

4.55.1 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

4.56 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.

4.57 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.

- 4.58 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
- 4.59 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.
- 4.60 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.
- 4.61 Slump tests shall be carried out immediately after sampling.
- 4.62 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.
- 4.63 Where specified and approved by Owner, suitable air entraining 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
- 4.64 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.
- 4.65 Where specified and approved by Owner, retarding agents shall be added to concrete mix in quantities specified by Owner.
- 4.66 Where specified and approved by Owner, water proofing agent conforming to IS.2645, shall be added in quantities specified by Owner.
- 4.67 Owner may at his discretion instruct the Contractor to use any other admixture in the concrete.
- 4.68 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.

4.69 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.

4.70 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.

4.71 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.

4.72 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.

4.73 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

4.74 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.

4.75 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.

4.76 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.

- 4.77 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.
- 4.78 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.
- 4.79 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.
- 4.80 Slots, openings, holes, pockets etc., shall be provided in the concrete work in the positions indicated in the drawings or as directed by Owner.
- 4.81 Reinforcement and other items to be cast in concrete shall have clean surfaces that will not impair bond.
- 4.82 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.
- 4.83 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.
- 4.84 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.
- 4.85 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.
- 4.86 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.
- 4.87 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.

- 4.88 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.
- 4.89 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.
- 4.90 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.
- 4.91 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.
- 4.92 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.
- 4.93 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 principle 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.
- 4.94 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.
- 4.95 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.
- 4.96 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.
- 4.97 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 sides 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 vertical: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.

4.98 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.

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

4.100 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 care 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.

4.101 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.

4.102 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.

4.103 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.

4.104 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.

4.105 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.

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

4.107 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.

- 4.108 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.
- 4.109 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.
- 4.110 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.
- 4.111 When placing concrete through reinforcing steel, care should be taken to prevent segregation of the coarse aggregate.
- 4.112 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.
- 4.113 Concrete shall be placed without interruption until completion of the work between predetermined construction joints, as specified hereinafter.
- 4.114 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.
- 4.115 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.
- 4.116 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.
- 4.117 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.

- 4.118 Dowels for construction work not likely to be taken up in the near future, shall be wrapped in tar paper & burlap.
- 4.119 Mass foundations shall be poured in lifts not exceeding 0.5 M in height unless otherwise indicated on drawings or approved by Owner.
- 4.120 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.
- 4.121 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.
- 4.122 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.
- 4.123 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.
- 4.124 Curing of concrete made of high alumina cement and super sulphated cement shall be carried out as directed by Owner.
- 4.125 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.
- 4.126 Ample water supply should be assured under pressure in pipes if required, with all necessary appliances of hose, spraying devices.
- 4.127 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.
- 4.128 All equipment, men, materials required for curing shall be on hand and ready for use before concrete is placed.
- 4.129 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

- 4.130 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.
- 4.131 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.
- 4.132 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.
- 4.133 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.
- 4.134 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.
- 4.135 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.
- 4.136 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.
- 4.137 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.

4.138 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.

4.139 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.

4.140 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.

4.141 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, subfloors 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.

4.142 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.

4.143 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.

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

4.145 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.

4.146 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.

4.147 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
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11. In consecutive steps –

Rise - Minus 3 mm, Tread – minus 3 mm	
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4.148 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

- 4.149 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.
- 4.150 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.
- 4.151 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.
- 4.152 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.
- 4.153 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.
- 4.154 Excessive construction camber to compensate for shrinkage, settlement, etc, which may impair the structural strength of members, will not be permitted.
- 4.155 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.
- 4.156 Where exposed concrete finishes are required, the forms shall be constructed with special care so that the resulting concrete surfaces require a minimum finish.
- 4.157 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.
- 4.158 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.
- 4.159 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.
- 4.160 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.

- 4.161 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.
- 4.162 Vertical construction joints or faces which will be exposed after the completion of the work shall be chamfered except where not permitted by Owner.
- 4.163 Wire ties passing through the walls are not allowed. In their place bolts passing through sleeves may be used.
- 4.164 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.
- 4.165 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.
- 4.166 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.
- 4.167 In normal circumstances (generally where temperatures are above 20°C) forms may be struck after expiry of the following period. :
 - 4.167.1 Walls, Columns and vertical sides of beams, 24 to 48 hours footings, pile caps etc.
 - 4.167.2 Sides of walls which are cast against earth
 - a) Beam soffits 18 days
 - b) Slabs 10 days
- 4.168 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.
- 4.169 Reinforced temporary openings shall be provided, as directed by Owner, to facilitate removal of formwork which otherwise may be inaccessible.
- 4.170 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.
- 4.171 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.
- 4.172 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.
- 4.173 Where concrete has to rest on rock, just the rock surface shall be cleaned with high pressure water and air jet.

- 4.174 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.
- 4.175 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.
- 4.176 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.
- 4.177 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.
- 4.178 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.
- 4.179 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.
- 4.180 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.
- 4.181 Under all ordinary conditions all foundations shall be dewatered and concrete placed in the dry.
- 4.182 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.
- 4.183 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 overstress or otherwise affect seriously the strength of the precast units. The reinforced side of the units shall be clearly marked.
- 4.184 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.
- 4.185 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.

- 4.186 All materials, workmanship and finished construction shall be subject to the continuous inspection and approval of Owner.
- 4.187 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.
- 4.188 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.
- 4.189 Upon the completion of the concrete work, all forms, equipment, construction tools, protective coverings and any debris resulting from the work shall be removed from the premises.
- 4.190 All debris, i.e. empty containers, scrap, wood, etc. shall be removed to "dump" daily.
- 4.191 The finished concrete surfaces shall be left in a clean condition satisfactory to Owner.
- 4.192 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.
- 4.193 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.
- 4.194 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.

5.0 GENERAL BUILDING WORKS SPECIFICATIONS:

- 5.1 This specification covers the general requirement for brick and stone masonry, plastering, flooring, doors, windows, ventilators, wood work, water proofing, false ceiling, painting and such other related works forming a part of this job, which may be required to be carried out though not specifically mentioned above. The work under this specification shall consist of furnishing of all tools, plants, labour, materials, any and everything necessary for carrying out the work.
- 5.2 Applicable codes and specifications
- 5.2.1 The following codes, standards and specifications are made a part of this specification. All standards, tentative specifications, specifications, codes of practices referred to herein shall be the latest edition including all applicable official amendments and revisions.
- 5.2.2 In case of discrepancy between this specification and these referred to herein, this specification shall govern.

- IS: 1077 Common burnt clay building bricks.
- IS: 3102 Classification of burnt clay bricks
- IS: 2180 Burnt clay building bricks, heavy duty.
- IS: 3495 Methods of sampling and testing clay building bricks.
- IS: 2691 Burnt clay facing bricks.
- IS: 2212 Code of practice for brick work.
- IS: 2185 Load bearing hollow concrete blocks
- IS: 5498 Lime-Cement-Cinder hollow concrete blocks.
- IS: 3115 Lime-Cement Cinder solid blocks.
- IS: 1597 Code of practice for construction of stone masonry (Part I)
- IS: 2394 Code of practice for application of lime plaster finish.
- IS: 2645 Integral cement water proofing compounds.
- IS: 1443 Code of Practice for laying and finishing of cement concrete flooring tiles.
- IS: 2114 Code of practice for laying in sity terrazzo floor finish.
- IS: 777 -Glazed Earthenware tiles.
- IS: 4021 Timber door, window and ventilator frames.
- IS: 2202 Wooden flush door shutters (Solid core type) Part I.
- IS: 1003 Timber panelled and glazed shutters. (Parts I & II)
- IS: 4020 Methods of tests for wooden flush doors: Type tests
- IS: 1761 Transparent sheet glass for glazing and framing purposes.
- IS: 4351 Steel door frames.
- IS: 1038 Steel doors, windows and ventilators,
- IS: 1081 Code of practice e for fixing and glazing of metal(Steel and aluminium) doors, windows and ventilators
- IS: 5807 Methods of test clear finishes for wooden furniture (Parts I & III)
- IS: 1477 Code of practice for painting of ferrous metals in buildings and allied finished (Parts I & II)
- IS: 2338 Code of practice for finishing of wood and wood-based materials (Part I)
- IS: 427 Code of practice for painting of ferrous metals in buildings and allied finished (Parts I & II).
- IS: 428 Distemper, oil emulsion, colour as required.
- IS: 2395 Code of practice for painting concrete, masonry and plaster surfaces.
- IS: 3384 Bitumen primer for use in water proofing and damp-proofing.
- IS: 1580 Bituminous compounds for water proofing and caulking purposes.
- IS: 1322 Code of practice for water proofing of roof with bitumen felts.

5.3 Brick work: Bricks used in works shall conform to the relevant Indian Standard. They shall be sound, hard, homogenous in texture, well burnt in kiln without being vitrified, table moulded, deep red; cherry or copper coloured, of regular shape and size and shall have sharp and square edges and parallel faces.

The bricks shall be free from pores, chips, flaws or humps of any kind. Bricks containing ungrounded particles and/ or which absorb water more than 1/6th of their weight when soaked in water for twenty four hours shall be rejected. Over burnt or under burnt bricks shall be liable to rejection. The bricks shall give a clear ringing sound when struck and shall have a minimum crushing strength of 35 kg/sq.cm unless otherwise noted in drawings.

- 5.3.1 The size of the brick shall be 23.0 x 11.5 x 7.5cm unless otherwise specified; but tolerance upto \pm 3 mm in each direction shall be permitted. However, bricks conforming in size to IS-1077 could be used. Bricks shall be provided with frogs. Only full size bricks shall be used for masonry work. Bricks bats shall be used only with the permission of the Institute / Project Engineer cum Estate Officer to make up required wall length or for bonding. Sample bricks shall be submitted to the Institute / Project Engineer cum Estate Officer for approval and bricks supplied shall conform to approved samples. If demanded by Project Engineer cum Estate Officer, brick sample shall be got tested as per IS 3495 by CONTRACTOR at no extra cost the Institute. Bricks rejected by Project Engineer cum Estate Officer shall be removed from the site of works within 24 hours.
- 5.3.2 Mortar: Mortar for brick masonry shall be prepared as per IS 2250. Mix for cement mortar shall be as specified in the respective items of work. Gauge boxes for sand shall be of such dimensions that one completed bag of cement containing 50 kgs. Of cement forms one unit. The sand shall be free from clay, shale, loam, alkali and organic matter shall be of sound, hard, clean and durable particles. Sand shall be approved by the Institute / Project Engineer cum Estate Officer. If so directed by the Project Engineer cum Estate Officer, sand shall be thoroughly washed till it is free of any contamination.
- 5.3.3 For preparing cement mortar, the ingredients shall first be mixed thoroughly in dry condition. Water shall then be added and mixing continued to give a uniform mix of required consistency. Cement mortar shall preferably be machine mixed, though hand mixing in a thorough manner may be allowed. The mortar so mixed shall be used within 25 minutes of mixing. Mortar left unused in the specified period shall be rejected.
- 5.3.4 The CONTRACTOR shall arrange for test on mortar samples if so directed by the Project Engineer cum Estate Officer.
- 5.3.5 Workmanship: All bricks shall be thoroughly soaked in clean water for at least one hour immediately before being laid. The cement mortar for brick masonry work shall be as specified in the respective item of work. Brick work 230 mm thick and over shall be laid in English Bond unless otherwise specified. 115 mm thick work shall be laid with stretchers. For laying bricks, a layer of mortar shall be spread over the full width of suitable length of the lower course. Each brick shall be pressed into the mortar and shoved into final position so as to embed the brick fully in mortar. Bricks shall be laid with frogs uppermost.
- 5.3.6 All brickwork shall be plumb, square and true to dimensions shown. Vertical joints in alternate courses shall come directly one over the other and be in line. Horizontal courses shall be levelled. The thickness of brick courses shall be kept uniform. For walls of thickness greater than 230 mm both faces shall be kept in vertical planes. All interconnected brickwork shall be carried out at nearly one level (so that there is uniform distribution of pressures on the supporting structures) and no portion of the work shall be left more than one course lower than the adjacent work. Where this is not possible, the work shall be raked back according to bond (and not saw toothed) at an angle not exceeding 450. But in no case the level difference between adjoining walls shall exceed 1.25 M. Workmanship shall conform to IS 2212.
- 5.3.7 Bricks shall be so laid that all joints are well filled with mortar. The thickness of joints shall not be less than 6 mm and not more than 10 mm. The face joints shall be raked to a minimum depth of 12 mm by raking tools daily during the progress of work when the mortar is still green, so as to provide a proper key for the plaster of pointing to be done. When plastering or pointing is not required to be done. The joints shall be uniform in thickness and be struck flush and finished at the time of laying. The face of brickwork shall be cleaned daily and all mortar droppings removed. The surface of each course shall be thoroughly cleaned of all dirt before another course is laid on top. If the mortar in the lower course has begun to set, the joints shall be raked out to a depth of 12 mm before another course is laid.
- 5.3.8 All brickwork shall be built tightly against columns, floor slabs or other structural members.

- 5.3.9 Where drawings indicate that structural steel columns are to be fireproofed with brickwork, the brick shall be built closely against all flanges and webs with all spaces between the steel and brickwork filled solid with mortar. Steel members partly embedded in brickwork and not indicated to be fireproofed with concrete, shall be covered with not less than 12 mm thick mortar unless directed otherwise by Project Engineer cum Estate Officer.
- 5.3.10 Miscellaneous inserts in masonry e.g. sleeves, wall ties, anchors, conduits, structural steel, steel lintels etc. shall be installed by the CONTRACTOR at no extra cost to the Institute. Furnishing of any of these inserts by the CONTRACTOR will be paid for separately. Openings, arches, etc. shall be provided as shown on the drawings. Chases, pockets, etc. shall be provided as shown on the drawings to receive windows, louvers, door frames etc. Wall ties and flashings shall be built into the brickwork in accordance with the drawings and specifications. It shall be clearly understood that the rates quoted by the CONTRACTOR include for fixing of inserts, leaving openings, cutting chases in brickwork for various trades etc.
- 5.3.11 Facing brickwork: Facing bricks of the type specified shall be laid in the positions indicated on the drawings and all facing brickwork shall be well bonded to the backing bricks. No facing brickwork shall at any time be more than 600 mm above the backing brickwork.
- 5.3.12 All facing brickwork shall be pointed as the work proceeds and internal faces of the brickwork shall be pointed with neat flush joint to give a fair face.
- 5.3.13 Faced work shall be kept clean and free from damage, discolouration etc. at all times. The CONTRACTOR shall fill carefully all holes with bricks similar to the surrounding brickwork, point brick work as required.
- 5.3.14 For facing brickwork, double scaffolding shall be used. No holes in brickwork for scaffolding shall be permitted.
- 5.3.15 The green work shall be protected from rain by suitable covering. Bricks shall be kept constantly moist on all faces for a minimum period of ten days. Brick work shall not be raised more than one metre per day.
- 5.3.16 The rates quoted by the CONTRACTOR are exclusive of transoms and mullions. CONTRACTOR shall provide the same as shown or indicated on the drawings. These shall be generally provided only in half and full brick walls. Dimensions of the transoms and mullions shall conform to the thickness of the wall. Concrete work for transoms and mullions shall conform to the specifications for concrete and shall be of grade M 20.
- 5.3.17 Where shown on the structural drawings, bricks for partition walls shall be stacked adjacent to the structural member to pre-deflect the structural member before the wall is built.
- 5.3.18 Measurement: Brick work of thickness one brick i.e. 230 mm and above shall, unless otherwise stated in the Schedule of Quantities, be paid in units of cu.m or part thereof. Brickwork of thickness less one brick i.e. less than 230 mm thick shall be measured and paid on the basis of rates quoted per sq.m or thereof. In all cases, the quantities measured and paid for, shall be those actually executed after making necessary deductions for openings etc. Brick masonry for steps and such other mass works and encasement shall be paid on the basis of rates quoted per cu.m or part thereof.
- 5.4 Concrete block masonry: Concrete blocks (hollow or solid) shall generally conform to IS: 2185. Blocks shall be regular in size and shape and shall be of specified strength. Blocks shall be properly cured before they are brought to sit. Half or three quarter size blocks are to be used wherever required to make up length of wall and broken blocks shall not be used. The texture of the blocks shall be such that plaster will adhere to it. The CONTRACTOR shall supply samples for approval. Blocks supplied shall conform to approved samples.
- 5.4.1 Mortar: Mortar shall be similar to mortar in brickwork as given above.
- 5.4.2 All blockwork shall be plumb, square and properly bonded. The joints shall be broken. The thickness of the courses shall be uniform with courses horizontal. All connected work shall be carried out at nearly one level and no portion of the work shall be left more than one course lower than the adjacent work.

5.4.3 Blocks shall be so laid that all joints are well filled with mortar. The thickness of joints shall not be less than 6 mm and not more than 8 mm. The face joints shall be raked to a minimum depth of 10 mm by raking tools daily during the progress of work when the mortar is still green, so as to provide a proper key for the plaster or pointing. When plastering or pointing is not required, the joints shall be struck flush. For pointed masonry or for masonry without plaster, smooth textured concrete blocks shall be used. The face of block work shall be kept clean at all times.

5.4.4 Where blocks are to be used for load bearing wells, the uppermost layer of blocks supporting slab or other structural members, shall be solid or treated as directed by the Project Engineer cum Estate Officer.

5.4.5 Pre-cast concrete screen blocks or 'jali' work may be used for decorative purposes. The CONTRACTOR shall furnish samples for approval.

5.4.6 Measurement: Blockwork of specified thickness shall be paid in units of sq.m. or parts thereof. If reinforcing bars are specified in horizontal courses, it shall be measured and paid for separately at quoted rate for reinforcement. In all cases, the quantities measured and paid for, shall be those actually executed after making necessary deductions for openings etc.

5.4.7 Miscellaneous inserts e.g. sleeves, ties, anchors, conduits etc., in block masonry shall be installed by Contractor, at no extra cost to Institute. Furnishing of any of these inserts by Contractor will be paid for separately.

5.5 Random rubble masonry, un-coursed in foundation, plinth and superstructure.

5.5.1 Stones for this work shall be hard, durable rock, clean or fine grained and uniform in colour, free from veins, flaws and other defects and shall conform to IS 1597 (Part I) . The stones shall be laid in mortar proportions specified for the particular item of work. Stones shall be got approved, if desired by Institute / Project Engineer cum Estate Officer.

5.5.2 For all work below ground level the masonry shall be random rubble un-coursed with ordinary quarry dressed stones for hearting and faced with selected quarry dressed stones.

5.5.3 For all work above ground level and I superstructure the masonry shall be random rubble, well bonded, faced with hammer dressed stones with square quoins at joints and corners.

5.5.4 No stones shall fall into the wall, either with a point or to length less than 1 ½ times its height. The thickness of the joints shall not exceed 12 mm.

5.5.5 Spalls and pinnings shall not be allowed to show on the face of the wall. Two bond stones each of minimum area of 500 cm² for every 1.0 sq.m. of each wall face shall be provided. These shall be through stones in walls 600 mm thick and under. In walls thicker than 600 mm, the length of bond stones shall be 2/3 times the thickness of walls. The stones for hearting of the wall shall not be less than 150 mm in any direction. Chips and spalls shall be wedged in to avoid thick mortar beds and joints. The well faces, corners and joints of openings shall be truly vertical. The quoins shall be of selected stones, neatly dressed with chisel to form the required angle and laid header - stretcher alternately.

5.5.6 The exposed face of the work shall be carefully and neatly point with mortar in all joints. On the other side, the joints shall be neatly struck with trowel while the mortar is fresh.

5.5.7 Mortar: The mortar for the work shall be as specified in the respective items of work and shall be prepared as per Clause 3.3.

5.5.8 Curing of masonry shall continue for a minimum of ten days.

5.5.9 Measurement: The unit of measurement shall be cu.m. or part thereof. Actual quantity of masonry shall be calculated from dimensions shown on the drawings less openings and shall be paid for.

5.6 Coursed rubble masonry (first sort) for superstructure : The stones used shall be hard, durable, rock free from veins flaws and other defects and shall conform to IS 1597 (Part I). Height of each course in the masonry shall not be less than 150 mm. The stones in each course shall be of equal height. All courses shall be of the same height unless otherwise specified. All stones shall be set in full cement

mortar of proportion specified for the respective item of work. Stones shall be got approved, if desired by Institute / Project Engineer cum Estate Officer.

- 5.6.1 The face stones shall be squared on all joints and beds. The beds being hammer or chisel dressed true and square for at least 75 mm from the face and the joints for at least 40 mm. The face of the stone shall be hammer dressed so that bushings shall not project more than 40 mm.
- 5.6.2 No spalls or pinning shall be allowed on the face. All bed joints shall be horizontal and side joints vertical and no joints shall be more than 10 mm in thickness.
- 5.6.3 No face stone shall be less in breadth than in height or shall tail into the work to a length less than the height and at least 1/3rd the number of stones shall tail into the work to at least twice their height or in walls over 600 mm in thickness 3 times their height.
- 5.6.4 Through stones shall be inserted every 1.5 metres to 1.8 meters apart in every course and shall run right through when the wall is not more than 600 mm thick. When the wall is more than 600 mm thick a line of two or more headers shall be laid from the face to face which shall overlap each other by at least 150 mm. A header shall have a length of at least thrice its height.
- 5.6.5 Stones shall break joint at least half the height of the course. Quoins shall be formed of stones at least 45 cm long, laid stretcher end header alternately. They shall be laid square in their beds, which shall be fair dressed to a depth of at least 100 mm. The corner shall be chisel dressed for a width of 25 mm.
- 5.6.6 The work on the interior face shall be precisely the same as on the exterior face unless the work is to be plastered in which case the side joints need not be truly vertical.
- 5.6.7 Hearting shall consist of flat bedded stones carefully laid on their proper beds and solidly bedded in mortar, chips and squalls of stone being wedged in wherever necessary so as to avoid thick beds or joints of mortar. Care shall be taken so that no dry work or hollow spaces shall be left anywhere in the masonry. The face and backing shall be brought up evenly but the backing should not be levelled up to at each course by the use of chips.
- 5.6.8 Mortar :The mortar for the work shall be as specified in the respective items of work and shall be prepared as of Clause 3.3
- 5.6.9 Curing of masonry shall continue for a minimum of ten days.
- 5.6.10 Measurement: The unit of measurement shall be cu.m. or part thereof. Actual quantity of masonry shall be calculated from dimensions shown on drawings less openings and shall be paid for.
- 5.6.11 Inserts, bolts, etc.: Inserts, bolts, etc. shall be provided in masonry and concrete works as indicated on the drawings. It is imperative that all inserts, bolts, fixtures and fittings shall be provided in their position very accurately. If the Project Engineer cum Estate Officer directs that such inserts and bolts be fixed by use of templates, the CONTRACTOR shall make arrangements for providing such templates. If as a consequence of negligence on the part of the CONTRACTOR, the inserts, bolts, fixtures, fittings, etc. are out of alignment, the CONTRACTOR shall make arrangements to have the inserts and bolts removed and re-fixed in their proper position as directed by the Project Engineer cum Estate Officer, at no cost to the Institute.
- 5.6.12 Measurement Inserts, bolts etc. shall be measured and paid for as indicated in Schedule of Quantities.
- 5.7 Rubble packing: Rubble used for packing under floors, foundations etc. shall be hard, durable rock free from veins, flaws and other defects. The quality and size of the rubble shall be subject to the approval of the Institute / Project Engineer cum Estate Officer.
- 5.7.1 Rubble shall be hand packed as directed by Project Engineer cum Estate Officer. This shall be laid closely in position on the sub-grade. All interstices between the stones shall be wedged-in with smaller stones of suitable size well driven to ensure tight packing and complete filling of interstices. Such filling shall be carried out simultaneously with the placing in position of rubble stones and shall not lag behind.
- 5.7.2 Small interstices shall be filled with hard clean sand and well watered and rammed.
- 5.7.3 Measurement: The unit of measurement shall be sq.m. for the specified thickness of rubble packing.

5.8 Cement pointing: The joints of masonry shall be raked at least 12 mm deep, 3 or 4 days after the courses are laid. The dust shall then be brushed out of the joints and the wall, washed with water if not done earlier. The mortar shall consist of one part of cement to one part of fine sand. Mortar shall be filled into joints and well pressed with special steel trowels. The joints shall not be touched again after it has once begun to set.

5.8.1 The joints of the points work shall be neat. The lines shall be regular and uniform in breadth and the joints shall be raised, flat, sunk or 'V' as may be directed. No false joints shall be allowed.

5.8.2 The work shall be kept wet for a week after the pointing is complete.

5.8.3 Whenever coloured pointing has to be done, the colouring pigment of the colour required shall be added to cement in such proportion as recommended by the manufacture and as approved by the Institute / Project Engineer cum Estate Officer.

5.8.4 Measurement: The area pointed shall be calculated in sq.m. from dimensions shown on drawings less openings and shall be paid for.

5.9 Cement plaster work: All joints in masonry shall be raked to a depth of 12 mm with a hooked tool made for the purpose when the mortar is still green and in any case within 48 hours of its laying. The surface to be rendered shall be washed with fresh clean water free from all dirt, loose material, grease etc. and thoroughly wetted for 6 hours before plastering work is commenced. Concrete surfaces to be rendered will however be kept dry. The wall should not be too wet but only damp at the time of plastering. The damping shall be uniform to get uniform bond between the plaster and the wall.

5.9.1 The proportion of the mortar shall be as specified under the respective items of work. Cement shall be mixed thoroughly in dry condition and then just enough water added to obtain a workable consistency. The quality of water, sand and cement shall be as per I.S. Standards. The mortar thus mixed shall be used immediately and in no case shall the mortar be allowed to stand for more than 25 minutes after mixing with water.

5.9.2 Curing of plaster shall be started as soon as the applied plaster has hardened enough so as not to be damaged. The decision as to when the plaster has hardened will be given by the Project Engineer cum Estate Officer. Curing shall be done by continuously applying water in a fine spray and shall be carried out for at least 7 days.

5.9.3 Whenever the specification or the item of work calls for water proofing, the CONTRACTOR shall provide the percentage of water proofing compound as specified in the items of work.

5.9.4 Where lath plaster is specified, it shall be paid for at the same rate as for plaster work without metal lath except that separate payment for metal lath will be made.

5.9.5 Ceiling plaster shall be done before wall plaster and wall plaster shall commence at top and work downwards.

5.9.6 Interior plaster: This plaster shall be laid in a single coat of 13 mm thickness. The mortar shall be dashed on the prepared surface with a trowel and finished smooth by trowelling on the surface with neeru II i.e cream). Neeru shall be properly slaked fat lime. The standard of finish expected is high and shall conform IS 2394. Interior plaster shall be carried out on jambs, lintel and sill faces, top and undersides, etc. as shown in the drawings or as directed by the Project Engineer cum Estate Officer. Rate quoted for plaster work shall be deemed to include plastering of all these surfaces. However, if the item of work includes plaster finish, no separate payment would be made under 'plastering work'.

5.9.7 Exterior Plaster: Exterior plaster work shall be carried out in 2 layers, the first layer being 14 mm thick and the second layer being 6 mm thick. The first layer shall be dashed against the prepared surface with a trowel to obtain an even surface. The second layer shall then be applied and finished leaving an even and uniform surface, trowel finished unless otherwise directed by the Project Engineer cum Estate Officer.

5.9.8 Exterior Sand Faced Plaster: The plaster shall be applied in 2 coats. The first coat or the scratch coat should be approximately 14 mm and shall be continuously carried out without break to the full length of wall or natural breaking points such as doors, windows, etc. The scratch coat shall be dashed on the

prepared surface with heavy pressure, brought to true and even surface and then lightly roughened by cross scratch lines, to provide bond for the finishing coat. The mortar proportion for this scratch coat shall be as specified in the respective item of work. The scratch coat shall be cured for at least 7 days and then allowed to dry.

- 5.9.9 The second coat shall be 6 mm thick and it shall be applied until at least 10 days have elapsed after the application of the scratch coat. Before application of the second coat, the scratch coat shall be evenly damped. This coat shall be applied from top to bottom in one operation and without joints, finish shall be straight, true and even. The mortar proportions of this coat shall be as specified under the respective item of work.. Only approved white sand shall be used for the second coat and for finishing work. Sand for finish shall be of even coarse size and shall be dashed on the surface and sponged.
- 5.9.10 Wherever 32 mm thick plaster has been specified, this is intended for purposes of providing beading, bands etc. This work should be carried out in two or three layers and as directed by the Project Engineer cum Estate Officer.
- 5.9.11 In the case of pebble face finished plaster, pebbles of approved size and quality all be dashed against the final surface to obtain as far as possible uniform pattern. In cases, workmanship shall all conform to IS 1601.
- 5.9.12 Measurement: The quantity of work to be paid for under this item shall be calculated by taking the projected surface of the area plastered after making necessary deductions for openings, doors, windows, fan openings etc. The actual plaster work carried out on jambs of doors, windows, openings etc. shall be measured and added. However, for purposes of payment under this item, plaster work carried on surface of items of work , which include plaster finishes, shall not be taken into account.
- 5.10 Waterproofing admixtures : If directed by the Institute / Project Engineer cum Estate Officer, the CONTRACTOR shall use approved waterproofing admixture made by reputed manufacturer in the mortar for plaster work. The quantity to be used etc. shall be in accordance with the manufacturer's instructions subject however to the approval of the Institute / Project Engineer cum Estate Officer. These admixtures shall not contain calcium chlorides unless specifically allowed by Project Engineer cum Estate Officer and shall conform to IS:2645. Payment shall be made for actual quantity of such admixture used unless it is already covered in the rates for the work concerned.
- 5.11 Mosaic terrazzo and plain cement tiling work flooring.
- 5.11.1 The type, quality, size, thickness, colour etc. of the tiles for flooring and skirting work shall be of best quality approved by the Institute / Project Engineer cum Estate Officer. For this purpose, the CONTRACTOR shall provide the Project Engineer cum Estate Officer with necessary samples for his selection.
- 5.11.2 Before the tiling work is commenced, the sub-surface shall be thoroughly cleaned and washed of all loose materials, dirt, and scum or laitance and then well wetted without forming water pools on the surface.
- 5.11.3 The tiles shall be laid on lime concrete mortar bedding of about 25 to 30 mm thick.. The proportion of mortar shall be one part of cement, 2 parts of lime and 6 parts of sand. The mortar shall be evenly spread on the sub-floor. Over this mortar bed, 5 kg. Of cement per sq.m. of floor area shall be spread. The tiles shall be fixed on this bed one after another, each tile being gently tapped with a wooden mallet till it is properly bedded and in level with the adjoining tiles. The joints shall be perfectly straight and uniform in thickness. The tiles shall be laid perfectly in level unless otherwise specified or required or desired by the Project Engineer cum Estate Officer. After laying the tiles the joints shall be finished with white cement or cement of approved colour.
- 5.11.4 For lime mortar, lime from burnt stone shall be used. It shall be free from ash and impurities and be in the form of lumps and not powder when brought to site. Lime which is damaged due to rain, soaking, moisture or air soaking will be rejected.
- 5.11.5 Floor tiles laid adjoining the wall shall project 12 mm under the plaster, skirting or dado as may be required by the Project Engineer cum Estate Officer. Half tiles and pieces shall be avoided as far as

possible. After laying, the flooring shall be allowed to cure undisturbed for seven days. Design traffic shall not be allowed on the floor for at least 14 days after laying the tiles.

5.11.6 About a week after laying the tiles, each and every tile shall be lightly tapped with a small wooden mallet to find out if it gives a hollow sound; if it does, such tiles along with any other cracked or broken tiles shall be removed and replaced with a new tile to proper line and level. The same procedure shall be followed again after the tiles are finally polished. For the purpose of ensuring that such replaced tiles match with those earlier laid, it is necessary that the CONTRACTOR order enough extra tiles from the factory to meet this contingency. The tiles shall finally be cleaned and polished by using dilute oxalic acid or any other method recommended by the manufacturer and approved by the Institute / Project Engineer cum Estate Officer.

5.11.7 After the joints have developed sufficient strength, the floors shall be machine polished to the desired finish as approved by the Institute / Project Engineer cum Estate Officer. Sufficient quantity of water shall always be used during polishing to prevent scratching.

5.11.8 For dado and skirting work, the vertical surface shall be thoroughly cleaned and wetted. Thereafter it shall be evenly and uniformly covered with about 12 mm thick 1:2 cement mortar. For this work the tiles as obtained from the factory shall be of the size required and practically fully polished. The back of each tile to be fixed shall be covered with a thin layer of neat cement paste and the tile shall then be gently tapped against the wall with a wooden mallet. This shall be done from the bottom of the surface upwards. The joints shall be as close as possible and the work shall be truly vertical and flush.

5.11.9 After the work has set, hand polishing with carborundum stones shall be done so that the surface attains a high gloss and shine. Corners and junctions shall be finished true. The workmanship shall conform to IS 1443. The work is subject to the approval of the Institute / Project Engineer cum Estate Officer. If any portion of the work is rejected by the Institute / Project Engineer cum Estate Officer, the same shall be removed and redone by the CONTRACTOR to the satisfaction of the Project Engineer cum Estate Officer at no extra cost to the Institute.

5.11.10 The procedure for laying and finishing cement tiles in floor and dado shall be as for mosaic tiles except that in this case the tiles shall be cement tiles instead of mosaic/terrazzo tiles.

5.11.11 Measurement: Unit of measurement for floor tiling, and dado shall be sq.meter or part thereof of the superficial area. Actual quantity of tiling work carried out will be measured and paid for after making deductions for openings etc. For skirting, unit of measurement shall be linear meter for the specified width.

5.12 In-situ terrazzo/mosaic flooring: The marble chips shall be of approved size, colour and shade. The cement used may be white coloured cement or cement mixed with colouring pigments as directed by the Project Engineer cum Estate Officer. The proportion of marble chips to cement shall be as directed by the Project Engineer cum Estate Officer but in no case it shall be less than 21/2:1.

5.12.1 Samples of terrazzo/mosaic work shall be prepared for approval of the Institute / Project Engineer cum Estate Officer. The entire work shall conform to the approved samples. For in-situ mosaic on stair treads, floors at building entrances etc. the CONTRACTOR shall provide a chequered non- slippery finish at no extra cost.

5.12.2 The terrazzo chips shall be laid after placing the base. The base shall consist of a layer of lime mortar as per CI.12.3 15 mm thick spread and levelled. Chips shall be thoroughly mixed dry and then white cement or cement of approved colour shall be added in specified proportion. Chips and cement shall be thoroughly mixed and evenly spread on the platform and not heaped. Water shall then be added to obtain a plastic mix of suitable consistency as directed by the Project Engineer cum Estate Officer.

5.12.3 Terrazzo layer shall be placed as soon as the screed coat has set sufficiently but in no case then the day thereafter. The thickness of terrazzo topping shall not be less than 10 mm. The surface shall be rammed to obtain the consolidation and additional chips shall be sprinkled on the surface and rammed in until surplus cement is worked out and chips forced together so that the finished floor will show not less than 70% aggregate. The surface is finally trowelled lightly.

5.12.4 The CONTRACTOR shall keep the floor moist not less than six days. The surface shall then be machine polished. Voids shall be filled with neat grouting of same kind and colour as matrix; this grouting shall remain at least 72 hours before being removed for final cleaning. The floor shall be refinished wherever necessary to leave the work in first close condition. The workmanship shall conform to SI.2114.

5.12.5 While the under bed is still plastic, metal dividing strips of brass or aluminium, about 35 mm wide and 1.25 mm thick, shall be inserted in the mortar bed according to the design of the floor, care being taken to see that no section exceeds. I.S. sq.m. in area. The top of strips shall be 10 mm above the surface of the under bed and shall conform to the finished level of the floor.

5.12.6 Measurement : Measurement and payment shall be as per Clause 4.11.11

5.13 Glazed tile work: The glazed tiles in paving and dado shall be of the best available first class quality approved by the Institute / Project Engineer cum Estate Officer and they should be laid on a base of 12 mm thick lime mortar. The tiles shall be of standard size without warp and with straight edges true and even in shape and size and of uniform colour. They shall be laid truly vertical on walls and truly horizontal on floors or to slopes as directed. The joint shall be very thin, uniform and perfectly straight. The joint shall be floated with white cement as approved by the Institute / Project Engineer cum Estate Officer. At the top of dado work, a coloured glazed tile border 75 mm deep shall be provided as approved by the Institute / Project Engineer cum Estate Officer. The rate quoted for paving and dado work shall be inclusive of angles, corner pieces, and approved colour border on top. Glazed tiles shall conform to IS.777.

5.14 Shahbad / tandur / kota stone flooring: Stones should be of approved quality, hard, sound, durable and uniform thickness. Edges shall be chisel dressed and the top surface shall be machine polished with joints running true and parallel from side to side. Stones should be laid on a bed of lime mortar. Thickness of mortar bedding should not be less than 12 mm and not more than 25 mm. Before laying, the stone slabs should be thoroughly wetted with clean water. Quantity of mortar mixed shall be just adequate to prepare a mortar bed over as much area as could be covered with the slabs within half an hour. The slabs are then laid and gently tapped with wooden mallet till it is firmly and properly bedded. There should be no hollows left. The joints should not be more than 2 mm thick. The joints should be struck smooth. The floor should be kept covered with damp sand or water for a week. Slabs should be of standard sized and shapes. Slabs supplied should meet all the required properties and test requirements as stipulated in IS Code 11224.

5.15 Integral cement finish on concrete floor : In all cases where integral cement finish on a concrete floor has been specified, the top layer of concrete shall be screeded off to proper level and tamped with tamper having conical projections so that the aggregate shall be forced below the surface. The surface shall be finished with a wooden float and a trowel with pressure. The finish shall be continued till the concrete reaches its initial set. No cement or cement mortar finish shall be provided on the surface. Where specified, a floor hardener as approved by the Institute / Project Engineer cum Estate Officer shall be supplied and used as recommended by the manufacturer.

5.16 Woodwork in doors, windows, partitions, louvers, railing etc.

5.16.1 Wood used for all work shall be the best of the respective class specified, and properly seasoned by at least 6 months air drying suitable for joiner's work, should be of natural growth, uniform in texture, straight grained, free from sapwood, dead knots, open shakes, boreholes, rot, decay and any and all other defects and blemishes.

5.16.2 The thickness specified for joiner's wrought timbers is, unless otherwise specified, prior to planning and 3 mm will be allowed from the thickness stated for each wrought face.

5.16.3 All joining shall be wrought on all faces and finished off by hand with sandpaper, with slightly rounded arises.

5.16.4 The joints shall be pinned with hard wood pins and put together with white lead. Jointing shall be by means of mortice and tenon or dovetailed joints as approved.

- 5.16.5 Any joiner's work which shall spilt, fracture, shrink, or show flaws or other defects due to unsoundness, inadequate seasoning or bad workmanship shall be removed and replaced with sound material at the CONTRACTOR'S expense.
- 5.16.6 Doors, windows, and ventilator frames, transoms and mullions shall be rebated. All dimensions shall be as per drawings. The top framing member of doors and top and bottom framing of windows and ventilators shall project about 150 mm in brickwork. The verticals of doorframes shall project about 50 mm below finished floor. Surface coming in contact with brickwork shall be painted with bitumen as directed by the Project Engineer cum Estate Officer. Each of the door and window frames shall be provided with 3 Nos. MS 225x25x6 flat split holdfasts on each side. These holdfasts shall be embedded in masonry or concrete work. The work shall conform to IS: 4021.
- 5.16.7 The doors shall be panelled or solid flush doors as described in the item of work. All flush doors shall be supplied with approved fittings such as hinges, mortise lock of approved make with handles on both sides, oxidized brass tower bolts and latch arrangements, door stops etc. and as shows in drawings but exclusive of door closers. Door closers, where separately specified shall be of heavy-duty hydraulic type to be approved by Institute / Project Engineer cum Estate Officer. Panelled doors shall have the same fittings except in place of union lock, an aldrop shall be provided. Each door leaf shall have two 250 mm tower bolts, two handles of aluminium or oxidized brass and one door stopper mounted near the bottom of door. External flush doors shall be made of weatherproof plywood. Flush doors shall conform to IS 2202 (Part I).
- 5.16.8 Doors will generally have no sills but if a few have to be provided; the CONTRACTOR shall do so at no extra cost to the Institute.
- 5.16.9 The type of window shall be as specified. Each shutter shall have one pair of hinges, two tower bolts one 225 mm long and another 150 mm long), one handle and one hook with eye and peg stay. Ventilators shall have two MS hold fasts and hinges, one handle and one hook and eye at each and one small tower bolt in the centre. Where so directed by the Project Engineer cum Estate Officer, the doors and windows shall be provided with parliamentary type hinges at no extra cost.
- 5.16.10 The workmanship of all door and window shutters shall conform to the requirements of IS: 1003 (Parts I & II) and IS 2202 (Part I). If required, flush door panels shall be got tested as per IS 4020.
- 5.16.11 Cupboards, almirahs, and shelves shall be provided as shown in drawings. The doors could be of either hinged type or sliding type as approved by the Institute / Project Engineer cum Estate Officer. All dimensions as furnished in the drawings shall be followed. Fixtures and fittings as shown on drawings or as directed by Project Engineer cum Estate Officer shall be used.
- 5.16.12 Railings and architrave shall conform to the shape shown on drawings or as approved and fixed by means of screws (counter sunk or otherwise) or bolts.
- 5.16.13 The finish expected is of a very high order and the work shall be all-inclusive whether or not all detailed specifications have been spelt out and the work shall be free from blemish.
- 5.16.14 No iron bars or grills are proposed to be provided in the windows or ventilators. Glass louvered ventilators where specified shall be provided.
- 5.16.15 Glazed windows, louvers, ventilators and doors shall be provided with either clear or pinheaded glass 5.5. mm thick which shall be free from all blemishes and shall conform to IS:1761. It should be clearly understood that glass which does not have uniform refractive index or which is wavy, will be rejected.
- 5.16.16 Woodwork shall not be painted, oiled or otherwise treated before it has been approved by the Institute / Project Engineer cum Estate Officer.
- 5.16.17 Measurement: All doors, windows, ventilators, louvers, will be measured in sq.m. The measurement will be taken to the outside of framework exclusive of horns, projections, etc. The rate quoted shall be all inclusive such as nails, screws, glazing, fixtures, fittings, providing peep holes, locking device, handles, door steps etc. The rate shall also be inclusive of polishing/painting with 3 coats of approved paint over primer coat.

5.17 Steel doors, windows and fittings: The steel doors, windows, ventilators shall conform to IS: 4351. All steel doors, windows, ventilators, and louvers etc. shall be of sizes as specified and conform to the description in the respective items of work. Whether or not specifically mentioned, all fixtures and fittings necessary for the satisfactory operation of the doors and windows shall be provided. Doors, windows and ventilators shall be obtained from an approved manufacturer. Specific approval for such purchase shall be obtained beforehand. Samples shall also be got approved before further manufacture starts, unless this is waived in writing by the Institute / Project Engineer cum Estate Officer. All steel doors shall be of pressed steel (18 gauge) flush type with or without removable transom. All doors shall be provided with a three way bolting device and locking arrangement with duplicate keys and handles on either side. The CONTRACTOR shall obtain windows with friction hinges in place of windows with peg stays if so directed by the Project Engineer cum Estate Officer. For centre hung and top hung ventilators suitable spring catch/pulley and chord arrangement shall be provided for facility of opening. Whenever fly mesh over windows is called for, they shall be fixed on the window and suitable lever type or rototype arrangement shall be provided for opening or closing of the glazed panels from inside. Prior approval of Institute / Project Engineer cum Estate Officer shall be taken before order is placed with the manufacturer.

5.17.1 Where specified, steel doors supplied shall be airtight. For this purpose, the CONTRACTOR shall provide necessary padding materials such as rubber, felt or any other approved material.

5.17.2 Measurement: Doors, windows shall be measured in sq.m of the actual size measured to the outside of the steel framework.

5.17.3 The rate quoted shall be inclusive of glazing with 5 mm thick glass free from all blemishes. The workmanship shall conform to IS 1081. The rate quoted shall also be inclusive of fixing the doors, windows, ventilators, louvers etc. in brick work, steel framing etc., by making holes/drilling holes in steel work where required..

5.17.4 The rate shall also include cost of painting two coats of approved enamel paint over one coat of approved zinc rich primer.

5.18 Rolling shutters: The rolling shutters shall conform to the size indicated in drawings and shall be of quality specified in the Schedule of Quantities. The rolling slats shall be in one piece and be made of heavy gauge steel sheets minimum 18 SWG in thickness. A cylindrical hood shall be provided on the top to enclose the shutter when it is open. The rolling shutters shall be provided with suitable looking arrangements and deep channel guides. In case galvanized rolling shutters are specified, the rolling shutter shall be made of hot dip galvanized slats, hood, deep channel guides all preferably in one piece.

5.18.1 In case of hand operated pull and push type, rolling shutters of sizes larger than 10 sq.m in area or in case of very large gear operated rolling shutters or as directed by the Project Engineer cum Estate Officer, rolling shutters shall be provided with ball bearings for smooth and efficient operation. In addition, in case of large rolling shutters and depending upon local wind conditions, the rolling shutters should also be provided with special wider channel guides or it shall be provided with central movable channel supports to take up the design wind pressures in the area.

5.18.2 The rates quoted shall be inclusive of providing three coats of approved paint over 2 coats of approved primer coat (One shop coat and one coat after erection) where not galvanized. Rates quoted shall also include cost of lever lock and erection. Fixing lugs to be provided to guide channel to suit actual site conditions or as directed by the Project Engineer cum Estate Officer at no extra cost.

Painting/polishing for wood work & iron work

- a) Paint/Polish to be used for various items of work shall be of best quality and shall be obtained ready mixed in sealed containers from approved manufacturer. The CONTRACTOR shall obtain the Institute / Project Engineer cum Estate Officer's approval for the make and colour of the paint he proposes to use. If required, Polish for woodwork shall be tested as per IS 5807 (Parts I & III).
- b) All surfaces shall be thoroughly cleaned of all dirt, loose particles and rust and approved prior to application of paint. For wood surface, a priming coat without colouring matter shall be first applied

after which all holes, cracks, etc. shall be stopped with putty and all knots properly killed with quick-lime,. Workmanship shall conform to IS:1477 (Parts I &II) and 2338 (Part I)

- c) Specified number of coats shall be applied and at least 24 hours shall elapse between the applications of successive coats. No painting shall be carried out on exterior work in wet weather or on surfaces which are not entirely dry.

5.19 Painting/polishing rate shall include all necessary scaffolding, cradles and plant. Measurements will be on the basis of sq.m. for doors and windows, only the projected area will be measured, if such painting/polishing is not already a part of the item, without deducting for the glazed portions though not painted. The CONTRACTOR'S rate should take this into account.

5.20 Distempering, white/colour washing and painting of walls

5.20.1 Distempering: The Surface to be treated shall be thoroughly cleaned of all dirt and loose particles etc. Inequalities and holes shall be filled with gypsum which should be allowed to set hard before distemper is applied.

5.20.2 Distemper shall be of well-known brands of approved make. It shall be applied by a broad stiff brush in two coats over a coat of primer. The first and second coat shall be applied only after the primer coat has thoroughly dried. The first coat shall be of a lighter tint. The shade of the distemper shall be got approved by the Institute / Project Engineer cum Estate Officer. Water bound and oil bound distemper shall conform to the requirements of IS 428 respectively.

5.20.3 White wash: Walls to be thoroughly cleaned before application of white wash. White wash shall be of ordinary fat lime and of good quality. It shall be slaked with an excess of water to the consistency of a cream and allowed to remain under water for 2 days. It shall then be strained through a cloth and 2 kg of clean gum added for every cubic meter of lime ready for white washing.

- a) Each coat is to be applied with a brush. It shall be laid with a stroke of the brush from the top downwards, another from bottom upwards over the first stroke, and similarly, one stroke from the right and another from the left over the first brush before it dries. Three such coats shall be applied.

5.20.4 Colour wash: Colour wash shall be applied the same way as white wash. Necessary and approved colouring matter shall be added to the white wash which has been strained. Only wash sufficient for the day's work shall be prepared each morning. If the finished surface is powdery and comes off easily or the general appearance is streaky, the work shall be rejected.

5.20.5 Painting: Paint to be used for the various items of work should be of approved make and colour. It is imperative that the CONTRACTOR should obtain Institute / Project Engineer cum Estate Officer's permission in regard to the make and colour of paint that he proposes to use for the various items of work. The painting work shall be carried out as directed by the Project Engineer cum Estate Officer, keeping, however, in view the recommendations of the manufacturer.

5.20.6 Where painting with plastic emulsion is specified, all uneven surfaces shall be made up by use of putty of appropriate quality, after the surface has been thoroughly cleaned of all dust, dirt and sand papered. One primer coat and 2 coats of emulsion paint shall be applied. Workmanship shall conform to the requirements of IS 2395.

5.20.7 Measurement: The actual quantity of work carried out will be measured in sq. meter after making deductions for openings etc. and shall be paid for.

5.21 Expansion joints, water stops, pre-moulded joint filters, flashings

5.21.1 Expansion joints: Expansion joints shall be provided with 20 gauge copper strips/MS hot dip galvanized strips of 250 mm width at locations shown on drawings or as approved by the Institute / Project Engineer cum Estate Officer. The strips shall be bent to the shape indicated on drawings and embedded properly in masonry. The joint width shall be uniform throughout and special care shall be taken to ensure proper bonding at expansion joints. Expansion joints shall be continuous and where two or more strips meet, they shall be lapped to the extent of 75 mm and joints properly soldered. The expansion joints shall be filled with pre-moulded joint fillers and sealed with mastic compound. For purposes of measurement, the laps provided will be neglected. Wherever an expansion joint between

the existing part and new part is proposed the rate quoted shall be inclusive of making necessary connections with existing parts.

- 5.21.2 Water stops: Water stops shall be of rubber or PVC Bars of approved make. These shall be provided at locations indicated on drawings. Water stops shall be lapped 100 mm and heat sealed to obtain continuity. Water stops shall be clean and free from grease etc. Projected portion of water stops shall be cleaned thoroughly of all concrete and mortar coating as directed before resuming concrete work. Water stops shall be in long lengths to avoid joints as far as possible.
- 5.21.3 Joint filler: Pre-moulded joint fillers shall be of a non-deteriorating and resilient type. A sample of material shall be approved by the Institute / Project Engineer cum Estate Officer before being brought on site. Installation shall be carried out properly and as directed.
- 5.21.4 Flashings: Metal or tar felt flashing shall be fixed as directed by the Project Engineer cum Estate Officer. Metal flashing where provided shall be welded / soldered to obtain continuity. Tar felt flashing shall be lapped for a minimum length of 150 mm.
- 5.21.5 Flashing shall be measured and paid for in linear meters for the specified width disregarding laps or joints.
- 5.21.6 Water proofing work: All surfaces to be water proofed shall be dry, clean, smooth and free from dust and loose particles.
- 5.21.7 Tar felt type: For a five-layer treatment, bitumen primer conforming to IS 3384 shall be applied. Over this primer coat, hot bitumen conforming to IS 1580 shall be applied at the rate of 1.2 kg/m². Hessian based felt type 3 Grade 2 conforming to IS 1322 shall be spread and embedded in the previously laid bitumen while hot. Hot bitumen will again be applied over the felt at the rate of 1.2 kg/m². Pea size gravel or grit shall be uniformly spread at the rate of 0.008 cum./sq.m. The end and side laps of each sheet shall not be less than 100 and 175 mm respectively and shall be firmly bonded with bitumen. The extreme ends shall be taken up about 100-150 mm along parapet wall and embedded in chases made in the wall and brick masonry and made good in plaster. The standard of water proofing shall comply with IS 1346. For seven layer treatment, one additional layer of felt and one layer of bitumen shall be laid before gravel layer in a manner described above for five layer treatment.
- 5.21.8 Brick bat coba china mosaic type: In case of works where brick bat coba and china mosaic are specified, brick bat coba of average thickness specified in the item of work shall be laid to the required slopes as shown on the drawings. Proportion of brickbat shall be 2 parts of brickbat to one part of lime mortar (one part of lime to 2 parts of sand). The brick bats shall be hard, well burnt and of size varying from 12 mm to 25 mm. Lime shall be of best quality of hydraulic lime double ground. While preparing brick bat concrete, jaggery in proportion indicated by the Project Engineer cum Estate Officer shall be added. The brick bat coba shall then be laid to slopes, providing necessary wattas, and beaten at least for 48 hours after laying. Over the brick bat coba a bedding of 1:2 lime mortar 20 mm to 25 mm thick, shall be provided. A layer of neat cement grout, about 10 mm thick shall then be laid. Immediately on application of cement grout, assorted pieces of coloured china, previously soaked in water shall be set closely on the fresh surface and properly tamped to the required grade. The cement grout freshly laid shall work its way to the top surface. The surface after completion of work shall be finally cleaned with sawdust and waste and it so directed by the Project Engineer cum Estate Officer with dilute acid. China mosaic shall be cured for at least 10 days. If so directed by the Project Engineer cum Estate Officer, border of colour or white mosaic shall be provided.
- 5.21.9 Brickbat coba and china mosaic shall be taken up the parapet walls to a height of 125 mm to 150 mm Necessary wattas shall be provided towards drain pipes as shown on drawings or as directed by the Project Engineer cum Estate Officer.
- 5.21.10 On prior approval from the Institute / Project Engineer cum Estate Officer, cement based proprietary type of waterproofing may be allowed to be done by a specialist CONTRACTOR,
- 5.21.11 The CONTRACTOR shall give a guarantee for any/all types of waterproofing for a minimum period of 7 years against bad or faulty material and construction and shall rectify the work at his own cost during the guarantee period.

5.21.12 Measurement: Payment for work executed would be made for projected area only between the inside of plastered walls. No payment would be made for rounding off at corners or for work carried on vertical faces of walls, slabs, parapet or column projections.

11.3.3 Specific Technical Requirements - SCADA

1.0 SUPERVISORY CONTROL AND DATA ACQUISITION (SCADA)

1.1 **PRE-QUALIFICATION CRITERIA** : The BIDDER/Supplier can be an Original Equipment Manufacturer (OEM) or OEM Authorised System Integrator. The Supplier should have designed, engineered, manufactured, type tested supplied and commissioned at least Five (5) EMS/ECS for Industries. These shall be in successful operation for a period of at least three (3) year as on offer submission date.

1.2 **Scope includes** Basic engineering, Design, Drawing preparation / Submission for Approval, Manufacture, Routine Testing (Factory Acceptance Testing), Packing, Supply, delivery up to site and Unloading at site. Temporary Storage, Positioning, Erection/Installation, Testing and Commissioning, Trials and As Built Documentation, Training of O&M Personnel and Handing overs.

1.3 **SCADA Platform** shall be **Distributed Architecture with IEC-61850** based for Protection Relay Control and interface along with Modbus TCP-IP for connectivity to Meters.

1.4 **Necessary Co-ordination** and interface between other equipment and it's respective vendor's is included in the Bidder's scope.

1.5 **The Proposed SCADA** system shall en-compass the newly proposed equipment such as Transformers, 415 V MAIN LV PANEL, Sub-distribution Board and APFC Panels. Following devices are envisaged part of respective Panels/switchgear.

- a) All the Protection relays are Numerical type with IEC-61850 Protocol on TCP-IP Network with CB Open/Close Control functionality.(3) The IEC 61850 compatible Relay make and model shall preferably be (a) Siemens - 7SR1206 (b) GE- P141 (c) C&S - CSEZEN F-550. (To be supplied as part of respective switchgear/panel). This being end user requirement.
- b) All VCB/ACB feeders are EDO type and provided spring Charging motor, Closing coil and Trip coils. SCADA/Local Selector Switch, Local ON/OFF/Trip Indication Lamps as well as status feed back for SCADA, Close/Open Pushbuttons from Local and provision for Remote SCADA shall be provided.
- c) All MCCB Feeder shall be Manually Operated and Local ON/OFF/Trip Indication Lamps as well as status feed back for SCADA shall be provided.
- d) All the TVM/LM/PQM meters shall be with Modbus Protocol on TCP-IP Network with measured value acquisition.

1.6 **Following minimum hardware components are to be included as part of SCADA.**

- a) Remote Input/output modules (RIO/ RTU/Flexi IO) 110VDC or 230VAC Powered, shall be used with Digital input and outputs such as CB Status monitoring and Control. These modules are to be envisaged to be part of the respective switchgear panels as per SCADA Architecture Drawing. Qty shall be decided by bidder along 20% Spare I/O points.
- b) Industrial grade Ethernet Switches with 110VDC or 230VAC Powered, as required shall be provided as part of the respective switchgear panels as per SCADA Architecture Drawing. Qty shall be decided by bidder along with 20% Spare ports in each switch. However these item shall be priced under SCADA as in BOQ

- c) Cat-5 or /6 Cable-Industrial Grade Ethernet cable shall be used to interconnect all the above devices to the server ,to be laid in the PVC Duct-External to the Panel-Bidder to estimate the Quantity required.
- d) SCADA system shall be with two numbers PC Based Server cum Engineering cum Operating Work Station in Hot-standby mode along with Laser jet Printer and associated Cubicle/Rack/Furniture. LCD Monitor-21 Inch Colour, Key Board, Mouse. EMS Server PC Server PC suitable to EMS software OS: Windows Server 2016 CPU: Intel Xeon Gold (10 core or more), processor speed 3.0 Ghz or more , RAM: 32 GB +, HDD: x5 600+ GB , Mouse, Monitor(21.5") ,Ethernet ports, USB ports, Graphics Adapter Including 128 MB of VRAM, MS Office 2016 (32 bit). Antivirus SQL std 2016 /2017 core-based license
- e) A 230VAC UPS of sufficient rating, minimum of 5kVA, shall be provided independently to cater to SCADA PC and Printer and Ethernet switches. APC make, 230VAC UPS, 19inch Rack mountable, of sufficient rating but with minimum of 5kVA with 12V SMF Battery Bank sized for 30minutes of Battery Back up.
- f) Redundant PC Workstation (Hot Standby) PC. LCD Monitor-21 Inch Colour, Key Board, Mouse
- g) Rittal make 19 inch based Rack along with Floor mounting Free Standing Cabinet, Glass Door to house Server Ethernet switch, PC and other accessories
- h) SCADA Architecture drawing is enclosed herewith Exhibit-10

1.7 Licensing

SCADA System License-Number of Tags shall be as per the connected Devices with minimum of 100 Tags per Device(Meter and Protection Relay)-One Time Buy, with out any recurring charges.

1.8 Following are the minimum functions of SCADA.

- a) Connectivity to upstream side 66 kV Substation SAS/SCADA- On OPC/ODBC. Connectivity/Interface to BMS supplied by Third party. A TCP-IP link/port shall be planned in the Server or Ethernet Switch as applicable.
- b) Connectivity to upstream side 66 kV Substation SAS/SCADA- On OPC/ODBC. Connectivity/Interface to BMS supplied by Third party. A TCP-IP link/port shall be planned in the Server or Ethernet Switch as applicable.
- c) Mimic SLD and CB Status monitoring on PC Workstation. CB Open and Close from PC workstation HMI Buttons (No interlocking requirements)
- d) Status monitoring and measured values, etc from Numerical Relays.
- e) Measured values Display, Tabulation, Report and Archiving.
- f) Alarms, Sequence of Events and Trends
- g) Source and Network Control. Electrical Distribution System Monitoring and Alarming.
- h) Electrical System Capacity Management.
- i) Power Quality Monitoring and Compliance. Power Events Analysis.
- j) Energy Usage Analysis and Energy Benchmarking.

k) Utility Bill Verification and Cost Allocation. Energy Performance Analysis and Verification.

1.9 Testing.

Integrated Site Acceptance and Demonstration of SCADA functionality at Site-7 Working Days minimum and Training of O&M Personnel shall also be included as part of scope. Three (3) copies of the training manuals will be included as a part of training.

11.4.1 OIL FILLED TRANSFORMER

1.0 SCOPE:

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.

2.0 CODES & STANDARDS:

- 2.1 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.
- 2.2 In case of imported equipment, standards of the country of origin shall be applicable if these standards are equivalent or stringent than the applicable Indian standards.
- 2.3 The equipment shall also conform to the provisions of CEA Regulations and any other statutory regulations currently in force in the country.
- 2.4 In case Indian standards are not available for any equipment, standards issued by IEC/BSNDE/IEEE/NEMA or equivalent agency shall be applicable.
- 2.5 Transformers shall conform to the currently applicable standards and codes of practice as specified in Data Sheet-A.
- 2.6 In case of any conflict between requirements specified in various applicable documents for the project, the most stringent one shall prevail. However Purchaser's decision in this regard will be final and binding.

3.0 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.

4.0 ELECTRICAL & PERFORMANCE REQUIREMENTS:

- 4.1 Transformers shall operate without injurious heating at the rated kVA at any voltage within $\pm 10\%$ 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 Transformer shall be suitable for continuous operation with a frequency variation of 5% from normal of 50 Hz without exceeding the specified temperature rise.
- 4.4 Overloads shall be allowed within 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.
- 4.5 The neutral terminal of windings with star or zigzag connection shall be designed for the highest over current that can flow through this winding.
- 4.6 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.
- 4.7 For transformers with tapping, full power tapping shall be provided.
- 4.8 The thermal and dynamic ability to withstand short circuit shall be demonstrated by tests or by reference to tests on similar transformers.
- 4.9 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.
- 4.10 All rated quantities subject to the VENDOR's guarantees shall be within the tolerances given in applicable standards.
- 4.11 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. transformersTransformers shall operate below the knee of the saturation curve at 110% voltage to preclude ferro resonance and non-linear oscillations.
- 4.12 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, 4.2 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 hysteresis characteristic curves shall be included in the bid ~~and in relevant Data Sheet B~~, and shall be subject to the PURCHASER's approval.
- 4.13 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.

5.0 CORE:

- 5.1 Transformer shall be double wound, core type with high grade cold rolled non-aging grain oriented low loss, high permeability silicon steel laminations (M-4 or better grade) perfectly insulated and clamped to minimise vibration and noise. Care shall be taken to insulate core-fastening bolts to reduce losses and avoid hot spots.
- 5.2 The magnetic circuit shall be constructed from high-grade cold rolled non-ageing grain-oriented silicon steel laminations. All parts of magnetic circuit shall be bonded to earth system.
- 5.3 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.
- 5.4 The construction is to be of 'core' type.
- 5.5 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.
- 5.6 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.
- 5.7 All steel sections used for supporting the core shall be thoroughly shot or sand-blasted, after cutting, drilling and welding.
- 5.8 The finally assembled core with all the clamping structures shall be free from deformation and shall not vibrate during operation.
- 5.9 The core clamping structure shall be designed to minimise eddy current loss.
- 5.10 The core shall be provided with lugs suitable for lifting the complete core and coil assembly.
- 5.11 The core and coils assembly shall be so fixed in the tank that shifting will not occur during transport or short circuits.
- 5.12 The framework and clamping arrangements shall be securely earthed in accordance with clause 6.0.

6.0 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.

7.0 WINDINGS:

7.1 Transformers shall have conventional type of windings. Foil type windings are not acceptable.
Windings shall be of copper and shall be designed to withstand the applicable thermal and dynamic short circuit stresses.

7.2 Windings shall be subjected to a shrinking and seasoning process, so that no further shrinkage occurs during service.

7.3 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.

7.4 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.

7.5 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.

7.6 Windings shall be brought out and terminated on outdoor bushings, cable boxes or bus-duct chamber, which will be located as specified on the data sheet.

7.7 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.

7.8 Windings and connections shall be braced to withstand shocks during transport or short circuits.

7.9 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.

7.10 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.

8.0 TANK:

8.1 Tank shall be made from good commercial grade, low carbon steel and shall be of welded construction and provided with gasketed steel cover plates. Base shall be suitably reinforced to prevent any distortion during lifting. Base channels shall be provided with skids and pulling eyes to facilitate handling.

- 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/cm² (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. All covers and seals shall be oil and airtight and shall not be affected by mineral or synthetic oil action.
- 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 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 ratings. 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 gunmetal bodies with gunmetal fittings for all sizes. 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 swiveled after jacking the transformer and they shall be lockable in both the positions.

11.0 TRANSFORMER COOLING:

11.1 Type of cooling shall be in accordance with data sheet.

11.2 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.

11.3 Unless otherwise approved, for all transformers ratings, tank mounted radiators/ coolers shall be of the detachable type with bolted and gasketed flanged connections. Detachable radiators (tank mounted) equipped with air vent, drain plug and lifting lugs shall be provided with shut-off valves for all transformer ratings to permit removal of any radiator unit without emptying the tank. Radiators shall be securely braced to prevent undue vibration. The clearance between all pipe work and live parts shall be more than the clearance for live parts to earth. 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.

11.4 Forced air-cooling system when specified shall have a weather proof IP-55 control panel to be installed on the body of the transformer, complete with cooler controls and cable glands necessary for Purchaser's external cable connections. Contacts shall be provided for remote indication/alarm for following operating conditions:

- a) Auto/manual selection
- b) Winding over temp.
- c) Fans ON (for each fan separately) & Fans tripped (for each fan separately).

11.5 In case forced cooling system (ONAF), transformers shall be capable of operating under natural cooled condition (ONAN) up to specified load. The forced cooling equipment shall come into operation by preset contacts of winding temperature indicator and the transformer shall operate as a forced cooled unit, initially as ONAN upto specific load and then as ONAF. Cooling shall be so designed that during total failure of power supply to cooling fans and oil pumps, the transformer shall be able to operate at full load for at least ten (10) minutes without the calculated winding hot spot temperature exceeding 140°C, also stopping of one (1) cooling fan in each bank should not have any effect on the cooling system.

11.6 Transformer fitted with two cooler banks, each capable of dissipating 50% of heat loss at continuous maximum rating, shall be capable of operating for 20 minutes in the event of failure of the oil circulating pump or blowers associated with one cooler without calculated winding hot spot temperature exceeding 140°C at continuous maximum rating.

11.7 If Forced air-cooling system is specified in Data Sheet-A for transformers with higher capacity, the following shall be supplied:-

- a) Groups of cooling air fans (running and stand by).
- b) Circulating oil pumps (running and stand by).
- c) Separate radiator banks.
- d) Automatic controls as shown in the schematic drawing.
- e) Local control cabinet with starters for fans and pumps and all devices for automatic control.

11.8 Cooling fans shall be complete with mounting/supporting structure. These shall be suitably sized to limit the temperature rise of the transformer to specified values with continuous maximum loading of ONAF rating and at maximum specified ambient temperatures. One standby fan per 50% cooler bank shall be provided.

11.9 In Auto mode all fans including redundant fans shall be running. In manual mode, provision shall be made for starting each fan independently.

12.0 TAP CHANGING GEAR:

12.1 Off-Circuit Tap Changing Gear (OFTC)

12.1.1 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 gasketed cover.

- 12.1.2 Off circuit tap changing gear shall have an external operating handle mounted on the transformer side and shall meet the following requirements:
 - a) Positive snap-action contact changing.
 - b) The mechanism shall be such that it is impossible for the contacts to be set in a position whereby the windings remain open-circuited or partly short-circuited.
 - c) Mechanical stops at the ends shall be provided to prevent overrun.
 - d) The driving rod through cover or tank wall shall be properly sealed against oil leakage under all service conditions.
- 12.1.3 The handle shall be metallic and the adequately sized in order to allow operation without the need of tools and be located in a directly accessible position.
- 12.1.4 The handle shall be provided with padlock facilities to lock the tap changer in the desired position.
- 12.1.5 Tap positions shall be clearly marked in line with the data given on the rating plate

13.0 CONTROL CABINETS:

	Transformer marshalling box
Execution	Outdoor, weather proof
Mounting	Tank mounted or mounted on a separate foundation
Wiring	All alarm and trip circuits shall be wired for auxiliary DC supply as specified.
Special requirements	Bottom of the tank mounted cabinet 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 Fittings made of steel or malleable iron shall be galvanised.

14.6 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°C in an ambient of 50°C.

14.7 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.

14.8 A separate neutral bushing shall be provided for neutral earthing of transformers. The neutral CT shall be mounted as below:-

CT for 51 NS shall be located in the earth path after bifurcation of neutral.

CT for 64R can be located before bifurcation of neutral.

Supporting arrangement for GI strip/cable as applicable shall be provided for connection of neutral bushing to earth/NGR.

14.9 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.

14.10 The applicable routine and type tests (if certificates of same are not available), as stated in the specified bushing standards shall be carried out.

14.11 Bushing current transformers shall comply with specified standards and meet the following requirements.

- It shall be possible to remove turret mounted CT's from the transformer tank, without removing the tank cover.
- All the secondary leads including tapings 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.
- Bushing CT name plate shall be mounted on the Transformer tank adjacent to the terminal box.
- Bushing CT Parameters indicated in the specification are tentative and liable to change within reasonable limits. The Bidder shall obtain the Purchaser's approval before proceeding with design of Bushing CTs.

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 box shall be weatherproof to IP-55. For fixed portion of cable box, inspection cover with lifting handle shall be provided.

- 15.3 Cable boxes shall be supplied with cable lugs and glands. For HV XLPE Cables double compression cable glands and crimping type tinned copper cable lugs shall be supplied. Gland plate shall be removable type. For single core cables, gland plate shall be of non-magnetic material. HV cable box shall be suitable for termination of specified size of XLPE insulated cable. The height between cable gland plate and terminals shall not be less than 600mm for cable upto 11 kV, and 900 mm for 22 kV and 33 kV cables. Cable box and disconnecting chamber shall be air insulated type.
- 15.4 Cable boxes shall be designed to accommodate complete cable termination fittings or sealing ends as required, including stress relieving /cones or other approved means for grading voltage stress on the terminal insulation of cables operating at voltage of 6.6 kV and above.
- 15.5 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.
- 15.6 Primary cable box (where applicable) shall be able to withstand specified primary system fault level for 0.20 secs.
- 15.7 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/ blanking plates.

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 flange. 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.
- 16.2 Terminal chamber for bus-duct termination shall have a gasketed cover plate bolted to it and shall be weatherproof to IP-55. A separate inspection cover with lifting handle shall be provided to facilitate connection and inspection. Phase sequence of the bus bars shall be as specified in the data sheets.

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. Degree of protection shall be minimum IP55. 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. Sloped rain hood shall be provided for the marshalling box.

- 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 circuits and **2.5 sq.mm.** for CT circuits.
- 17.4 All protective devices and neutral CTs shall be wired by means of PVC insulated copper conductor armoured cables upto the marshalling box. Terminals shall be clamp type. Removable gland plate with double compression type glands shall be provided. Lamp with switch & socket and humidistat controlled Panel space heater shall be provided in the marshalling box. Preferably, marshalling box shall be located on the front side of transformer.

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 in non-returnable drums. 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.
- 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. All gasketed joints shall have shunts made of copper strips.
- 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 level marking.
- 19.10 Thermometer pocket.

19.11 The conservator of sufficient volume to maintain the oil seal from the minimum ambient temperature of -5° C up to an oil temperature of 100° C , with oil level varying within the minimum and maximum visible levels. The conservator shall be provided with the following accessories:

- A flexible oil resistance air bag shall be provided for conservator. Air bag shall be designed to withstand repeated expansion and contraction due to changes in oil level.
- 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.
- 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.
- A bolted cover at one end for cleaning.
- Valve for shutting off oil to the transformer

19.12 Jacking lugs, if the transformer filled with oil weighs above 3000 kg.

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 with towing lugs.

19.15 A Pressure Relief Device with contacts for trip and alarm for all transformer ratings. 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~~, 110V 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. Separate buchholz relay shall be provided for main tank ~~and OLTC chamber~~. This shall be double float type for the main tank with separate normally open trip and alarm contacts. Isolating valve shall be provided on either side of the relay and distance piece shall be supplied.

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:

- One (1) top filter valve with blanking plate.
- 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~~, 110V 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 4-20mA Transducers for OTI & WTI and Tap position indication.

20.0 TESTS:

20.1 Routine Tests

20.1.1 All routine tests as per latest 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) Vacuum withstand test.
- b) 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 0.35 kg/ 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.
- c) Magnetic balance test for 3 phase units.
- d) Measurement of tan-delta and capacitance of each winding to earth (with all other windings connected to earth) and between all windings, connected together, to earth.

- e) Partial Discharge measurement.

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.
- 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 Retesting

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

20.6 Test reports

- 20.6.1 Test results shall be corrected to a reference temperature of 75°C.
- 20.6.2 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 The Losses Indicated in the specification shall act as upper ceiling limits during testing/ measurement of losses for acceptance of the transformers.
- 21.3 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.
- 21.4 No tolerances beyond the maximum value of losses stipulated in the specification shall be allowed both for the 'guaranteed losses' and for the measured/tested values during testing of the Power Transformers.
- 21.5 Should the losses as measured on the transformer after manufacture be found in excess of the quoted values of the guaranteed losses with permissible positive tolerance, the VENDOR shall pay to the PURCHASER, penalty charges based on the charges indicated in Data Sheet-A.

- 21.6 If the 'guaranteed losses' are lower than the minimum losses stipulated in the specification, the same will be treated as freak losses.
- 21.7 In case the Bidder declares the 'guaranteed losses' as 'maximum' or indicates any tolerance limit for the same in the Bid, the declared guaranteed losses along with the declared tolerances, if any, will be taken directly for evaluation (i.e without loading tolerance limit of +10% over his 'guaranteed losses'). However, for levy of penalty following will be done:
 - 21.8 In case the Bidder indicates the losses as Maximum in the Bid, it will be considered that the Bidder has included 10% tolerance as per IS and the Guaranteed loss will be arrived by unloading 10%.
 - 21.9 In case the Bidder indicates the tolerances, penalty will be levied as per specification to an extent of the limit of the tolerance quoted.
 - 21.10 In case the Bidder doesn't indicate 'maximum' or the 'tolerance' limit, in such cases, for the purpose of evaluation, a maximum of 10% will be loaded to his 'guaranteed losses' as per specification

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 $\pm 10\%$ 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 $5^\circ C$.
- 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:

23.1 Along with the Bid:

Whether explicitly mentioned or not in the various sections of this specification, BIDDER shall submit **One set** of following documents and drawings.

- a) Confirmation to Technical Compliance

- b) Confirmation to Technical Data Sheets
- c) General Arrangement Drawing (Plan, Elevation & Side view)
- d) Bill of materials and makes
- e) Type Test certificate of identical rating transformer
- f) Deviation Statement (if any)
- g) Catalogues/Brochures/Manuals
- h) List of Mandatory Spares
- i) List of Maintenance Spares
- j) List of Commissioning Spares
- k) List of Special Tools & Tackles

Transformer overall general arrangement drawings giving plan, elevation and side view with complete bill of material and makes; along with duly filled Datasheet- B1 & B2. Datasheet- B1 & B2 shall be completely filled with the technical data required against each serial no. Data other than technical value will not be entertained and such Datasheets will not be considered for Evaluation.

23.2 **On award of contract.**

Whether explicitly mentioned or not in the various sections of this specification, VENDOR/MANUFACTURER documentation shall include hard copies of all drawings related to this package in **FOUR** sets (Hardcopy) and **one set** (softcopy through email) to PURCHASER and PCPL for approval before start of manufacture.

The following drawings and data shall be furnished in four sets for approval before start of manufacture:

- a) Guaranteed Technical Particulars (GTP).
- b) Schedule of Tests as per latest applicable standards.
- c) List of drawings with their revision no. and date.
- d) General arrangement (GA) drawings of transformer with plan and elevation and Bills of Material.
- e) Winding & Core section details
- f) List of fittings.
- g) List of Make and type of each components/ fittings.
- h) Transformer foundation Plan drawing.
- i) Drawing for CT mounting arrangements.
- j) Shipping drawing showing dimensions and weights.
- k) GA drawings of HV and LV, Phase and neutral bushing assembly and termination details with all technical data.
- l) GA drawings of Busduct & Cable Box Assembly.
- m) Rating and Diagram plate.
- n) Oil filling instruction plate.

- o) Valve schedule & Valve location Diagram.
- p) GA, Control schematic and wiring diagram for transformer marshalling box.
- q) Erection drawing.
- r) Painting Procedure
- s) Quality Assurance plan (QAP) for design, raw material, bought out items, manufacture and testing (FAT).
- †) Interconnection Cable schedule between MB, ~~OLTC, RTCC & CCC~~.

23.3 **On dispatch of Transformer.**

Vendor documentation shall include hard copies of the following in **Six sets** along with the delivery of transformer to site

- a) ASMADE drawings related to this package,
- b) Witnessed and Signed FAT reports
- c) Calibration certificates of test kits used for FAT.
- d) Manufacture test certificates for bought out items
- e) Operating and instruction manuals
- f) O & M manual
- g) Training manuals.
- h) Loose materials list with quantities.
- i) Essential & Recommended Spares list with quantities

24.0 **SPARES:**

24.1 The BIDDER shall quote itemised prices for the following essential spares required for 3 years trouble free operation.

- a) Complete set of gaskets.
- b) One bushing of each type.
- c) One Dial type thermometer
- d) Oil level gauge
- e) Complete set of winding temperature-indicating equipment
- f) Pressure relief valve
- g) Silica-gel breather
- h) One valve of each type
- i) Buchholz relay or fault pressure relay
- j) One CT of each type
- k) OLTC motor
- l) 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 shall 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 PURCHASER's incoming power cables from remote panels.

11.4.2 Oil Filled Power Transformer-Datasheets

DATA SHEET-A1					
SL.NO	DESCRIPTION		UNIT	DATA	
1.0 GENERAL	1.1	Application/ designation		Distribution /TR1	Distribution/TR 2
	1.2	Quantity required	Nos.	1	1
	1.3	Installation	Indoor/ Outdoor	Outdoor	Outdoor
	1.4	Degree of protection as per IS 2147		IP 55	IP 55
2 . .	2.1	Rating	kVA	2500	1500
	2.2	Number of phases & frequency		Three phase,50Hz	Three phase,50Hz
	2.3	Number of windings		Two (2)	Two (2)
	2.4	Type of cooling		ONAN	ONAN
	2.5	No load voltage	HV	11	11
			LV	0.433	0.433
	2.6	Winding Connection	HV	Delta	Delta
			LV	Star	Star
	2.7	Vector group		Dyn11	Dyn11
	2.8	Percentage impedance (HV to LV)	%	8	6.25

	2.9	Direction of Power Flow	HV to LV/ LV to HV/ Bi directional	HV to LV	HV to LV
3.0 SYSTEM VOLTAGE [E]	2.10	Winding Insulation Category	HV LV	Uniformly/ Non uniformly Insulated	Uniformly
				Uniformly	Uniformly
4.0 NEUTRAL EARTHING	3.1	Nominal system voltage	HV	kV	11
			LV	kV	0.433
	3.2	Highest system voltage	HV	kV	12
			LV	kV	0.433
	3.3	System fault level	HV / LV	KA	25/65
4.0 NEUTRAL EARTHING	4.1	System neutral			
		HV		Effectively Earthed	Effectively Earthed
		LV		Effectively Earthed	Effectively Earthed
	4.2	Transformer neutral			
		HV		NA	NA
		LV		Solidly Earthed	Solidly Earthed

5.0 WITHSTAND VOLTAGE	5.1	Impulse (1.2/50 μ sec wave)	HV	kVp	75	75
			LV	kVp	8	8
	5.2	Power frequency withstand voltage DRY	HV	kV	28	28
			LV	kV	3	3
		Power frequency	HV	kV	28	28

DATA SHEET-A1								
SL.NO	DESCRIPTION			UNI T	DATA			
6.0 TEMPERATURE RISE		withstand voltage WET	LV	kV	3	3		
	5.3	Transformer Neutral power frequency withstand voltage	HV	kV	NA	NA		
			LV	kV	3	3		
7.0 TAP CHANGING	6.1	Reference ambient temperature		°C	50	50		
	6.2	Oil by thermometer over the ambient		K	40	40		
	6.3	Winding by resistance over the ambient		K	45	45		
7.0 TAP CHANGING	7.1	Taps required: On load / off circuit			Off Circuit	Off Circuit		
	7.2	Tapping on windings			HV	HV		
	7.3	Total tapping range			%	+5 to -5		
	7.4	Tapping Steps			%	2.5		
	7.5	Control	Manual / automatic		Manual	Manual		
			Local / remote		Local	Local		
	7.6	Control cubicle by			Vendor	Vendor		
	7.7	Voltage class of OCTC/OFTC			kV	12		
	7.8	Current rating of OCTC/OFTC			A	By Bidder		
8.0 DETAILS OF TRAFO. FOR PARALLEL OPERATION	7.9	Type of OLTC installation In tank/ Separately mounted			By Bidder	By Bidder		
	8.1	Manufacturer's name			NA	NA		
	8.2	Rating						
	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		
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9.0 BUSHINGS	9.1	Voltage class	HV Line end	kV	12	12
			LV Line end	kV	1.1	1.1
			TV Line end	kV	NA	NA
			HV neutral	kV	NA	NA
			LV neutral	kV	1.1	1.1
	9.2	Impulse wave withstand (1.2/50 sec wave)	HV	kVp	75	75
			LV	kVp	8	8
	9.3	Power frequency withstand for 1 Min.	HV Line end	kV	28	28
			LV Line end	kV	3	3
			HV neutral	kV	NA	NA
			LV neutral	kV	3	3
	9.4	Minimum clearance	HV ph to ph	mm	130	130
			LV ph to ph	mm	By Bidder	By Bidder
			HV ph to earth	mm	80	80
			LV ph to earth	mm	By Bidder	By Bidder
	9.5	Minimum creepage distance (total protected)	HV Line end	mm	25mm/KV 300	25mm/KV 300
			LV Line end	mm	25	25
			HV neutral	mm	NA	NA
			LV neutral	mm	25	25
	9.6	Bushing CT details	HV phas e Bushi ngs	Nos	NA	NA
				Paramete rs	NA	NA
			HV Neutr al bushi ng.	Nos	NA	Na
				Paramete rs	NA	NA
			LV Phas e Bush ings	Nos	NA	Na
				Paramete rs	NA	NA
			LV Neutr al bushi ng	Nos	2	2

				Parameters	<u>NCT-1</u> 4000/1A, Cl.5P10, 15VA <u>NCT-2</u> 4000/1A, Cl.PS, (V _k , R _{ct} and I _m shall be decided during detail engg.)	<u>NCT-1</u> 2500/1A, Cl.5P10, 15VA <u>NCT-2</u> 2500/1A, Cl.PS, (V _k , R _{ct} and I _m shall be decided during detail engg.)	
10.0 TERMINAL CONNECTIONS		10.1		HV line end bushing/ cable box/ Cable box with disconnecting chamber.		Cable box with disconnecting chamber	
		10.2		LV line end bushing/ cable box/ cable box with disconnecting chamber/ Bus duct.		Busduct termination	
		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	No	
				Size of take off conductor	HV	NA	
					LV	NA	
11.0 EARTHING TERMINAL	10.6	Cable box, lugs and glands		Required	Yes/No	Yes	
				Size of cable	HV	1R x 3C x 240 / 185 Sq.mm., 11kV (E) grade, Al, XLPE, Armoured power cable	
	11.1				LV	NA	
						NA	
12.0 MISC	11.2	Material of conductor		Body		GS strip	
				Neutral		Copper	
	12.1	Size of conductor		Body	m m	75 x 10	
				Neutral	m m	50 x 8	
			Plain/ flanged		Plain	Plain	
			Unidirectional/ bi-directional		Bi-Directional	Bi-Directional	

	12.2	Vacuum withstand capability of Main tank with bushings, radiators, fittings & accessories		760mm of Hg	760mm of Hg
	12.3	Filled with oil Transformer to be transported	Yes/ No	No	No
		Without oil with inert gas, Gas Cylinder and accessories, pressure gauge	Yes/ No	Yes	Yes
13.0 OPTIONAL FITTINGS REQUIRED	13.1	Magnetic oil level gauge with low oil level alarm contacts as per clause 19.11	Yes/ No	Yes	Yes
	13.2	Pressure relief device as per clause 19.15	Yes/ No	Yes	Yes
	13.3	Dial type thermometer with two contacts for oil temp. as per clause 19.16	Yes/ No	Yes	Yes
	13.4	Gas and oil actuated i.e., Bucholz relay as per clause 19.17	Yes/ No	Yes	Yes
	13.5	Winding temperature indicator with two contacts with two contacts as per clause 19.20	Yes/ No	Yes	Yes
	13.6	On load tap changer as per specification section 6.4.3	Yes/ No	No	No
	13.7	Oil surge relay with alarm and trip contacts for OLTC	Yes/ No	No	No
	13.8	Valves as per clause 9.0	Yes/ No	Yes	
	13.9	Four plain rollers in place of fixing channels	Yes/ No	Yes	Yes
PEN ALT Y	14.1	Formula for evaluation of bids (Wi = No Load loss, Wc = Load loss & Wp = Auxiliary Loss)		Refer Section-6.3.1 (Specific technical requirement)	Refer Section-6.3.1 (Specific technical requirement)

	14.2	Rates of penalty for exceeding the guaranteed losses per kW	Wi Wc W P	Refer Section-6.3.1 (Specific technical requirement)	Refer Section-6.3.1 (Specific technical requirement)
15.0 ESSENTIAL SPARES	15.1	Complete set of gaskets	Set	1	
	15.2	Bushing of each type	Nos	1	
	15.3	Dial type thermometer	Nos	1	
	15.4	Complete WTI equipment	Nos	1	
	15.5	Pressure relief valve/ Explosion vent diaphragas	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		NA	
	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.			

	16.3	<p>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:-</p> <ul style="list-style-type: none"> 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. 		NA	NA
	16.4	<p>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</p> <ul style="list-style-type: none"> a) Digital voltmeter with phase selection facility for indication of transformer LV side (11kV) voltage. 		NA	NA

DATA SHEET A2 APPLICABLE STANDARDS			
SL.NO.	ITE M	STANDA RD	
1.0	Power transformer	IS 2026	IEC 60076
2.0	Outdoor type 3-phase distribution transformers	IS 1180	
3.0	Fitting & Accessories for Power transformers	IS 3639	IEC
4.0	Guide for Loading of oil immersed transformers	IS 6600	IEC 60354
5.0	Insulating Oil	IS 335	IEC 60296
6.0	Bushings	IS 2099	IEC 60137
7.0	Degree of protection	IS 2147	IEC 60144
8.0	Buchholz relay	IS 3637	IEC

9.0	On load tap changer	IS 8468	IEC 60214
10.0	Application Guide for OLTC	IS 8478	IEC 60542
11.0	Code of Practices for selection, Installation and maintenance of Transformer	IS 10028	IEC
12.0	Current Transformers	IS 2705	

Section 11.5.1 - HV SWITCHGEAR

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 HV Indoor Metal-Clad switchgear.

2.0 CODES AND STANDARDS:

2.1 The design, material, construction features, manufacture, inspection, testing and performance of indoor metal clad switchgear 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 Indoor Metal-clad switchgear shall conform to the latest applicable standards specified in Data Sheet -A. In case of any conflict between the standards and this specification, more stringent requirement of the two shall govern.

3.0 MAJOR PARAMETERS

3.1 The major parameters of the switchgear and associated equipment are specified in enclosed Data sheet A1. The Bidder shall confirm compliance of these data in full. Deviations, if any, shall be specifically brought out in the schedule of Technical Deviations.

3.2 The bill of material for each type of cubicle is given in enclosed single line diagram/module drawings/ Bill of material. The scope of supply shall include all these items.

4.0 CONSTRUCTIONAL FEATURES:

4.1 Metal-clad switchgear shall comprise metal-enclosed switchgear and control gear in which components are arranged in separate compartments with metal-enclosure intended to be earthed.

The metal-clad switchgear and control gear shall have separate compartments for the following components:

- Each set of busbars
- Switching device (Circuit Breaker/Contactor/Load Break switch/Fuses).
- Power Cable Terminations.
- Metering, control & auxiliary switching devices and relaying devices.

4.2 The switchgear shall be totally dust, moisture and vermin-proof. The degree of protection shall be as specified in Data sheet A1.

4.3 The current transformers shall be fitted on the fixed portion of the switchgear and not on the Breaker truck.

4.4 The Cable compartment shall fully house all power cable connections along with associated cable terminations. Wherever zero sequence current transformers are

provided for earth fault protection, these shall also be located inside the cable compartment.

4.5 All doors of panels, removable covers shall be gasketed all around with neoprene gaskets of proper size. All louvers shall have screen and filter. Vent openings shall be covered with grills so arranged that hot gases or other material cannot be discharged through them in a manner that can injure the operating personnel. The screens and grills shall be made of either brass or galvanised iron wire mesh.

4.6 Metal-clad unit shall comprise of rigid welded structural frame enclosed completely by metal sheets smoothly finished, levelled and free from dents and uneven surfaces. The thickness of sheet steel shall be as specified in Data Sheet A1.

4.7 Painting

4.7.1 All sheet steelwork shall be phosphated in accordance with the following procedure and in accordance with relevant standards for phosphating iron and steel.

- Oil, grease, dirt and swarf shall be thoroughly removed by emulsion cleaning.
- Rust and scale shall be removed by pickling with dilute acid followed by washing with running water rinsing with slightly alkaline hot water and drying.
- After phosphating, thorough rinsing shall be carried out with clean water, followed by final rinsing with dilute dichromate solution and oven drying.

4.7.2 After phosphating, the sheet metal shall be subjected to powder coating process. The powder coating shall be carried out by spraying Polyester Epoxy powder (60/ 40) or equivalent using electrostatic or corona gun. After uniform deposition of the powder to the required thickness on to the object, it shall be transferred to a curing oven.

4.7.3 The final finished thickness of paint film on steel shall not be less than 100 microns, and shall not be more than 150 microns.

4.7.4 Finished painted equipment shall present an aesthetically pleasing appearance, free from dents and uneven surfaces with unique colour shade.

4.8 Switchgear design shall comprise fully compartmental execution having separate vertical sections for each circuit. Compartments with doors for access to operating mechanism shall be so arranged as not to expose high voltage circuits. Switchgear cubicles shall be provided with hinged doors on the front with facility for padlocking door handles.

4.9 Structures, busbars and control wiring troughs shall be so designed and arranged to make future extensions readily feasible on either side.

4.10 Instruments, relays and control devices shall be mounted flush on hinged door of the metering compartment located in the front portion of cubicle. Panel door shall be supported by strong hinges and braced in such a manner as to ensure freedom from sagging, bending and general distortion of panel or hinged parts.

4.11 Switchgear cubicles shall be provided with bottom sheet metal plates of 3 mm thick (minimum). Cubicles shall be fitted with removable gland plates in the cable termination chamber at bottom for entry of cables. The gland plates shall be of non-magnetic material, if single core cable terminations are specified.

4.12 Mounting sills in the form of mild steel channels properly drilled shall be supplied along with anchor bolts for mounting the switchgear cubicles. These shall be

despatched in advance so that they may be installed and levelled when concrete foundations are poured.

- 4.13 All corresponding components of cubicles of same rating shall be interchangeable with one another.
- 4.14 Each switchgear cubicle shall be fitted with a label on the front and rear of the cubicle. Each switchgear shall also be fitted with label indicating the switchgear designation, rating and duty. Each relay, instrument, switch, fuse and other devices shall be provided with indelibly marked individual designation labels with proper sized letterings at both front & rear of the mounting door sheet. Size and wording of the labels shall be subject to the PURCHASER'S approval.

5.0 TYPES OF PANELS

- 5.1 The following type of panels shall be supplied as specified in Data Sheet A1.
 - a) Circuit Breaker Panel
 - b) Contactor panel: The panel shall comprise contactor with load break isolator and HRC Fuses.
 - c) Switch-Fuse Unit (SFU): Panel comprising load break isolator and HRC Fuses.
- 5.2 Off load isolators shall be supplied with circuit breaker for double bus bar system. The isolators shall be operated only when the breaker is open.

6.0 SAFETY INTERLOCKS & FEATURES:

Switchgear shall be provided with following inter locks:

- 6.1 Withdrawal or engagement of a circuit breaker or isolator shall not be possible unless it is in the open position.
- 6.2 Operation of a circuit breaker or isolator shall not be possible unless it is fully in-service position, withdrawn to test position or fully drawn out.
- 6.3 Compartment door of a breaker or isolator shall not be possible to open unless the associated breaker or isolator is in open position.
- 6.4 Circuit breaker/isolator cubicles shall be provided with safety shutters operated automatically by the movement of the circuit breaker/ isolator carriage, to cover the stationary isolated contacts when the breaker/ isolator is withdrawn. Padlocking facilities shall be provided for locking the shutters positively in the closed position. It shall, however be made possible to open the shutters intentionally against spring pressure for testing purposes only.
- 6.5 A breaker/ isolator of given rating shall be prevented from engaging with a stationary element of other / higher rated one.
- 6.6 The breaker/ isolator carriage shall be earthed before the main circuit breaker/isolator controls are plugged in the stationary contacts, i.e. before the control circuit is completed. Positive earthing of circuit breaker/isolator truck shall be maintained in the connected position.
- 6.7 Caution nameplate, "**Caution Live Terminal**" shall be provided at all points where the terminals are likely to remain live and isolation is possible only at remote end, i.e. incoming terminals of main breaker / isolator.

6.8 The closing and tripping circuit of each feeder controlling device will be interlocked electrically with the PURCHASER'S equipment to be specified later and the VENDOR shall arrange for the necessary wiring.

7.0 MAIN BUS BARS:

7.1 **Main busbars shall be of electrolytic grade copper** (tough pitched-99% purity) or ~~Aluminium Alloy, E91E grade~~ as specified in Data Sheet -A, conforming to relevant standards specified there in.

7.2 Bus-bars shall be located in air insulated enclosures and segregated from all other compartments of the cubicle. Direct access or accidental contact with busbars and primary connections shall not be possible. To provide a seal between adjacent cubicles, busbars shall be taken through seal-off bushings or insulating pads.

7.3 Bus-bars shall either be air insulated or encapsulated in epoxy and phase segregated by means of insulated phase barriers as specified in Data Sheet -A. The insulating material for phase barriers shall be made of non-hygroscopic material such as glass reinforced plastic or epoxy, which shall provide adequate insulation for the specified voltage class.

7.4 All busbar joints and bus tap joints shall be silver faced. Plain and spring washers shall be provided to ensure good surface contacts at the joints and taps. Wherever copper to dissimilar materials connections are required, suitable bimetallic connectors or clamps shall be used at joints & taps.

7.5 Bus-bars shall be rated in accordance with the service conditions and the rated continuous and short time current ratings specified in Data Sheet - A. Calculations shall be submitted for the busbar sizing taking into account ambient, enclosure and proximity de-ratings.

7.6 Bus-bars shall be adequately supported on insulators to withstand dynamic stresses due to short circuit current specified in Data Sheet -A. Busbar support insulators shall conform to relevant standards specified in Data Sheet -A.

7.7 The busbar clearances in air shall be as specified in Data Sheet -A.

7.8 Busbars shall not be painted and all performance characteristics specified shall be obtained with unpainted busbars.

8.0 CIRCUIT BREAKERS:

8.1 Circuit breakers shall be of Vacuum or SF6 type as specified in Data Sheet -A. These shall conform to relevant standards specified in Data Sheet -A and shall be of the horizontal draw-out type. Circuit breakers shall comprise three separate identical single pole units operated through a common shaft by the operating mechanism.

8.2 Circuit breakers shall be suitable for switching duty of transformers whose maximum capacity is furnished in Data Sheet-A and other devices specified in Data Sheet-A.

8.3 Circuit breaker along with its operating mechanism shall be mounted on a wheeled carriage moving on guides, designed to align correctly and allow smooth movements. Isolating plugs and sockets for auxiliary power as well as control circuits shall be of robust design and fully self-aligning. Plugs and sockets for

auxiliary power circuits shall be silver faced and shall be insulated with FRLS PVC or similar insulating material shrouds.

8.4 There shall be 'Service', 'Test' and 'Fully withdrawn' distinct positions for the breakers in it's housing. In the 'Test' position, the circuit breaker shall be capable of being tested for operation without energising the power circuits, i.e. the control circuits shall remain undisturbed while the power contacts shall be disconnected. Separate limit switches each having a minimum of 3 NO + 1 NC contacts shall be provided for both 'Service' and 'Test' positions of the circuit breakers as spares. These contacts shall be rated for 10A, 240V AC and 0.5A (inductive breaking) at 220V DC.

8.5 Connection of the control circuit between the fixed portion of the cubicle and the breaker carriage shall be by means of a 24-pin plug and socket arrangement. If a 24-pin arrangement is inadequate for the control and interlock scheme offered by the VENDOR, the VENDOR shall provide plug and socket having adequate number of pins. The plug and socket shall be so designed that, it shall be possible to engage or disengage the plug into the socket in 'test' position only, thereby eliminating the possibility of faulty insertion and wiring connections. The plug, after insertion, shall remain secured in position by spring clamps, which need considerable force to operate. The length of the plug chord shall be such that plug can be inserted into the socket only when the breaker is in 'test' and move further to 'Service' position. But it shall be necessary to withdraw the plug from the socket before the breaker truck can be pulled out into the "Fully Withdrawn" position. It shall not be possible to move the circuit breaker into service or fully in position unless plug and socket be inserted in position.

8.6 Vacuum breakers shall have completely sealed interrupting units for interruption of arc inside the vacuum chamber. The breakers shall be provided with "contact wear indicator" visible from the front of the equipment, without requiring opening of the 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 when in drawn out position for mechanical testing of the interrupter to check loss of vacuum.

8.7 The vacuum breakers shall be complete with integral surge arrestors to provide protection to the equipment controlled by the breaker, against switching surges.

8.8 SF6 circuit breakers shall operate on puffer or rotating arc principle. The breaker shall have, SF6 gas pressure 'low' and 'very low' alarm and trip contacts.

9.0 OPERATING MECHANISM:

9.1 Circuit breaker shall be power operated, either by pneumatic or by a motor charged spring operated mechanism.. Main poles of the breakers shall be such that unless otherwise specified, the maximum difference between instants of contacts touching during closing shall not exceed quarter a cycle of the rated frequency.

9.2 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 only and use of a contactor to achieve this feature shall not be acceptable.

9.3 Main poles of the breakers shall operate simultaneously.

9.4 Closing and Trip Circuits

9.4.1 Closing and trip coils shall be rated for satisfactory operation on the control supply voltage specified in Data Sheet A1.

9.4.2 Close and trip coils shall operate satisfactorily under the following conditions of supply voltage variations:-

- a) Closing Coils - 85% to 110% of rated voltage
- b) Trip Coils - 50% to 110% of rated voltage.

9.4.3 Electrical anti-pumping feature shall be provided.

9.4.4 Trip circuit supervision relay shall be provided to indicate 'trip circuit healthy' in the switchgear and remote panel and to provide alarm for 'trip circuit faulty'.

9.5 Spring Operating Mechanism

9.5.1 Spring charging motor shall be universal type suitable for operation on AC and DC control voltages specified in Data Sheet A1 with voltage variation of 80% to 110% of rated voltage.

9.5.2 Spring operated mechanism, shall be complete with spring charging motor, opening spring, closing spring with limit switch for automatic charging and all necessary accessories to make the mechanism a complete operating unit.

9.5.3 As long as power is available to the spring charging motor, a continuous sequence of closing and opening operations shall be possible. After failure of power supply to the motor, at least one open-close-open operation of the circuit breaker shall be possible.

9.5.4 Breaker operation shall be independent of the spring charging motor, which shall be used solely for compressing the closing spring.

9.5.5 Closing action of the circuit breaker shall compress the opening spring ready for tripping. When closing springs are discharged, after closing a breaker, closing springs shall automatically be charged for the next operation.

9.5.6 Motor shall be such that it requires a maximum of about 30 sec for fully charging the closing spring.

9.6 Operating Mechanism Control

9.6.1 Operating Mechanism shall normally be operated by remote electrical control when the breaker is in "Service" position. Electrical tripping shall be performed by shunt trip coils. Provision shall be made for local electrical control when the breaker is in "Test" position by a control switch on the switchgear cubicle door. Also, "Local/Remote" selector switch lockable in "Local" position shall be provided on the cubicle door.

9.6.2 The following indicating lamps shall be provided on the front panel:-

- a) 'Red', 'Green', and 'Amber' lamps for breaker 'on', 'off' and 'auto trip' indication.
- b) 'Red' lamps for test and service position.
- c) 'White' lamp for trip circuit healthy
- d) 'Blue' lamp for spring charged.

9.7 Breaker Accessories

The following accessories shall be provided with each breaker.

- 9.7.1 Mechanical trip and close push buttons for manual operation under emergency. The mechanical trip button shall be provided on the front door with a shrouded cover. The mechanical close button shall be accessible after opening the front door.
- 9.7.2 Mechanical position indicator for ON/OFF status of the breaker.
- 9.7.3 Mechanical position indicator for Test and Service position of the breaker.
- 9.7.4 Breaker auxiliary switches mounted on the fixed portion of the cubicles and directly operated by the breaker operating mechanism. 6 'NO' and 6 'NC' potential free contacts shall be provided for purchasers use. These contacts shall be in addition to those utilized in the control circuit of the breaker by the vendor.
- 9.7.5 Mechanical position indicator for closing spring charged.
- 9.7.6 Manual spring charging facility.
- 9.7.7 Operation Counter
- 9.7.8 All Mechanical position indicators shall be so located that they are visible to the operator standing in front of the switchgear with cubicle door closed.
- 9.7.9 All electrical contacts provided for purchasers use shall be potential free contacts rated 10A, 240V AC and 0.5A (inductive breaking) 220V DC.

10.0 CONTACTORS

- 10.1 The contactor shall be triple pole, vacuum type.
- 10.2 The contactor shall be suitable for Direct On Line (DOL) switching of AC Induction motor and of utilisation category AC3 unless otherwise stated in Data Sheet.
- 10.3 The contactor shall be suitable for 'local' and 'remote' closing and opening.
- 10.4 The contactor shall provide 6 'NO' and 6 'NC' auxiliary contacts for purchaser's use.
- 10.5 The contactor along with load break switch isolator and fuses shall be mounted on a withdrawable carriage similar to circuit breakers.

11.0 SWITCH FUSE UNIT

- 11.1 The switch isolator shall be load break type capable of breaking the load current specified in Data Sheet A1.
- 11.2 The switch shall be manually operated or motor operated as specified in Data Sheet A1.
- 11.3 The switch shall be able to make and carry for specified duration the fault currents specified in Data Sheet A1.
- 11.4 The switch shall provide 4 'NO' and 4 'NC' auxiliary contacts for purchasers use.
- 11.5 The fuses shall be single pole, HRC type suitable for the fault duty specified.
- 11.6 The high voltage fuses shall be ofstriker pin type. On blowing of fuse in any phase, the switch unit shall open outto prevent single phase operation.
- 11.7 The switch fuse unit shall be draw out type.

12.0 CURRENT TRANSFORMERS

- 12.1 Each panel shall be provided with metering and protection current transformers (CTs) as shown in the single line diagrams.
- 12.2 The CT parameters are given in the single line diagrams and Data Sheets. The BIDDER shall ensure that the specified ratings are adequate for the relays and meters furnished by him. If specified ratings are not adequate, the BIDDER shall offer CTs of required rating.
- 12.3 The CTs shall be of cast resin type and completely encapsulated.
- 12.4 The CTs shall withstand the momentary and short time fault current rating specified for the switchgear.
- 12.5 The core balance CTs shall be suitable for the respective outgoing feeder and suitably supported.
- 12.6 Test links shall be provided in the secondary leads of CTs to carry out current and phase angle measurement tests.
- 12.7 All CTs shall be earthed through a separate earth link on the terminal block to permit measurement of CT insulation resistance.
- 12.8 The CT shall have polarity indelibly marked on each CT and associated terminal block.

13.0 VOLTAGE TRANSFORMERS

- 13.1 Each panel shall be provided with metering and protection voltage transformers (VTs) as shown in the single line diagrams.
- 13.2 The VT parameters are given in the single line diagrams and Data Sheets. The bidder shall ensure that the specified ratings are adequate for the relays and meters furnished by him. If specified ratings are not adequate, the BIDDER shall offer VTs of required rating.
- 13.3 The VTs shall be of cast resin type and completely encapsulated.
- 13.4 The VTs shall be single phase, draw out type.
- 13.5 Each single pole VT shall be housed in a separate sheet metal compartment.
- 13.6 The VT shall have a continuous over voltage factor of 1.2 and short time over voltage factor as follows:-
 - a) 1.5 for 30 seconds in case of effectively earthed system.
 - b) 1.9 for 8 hours in case of non-effectively earthed system.
- 13.7 The VT shall be protected by HRC fuses on the primary side and RCBO on the secondary side.
- 13.8 The VT shall have polarity indelibly marked on each VT and associated terminal block.

14.0 INDICATING INSTRUMENTS & METERS:

- 14.1 Instruments and meters shall be supplied as shown in single line diagram/data sheets.

- 14.2 Electrical indicating instruments shall be of minimum 96mm square size, 240 degree scale deflection with a class of accuracy of 0.5/ 1.0 as applicable, suitable for flush mounting.
- 14.3 Indicating instruments shall have provision for zero adjustment outside the cover.
- 14.4 Instrument dials shall be parallax free with black numerals on a white dial.
- 14.5 Watt-hour metes shall be of the direct reading electrodynamic type complete with cyclometer type dials and reverse running stops.
- 14.6 Digital multifunction power monitor (MF) shall be supplied when specified in single line diagram/Data sheet. The multifunction meter shall include monitors for voltage, current, frequency, power factor, power(kVA, kW, kVAR) and energy (kVAh, kWh, kVARh inductive and capacitive) The MF shall have class of accuracy 0.5. The MF shall have RS 485 port connection for communication with PLC/SCADA.

15.0 INDICATING LAMPS

- 15.1 Indicating lamp shall be:
 - of the cluster LED type and of low watt consumption,
 - provided with step-down transformer and
 - provided with translucent lamp covers of colours as required in the control wiring diagrams.

- 15.2 Bulbs and lenses shall be easily replaceable from the front

16.0 CONTROL & SELECTOR SWITCHES:

- 16.1 Control and selector switches shall be:
 - of the rotary type with enclosed contacts,
 - adequately rated for the purpose intended (min. acceptable rating is 10A continuous at 240V AC and 1A (inductive break) 220V DC and
 - provided with escutcheon plates clearly marked to show the positions
- 16.2 Control switches shall be:
 - of the spring return to normal type and
 - provided with pistol grip type handles
- 16.3 Control switches for circuit breaker control shall be provided with:
 - contact development as specified in bill of material of enclosed drawings.
- 16.4 Wherever specified in data sheets, control switches with built-in flashing type discrepancy lamps shall be provided to control circuit breakers in lieu of the normal control switch, red, green and amber indicating lamps. The discrepancy lamp shall be replaceable from the front of the module door.
- 16.5 Selector switches shall be:
 - Of the maintained contact stay put type. Switches in ammeter circuits shall have make-before-break type contacts
 - Provided with oval handles

17.0 PUSH BUTTONS:

17.1 Push buttons shall be:

Of the momentary contact, push to actuate type rated to carry 10A at 240V AC & 1A (inductive breaking) at 220V DC

Fitted with self reset, 2 NO and 2 NC contacts

Provided with integral escutcheon plates marked with its function

17.2 'Start', 'Open', 'Close' push buttons shall be green in colour

17.3 'Stop' push buttons shall be red in colour

17.4 All other push buttons shall be black in colour

18.0 PROTECTION RELAYS

18.1 All protection relays shall be supplied as shown in single line diagrams/ Data sheets.

18.2 All relays shall be static or numerical type. Multi function relays shall be provided wherever applicable. Multifunction relays shall have provision for communication with PLC/ SCADA.

18.3 Multifunction numerical relays shall have the following features:-

All Currents and Voltages measured in true RMS values.

A LCD screen that shall show all the values measured by the relay as well as the preset parameters.

Programmable LED indications.

Programmable scheme logic which shall allow the user to customise the protection and control functions.

Independent protection settings for each relay element.

Self supervision of the relay with alarm for relay failure.

Trip circuit supervision of the breaker in both breaker open and closed states.

Voltage transformer supervision to detect loss of one, two or three phase VT signals.

Current transformer supervision to detect loss of phase CT signals and inhibit the operation of current dependent protection elements.

18.4 Post Fault Analysis

The numerical relays shall have events, fault and disturbance recorders with the following features:-

All records shall be time lagged to a resolution of 1 ms using internal real time clock.

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.

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.

The fault recorder shall maintain records for at least last 5 faults in non-volatile memory. Oscillographic fault records shall be provided.

The disturbance recorder shall store at least 20 disturbance records of up to 10.0 seconds in nonvolatile memory. The data shall be sampled 12 times a cycle. All channels and trigger sources shall be user configurable.

18.5 Local and Remote Communications

The numerical relays shall provide the following communication facilities

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.

The remote communication shall be provided by RS 485 port connection and communication protocol suitable for Communication with SCADA. All internal information such as measurements, adjustments, settings, post fault analysis records shall be available via the communication network.

- 18.6 Relays shall be suitable for flush mounting with only flanges projecting.
- 18.7 All protective relays shall be in draw out cases with built in test facility. Necessary test plugs shall be supplied loose and shall be included in VENDOR's scope.
- 18.8 High speed tripping relays shall be supplied when shown in single line diagrams/Data sheets. The tripping relay shall be hand reset type.
- 18.9 Auxiliary relays and time delay relays shall be supplied as shown in single line diagrams/Data sheets/ Schematic drawings.
- 18.10 Auxiliary relays for multiplying equipment status/ position contacts shall be of Areva make type VAJC or equivalent bi stable relay and shall not be either contactor type or mono stable relay.

19.0 EARTHING:

- 19.1 An earth bus shall be provided and extended through out the length of the switchgear to facilitate dual point earthing. It shall be brazed/ bolted to the frame work of each panel and each breaker earthing contact bar.
- 19.2 The earth bus shall have sufficient cross section to carry the momentary short circuit and short time fault current for the duration as specified in Data Sheet-A, without exceeding maximum allowable temperature rise.
- 19.3 Suitable clamp type terminals at each end of the earth bus shall be provided to suit the size of the PURCHASER's earthing conductor.
- 19.4 All non-current carrying metal work of the switchboard shall be effectively bonded to the earth bus.
- 19.5 Bolted joints, splices, taps etc. to the earth bus shall be made with at least two bolts.

- 19.6 Hinged doors shall be earthed through flexible earthing tinned Cu braid of suitable size.
- 19.7 Positive earthing of circuit breaker frame shall be maintained when it is in the connected position and in all other positions whilst the auxiliary circuits are not totally disconnected.
- 19.8 The circuit breaker frame contacts/ control circuit contacts are plugged in the associated stationary contacts.
- 19.9 Circuit/ Busbar Earthing Facility
 - 19.9.1 It shall be possible to connect each circuit or set of 3 phase busbars of the switchgear to earth either through earthing switches or through truck mounted earthing devices (in the Incomer/ Bus PT panel with suitable arrangement to earth only the dead bus).
 - 19.9.2 Integral earthing switches shall be mechanically interlocked with the associated breaker / isolator to prevent earthing of live circuit of busbars.

20.0 CUBICLE ACCESSORIES AND WIRING:

Cubicle accessories and wiring shall include following:

- 20.1 Inter-cubicle wiring between cubicles of same switchgear shall be carried out by the VENDOR. Separate schematics, internal and inter-cubicle wiring diagrams and external cable connection diagrams for each cubicle shall be furnished by the VENDOR. The external connection drawings shall indicate all external connections to be made by the PURCHASER to the respective cubicles from the PURCHASER'S remote equipment. Necessary data for remote connections will be furnished by the PURCHASER to the VENDOR.
- 20.2 It shall be the responsibility of the VENDOR to select motor protection relays whose characteristics shall match with motor characteristics for the motor feeders.
- 20.3 One common two pole miniature circuit breaker of adequate rating for controlling DC supplies to tripping and closing circuits of breaker.
- 20.4 10% spare terminals of each size in each Terminal blocks in addition to those used to complete internal wiring and inter-cubicle wiring shall be made available for purchaser's use.
- 20.5 All accessories such as Local / Remote selector switch, breaker control switch with indicating lamps, 'Tests' and 'Services' position limit switches with position indicating lamps etc. as per attached specifications and drawings shall be included in the VENDOR'S scope of supply.
- 20.6 Inter-cubicle looping of control and cubicle space heating supplies for all the panels of switchgear shall be carried out by the VENDOR.
- 20.7 Terminals suitable to receive cables for motor space heater shall be provided in each cubicle by the VENDOR for the motor feeders.
- 20.8 Segregation of auxiliary and control terminals for AC & DC shall be followed in all locations.
- 20.9 Wiring inside the switchgear shall be carried out with 1100/650 V grade, FRLS PVC insulated, stranded conductor wires. Control circuits shall be wired with copper conductor of at least 2.5 sq.mm for CT circuits and 1.5 sq.mm for VT and other

circuits, the number and size of strands shall be 7 of 0.67 mm and 0.5 mm diameter respectively.

21.0 CABLE BOXES & GLANDS:

- 21.1 Cables boxes/ pot heads and glands shall be provided in the switchgear.
- 21.2 Cable boxes/ pot heads for power cables shall be suitable for stranded aluminium conductor, cross linked polyethylene insulated cables, as specified in Section-C and / or Data Sheet-A.
- 21.3 Cable terminating boxes shall be supplied complete with all accessories (excluding heat shrinkable sleeves and kits) required for terminating PURCHASER's cables should be furnished by the VENDOR.
- 21.4 The accessories shall include but not be limited to armour clamps, brass glands, pig tails etc.
- 21.5 Connecting leads of adequate size with terminal clamps for connecting cable box terminal to switchgear equipment terminals shall be included.
- 21.6 Cable box shall withstand the short circuit rating of the switchgear.
- 21.7 Necessary number of cable glands shall be provided for terminating auxiliary power and control supply cables.
- 21.8 Glands shall be of heavy-duty brass castings, machine finished and complete with check nut, washers, neoprene compression ring etc.

22.0 MISCELLANEOUS ACCESSORIES:

22.1 Heater

Each switchgear cubicle shall be equipped with heaters to prevent moisture condensation within the enclosure and shall be complete with MCB unit for power supply. Heaters shall be suitable for continuous operation on 240V, 1 phase, 50Hz. AC supply and shall be controlled by a humidistat.

22.2 Plug Point

A 240V, 1 phase, 50 Hz. AC plug point shall be provided in the interior of each cubicle with an MCB for connection of hand lamps.

22.3 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 for three (3) years satisfactory operation and catalogue numbers.

- a) One complete pole of the breaker.
- b) Closing coil.
- c) Tripping coil.
- d) Spring charging motors along with closing and tripping springs.
- e) Set of gaskets.
- f) Busbar support insulators.

- g) Auxiliary switch assemblies.
- h) Operating mechanism rods.
- i) Limit position switches.
- j) Local/remote selector switches
- k) Breaker control switches.
- l) Bus seal -off bushings.
- m) Various types of relays.
- n) Indicating lamps.
- o) Cable boxes/ pot heads of different types.
- p) Fixed and moving plug contact assemblies.
- q) Different types of CTs & PTs.
- r) Main Fixed and moving contact assemblies for breakers.

23.0 TESTS AND TEST REPORTS:

- 23.1 The VENDOR shall completely assemble, with all the associated equipment including bought out items mounted and wired and test each cubicle as per relevant standards specified in Data Sheet-A. All type and routine tests shall be carried out as per this standard. Type test reports for short circuit and temperature rise shall be submitted along with the bid.
- 23.2 Type tests and routine tests shall be carried out on all associated equipment as per relevant standards specified in Data Sheet-A.
- 23.3 Copies of the test certificates shall be submitted for the PURCHASER'S approval before despatch of the switchgear. The switchgear shall not be despatched unless the test certificates are approved. Bound copies of complete test results as specified in the distribution schedule shall be furnished with the switchgear. These shall include complete reports and results of the routine tests as also certified copies of type tests carried out on equipment of identical design.
- 23.4 Oscillographic test records for closing and tripping timings of the breakers shall also be furnished.

24.0 DRAWINGS AND DATA:

As part of the proposal, the VENDOR shall furnish relevant descriptive and illustrative literature on breakers, contactors and associated equipment and the following for preliminary study.

- a) Complete assembly drawings of the switchgear showing plan, elevation and typical sectional views and locations of cable boxes/pot heads, busbar chamber, metering and relay compartment and terminal blocks for external wiring connections.
- b) Typical and recommended schematic diagrams for control and supervision of circuit breakers.

- c) Foundation plan showing location of foundation channels, anchor bolts and anchors, floor plans and openings for all cables entry etc.
- d) Type test certificates along with oscillograms for breakers of identical ratings.

11.5.2 11kV SWITCHGEAR DATASHEETS

DATA SHEET - A1									
Sl. No.	Description			Unit	Data				
1.0. SWITCHGEAR CUBICLES AND BUS BARS RATING	1.1	Rated Voltage/ Phases/ Frequency		kV/ No./ Hz	11/3/50				
	1.2	System Neutral Earthing	Effectively earthed		Solid Earthed				
			Non Effectively Earthed.		No				
	1.3	Maximum System Voltage.		kV	12				
	1.4	One minute power frequency withstand voltage		kV (rms)	28				
	1.5	1.2/50 μ Sec impulse withstand voltage		kVp	75				
	1.6	Short circuit withstand at rated voltage	Current	kA	25				
			Time	s	3				
	1.7	Dynamic rating		kAp	62.5				
	1.8	Reference ambient temperature.		°C	45				
	1.9	Continuous current rating of busbars under site reference ambient temp.		A	As per SLD				
	1.10	Maximum temperature of (final) busbars, droppers, connectors & contacts at continuous current rating under site reference ambient temperature.		°C	85				
	1.11	Maximum temperature final of Cable termination Point		°C	85				
	1.12	Applicable standards			As per Data sheet A2				
2.0. SWITCHGEAR PARTICULARS	Designation	Bus Bars		Cable Entry Top / Bottom (T/B)	Total no. of CB/ SFU cubicles per Switch board	No of Bus PT			
		A	Cu / Al	Power	Control				
	2.1	Main HT Panel	630	Cu	B	B	5	1	2
	2.2								
	2.3								
	2.4								
	2.5								

2.6								
2.7								
2.8								
2.9								
2.10								

DATA SHEET - A1			
Sl. No.	Description	Unit	Data
5.0 BREAKER PARTICULARS	see operating mechanism.		
	num no of auxiliary contacts		+ 6 NC through bistable relay
	num No. of contacts in each position switch		osition: 3NO + 1 NC e Posn. 3 NO + 1 NC
	stand test voltage		
	a) minute power frequency	ns)	
	b) se (1-2x50 μ wave)	ak)	
	ary control voltage		
	a) osing/ tripping coil	'DC	DC
	b) ring charging motor	'DC	AC
	c) ace heaters and lighting		AC
	5.15 er application		
	a) ormer control	No	
	b) control	No	
	c) itor control	No	
	5.16 er Auxiliaries required		
	a) unction counter	No	
	b) nical position indicator	No	
	c) nical close & trip push button	No	
6.0 SWITCH FUSE UNITS	5.17 er Classification for electrical endurance as per IEC 62271-100	2	
	5.18 er classification - mechanical operations as per IEC 62271-100	42	
	5.19 er classification for Capacitor Switching as per IEC 62271-100	2	
	6.1 Type		
	6.2 operated	No	
	6.3 e Frequency & No of phases		
	6.4 Current at site reference Ambient temperature		
	6.5 Breaking Current	A (rms)	
	6.6 Making Current	peak)	
	6.7 Time withstand Current/	ns)	
	6.8 see operating mechanism	No	

DATA SHEET - A1				
Sl. No.	Description		Unit	Data
6.0 SWITCH FUSE UNITS	Number No of Auxiliary contacts			
	Minimum power frequency with stand voltage			
	μs Impulse withstand Voltage			
	Auxiliary Control Voltage			
	a) For operating Motor	DC		
	b) Lighting Lamps	DC		
	Control Application			
	a) Transformer Control	No		
	b) Control	No		
	c) Generator Control	No		
	Type of HV Protection			Fuse
	Type of HRC Fuse			Edge type with pop-up plunger mechanism on fusing action
7.0 HV CONTRACTORS	Fuse Rating			
	Rating Details			
	a)			Non trip bar actuated toggle type. The trip bar shall be actuated when the fuse in any phase trip
	b) Trip	No		
	c) Type of Shunt Trip			
	7.1			
	7.2 Voltage, No of phases & frequency			
	7.3 Factor Application			
	a) Control	No		
	b) Generator Control	No		

DATA SHEET - A1				
Sl. No.	Description		Unit	Data
	a) Voltage		AC/DC	
8	Auxiliary Contacts			4NC for purchasers use

8.0 CURRENT TRANSFORMERS	1		poxy Resin	
	2	n voltage & frequency	50Hz	
	3	of insulation	3 or better	
	4	primary current & ratio ref. Dwg. Nos.	o corresponding SLD	
	5	acy class & burden		
	6	ime 1 s Current rating & dynamic rating	& 62.5kApeak	
9.0 VOLTAGE TRANSFORMERS	1		poxy Resin	
	2	Voltage	$\sqrt{3}$ $\sqrt{3}$	
	3	d of connection	Star	
	4	voltage factor	ntinuous 30seconds	
	5	of insulation	E or better	
	6	acy class & burden	o corresponding SLD	
10.0 H.V. FUSES	.1	current	T Primary protection	
	.2	te class	AC	
	.3	etrical interrupting Current		
	.1	acy class	SLD	
	a)	ting meters		
	b)	Energy meters		
	c)	Multifunction meters		
12.0 MIMIC DIAGRAM	.1	Diagram required	No	
	.2	r of mimic	een (Shade 217 of IS 5) for 11kV	

DATA SHEET - A1				
Sl. No.	Description		Unit	Data
13.0 WIRING DETAILS	.1	al of conductor	edCu/Al	
	.2	f wires		
)	cuits	n	
)	cuits	n	

	ary circuits	n	
.3	te grade		
.4	of insulation		PVC
.5	hal block details		type, Finger touch proof
14.0 NOTES	.1	: All indicating instruments and meters shall be supplied as shown in Single Line Diagram and shall be as per Clause 14.0 of section 6.5.1	
	.2	: Protection relays shall be microprocessor based numerical relays as shown in Single Line Diagram and shall be as per Clause 18.0 of section 6.5.1	
	.3	: Composite numerical relays shall be offered wherever individual relays are specified/indicated.	

DATA SHEET - A2		
APPLICABLE STANDARDS		
No.	Description	Standards

Circuit breakers	87	62271-100
Bus & switch Isolators	0	60265
Bus	5	60282
Relay of Protection	2	60529 60144
Relays	4	168
Weldings	9	14, 5621 60137
Current transformers	5	44 61869
Potential transformers	6	60186 61869
Switches	IS 13010 79, IS 11448 0	62056 62053-21
Bus & connectors	1	305
Steel galvanising	9	
3		
Voltage Switchgear and Control gear Assemblies.		62271-202

S:

1. Equipment, associated accessories, component/parts raw material and tests shall confirm to the above and applicable latest IEC/BS/IEEE standards.

DATA SHEET - A3				
BILL OF QUANTITIES				
No.	Spec No.	Description	Unit	BOQ for Panel of each type

	<p>ut</p> <p>in Equipment: Breakers, Isolators, Switch-Fuses, contactors, CTs & VTs etc</p> <p>ering</p> <p>tection Relays</p> <p>ntrol & Selector les, Push buttons</p> <p>icating lamp</p> <p>cellaneous: heater, Panel illuminating lamp, power socket, MCBs, RCBOs etc</p>					
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DATA SHEET - C (to be filled in by the BIDDER and Submitted after award of contract)			
Sl. No.	Description	Unit	Bidder's Data
1			

	ink / dead tank design		
	er of breaks per phase		
	um clearances		
	en poles		
	between live parts and earth		
	um between live parts		
	ring over voltages generated by the circuit breaker		
	ing off to running at no load	Peak line to earth)	
	ing off motor with its rotor locked	Peak line to earth)	
	ing off unloaded transformer (Ratings of motors and transformers as per "Auxiliary One Line Diagram"	Peak line to earth)	
	contact		
	al		
	facing provided	lo	
	ness of the facing		
	n contact pressure	m2	
1.7	g contacts		
a)			
b)	al		
c)	facing provided	lo	
d)	ness of the facing	n	
e)	n contact pressure	m2	
	n of contact travel		
b)	length of break per pole		
c)	f contact travel at tripping	ec	
d)	f contact travel at closing	ec	

DATA SHEET - C			
(to be filled by the BIDDER and Submitted after award of contract)			
Sl. No.	Description	Unit	Bidder

2.0 VACUUM BOTTLES	1.9	Condition of closing during power supply failure		
	1.10	Condition of coil consumption at rated voltage		
	1.11	Oil consumption at rated voltage		
	2.1	Wire inside the interrupter	g	
	2.2	Electrode wear indication provided	lo	
	2.3	Gap between the contacts in vacuum in open condition		
	2.4	Condition of contact		
	2.5	Rate shielding against X-ray radiation provided	lo	
	2.6	Designation & Make of the Vacuum bottle used		
	3.1	Wire of SF6 gas		
	3.2	Condition of operating mechanism pneumatic/spring/hydraulic charged		
3.0 SF6 BREAKERS	3.3	Condition of air pressure		
	3.4	Condition of the local air receiver		
	3.5	Condition monitor for SF6 gas provided		
	3.6	Condition of SF6 gas		
	4.1	Condition of closing mechanism		
	4.2	Condition of charging motor		
	a)	Condition of voltage		
	b)			
	c)			
	d)	Condition of insulation		
4.0 CLOSING MECHANISM	4.3	Condition of spring charging motor between 80 to 100% of rated voltage		
	4.4	Condition required to charge the spring from fully discharged condition		

DATA SHEET - C (to be filled by the BIDDER and Submitted after award of contract)			
Sl. No.	Description	Unit	Bidder
G M E 5	Condition and short circuit protection details		

6	vision made for immediate charging of closing spring after a closure	Io	
7	iate spring reserve for one O-C-O operation without intentional time delay	Io	
8	nical indication for spring charged/discharged condition provided	Io	
9	er slow closing/opening is feasible for maintenance/testing	Io	

11.6.1 MV SWITCHGEAR

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 metal-enclosed Medium Voltage Switchgear of voltage not exceeding 1,100 V AC.

2.0 CODES & STANDARDS:

- 2.1. The design, construction, manufacture and performance of equipment shall conform to latest applicable standards and 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. Equipment shall conform to the latest applicable Standards as mentioned in Data Sheet- A2. In case of conflict between the Standards and this specification, more stringent requirement of the two shall govern.

3.0 SHEET METAL WORK:

- 3.1. The switchgear frame shall be fabricated using thick cold rolled sheet steel plate as per general industry standard.
- 3.2. The thickness of sheet steel shall be as states in Data sheet-A1. Mounting plates shall be fabricated from 3mm thick cold rolled sheet steel.
- 3.3. All panel edges and door edges shall be reinforced against distortion by rolling, bending or by the addition of welded reinforcement members.
- 3.4. Cut outs shall be true in shape and devoid of sharp edges.
- 3.5. The complete structure shall be rigid, self-supporting, and free from vibration, twists and bends.

4.0 PAINTING:

- 4.1. All sheet steelwork shall be phosphated in accordance with the following procedure and in accordance with applicable standards mentioned in Data Sheet-A2.
- 4.2. Oil, grease, dirt and swarf shall be thoroughly removed by emulsion cleaning.
- 4.3. Rust and scale shall be removed by pickling with dilute acid followed by washing with running water, rinsing with slightly alkaline hot water and drying.
- 4.4. After phosphating, thorough rinsing shall be carried out with clean water, followed by final rinsing with dilute dichromatic solution and oven drying.
- 4.5. After phosphating, the sheet metal shall be subjected to powder coating process. The powder coating to be carried out by spraying the Polyester Epoxy powder (60/ 40) using an electrostatic gun, or **Corona** gun. After uniform deposition of the powder to the required thickness, i.e., 100 microns minimum, or as per Data Sheet A, on to the object, it is transferred to a curing oven.

- 4.6. Depending on the paint grade, type of finish, the painted object shall be cured in an oven under controlled environment to attain uniform wrinkle & scratch free finish.
- 4.7. The final finished thickness of paint film on steel shall not be less than 100 microns, and shall not be more than 150 microns.
- 4.8. Finished painted appearance of equipment shall present an aesthetically pleasing appearance, free from dents and uneven surfaces.

5.0 CONSTRUCTIONAL FEATURES:

- 5.1. Switchgear shall be:
 - a) Of the metal clad, indoor, floor mounted modular type
 - b) Of compartmentalised design in accordance with IEC 60439-1. The form of internal separation shall be as stated in Data sheet A1.
 - c) Made up of the requisite vertical sections
 - d) Of dust and vermin proof construction
 - e) Provided with a degree of protection as stated in Data sheet A1.
 - f) Easily extendable on both sides by adding vertical sections after removing the end covers
 - g) Provided with a metal sill frame made of structural steel channel section properly drilled for mounting the Switchgear along with necessary mounting hardware. All hardware shall be zinc plated and passivated.
 - h) Provided with labels on the front and rear indicating the switchgear designation
 - i) Provided with cable entry facilities at top with thick removable gland plates of thickness as per general industry standard on POWER panels with necessary cable glands. These plates shall be non-magnetic.
 - j) Of uniform height of not more than 2450 mm
 - k) Of single front or double front execution as specified in Data Sheet-A
 - l) Provided with gaskets all round the perimeter of adjacent panels, panel and base frame, removable covers and doors
 - m) Provided with busbars running at the top or bottom, as required, all along the length of the switchgear in a separate sheet steel enclosure.
- 5.2. Operating devices shall be incorporated only at the front of the switchgear. No equipment needing manual operation shall be located at a height less than 250 mm above ground level.
- 5.3. The switchgear shall be divided into distinct vertical sections, each comprising:
 - a) A completely metal enclosed busbar compartment running horizontally.
 - b) Individual feeder modules arranged in multi-tier formation. It is essential that the modules are integral multiples of the basic unit size to provide for flexibility in changes, if any, at site.

- c) Enclosed vertical busbars serving all modules in the vertical section. For safety isolation of the vertical bus bars, insulating barrier with cut-outs shall be provided to allow the power stab-in contacts to engage with vertical busbars.
- d) A vertical cable alley covering the entire height. The cable alley shall be 500 mm wide for modules of 400 Ampere and above and minimum 250 mm for modules less than 400 Ampere.
- e) Separation barrier between main bus bar, auxiliary power & control buses as required shall be located to enable easy identification, maintenance and segregation from the main power buses. Tap-off connections from these buses shall be arranged separately for each vertical section.

5.4. Each vertical section shall be equipped with space heaters, which may be located in the cable alley.

5.5. One metal sheet shall be provided between two adjacent vertical sections running to the full height of the switchgear except for the horizontal busbar compartment. However, each shipping section shall have metal sheets at both ends.

5.6. All equipment associated with a single circuit shall be housed in a separate module compartment of the vertical section. The compartment shall be sheet steel enclosed on all sides and the rear, with rubber grommets provided on the cable alley side for power and control cable entry. The front of the compartment shall be provided with a hinged door. Components mounting details and panel fabrication details shall be submitted by VENDOR for PURCHASER's approval.

5.7. For draw-out type modules, only the handles of control and selector switches, push buttons, knobs & cut-outs for lamps and meters shall be arranged on the front doors of the respective compartments to permit operation without opening the door. On circuit breaker controlled circuits, protective relays shall be mounted on the front door of the compartment. All other equipment pertaining to a circuit shall be mounted on the withdrawable chassis. All cut-outs shall be provided with gaskets for dust proofing.

5.8. Current transformers shall not be directly mounted on the buses. Current transformers on circuit breaker controlled circuits shall be mounted on the fixed portion of the compartment.

5.9. In Air Circuit Breaker compartments, external cable connections shall be carried out in separate cable compartments for power and control cables.

5.10. After isolation of the power and control connections of a circuit, it shall be possible to safely carry out maintenance in a compartment with the busbars & adjacent circuits live.

5.11. The withdrawable chassis shall move on suitable guides and on suitable plated steel or stainless steel rollers or balls to facilitate easy withdrawal.

5.12. Cable alleys shall be provided with suitable hinged doors. It shall be possible to safely carry out maintenance work on cable connections to any one circuit with the busbars and adjacent circuits live. Adequate number of slotted cable support arms shall be provided for clearing the cables.

5.13. Rear of single front switchgear shall be provided with removable panels. It shall be possible for one person to remove and fix the removable panel.

5.14. All doors shall be provided with concealed type hinges and captive screws.

5.15. The withdrawable chassis housing circuit breakers shall be of the fully draw out type.

5.16. The withdrawable chassis housing feeder control equipment not incorporating air circuit breakers shall be one of the following types as specified in Data sheet A1:

5.16.1. **Fixed Type Withdrawable Chassis:**

In this type of construction, all power connections to the equipment mounted on the withdrawable chassis shall be of bolted type. All control circuit connections to equipment mounted on the withdrawable chassis shall be carried out through conventional terminal blocks mounted in the respective chassis. It shall be possible to draw out the chassis after unbolting/unscrewing all the power and control circuit connections to the equipment mounted on the withdrawable chassis.

5.16.2. **Fully draw out type withdrawable chassis:**

In this type of construction, it shall be possible to draw out the withdrawable chassis without having to unscrew or unbolt any connections to the equipment mounted on the withdrawable chassis. The power and control draw out type connections shall be of the stab-in or sliding type. All draw out contacts, including for auxiliary and control wiring shall be of self aligning type.

5.17. **Interchangeability:**

5.17.1. All identical equipment and corresponding parts including chassis of draw out modules of the same size and rating shall be interchangeable without having to carryout modifications. For trouble free interchangeability, the draw out arrangements shall be designed such that normal dimensional variations are taken care of by self-aligning feature of the modules.

5.17.2. Components and equipment that are not fully interchangeable are liable for rejection. VENDOR shall replace all such equipment by interchangeable equipment at his cost.

5.18. The draw-out contacts shall be only between copper/ copper alloy/ aluminium faces, which are silver or tin plated. The contact design shall be such that there should be no arcing/ deformation under the associated peak short-circuits current.

5.19. Switchgear shall be designed in such a way that all component equipment and bus-bars operate satisfactorily without exceeding their respective maximum permissible rise in temperature under ambient temperature conditions prevailing within the switchgear cubicle, with reference ambient temperature outside the switchgear cubicles as specified in Data Sheet-A1.

5.20. Provision of ventilating louvers is considered undesirable. If ventilating louvers are considered essential by the VENDOR, these may be provided. However, all ventilating louvers shall be provided with fine-screened brass or GI meshes to prevent entry of vermin and dust.

5.21. **Safety Features.**

5.21.1 **Door interlock**

The door of each compartment shall be so interlocked such that the door cannot be opened unless the circuit is off.

5.21.2 **Shrouding of live parts**

Bolted power cable connections and other accessible live parts shall be covered with removable shrouds to prevent direct contact with live parts.

5.21.3 Finger touch proof

All terminal block connections as well as connections to terminals of all devices shall be finger touch proof.

6.0 MODULE TYPES:

- 6.1. The various types of modules indicating the control requirements of each type are detailed in the enclosed Single line diagram(s).
- 6.2. All devices shown in the module drawings shall be included in the scope of supply.
- 6.3. Physical size of compartment for each type of control and current rating shall be so chosen that all the basic and additional equipment can be housed in the compartment. No equipment/ devices associated with any particular circuit shall be permitted to be mounted in any other circuit module.

7.0 MAIN & AUXILIARY BUSES

7.1 Main Buses & Taps:

- 7.1.1 Switchgear shall be provided with three phase or three phase and neutral busbars as specified in Data Sheet- A1.
- 7.1.2 Busbars shall be of uniform cross section throughout the length of the switchgear, and up to the terminals of the incoming feeder circuit breaker/ switch.
- 7.1.3 The busbars shall be made of high conductivity copper or aluminium alloy of E91E grade as specified in Data Sheet-A1.
- 7.1.4 Busbars shall be provided with at least the minimum clearances in air as specified in Data sheet-A1.
- 7.1.5 All bus-bars, bus-taps shall be insulated with close fitting sleeve of hard, smooth, dust and dirt free plastic insulation of high dielectric strength (450 V/mil) to provide a permanent high dielectric non-ageing and non-tracking protection; impervious to moisture, tropical conditions and fungi. The insulation shall be non-inflammable and self-extinguishing and in fast colours to indicate phases. The joints shall be insulated in such a way as to provide for accessibility of contact bolts for maintenance. Joints shall be covered with removable moulded shrouds made out of fibre glass reinforced polyester. The dielectric strength and properties shall hold good for the temperature range of 0° C to 90° C. If the insulating sleeve is not coloured but black, busbars shall be colour-coded with coloured bands at suitable intervals.
- 7.1.6 Busbars shall be adequately supported and braced to withstand the stresses due to the specified short circuit currents for the associated switchgear. Busbar supports shall be made of glass reinforced moulded plastic material or cast resin or Hylam sheets or Permali wood.
- 7.1.7 Separate supports shall be provided for each phase of the busbars. If a common support is provided for all three phases, anti-tracking barriers shall be incorporated.

7.1.8 Busbar joints shall be complete with high tensile steel bolts, Belleville washers and nuts. Bus bars shall be thoroughly cleaned at the joint locations and suitable contact grease shall be applied just before making a joint.

7.2 Auxiliary Buses

7.2.1 Auxiliary buses for control power supply, space heater power supply or any other specified service shall be provided. These buses shall be insulated, adequately supported and sized to suit specific requirements. The material of control power supply buses shall be of electrolytic copper. The material for space heater power supply buses shall be same as that for the main power buses. Auxiliary bus bars and necessary connections to the associated circuits shall be in the VENDOR's scope.

8 INSULATORS:

8.1 Material:

8.1.3 The insulators shall be preferably made of SMC or Glass Filled Epoxy or equivalent type of non-hydroscopic insulating supports are acceptable.

8.2 Mechanical Strength:

The insulators shall possess sufficient mechanical strength to withstand the forces due to momentary short circuit currents of magnitude detailed in this specification. The spacing of the bus insulators shall be decided giving due factor of safety.

8.3 Electrical Strength:

As a consequence of current loading and variation in external temperatures, condensation of moisture may take place on the surface of the insulators. Hence the insulators shall have a high creepage distance and a withstand voltage rating sufficient to provide specified insulation under highly humid conditions.

8.4 Successful VENDOR shall furnish calculations for bus bar support spacing and selection for approval before commencement of manufacturing activity.

9 AIR CIRCUIT BREAKERS:

9.1 The air circuit breaker (ACB) shall be Four pole/ Triple pole/ Triple pole and Neutral (TPN) as shown in single line diagrams/ Data sheet A.

9.2 Circuit breakers shall be provided with:

9.2.1. Air break draw out type, mounted along with its operating mechanism on a wheeled carriage moving on guides, designed to align correctly and allow easy movements.

9.2.2. The shunt and/or series trip as specified in Data Sheet-A. Even for series trip breaker, shunt trip shall be provided when specified in Data sheet A.

9.2.3. An operating mechanism of the type specified in Data Sheet-A1

9.2.4. Mechanically operated targets to show 'Open', 'Closed', 'Service' and 'Test' positions of the circuit breaker

9.2.5. Mechanically operated, red 'trip' push button, shrouded to prevent accidental operation

- 9.2.6. Locking facilities in the 'Service', 'Test, and 'Isolated', positions. In test position, the breaker will be tested without energising the power circuits. The breaker shall remain fully housed inside the compartment in the test position.
- 9.2.7. 6 NO and 6 NC potential free auxiliary contacts, rated 6A at 240V AC and 1A (inductive breaking at 220V DC).
- 9.2.8. 'Red', 'Green' and 'Amber' indicating lamps to show 'Closed', 'Open', and 'Auto-trip' conditions of the circuit breaker when breaker operation is controlled by a control switch.
- 9.2.9. Circuit breakers shall be provided with in-built microprocessor based over load, short circuit and earth fault releases with adjustable time delay settings. The release shall have add on feature for communication with PLC/SCADA.
- 9.3. Circuit breakers shall be provided with the following interlocks:
 - 9.3.1. It shall not be possible to plug-in a closed circuit breaker, or to draw out a circuit breaker in the closed position.
 - 9.3.2. It shall not be possible to operate a circuit breaker unless it is in the fully plugged-in, test, or fully isolated position.
 - 9.3.3. Suitable position switches having 2 NO + 2 NC contacts shall be provided for each position of the breaker for indication and interlocking purposes.
- 9.4. Circuit breaker closing and trip coils shall be rated for satisfactory operation on a control supply system voltage indicated in Data Sheet-A1.
- 9.5. Whenever specified in Data Sheet-A1, breakers shall be provided with castle key interlocking device to prevent paralleling of two breakers.
- 9.6. Closing and trip coil shall operate satisfactorily under the following conditions of supply voltage variation:
 - 9.6.1. Closing coils - 85% to 110% of rated voltage.
 - 9.6.2. Trip coils - 70% to 110% of rated voltage.
- 9.7. In addition to the adjustable current setting range specified in the Data Sheet, short circuit releases shall be provided with at least four adjustable time delay settings. If it is not possible to provide the specified adjustable current setting range for the short circuit releases, shunt trip circuit breakers shall be offered and indicated in Data Sheet - B by the VENDOR.
 - 9.7.1. Each of the foregoing releases shall be provided with a single pole, double throw, and potential free alarm contact rated for 0.5A, 220V DC.

9.8. **Operating Mechanism:**

- 9.8.1. Circuit breaker shall be provided with a manual operating mechanism or power operated mechanism as specified in Data Sheet-A1.
- 9.8.2. Manually operated mechanism shall be of the spring charging stored energy type, unless otherwise specified in Data Sheet-A1.
- 9.8.3. Power operated mechanism shall be of the motor wound spring charging stored energy type.

- 9.8.4. The closing action of the circuit breaker shall charge the tripping spring ready for tripping.
- 9.8.5. Speed of closing of contacts shall be independent of the speed with which the handle is operated.
- 9.8.6. All stored energy mechanisms shall be provided with mechanical indicators to show the 'Charged' and 'Discharged' conditions of the spring.
- 9.8.7. Circuit breakers provided with stored energy operating mechanisms shall be provided with the following interlocks:
 - a) The circuit breaker shall not close unless the spring is fully charged.
 - b) Shocks, vibrations, or failure of springs shall not operate the breaker or prevent intended tripping.
- 9.8.8. Power operated mechanisms shall be:
 - a) Provided with a universal motor suitable for operation on AC and DC control supplies specified in Data Sheet-A1 with voltage variation from 85% to 110% rated voltage.
 - b) Designed to enable a continuous sequence of closing and opening operation as long as power is available and at least one opening operation on power supply failure.
 - c) Provided with emergency manual charging facilities
 - d) Provided with facilities for remote panel closing and opening operations whenever specified in Data Sheets as per breaker module designation and respective enclosed control scheme drawing.
- 9.8.9. Spring charging time for power operated mechanism shall not exceed 15 seconds.
- 9.8.10. Power operating mechanisms shall be provided with the following additional features:
 - a) Closing of the circuit breaker shall automatically initiate recharging the spring to make the circuit breaker ready for the next closing operation.
 - b) The motor shall be mechanically de-coupled as soon as the emergency manual charging handle is coupled
 - c) The circuit breaker mechanism shall make one complete closing operation once the control switch has been operated and the first device in the control scheme has responded even though the control switch is released before the closing operation is complete provided there is no counter trip impulse.
 - d) Closing controls shall be so arranged that only one closing operation of the circuit breaker shall result from each close initiating impulse, even if the breaker trips while the initiating device is held in the 'Close' position. An electrical anti-pumping relay shall be provided on the circuit breaker chassis for this purpose, incorporated in the circuit breaker.

9.9. Protection Co-ordination:

It shall be the responsibility of the VENDOR to fully co-ordinate the overload and short circuit tripping of the circuit breakers with the upstream and downstream circuit breakers/motor starters, to provide satisfactory discrimination.

10 MOULDED CASE CIRCUIT BREAKERS:

- 10.1 Moulded case circuit breakers (MCCB) shall be provided when called for in Data Sheet-A1. The MCCBs shall conform to the latest applicable standards.
- 10.2 MCCB in AC circuits shall be of Four pole (4P)/ Triple pole (3P)/ Triple pole and Neutral (TPN) construction arranged for simultaneous 3/4 pole manual closing and opening and for automatic instantaneous tripping on short circuit. If indicated in Data Sheet-A1, power closing device for remote operation and/ or shunt trip shall be provided. Operating mechanism shall be quick-make, quick-break and trip-free type. The ON, OFF & TRIP positions of the MCCB shall be clearly indicated and visible to the operator when mounted as in service. Front of board operating handle shall be provided.
- 10.3 The MCCB shall be provided with short circuit and overload releases with adjustable current and time settings.
- 10.4 The MCCB shall be provided with the following accessories when called for in Data Sheet A1 / Module drawings:-
 - a) 'NO' and 'NC' auxiliary contacts.
 - b) Fault contact for breaker trip through releases.

The number of each type of contact shall be as indicated in the module drawings. If adequate number of contacts are not available, auxiliary relays shall be provided to multiply the contact.

- 10.5 MCCB shall be capable of withstanding the thermal stresses caused by overloads and the mechanical stress caused by the peak short circuit current of value associated with the switchgear rating. The maximum tripping time under short circuit shall not exceed 20 milliseconds.
- 10.6 MCCB shall have provision for pad locking in off position.

11 MOTOR PROTECTION CIRCUIT BREAKERS:

- 11.1 Motor protection circuit breakers (MPCB) shall be provided for motor feeders as shown Data Sheet A/ Single Line Diagrams.
- 11.2 The MPCB shall be similar to MCCB except that the overload release shall be selected to suit the motor rating. The overload release shall have adjustable time and current setting.
- 11.3 The rating of the MPCB shall be selected to provide type 2 co-ordinations with the contactors/soft starter/ VFD of the circuit.
- 11.4 MPCB shall be provided with the accessories similar to MCCB.

12 MINIATURE CIRCUIT BREAKERS:

- 12.1 Miniature Circuit Breakers (MCB) shall be provided for auxiliary power and lighting circuits as shown in single line diagrams.

- 12.2 The MCB shall be 3 pole/ TPN/ 2 pole/ SPN type as shown in single line diagrams and shall comply with latest applicable standards as mentioned in Data sheet A2.
- 12.3 The MCB shall have overload and short circuit releases. The tripping characteristic curve shall be of type B/C/D as shown in Data sheet-A1.
- 12.4 The MCB shall be fixed type, manually operated.
- 12.5 The MCB shall be provided with auxiliary contacts and fault signalling contact when required as per Data Sheet-A1 or module drawings.

13.0 EARTH LEACKAGE CIRCUIT BREAKER:

- 13.1. Earth leakage circuit breaker shall be either RCCB or RCBO type as shown in Data Sheet-A1/ Single line diagrams. These shall comply with the latest applicable standard.
- 13.2. The RCCB shall detect the earth leakage current and trip on earth leakage current above the set value. This shall be used in conjunction with the MCB.
- 13.3. The RCBO shall have overload and short circuit protection in addition to earth leakage protection.
- 13.4. The leakage current sensitively shall be as indicated in data sheet A1.
- 13.5. RCCB/ RCBO of (i) type shall be supplied when called for in Data sheet A1. RCCB/ RCBO of this type shall be immune to nuisance tripping due to,
 - a) Harmonics generated by the load.
 - b) Transient switching current.
 - c) Transient over voltages due to lightning, switching of switchgear etc.

14.0 CONTACTORS:

- 14.1. Contactors shall be electro-magnetic, double air break, non gravity type and shall comply with the latest applicable standard as mentioned in Data sheet.
- 14.2. Contactors shall have utilisation category as mentioned in Data sheet-A1 and shall be suitable for uninterrupted duly unless otherwise stated in Data sheet.
- 14.3. The Contactor shall have minimum two 'NO' and two 'NC' auxiliary contacts. If additional contacts are required as per module drawing, auxiliary relays shall be supplied to multiply the contact.
- 14.4. The operating coil of the contactor shall have insulation class E or better.
- 14.5. The coil voltage shall be as mentioned in Data sheet-A1.

15.0 MOTOR STARTERS:

- 15.1. Each AC induction motor starter module shall be provided with any of the following types of starters as indicated in the Data sheet and/ or single line diagram.
 - a) Direct on line (DOL) starter.
 - b) Start/Delta starter. (Open/ close transition)

- c) Reversing starter.
- d) Variable speed drive.
- e) Soft starter.

15.2. The motor starters shall be in accordance with specification no PCPL-4-S4-155 and associated Data sheets.

16.0 CURRENT TRANSFORMERS:

- 16.1. Current transformers shall be of dry type.
- 16.2. Current transformer shall have a short time withstand rating equal to the short time withstand rating of the associated switchgear for one second for breaker feeders. For feeders with fuse/ MCCB/ MPCB/ MCB, CT shall have withstand capacity equal to let through current of associated SCPD.
- 16.3. The minimum performance requirements of current transformers shall be as per the single diagram(s) enclosed.
- 16.4. Notwithstanding the above clause 16.3, it shall be the Vendor's responsibility to co-ordinate the current transformer burden with the requirements of relays, instruments and leads associated with that particular current transformer.
- 16.5. Test links shall be provided in both secondary leads of the CTs to easily carry out current and phase angle measurement tests.
- 16.6. All current transformers shall be earthed through a separate earth link on the terminal block to permit easy measurement of the current transformer insulation resistance.

17.0 VOLTAGE TRANSFORMERS:

- 17.1. Voltage transformers shall be of dry type.
- 17.2. The minimum performance requirements of voltage transformers are as per the single line diagram(s) enclosed.
- 17.3. All secondary windings of voltage transformers including open delta windings shall be rated for $110\text{ V}/\sqrt{3}$ per phase.
- 17.4. Voltage transformer shall have a continuous over voltage factor of 1.2 and short time over voltage factor as follows:
 - 1.5 for 30 seconds in case of effectively earthed system,
 - 1.9 for 8 hours in case of non-effectively earthed system where all earth faults are detected and cleared,
 - 1.9 continuous in case of non-effectively earthed system where it is expected to operate with uncleared earth faults in the system
- 17.5. Voltage transformers shall be complete with suitably rated MPCB on the primary side and RCBO on the secondary side. The rupturing capacity rating of the associated switchgear shall be brought down to the capacity of MCB by use of fault limiting devices mounted close to the bus.
- 17.6. It shall be possible to replace voltage transformers without having to de-energise the main bus bars.

17.7. The terminals of V.T. secondary and tertiary windings, which are required to be connected to earth, shall be earthed by an isolating link without a fuse.

18.0 INDICATING INSTRUMENTS & METERS:

18.1. Electrical indicating instruments shall be of minimum 96 mm square size, 90 degree scale deflection with a class of accuracy as mentioned in Data Sheet-A1/ Single line diagram(s), suitable for flush mounting.

18.2. Indicating instruments shall have provision for zero adjustment outside the cover.

18.3. Instrument dials shall be parallax free with black numerals on a white dial.

18.4. Watt-hour metes shall be of the direct reading electrodynamic type complete with cyclometer type dials and reverse running stops.

18.5. Wherever shown in single line diagram, single digital multifunction meter (MF) of approved make shall be provided. The multifunction meter shall monitor voltage, current, frequency, power factor, power (kVA, kW, kVAR) and energy (kVAh, kWh, kVARh both inductive and capacitive). The MF shall have communication port to communicate with plant PLC/ SCADA.

19.0 INDICATING LAMPS

19.1. Indicating lamp shall be:
Of the multiple LED type and of low watt consumption,
Provided with step-down transformer,
Provided with translucent lamp covers of colours 'Red', 'Green' and 'Amber' as required in the control wiring diagrams,

19.2. Bulbs and lenses shall easily be replaceable from the front

20.0 CONTROL & SELECTOR SWITCHES:

20.1 Control and selector switches shall be:
Of the rotary type with enclosed contacts,
Adequately rated for the purpose intended (min. acceptable rating is 10A continuous at 240V AC and 1A (inductive break) 220V DC),
Provided with escutcheon plates clearly marked to show the positions.

20.2 Control switches shall be:
Of the spring return to normal type,
Provided with pistol grip type handles.

20.3 Control switches for circuit breaker control shall be provided with Contact development as specified in bill of material of enclosed drawings.

20.4 Wherever specified in data sheets, control switches with built-in flashing type discrepancy lamps shall be provided to control circuit breakers in lieu of the normal control switch, red, green and amber indicating lamps. The discrepancy lamp shall be replaceable from the front of the module door.

20.5 Selector switches shall be:

Of the maintained contact stay put type. Switches in ammeter circuits shall have make-before-break type contact

Provided with oval handles

21.0 PUSH BUTTONS:

21.1 Push buttons shall be:

Of the momentary contact, push to actuate type rated to carry 10A at 240V AC & 1A (inductive breaking) at 220V DC

Fitted with self reset, 2 NO and 2 NC contacts

Provided with integral escutcheon plates marked with its function

21.2 'Start', 'Open', 'Close' push buttons shall be green in colour

21.3 'Stop' and 'Trip' push buttons shall be red in colour

21.4 All other push buttons shall be black in colour

22.0 SURGE ARRESTERS:

22.1. Surge Arresters shall be provided on the Incomer circuit of switchboards as indicated in the Single Line Diagram/Data sheet A.

22.2. The Surge Arresters shall be of voltage limiting type (Varistor/ clamping diode) unless otherwise specified in Data Sheet A.

22.3. The Surge Arrester shall have the following features:-

- a) Draw out type.
- b) Single pole (1P)/ Single pole and Neutral (1P+N)/Triple pole (3P)/ Triple pole and Neutral (3P+N) as indicated in Data sheet A.
- c) Operating indicator on front panel.
- d) Contract for remote indication.

22.4. The Surge Arrester shall have the technical particulars as stated in data sheet A1.

22.5. The Surge Arrester shall:-

- a) Limit the voltage to a maximum value U_p for any current equal to or less than nominal value I_n .
- b) Automatically stop conducting when the surge is over.
- c) Withstand minimum 15 discharges at rate discharge current (I_n) without damage.

23.0 SPACE HEATERS:

Space heaters for switchgear panels shall be:

Suitable for operation on a supply system specified.

Provided with single pole MCB with overload and short circuit release provided with humidistat to cut-in the heaters to prevent condensation of moisture on insulating parts.

24.0 CABLE TERMINATIONS:

- 24.1 Suitable compression type, heavy duty brass cable glands with check nuts, rubber sealing ring and brass washers mounted on a removable gland plate shall be provided to support all power and control cables entering the switchgear, if asked for in Data Sheet-A1. Cable glands shall incorporate built-in facilities for earthing the wire armour of cables. Cable glands shall be plated to avoid corrosion.
- 24.2 Power cable glands and crimping type lugs suitable for the cable sizes indicated shall be supplied. Approximate quantity of control cable glands for different types of modules are indicated in the module wiring diagrams, bill of material. If during the course of detailed engineering of the switchgear it is found necessary to provide more glands or glands of higher size than those envisaged, the VENDOR shall provide and accommodate the same in the relevant modules.
- 24.3 The VENDOR shall select the power cable glands and lugs based on the cable sizes provided at Data Sheet-A1/ Single Line Diagram.
- 24.4 For supporting and clamping cable cores at regular intervals inside the cable alleys, suitable slotted angles, up to the respective terminal blocks, shall be provided.
- 24.5 Necessary crimping type of tinned-copper cable lugs for connecting the individual cores to the respective terminals shall be provided.
- 24.6 When a Core Balance CT (CBCT) is provided for earth fault protection and the armour clamping is done before the CBCT looking from inside the module, insulated pig tail of sufficient length shall be provided for grounding the armour taking the ground lead through the CBCT

25.0 INTERNAL WIRING:

- 25.1 Wiring inside the switchgear shall be carried out with 1100/ 650 V grade, FRLS PVC insulated, stranded conductor wires. Minimum size of conductor for power circuits is 4 sq.mm copper or equivalent size aluminium conductor. Control circuits shall be wired using copper conductor of at least 2.5 sq.mm for CT circuits and 1.5 sq.mm for VT and other circuits, the number and size of strands shall be 7 of 0.67 mm and 0.5 mm diameter respectively.
- 25.2 Engraved identification ferrules, marked to correspond with the wiring diagrams shall be fitted to each wire. Ferrules shall be of yellow colour with black lettering.
- 25.3 Wires forming part of a tripping circuit of circuit breaker shall be provided with an additional red ferrule marked 'T'.
- 25.4 Spare auxiliary contacts of all equipment forming part of the switchgear shall be wired up to the terminal blocks.
- 25.5 Wiring for any equipment supplied by the PURCHASER for which the VENDOR has to provide cut-outs (where indicated in the data sheets) shall be provided upto the terminal blocks.
- 25.6 Spare and unassigned modules shall be complete with internal wiring.

- 25.7 Wiring shall be terminated on preferably stud type terminal blocks such that the wires are connected by cable lugs with nuts and washers/ lock nuts.
- 25.8 Not more than two connections shall be made on any one terminal.

26.0 TERMINAL BLOCKS:

- 26.1 Terminal blocks (both for power and control circuits) shall be of reputed make especially for CT and VT circuits. It shall comprise finely threaded pairs of brass studs of at least 6 mm diameter, links between each pair of studs, washers, nuts and lock nuts. The studs shall be securely locked within the mounting base to prevent their turning. Insulated barriers shall be provided between adjacent terminals.
- 26.2 Terminals for circuits with voltage exceeding 110 V shall be shrouded. Terminal blocks shall be grouped depending on voltage level of the circuit. Different voltage groups of terminal blocks shall be segregated.
- 26.3 Terminal blocks shall be adequately rated to carry the current of the associated circuit. Minimum rating of the terminal block is 10A.
- 26.4 Terminals shall be numbered for identification as per enclosed drawings. Engraved white-on-black labels shall be provided on the terminal blocks, describing the function of the circuit.
- 26.5 Where duplication of a terminal block is necessary, it shall be achieved by solid bonding links.
- 26.6 Terminal blocks for CT secondary lead wires shall be provided with shorting, disconnecting and earthing facilities.
- 26.7 Terminal blocks shall be arranged with at least 100 mm clearance between two sets of terminal blocks.
- 26.8 Minimum 10% spare terminal blocks shall be provided.

27.0 LABELS:

- 27.1 All labels shall comprise white letters on a black background
- 27.2 Labels shall be made of non-rusting metal or 3-ply lamicoid, or engraved PVC
- 27.3 Labels shall be properly fixed, with provision to prevent disorientation due to expansion.
- 27.4 Size of lettering shall be 6 mm, unless otherwise specified.
- 27.5 Module name plates shall be provided both at front and back of the panel.
- 27.6 Manufacturer's rating plate shall be provided with panel description, rating, year of manufacturing, serial number of the panel, etc.

28.0 EARTHING:

- 28.1 Each Switchgear shall be provided with an earth busbar running along entire length of the board. Material and size of the earth busbar shall be as specified in Data sheet-A1. At either end of the earth bus, one (1) clamp type terminal with nuts, bolts and washers shall be provided for bolting the PURCHASER'S earthing conductor of size

and material indicated in Data sheet-A1. In case the earth bus is provided near top of the switchgear, one down comer at either end shall be provided for connection to the PURCHASER's earthing conductor.

- 28.2 Earth busbar shall be supported at suitable intervals.
- 28.3 Positive connection between all the frames of equipment mounted in the switchboard and earth busbar shall be provided by using insulated copper wire/bare busbars of cross section equal to that of the busbar, or equal to half the size of circuit load current carrying conductor, whichever is smaller.

29.0 TESTS:

29.1 Type Tests

The switchgear shall be fully type tested assembly (TTA) in accordance with IEC 60439-1. The type tests to be performed on the switchgear shall include the following in accordance with IEC 60439-1:

- a) Temperature rise test.
- b) Verification of dielectric properties.
- c) Short circuit withstand test.
- d) Effectiveness of the protection circuit.
- e) Clearances and creepage distances.
- f) Mechanical operation.
- g) Degree of protection.

29.2 Routine Tests.

Routine tests on the fully assembled and wired switchgear shall be carried out as per applicable standards. The routine tests shall include:-

- a) Dielectric Test.
- b) Verification of wiring as per approved schematics.
- c) Electrical control, protection, interlock and sequential operation tests.

29.3 BIDDER shall submit available type test reports of temperature rise and short circuit tests of similar switchgear. In addition, calculations of temperature rise shall be submitted for approval.

29.4 Routine tests shall be carried out on all associated equipment supplied with switchgear, as per relevant standards. Type test certificates of all associated equipment shall be furnished.

29.5 Certified copies of all type and routine test certificates shall be submitted for the PURCHASER's approval before dispatch of the switchgear.

30.0 DRAWINGS & DATA:

30.1 As part of the proposal, BIDDER shall furnish the following drawings and data:

- a) For each switchgear, overall dimensional drawing showing front view, plan, elevation and cross-section.

b) Compliance to Data Sheet. ~~Data Sheet B duly filled in.~~

All drawings and data sheets shall be annotated in English.

31.1 SPARE PARTS

31.1 Whether included in the VENDOR's recommendation or not, unit prices of essential spares as indicated in Data Sheet A1 shall be quoted.

31.2 The BIDDER shall furnish list of recommended spares for three years satisfactory operation.

11.6.2 MV SWITCHGEAR DATASHEETS

DATA SHEET - A1						
Sl. No.	Description			Unit	Data	
1.0 SWITCHGEAR & BUSBAR RATING	1.1	Rated Voltage, Phases & Frequency			415V, 3 ph, 50Hz	
	1.2	System Neutral Earthing : Effectively / Non effectively			Effectively	
	1.3	Maximum System Voltage			Volts	456.5V (considering 110%)
	1.4	One minute Power Frequency Voltage				
	a)	Power Circuits			Volts	2500
	b)	Control Circuits			Volts	2500
	c)	Aux. Circuits connected to sec. Of CTs			Volts	2500
	1.5	Continuous Current Rating of Bus bars under Site reference Ambient Temperature				Refer SLD
	1.6	Reference Ambient Temperature			°C	45
	1.7	Maximum Temperature of Busbars, droppers & contacts at continuous current rating under site reference ambient Temp.			°C	85
	1.8	Short circuit withstand for Busbars & Droppers				
	a)	Short Time (1 s) at 415V			kA (rms)	Refer SLD
	b)	Dynamic Rating			kA (Peak)	Per IEC
	1.9	Standard Applicable				As per Data sheet A2
2.0 SWITCHGEAR PARTICULARS	Designation		Busbar Details			Single Front (SF) Double Front (DF) Fixed (F)
		Amps	Cu/ Al	TP/ TPN	SF/ DF	Fully draw out (FD) Cable Entry Top (T) Bottom (B)
	1.	Main LT Panel	4000	Al	TPN	SF
	2.	Sub DB	2500	Al	TPN	SF
	3.					
	4.					
	5.					
	6.					

RC UI T	7.							
	8.							
	9.							
	10.							
	11.							
	12.							
	13.							
	14.							
	15.							

DATA SHEET - A1						
Sl. No.	Description		Unit		Data	
3.0 SWITCHGEAR CONSTRUCTIONAL REQUIREMENTS	3.1	Panel internal form of separation as per IEC 61439			3b	
	3.2	Sheet Steel	Type	Cold rolled/ Hot rolled	Cold Rolled	
			Thickness	Frame mm	2	
				Doors mm	2	
				Cover s mm	2	
	3.3	Degree of protection as per IS:13947			IP54	
	3.4	Colour finish shade as per IS:5		Interior		
				Exterior	RAL7032	
	3.5	Earthing Bus		Material	GS	
				Size	75x10mm	
	3.6	Purchaser's Earthing Conductor		Material	GS	
				Size	75x10mm	
	3.7	Clearances in air of live parts (Min.)		Phase to Phase	25mm	
				Phase to Earth	25mm	
	3.8	Metal enclosed Bus duct/Bus trunking / Cable entry to cubicles if required		a) Top/ Bottom	Top	
				b) Indoor/ Outdoor	Indoor	
	3.9	Busbar Insulation	Air insulated with phase barriers	Yes/ No	-	
			Fully insulated	Yes/ No	Yes	
	3.10	Safety Interlocks,				
	a)	Door Interlock		Yes/ No	Yes	
	b)	Shrouding of live parts		Yes/ No	Yes	
	c)	Finger touch proof connection		Yes/ No	Yes	
RC UI T	4.1	Circuit Breaker utilisation category		A/ B	B	
	4.2	Voltage frequency & No. Of Phases			Refer SLD	

	4.3	Rated operating duty			Uninterrupted
	4.4	Rated breaking capacity		Icu	Refer SLD
	a)	MVA			
	b)	Service breaking current at, 0.25 P.F.(I _{cs})		kA (rms)	100% Icu
	4.5	Short circuit withstand capacity	Current	kA (rms)	100% Icu
			Duration	second	1sec
	4.6	Rated making current		kA (peak)	Per IEC
	4.7	Rated current at site reference ambient temperature (in panel rating)			Per SLD

DATA SHEET - A1					
Sl. No.	Description		Unit	Data	
4.0 AIR CIRCUIT BREAKER (ACB)	4.8	Type of operating mechanism	Manual, spring assisted	Yes/ No	
			Manual, spring charged	Yes/ No	
			Motor operated spring assisted	Yes/ No	Yes
			Mechanical Spring Charged Indicator	Yes/ No	Yes
	4.9	Key Interlocking required		Yes/ No	No
	4.10	Shunt Trip required		Yes/ No	Yes
	4.11	Protection required			
	a)	Relays / series releases			Yes
	b)	Relay Type & Settings			As per SLD
	c)	Under voltage release required		Yes/ No	YES only for incomers and Bus couplers.
				Setting	
	4.12	Minimum No. Of Auxiliary contacts (Spare after meeting all the scheme requirements)			2NO+2NC
	4.13	Control Voltage	For spring charging motor	Volts AC/ DC	240V AC
			For closing & tripping	Volts AC/ DC	110V DC
			For Indications	Volts AC/ DC	110V DC
	4.14	Accessories required			
	a)	Mechanical position indicator for On/Off status		Yes/ No	Yes
	b)	Mechanical position indicator for Test & Service position		Yes/ No	Yes
	c)	Breaker operation counter		Yes/ No	Yes
	4.15	Manual operation required in addition to			

5.0 MCCB		electrical operating devices		
	a)	For spring charging & closing	Yes/ No	Yes
	b)	For tripping	Yes/ No	Yes
	4.16	Annunciator required	Yes/ No	Yes
	4.17	Standards application		As per Data sheet A2
	5.1	Moulded case circuit breakers to be provided		
	a)	For Motor Control Circuits	Yes/ No	NA
	b)	For other circuits	Yes/ No	Yes
	5.2	Voltage frequency & No. Phases		Refer SLD
	5.3	Utilisation category	A/B	B
	5.4	Rated Operating duty		Uninterrupted
	5.5	Rated service breaking capacity at, 0.25PF (I _{CS})	kA (rms)	100%Icu

DATA SHEET - A1				
Sl. No.	Description		Unit	Data
5.0 MOULDED CASE CIRCUIT BREAKER (MCCB)	5.6	Short circuit withstand capacity	Current Duration	kA (rms) s 1sec
	5.7	Rated making current		kA (peak) Per IEC
	5.8	Rated current at site ref. Ambient temperature (in panel rating)	A	Per SLD
	5.9	On/Off Operation		
	a)	Manual	Yes/ No	Yes
	b)	Power closing device for remote operation	Yes/ No	No
	c)	Shunt trip	Yes/ No	Yes
	5.10	Releases required	Yes/ No	Yes (LSIG)
	a)	Over load inverse time		Yes
	b)	Short circuit		Yes
	c)	Earth fault	Yes/ No	Yes
	5.11	Accessories required		
	a)	Breaker Auxiliary contacts		Yes
	b)	Fault signalling contact for breaker auto trip through releases	Yes/No	Yes
	5.12	Termination arrangement		Terminal Spreaders shall be provided with phase barriers.
	5.13	Control Voltages		
	a)	For operating motor	Volts	NA

6.0 MPCB			(AC/ DC)	
	b)	For closing/tripping	Volts (AC/ DC)	NA
	c)	For Indication	Volts (AC/ DC)	110V DC
	5.14	Standards applicable		As per Data Sheet A2
	6.1	Motor Protection Circuit Breakers to be provided		
	a)	For Motor Control Circuits	Yes/ No	NA
	b)	For other circuits	Yes/ No	As applicable
	6.2	Voltage frequency & No. Of Phases		
	6.3	Utilisation category	A/B	
	6.4	Rated Operating duty		
	6.5	Short circuit withstand capacity	Current Duration	kA (rms) s

DATA SHEET - A1				
Sl. No.	Description		Unit	Data
6.0 MOTOR PROTECTION CIRCUIT BREAKER (MPCB)	6.6	Rated service breaking capacity at, 0.25PF (I_{CS})	kA (rms)	
	6.7	Rated making current	kA (rms)	
	6.8	Rated current at site ref. Ambient temperature (in-panel rating)	A	
	6.9	On/Off Operation		
	a)	Manual	Yes/ No	
	b)	Power closing device for remote operation	Yes/ No	
	c)	Shunt trip	Yes/ No	
	6.10	Releases required		
	a)	Over load inverse time		
	b)	Short circuit		
	c)	Earth fault	Yes/ No	
	6.11	Accessories required		
	a)	Breaker Auxiliary contact		
	b)	Fault contact for breaker Auto trip		
	c)	Manual Hand RESET feature without opening door of MCC		
	6.12	Termination arrangement		Terminal spreaders shall

7.0 MCB				be provided with phase barriers.
	6.13	Control Voltages		
	a)	For operating motor	Volts (AC/DC)	
	b)	For closing/tripping	Volts (AC/DC)	
	c)	For Indication & Control	Volts (AC/DC)	
	6.14	Standards applicable		As per Data Sheet A2
	7.1	Miniature circuit breakers to be provided		
	a)	For Motor Control Circuit	Yes/No	No
	b)	For Other circuit	Yes/No	As applicable
	7.2	Voltage frequency & No. Of Phases		

DATA SHEET - A1				
Sl. No.	Description		Unit	Data
7.0 MINIATURE CIRCUIT BREAKER	7.5	Short circuit withstand capacity	Current Duration	kA (rms) s
	7.6	Rated current at site ref. Ambient temperature	A	
	7.7	Tripping characteristic curve for		
	a)	For Lighting & small power application		B Curve
	b)	For UPS Power application		D Curve
	c)	For DC application		D Curve (DC MCB)
	7.8	Positive Switch Operated Indication		Required
	7.9	Switching C-O cycles (minimum)		20,000
	7.10	Standards applicable		As per Data Sheet A2
	8.1	Contractor to be provided		NA
8.0 CONTACTOR	a)	For Motor Control Circuits	Yes/ No	
	b)	For other circuits	Yes/ No	
	8.2	Voltage frequency & No. Of phases		
	8.3	Rated Operating duty		
	8.4	Rated current at site ref. Ambient temperature	A	
	8.5	On/ Off Operation		
	a)	Auto	Yes/ No	

	b)	Manual	Yes/ No	
	c)	Remote power operated	Yes/ No	
	8.6	Control Voltage	Volts	
	a)	For coil Voltage	AC/ DC	
	8.7	Standards applicable		As per Data Sheet-A2
9.0 EARTH FAULT RELAY	9.1	Make		
	9.2	Setting		
	a)	Range		
	b)	Time Setting		
	9.3	Location		
10.0 EARTH LEAKAGE CIRCUIT BREAKER (RCBO)	10.1	Type	RCCB/ RCBO	
	10.2	Application		
	a)	For Motor circuits	Yes/ No	
	b)	For Lighting circuits	Yes/ No	
	c)	For other circuits	Yes/ No	As applicable
	10.3	Enhanced immunity to unwanted tripping (type 'i') required	Yes/ No	
	10.4	Voltage, frequency & No. Of Phases		
	10.5	Rated operating duty		

DATA SHEET - A1				
S1. No.	Description		Unit	Data
11.0 SURGE ARRESTERS	10.6	Rated service breaking capacity at 0.5 PF(I _{cs})	kA (rms)	
	10.7	Rated current at site ambient temperature	Amps	
	10.8	Leakage current setting for protection		
	a)	For human safety	mA	30
	b)	For Fire safety	mA	
	10.9	Positive switch operated indication		Yes
	10.10	Switching C-O cycles		20000
	10.11	Applicable standard		As per Data Sheet
	11.1	Application		NA
	11.2	Type		
	11.3	Maximum continuous operating voltage		
	11.4	Voltage protection level		
	11.5	Rated discharge current for 8/20 μ s wave		
	11.6	Maximum peak value of 8/20 μ s wave		

	11.7	Applicable standard		
12.0 CURRENT TRANSFORMER	12.1	Type		Refer SLD
	12.2	Class of insulation		
	12.3	CT parameters		
	a)	Rated primary current and ratio		
	b)	Accuracy class and burden		
	c)	Knee point voltage and excitation current		
	12.4	Short circuit withstand current and time kA/1sec	kA(rms)	
13.0 VOLTAGE TRANSFORMER	12.5	Dynamic current withstand	kAp	
	12.6	Applicable insulation		
	13.1	Type		Refer SLD
	13.2	Class of insulation		
	13.3	VT parameters		
	a)	Number of windings		
	b)	Voltage ratio		
	c)	Method of connections		
	d)	Accuracy class and burden		
	13.4	Rated voltage factor		
	13.5	Applicable standards		

DATA SHEET - A1				
Sl. No.		Description	Unit	Data
14.0 MODULE DRAWINGS	Module Type	Description	Drawing No	
	1			
	2			
	3			
	4			
	5			
	6			
	7			
	8			
	9			
0 TE CT	10			
	15.1	Fully Type Tested Assembly (TTA) to be provided as per IEC-61439-1	Yes/No	YES

16.0 ESSENTIAL SPARES TO BE SUPPLIED	15.2	Type Tests shall include:-		
	a)	Temperature rise test	Yes/No	Yes
	b)	Dielectric Tests	Yes/No	Yes
	c)	Short circuit withstand test	Yes/No	Yes
	d)	Clearance and creepage distances	Yes/No	Yes
	e)	Mechanical operations	Yes/No	Yes
	f)	Degree of Protection	Yes/No	Yes
16.0 ESSENTIAL SPARES TO BE SUPPLIED	15.3	Routine Tests		As per applicable standard
	16.1	COMPLETE Air Circuit breaker with operating mechanism and releases where specified of the following ratings		Per SLD
	a)			
	b)			
	c)			
	d)			
	16.2	Complete MCCB/MPCB with operating mechanism and releases of the following ratings		Per SLD
16.0 ESSENTIAL SPARES TO BE SUPPLIED	a)			
	b)			
	c)			
	d)			

DATA SHEET - A1				
Sl. No.	Description		Unit	Data
16.0 ESSENTIAL SPARES TO BE SUPPLIED	16.3	Complete MCB with releases of the following rating		
	a)			
	b)			
	c)			
	d)			
	16.4	Complete RCBO with releases		
	16.5	Closing & tripping coils		
16.0 ESSENTIAL SPARES TO BE SUPPLIED	16.6	Operating motors		
	16.7	Auxiliary contact blocks		
	16.8	Moving auxiliary contact blocks		

	16.9	Breaker control switches		
	16.10	Service selector switches		
	16.11	Indicating Lamps with series Resistors		
	a)	Red		
	b)	Green		
	c)	Amber		
	d)	Blue		
	f)	White		
	16.12	Voltage Transformer of each rating		
	16.13	Control Transformer of each rating		
	16.14	Surge Arrester		
17.0 NOTES				

DATA SHEET - A2				
APPLICABLE STANDARDS				
Sl. No.	Description	STANDARDS		
01	Specification for low voltage switchgear and control gear		IS:13947	IEC 60439 IEC 61439
02	AC circuit breakers		IS:13947, Part 2	IEC 60947-2
03	Factory built assemblies of Switchgear and control gear for voltages up to and including 1000V AC & 1200V DC.		IS:8623	
04	Air break switches		IS:13947	

		Part 3	
05	Miniature circuit breakers	IS:13032	IEC-60898
06	Contactors & Starters	IS:13947 Part 4	
07	Control switches/push buttons	IS:13947 Part 5	
08	Current transformers	IS:2705	
09	Voltage transformers	IS:3156	
10	Relays	IS:3231	
11	Indicating instruments	IS:1248	
12	Arrangement for busbars main connections and accessories	IS:5578 IS:11353	
13	AC electricity meters	IS:8530,722, 13010,13779 ,11448	
14	Degree of protection	IS:2147	
15	The performance of AC control gear equipment rated up to 600V for use on high prospective fault current system		
16	Code of practice for installation and maintenance of switchgear	IS:10118	
17	Climate proofing of electrical	--	
18	Code of practice for phosphating iron & steel	IS:6005 BS:3189	
19	Wrought aluminium & aluminium alloys for electrical purposes	IS:5082	

11.7.1 Cross Linked Polyethylene (XLPE) Insulated Cables upto 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°C 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°C during continuous operation at full rated current. The temperature after a short circuit for 1.0 second, shall not exceed 250°C, with initial conductor temperature of 90°C

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°C.

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:

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

11.7.2 Cross Linked Polyethylene (XLPE) Insulated Cables upto 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 / RCC Hume pipe	
	1.3	Design ambient temperature		°C	45
	1.4	Ground Temperature		°C	35
	6	Minimum drum length		m	250
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	
	2.7	System Fault Level		kA(rms)	25
	2.8	CB Breaking capacity		kA(rms)	25
	2.9	Relay & CB Opening time		m sec	1000 m.sec for incomer
	3.1	Cable type		H1	H1
3.0 DESCRIPTION OF CABLE	3.2	No. of cores		3	3
	3.3	Conductor size		Sq.mm	400
	3.4	Conductors			
	a)	Material		Cu/Al	Al
	b)	Stranded		Yes/No	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	

DATA SHEET - A1								
SL. NO.	DESCRIPTION		UNIT	DATA				
3.8	Core identification			NA				
a)	Up to 3.3 kV cables			By numerals printed on the cores				
b)	Cables above 3.3 kV			Cable type				
				H1	H2	H3		
						H4		
3.9	Inner sheath							
a)	Material			PVC				
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		Singlestrip				
		Double wire/strip						
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 SECTION -7.1 (BOQ)				

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	IS 694 :1990

	1100 V	
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	IS 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	IS 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	IS 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

11.8.1 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 cables for working voltages up to and including 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. 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 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. The nominal thickness of insulation shall be as per applicable standards.
- c) Inner Sheath: The laid up cores shall be provided with Extruded PVC inner sheath. It shall be as circular as possible. The thickness of inner sheath shall be as per applicable standards.
- 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 Core Identification

Cable up to 5 cores shall be identified by colouring of insulation. For cables more than 5 cores, the identification shall be done by numericals printed on the cores.

3.4 **Armouring**

The armouring shall comprise the following:-

- a) For multi core cables: Single / double galvanised 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.

The dimensions of wire/strip shall be as per applicable standards.

3.5 **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.

3.6 **Requirement of special sheath for FRLS cable:**

3.6.1 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.

3.6.2 Test for Flame Retardance

- c) Oxygen Index

The critical oxygen index value shall be minimum 29 at 250°C 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.

3.6.3 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.

3.6.4 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.

3.6.5 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.

3.6.6 Tests for Water Absorption

3.6.6.1 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.

3.6.7 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.

3.7 Temperature Rise

- a) The maximum conductor temperature shall not exceed 90°C 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°C with initial conductor temperature of 90°C.
- c) The bidder shall furnish charts for derating factors under different conditions of laying.

3.8 **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.
- 5.2 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.
- 5.3 All type test reports shall be subjected to purchaser's approval.

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 confirm the technical requirements of Data Sheet 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.

11.8.2 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	65
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. No	Description	Data						
1	Designation	Power Cables						
2	Conductor							
a)	No. of wires	3.5C	3.5C	3.5C	3.5C	3.5C	3.5C	4C
b)	Size (sq. mm)	400	300	240	185	120	70	25
c)	Stranded/ Solid	Stranded						

d)	Material	Aluminium (Al)
3	Core Insulation Material	XLPE
4	Filler Material	PVC
5	Inner Sheath Material	Extruded PVC
6	Armour	
a)	Material	GS
b)	Type	Single steel Wire/Strip
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	°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. No	Description	Data						
1	Designation	Control Cables						
2	Conductor							
a)	No. of wires	3C	3C	5C	5C	7C	7C	12C
b)	Size (sq. mm)	2.5	4	2.5	4	2.5	4	2.5
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	GS						
b)	Type	Single steel Wire/Strip						
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 in 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

11.9.1 SEGREGATED/NON SEGREGATED PHASE METAL ENCLOSED BUS DUCT

1.0 SCOPE:

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 segregated / Non - segregated phase metal enclosed bus ducts.

2.0 CODES & STANDARDS:

- 2.1 The design, material, construction, manufacture, inspection, testing and performance of segregated / non segregated phase metal enclosed bus duct 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 Equipment shall conform to the latest applicable standards as mentioned in Data Sheets. In case of conflict between the standards and this Specification, this specification shall govern.

3.0 DEFINITION:

A segregated phase bus duct is one in which phase conductor with its associated connections, joints, accessories and insulating supports are enclosed in an earthed metal housing with either metal or insulation barrier between the phases. If the BIDDER offers insulated barriers, the type, composition, electrical withstand characteristics and thickness of the insulating material used shall be indicated by the BIDDER in his bid and shall be subject to the PURCHASER'S approval.

4.0 BUSDUCT ENCLOSURE:

4.1 Material:

- 4.1.1 The enclosure shall be made of steel or aluminium alloy as specified in Data Sheet-A. The grade of steel or aluminium alloy shall be indicated by the BIDDER in his Bid and shall be subject to the PURCHASER's approval.

4.2 Shape:

- 4.2.1 Except as noted otherwise in Data Sheet-A, the section of the busduct enclosure shall either be square or rectangular.

4.3 Mechanical Strength:

- 4.3.1 The design of the Busduct enclosure shall be such that it will withstand the internal or external pressures resulting from the following:
 - a) Normal operating conditions,
 - b) Momentary short-circuit currents (Peak),
 - c) Rigours of adverse weather conditions, and
 - d) Combination of the above.

4.3.2 The enclosure shall be of sturdy construction to have inherent strength to withstand the above forces.

4.4 Construction:

4.4.1 The Busduct shall be designed for indoor/ outdoor installation as specified in Data Sheet-A, with a dust and vermin-proof construction.

4.4.2 Busduct installations meant for outdoor application shall be of weatherproof construction and shall have degree of protection IP-66.

4.5 Painting:

4.5.1 The outside of the busduct enclosure shall be given a finish as per the PURCHASER's requirement specified in Data Sheet-A.

4.6 Temperature Rise:

4.6.1 Under normal operating conditions, the hot spot temperature of the enclosure shall not exceed 70° C. In areas where the operating personnel are likely to touch the enclosure during operation, either the enclosure temperature shall be limited to 60° C or suitable thermal barrier shall be provided.

4.7 Flexible Expansion and Rubber Bellow Joints:

4.7.1 Flexible expansion joints for the enclosure shall be provided wherever deemed necessary by the VENDOR. The flexible joints shall take care of expansion and contraction due to temperature variations and fault conditions.

4.7.2 Rubber bellow joints shall be provided at terminations at transformers and switchgear cubicles.

4.8 Bonding:

4.8.1 Necessary bonding shall be provided at the above expansion joints if made of insulating material.

4.9 Terminal Enclosures and Flanges:

4.9.1 Three-phase terminal enclosures shall be provided with flanged ends with drilling dimensions to suit the flanges at equipment terminals. The busduct shall be properly aligned with the equipment terminals.

4.9.2 The flanges shall be provided with gaskets, nuts, bolts etc.

4.10 Gaskets:

4.10.1 The gasket material and thickness shall be so selected as to satisfy the operating conditions imposed by temperature, weathering durability etc. Care shall be exercised to ensure that covers fit easily, that the required compression of the gaskets can be obtained without damage to the inspection covers by bolts and that covers do not bend after this compression has been applied. Over-compression of the gaskets shall be avoided.

4.10.2 The material of the gasket shall preferably be neoprene closed-cell sponge rubber or equivalent.

4.10.3 Flanges with gaskets shall be provided at the equipment terminal connections.

4.11 Inspection covers

4.11.1 Provision shall be made for periodic inspection of insulators by means of inspection covers. The inspection covers shall be provided at the bottom with quick-acting stainless

steel clamps and shall have gaskets. There shall be no joints or fixing bolts on the top surface through which water could seep through.

4.12 Drain plugs and vents

Filter type drain plugs shall be installed at low points along the run of the bus duct to drain out automatically any moisture condensing within the bus enclosure. The drain plugs shall be fitted with porous filter elements which will permit the escape of moisture but prevent the ingress of dust. The filter elements shall be easily removable for cleaning purposes.

4.13 Miscellaneous Hardware:

4.13.1 The busduct shall not have any through bolts. All nuts and bolts shall be mild steel hot dip galvanised. M.S. spring washers shall be provided for making satisfactory joints. Clamps, splice plates etc. shall be provided wherever necessary.

4.14 Earthing:

4.14.1 Necessary earthing arrangement as applicable shall be provided with clamps to receive the PURCHASER'S station earthing bus. All accessories and hardware required for the earthing arrangement shall be provided by the VENDOR.

4.15 Rain Cover

Whenever the outdoor portion of the busduct is not of welded construction but of bolted type, a continuous hood made of non-magnetic material shall be provided over the entire length of the outdoor portion of the busduct to prevent ingress of water particles due to rainfall directly on busduct enclosure. This hood shall be mounted on bus duct supporting structures and all hardware and accessories required for mounting the hood and its supports shall be subject to the PURCHASER'S approval.

5.0 BUS CONDUCTOR:

5.1 Material

The material of the conductor shall be aluminium alloy or copper as specified in Data Sheet-A. The grade of aluminium alloy or copper shall be indicated by the BIDDER in his Bid and shall be subject to the PURCHASER's approval.

5.2 Rating

The bus conductor shall be designed to carry the rated current under specified Site operating conditions without exceeding enclosure final temperature of 70° C. Also, the temperature of the bus shall not exceed 250° C while carrying the specified short circuit current for one second when a fault occurs at the operating temperature.

5.3 Shape:

Except as noted otherwise in Data Sheet-A, the section of the bus conductors used shall be either rectangular, tubular or hollow square/rectangular type and the cross sectional area shall be based on the current rating.

5.4 Mechanical Strength:

The bus conductors and insulated supports shall withstand without permanent deformation, deterioration of conductor material and reduction in the BIL value of the busduct, the stresses consistent with the momentary short circuit current specified in this Specification.

5.5 Joints:

5.5.1 Adjacent sections of the busduct shall be bolted to provide an efficient, electrically continuous and mechanically strong connection.

5.5.2 Welded Expansion Joints:

Flexible aluminium or copper connectors welded to the main busbars shall be provided wherever deemed necessary.

5.5.3 Bolted Rigid Joints:

The connectors shall be of the same material as the conductor and these shall be silver-plated to ensure an efficient connection. The bolting schedule and contact pressures shall conform to accepted codes of practice.

5.5.4 Bolted Flexible Joints:

Flexible braided copper connections shall be provided at the equipment terminal connections. Bimetallic connectors shall be provided between the busbar and the copper flexible if the bus conductor is of aluminium alloy. The joints shall be capable of 25-mm settlement of the equipment mounting pads. The joints shall be suitably designed to take care of the vibration at the terminals as well as the expansion and contraction of the busbars.

5.5.5 Bolted Expansion Joints:

Expansion joints made of aluminium or copper strips shall be provided wherever deemed necessary by the VENDOR, to take care of expansion and contraction of the busbars under normal operating conditions.

5.5.6 All the above joints shall be tested for temperature rise to prove the adequacy of the design. The maximum temperature rise at the joints shall be less than the specified temperature rise for the busbars.

5.6 Hardware:

5.6.1 All bolts, nuts and lock washers used in the busduct assembly shall be of high tensile steel and plated for corrosion resistance. Spring washers of 'Belleville' type or equivalent shall be used.

5.6.2 Suitable splice plates and bimetallic connectors shall be provided wherever necessary.

5.7 Disconnecting Links:

5.7.1 Disconnecting links with rating same as that of the main bus bars shall be provided in the run of the busduct to facilitate disconnection of the busbars during testing and maintenance. The separation of the busbar sections with the bolted links removed shall be sufficient to withstand the rated Power Frequency withstand voltage of the busduct.

5.8 Shorting Links

5.8.1 Shorting jumpers, for the purpose of drying out the equipment before commissioning or for carrying out short circuit test on the equipment, rated for the main bus current shall be supplied for shorting the busduct at a location, adjacent to the disconnecting links.

5.8.2 The shorting links shall have drilling dimensions matching those of the main bus disconnecting links. Suitable supporting structures and support insulators for the shorting links if necessary shall also be offered.

6.0 PHASE BARRIERS

- 6.1 When segregated type of phase busduct is specified in data sheet-A, phase barriers shall be provided between the phases.
- 6.2 The phase barriers shall be of metal or insulating material as specified in data sheet-A. When metal barriers are specified, the material shall be same as that of the busduct enclosure material.
- 6.3 Insulated phase barriers, when specified, shall be made of non-hygroscopic insulating material such as fibre glass.

7.0 BUS SUPPORT INSULATORS

- 7.1 Within the busduct the bus shall be mounted and supported on insulators. The insulators shall be mounted on resilient pads provided in the bus enclosure.

7.2 Material:

- 7.2.1 The insulators shall be either porcelain or resin cast.
- 7.2.2 For busducts with voltage rating upto 1100 volt. 'PERMALI' wood or equivalent type of non-hygroscopic insulating supports are acceptable.

7.3 Mechanical strength

The insulators shall possess sufficient mechanical strength to withstand the forces due to momentary short circuit currents. The spacing of the bus insulators shall be decided giving due factor of safety.

7.4 Electrical Strength:

As a consequence of current loading and variation in external temperatures in the external sections of the busduct, condensation of moisture may take place on the surface of the insulators. Hence, the insulators shall have a high a high creepage distance and a withstand voltage rating sufficient to provide specified insulation under highly humid conditions.

8.0 WALL FRAME ASSEMBLY AND SEAL OFF BUSHINGS

8.1 Wall frame assembly

Wherever the busduct passes through the plant building wall, from indoors to outdoors, a wall frame assembly with seal-off bushings shall be provided to prevent any leakage of rain water, infiltration of dust and air temperature variations from indoors to outdoors. The wall frame shall be fabricated out of aluminium angles and sheet and shall be suitable for grouting in the wall. It shall be provided with flanges on both sides to receive the busduct flanges.

8.2 Seal-off Bushings

The busduct shall be equipped wherever necessary with seal-off bushings to prevent interchange of air at different temperatures. The seal-off bushings shall be flanged type.

8.3 Material

The insulators for wall frame assembly and seal-off bushings shall be of porcelain. Also the bushings shall be designed for thermal expansion/contraction due to temperature differential for outdoor/indoor use.

8.4 Mechanical strength

The insulator shall withstand the maximum short circuit forces under fault conditions specified. The insulator material shall not deteriorate under normal operating temperatures or due to temperature rise under fault conditions.

8.5 **Electrical strength**

The electrical properties of the insulator shall be in conformity with this specification.

9.0 **PHASE CLEARANCES:**

9.1 The minimum phase to phase and phase to earth clearances of busbars within the enclosures shall be as specified in Data Sheet-A.

10.0 **BUS DUCT SUPPORTS**

10.1 **Material**

The supporting structures shall be fabricated from standard steel sections and shall be hot dip galvanised after fabrication. The hot dip galvanising shall be in accordance with standards listed in data sheet-A

10.2 **Mechanical strength**

The supporting structures shall be designed to withstand the dead weight of the busduct and also the short circuit forces under maximum fault conditions and also the wind load and forces due to seismic accelerations which are specified in data sheet-A and/or section-2 entitled 'Project Information'. Calculations shall be furnished to substantiate the above and shall be subject to the PURHASER'S approval.

10.3 **Accessories and hardware**

The supporting structures shall include supporting members, brackets, hangers, longitudinal beams, channels, nuts, bolts, washers and all other hardware which are necessary for the erection and support of the entire busduct installation. All the accessories and hardware of ferrous material shall be hot dip galvanised.

10.4 **Method of support**

- 10.4.1 Indoor portion of the busduct may be supported from the floor or ceiling beams.
- 10.4.2 Outdoor portion of the busduct shall be supported from ground below on suitable foundation in the ground.
- 10.4.3 The foundations and structures in outdoor area shall clear the transformers, transformer foundations, cable trenches, etc.
- 10.4.4 The foundations and structures for busduct in outdoor area shall clear the transformers, transformer foundations, cable trenches etc.

10.5 **Earthing:**

- 10.5.1 Each supporting structure shall be securely connected at two points to the PURCHASER's station earthing bus. All necessary hardware, such as clamps, connectors etc., required for this purpose shall be furnished by the VENDOR.

10.6 **Markings:**

10.6.1 All components of the busduct along with the supporting structure shall be distinctly marked for erection in accordance with the erection drawings to be prepared & furnished by the VENDOR. These marks shall be made in a manner as not to be obliterated and erased in transit or to damage the galvanising of the busduct or the supporting structure.

11.0 MISCELLANEOUS:

11.1 Studs, nuts, bolts and tapped holes shall conform to SI units and to relevant standards. Only hexagonal nuts shall be used. All bolt holes shall be spot faced for nuts.

11.2 Castings and forging shall conform to respective material specifications and shall be free from flaws. They shall be machined true as per good workshop practice. Welding shall be performed in accordance with relevant recognised standards.

11.3 All threaded pipe connections and fittings, pipe flanges and tube fittings shall comply with relevant standards.

11.4 Caution boards shall be supplied indicating voltage rating warning about enclosure temperature at every transport section.

12.0 DESIGN REQUIREMENTS OF BUSWAYS:

12.1 The bid shall contain design calculation in support of the following parameters of the busduct design:

- Sizing of the busbars vis-à-vis thermal capability to withstand rated continuous current and one second short time current.
- Spacing of the insulators vis-à-vis mechanical strength to withstand forces due to momentary short circuit current.
- Heat loss and temperature rise calculations for conductor and enclosure. Wherever rain hood is provided the effects of solar radiation may be neglected while calculating temperature rise.

12.2 The bid shall be complete with all heat loss calculations. All formulae and other information from which the heat losses have been derived shall be enlisted.

13.0 SPACE HEATERS

13.1 The busduct shall be provided with space heaters of adequate capacity to maintain the internal temperature above the dew point to prevent moisture condensation within the busduct. The space heaters shall be rated for 240V single phase, 50Hz, AC supply. The space heater shall be automatically controlled by humidistats.

14.0 DRAWINGS

The VENDOR shall furnish the following drawings for the busduct for purchases approval:-

- General arrangement and dimensioned layout of the busduct installation showing the connections to equipment and tap-offs, if any.
- Drawing showing the requirement of embedments in PURCHASER'S floors, ceilings, walls etc.
- Structural drawings along with foundation details for the structures.
- Drawing showing the terminal connections between the busduct and the equipment terminals.

- 14.5 Details of seal-off bushing and wall frame assembly.
- 14.6 Details of busduct bonding arrangement.
- 14.7 Itemised bill of material for complete busduct covering all the components and associated accessories.
- 14.8 Arrangement of the bus, insulators etc. within the busduct.
- 14.9 Details showing a typical busduct joint between sections.
- 14.10 Details of typical rigid and expansion connections

15.0 TESTS & TEST REPORTS:

- 15.1 The following type and routine tests shall be conducted on representative section of the busduct assembly. The busduct assembly tested shall include bolted connections and flexible connections.
- 15.2 The tests shall be conducted as per standards indicated in these specifications.

15.3 Type Tests:

The Type tests shall include the following tests:

- a) One-minute power frequency withstand voltage test.
- b) Impulse withstand test
- c) Megger test
- d) Temperature rise test of conductors and enclosures.
- e) Short circuit Current withstand test.
- f) IP Class test.
- g) Any other test required as per relevant standard.

15.4 Routine Tests:

The routine tests shall include the following tests:-

- a) One-minute power frequency withstand voltage test.
- b) Megger test.
- c) Dimensional verification
- d) Any other required as per relevant standard.

15.5 Test Report for Components:

Manufacturer's type and routine test certificates shall be submitted for tests conducted as per relevant standards for the following components:

- a) Insulators

- b) Seal off bushings
- c) Bolted and flexible joints
- d) Busbars
- e) Enclosure material
- f) Galvanising of support structures

16.0 SPARES:

Whether included in the BIDDER's recommendation or not, unit prices of the following items or the items recommended by them shall be quoted together with their suggested quantities and catalogue numbers:

- a) Bus support insulators
- b) Flexible connectors
- c) Bends
- d) Isolating links
- e) Different type of gaskets
- f) Seal off bushing.

11.9.2 BUS DUCT DATASHEET

DATA SHEET - A1

SI No.	Description			Unit	Data
1.0 BUS DUCT	1.1	Type of Busduct	Segregated phase		Non - Segregated phase
			Non segregated phase		
	1.2	Type of cooling			Naturally cooled
	1.3	Installation		Indoor/Out door	Partly indoor and Partly outdoor
	1.4	Degree of protection of enclosure		Indoor/Out door	IP54 for indoor / IP66 for outdoor
2.0 RATING	2.1	Rated voltage & Frequency		V & Hz	415V & 50Hz
	2.2	Highest system voltage		V	1100
	2.3	One minute power frequency withstand voltage		kV (rms)	2.5
	2.4	1.2/50 μ s impulse withstand voltage		kVp	8
	2.5	Continuous current rating of Bus Ducts under site conditions		A	4000 A (2 Runs) 2500 A (1 Run)
	2.6	Momentary current rating		kA (Peak)	105
	2.7	Short time rating	Current	kA (rms)	65
			Duratio n	Sec	1
	2.8	No. Of Phases			3(Three) P + 100% 1N +2 PE
	2.9	Maximum ambient temperature		°C	45
	2.10	Max. Temperature of Busbars at rated current and maximum ambient temperature		°C	85
	2.11	Max. temperature of Enclosure at rated current and at maximum			70

	ambient temperature	°C	
3.0 BUS CONDUCTOR	3.1 Bus conductor material	Cu/Al	Aluminium
	3.2 Shape of conductor		Rectangular / By bidder
	3.3 Cross section area of conductor	Sq mm	As per vendor's design By bidder
4.0 BUS ENCLOSURE	4.1 Bus Enclosure Type		Metal enclosed
	4.2 Bus Enclosure Material		Non-magnetic Aluminium alloy or CRCA sheet steel
	4.3 Shape of Enclosure		Rectangular
	4.4 Enclosure Thickness	mm	3
	4.5 Clearance at terminating ends:	Ph to Ph Ph to Earth	25 25
	4.6 Type of joints between adjacent section of Bus conductor	Welded/ Bolted	Bolted
	4.7 Phase barrier material		<u>NA</u>
	4.8 Thickness of phase barrier	mm	<u>NA</u>
	4.9 Dimensions of enclosure	Height Width	As per vendor's design By bidder
5.0 BUSWAY COMPONENTS AND ACCESSORIES	5.1 Straight length - Indoor	Mtrs	Refer price schedule (section-7) and layout drawings
	5.2 Straight length - outdoor	Mtrs	Refer price schedule (section-7) and layout drawings
	5.3 90° degree bend (vertical/Horizontal)	Nos	Refer price schedule (section-7) and layout drawings
	5.4 Adaptor box - switchboard end	Nos	Refer price schedule (section-7) and layout drawings
	5.5 Adaptor box - Transformer end	Nos	Refer price schedule (section-7) and layout drawings
	5.6 Braided copper flexible at switchboard end	Set	Refer price schedule (section-7) and layout drawings
	5.7 Braided copper flexible at transformer end	Set	Refer price schedule (section-7) and layout drawings
	5.8 Galvanised steel support structure	Set	By bidder
	5.9 Busduct hanger supports	Set	By bidder
	5.10 Wall frame assembly with seal off bushings.	Set	Wall frame assembly with Seal off Bushing and Fire Barrier
	5.11 Space Heater Assembly	Set	Refer price schedule (section-7) and layout

6.0 GENERAL				drawings
	5.12	Siliga Gel Breathers	Set	Refer price schedule (section-7) and layout drawings
	5.13	Phase Cross Over Assembly	Set	Refer price schedule (section-7) and layout drawings
	5.14	Rubber bellows		By bidder
	5.15	All other materials as required		By bidder
	5.16			
	6.1	External Earthing Conductor	Material	GS
			Size	mm 50 x 6
	6.2	Finish of Busduct	Exterior	RAL 7032
			Interior	Black matt finish
	6.3	Layout drawing enclosed	Yes/ No	Yes
			DRG No.	PCPL-2013-4-GA-002
	6.4	Rain hood required for outdoor part	Yes/ No	YES

NOTE: The quantities indicated are as estimated for bidding purpose. Any other item which may be required for completion of the job and not specified shall be quoted by the vendors complete with unit rates.

DATA SHEET - A2			
APPLICABLE STANDARDS			
S1 No.	DESCRIPTION	STANDARDS	
01	Busways	IS	IEC 60439-1&2
02	Bus Conductor material	IS 5082 IS 63401	
03	Current Transformer	IS 2705	IEC 60185
04	Voltage Transformer	IS 3156	IEC 60186
05	Porcelain Post Insulator	IS 2544	IEC 60168
06	Hot Dip Galvanizing	IS 2629 IS 2633	
07	Phosphate treatment of Iron & Steel	IS 6005	
08	Thermal Evaluation and Classification of Electrical Insulation		IEC 60085

11.10.1 BATTERY

1.0 SCOPE

- 1.1 This specification covers the design, material, construction features, manufacture, and inspection and testing at site of stationary Lead Acid Sealed Maintenance Free (SMF) storage battery complete with battery racks, inter cell and inter tier connectors and all other accessories.
- 1.2 In case of conflict between any section or clause of this specification and Data Sheet-A, the requirements of Data Sheet-A shall govern

2.0 CODES & STANDARDS

- 2.1 The design, material, 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 VENDOR of this responsibility.
- 2.2 The equipment shall conform to the latest edition of standards mentioned in Data Sheet-A.

3.0 TYPE

- 3.1 The battery offered shall be one of the following types as mentioned in Data sheet -A.
 - a) Stationery Lead Acid Battery of the following types :-
 1. Vented type`
 2. Valve regulated type (VRLA)
 - b) Nickel – Cadmium Battery

4.0 STATIONERY LEAD ACID BATTERY - VENTED TYPE

4.1 General

- 4.1.1 The equipment offered shall be complete with all parts that are necessary or usual for the efficient operation of the equipment, whether specifically mentioned or not.
- 4.1.2 Stationery cells shall be designed to withstand mechanical stresses during transportation and handling.

4.2 Features of construction

- 4.2.1 The general feature of construction shall be as specified below.
- 4.2.2 Plante' Positive Plates.

The plante' positive plate shall be cast solid in pure lead in one piece and shall have adequate mechanical strength. It shall be electrochemically formed and shall be capable of operating under normal working condition without buckling or cracking. Welding together of small size lead castings or fully formed plates to form larger sizes will not be accepted.

- 4.2.3 Tubular Positive plate shall consist of suitable bar with spines cast of suitably alloyed lead to give adequate mechanical strength. Porous, acid resistant and oxidation resistant tubes shall be inserted one over each spine. After insertion, the tubes shall be adequately filled and packed with active material before their lower ends are closed by a common

bar. The construction and material of the tubes shall be such as to reduce loss of active material and to withstand normal internal stresses developed during service.

4.2.4 Pasted Positive Plates

The pasted positive plates shall consist of either pure lead, low antimonial lead alloy or lead calcium positive grids; having double separation with a glass wool retainer mat or any other suitable material placed against the surface of the positive plates, for good service life.

4.2.5 Negative Plates

The negative plates shall normally be of the box type. End negative plates, if of box type may be of the half pasted type. Pasted plates shall have adequate mechanical strength and shall be so designed that the active material is maintained in intimate contact with the grid under normal working conditions.

4.2.6 Containers

The containers shall be made of plastics, or fibre reinforced plastics (FRP). The container shall be spill proof and leak proof, explosion resistant and increased safety type enclosure.

4.2.7 Separators

The plate separators shall consist of a micro porous matrix, the battery separator shall maintain the electrical insulation between the plates and shall allow the electrolyte to permeate freely. The VENDOR shall indicate the material of the separator.

4.2.8 Electrolyte

The electrolyte shall be battery grade sulphuric acid conforming to latest editions of relevant standards.

4.3 Each cell shall be equipped with a device to indicate the minimum and maximum electrolyte level.

5.0 STATIONARY LEAD ACID BATTERY - VALVE REGULATED TYPE

- 5.1 Valve regulated lead acid (VRLA) type battery shall have immobilised electrolyte in the form of absorbent glass mat (AGM) or gel or other equivalent method.
- 5.2 The VRLA cell shall be closed under normal conditions but shall be provided with a control valve which shall allow escape of gas if the internal pressure exceeds the predetermine value. The valve shall not allow gas/air to enter into the cell. The cell shall not require addition of electrolyte and shall be maintenance free.
- 5.3 Under recommended operating condition, the temperature of VRLA cells shall be sufficiently low to prevent thermal runaway. The manufacturer shall furnish
 - a. The temperature limit
 - b. The recommended measures to reduce risk of thermal runaway.
- 5.4 Under recommended operating condition, all the oxygen and hydrogen gases produced in positive and negative plates shall recombine internally to form water and no gas shall be evolved.
- 5.5 The battery shall be normally operated in float charging mode. The manufacturer shall advise the following to select the battery charger parameter:-
 - a. The float charging voltage and current under normal condition when the battery is fully charged.

- b. The maximum float charging voltage to recharge a partial/fully discharged battery without the risk of higher gas evolution.
- c. The maximum allowable float charging current
- d. The recommended mode of charging such as:-
 - I. Constant voltage
 - II. Constant voltage- constant current etc.
- e. The limiters to be provided to avoid over charging shall be advised.

5.6 VRLA cells shall carry the polarity marking of at least the position terminal. The polarity marking shall be in accordance with IEC 417.

6.0 NICKEL-CADMIUM BATTERY

- 6.1.1 The battery shall comprise vented Nickel-Cadmium rechargeable cells.
- 6.1.2 The battery container and lid shall be alkali resistant, non-aging material with high impact strength. It shall have smooth sides except for receptacles, hold down bar, vent tubes, name plate, latches and polarity marking.
- 6.1.3 The cell container shall be of high strength alkali resistant material either nickel plated mild steel/ stainless steel or non-porous plastic as specified in Data Sheet-A
- 6.1.4 The connector covers shall be of hard PVC to prevent external short circuiting.
- 6.1.5 The venting device shall be of anti splash type and shall allow the gases to escape freely and shall effectively prevent the electrolyte from coming out. Provisions shall be made for drawing electrolytes samples, checking and topping of the electrolyte.
- 6.1.6 The electrolyte used shall be a solution of potassium hydroxide in distilled water or de-mineralised water made up to the specific gravity at 27°C.
- 6.1.7 Cell Designation.

Vented Nickel-Cadmium prismatic rechargeable cells shall be designated by letter 'K' followed by a letter L, M, H, or X which signifies the following:

L	-	Low rate of discharge (up to 0.5 Cs)
M	-	Medium rate of discharge (above 0.5 Cs up to 3.5 Cs)
H	-	High rate of discharge (above 3.5 Cs up to 7 Cs)
X	-	Very high rate of discharge (above 7 Cs)

- 6.1.8 The group of two letters shall be then followed by a group of figures indicating Amp-hour capacity. Cells in plastic material shall be marked with letter 'P' after the figures.
- 6.1.9 Separators used for the cells shall be porous alkali resistant and high insulating capacity to avoid shorting or leakage of the current between the plates of opposite polarity. The separator shall be dimensionally stable without deformation at the room temperature.
- 6.1.10 The normal voltage of a single cell shall be 1.2 volts.
- 6.1.11 The rated capacity in Ampere hours (Ah) shall be at 5 hours discharge rate to a final voltage of 1.0 Volts/Cell at specified temperature.

7.0 CONNECTORS AND TERMINAL POSTS

Inter cell and inter-tier connectors and terminal posts shall be of copper. Terminal posts shall be designed to accommodate external bolted connection conveniently and positively. Each terminal post shall have two bolt holes of the same diameter, preferably at right angles to each other. The bottom hole shall be used to terminate the inter cell connection. The top hole shall be left for PURCHASER's terminal connections. All the metal parts of the terminals shall be lead coated if necessary. The VENDOR shall indicate this in the bid. The junction between terminal posts and cover and between cover and container shall be so sealed as to prevent any seepage of electrolyte.

8.0 ACCESSORIES

The battery shall be complete with accessories and devices, including but not limited to the following as applicable for the type of battery.

- i) Battery racks
- ii) Porcelain insulators, rubber pads etc.
- iii) Set of inter cell, inter-tier and inter bank connectors as required for the complete installation.
- iv) Electrolyte for first filling +10% extra in plastic bottles or drums, for Ni-Cd battery.
- v) Accessories for testing and maintenance.
 - a) One - -3, 0, +3 volts DC Voltmeter with suitable leads for measuring cell voltage.
 - b) One -Hydrometer for measuring specific gravity of electrolyte in steps of 0.002.
 - c) One - Filler hole thermometer fitted with plug and cap and having specific gravity correction scale.
 - d) Three -Pocket thermometers
 - e) Two sets - Funnels or siphon hydrometer and plastic jugs for topping up.
 - f) Two - Graduated plastic level test tube for electrolyte level checking.
 - g) Two - PVC aprons
 - h) Four- PVC GLOVES and any other protective wearing apparel to be specified by VENDOR
 - i) Two- Cell lifting straps
 - j) One set - Terminals and cable boxes with glands for connecting cable as required.
 - k) Spare connectors
 - l) Spare vent plugs
 - m) Spare nuts and bolts
 - n) Suitable set of spanners
 - o) PVC spill trays under the Battery cells
 - p) One set - Cell topping up apparatus (for large sizes of Ni-Cd cells) VENDOR shall list the items.
 - q) Insulated wrencher (for sealed lead acid battery).

9.0 BATTERY LAYOUT

9.1 Unless otherwise specified the battery shall be complete with battery racks and preferably mounted in single tier arrangement. VENDOR shall furnish dimensioned drawings of the battery layout for PURCHASER's approval. For smaller units, utilising sealed-in type of batteries, mounting of the battery in sheet metal cubicle will be acceptable.

9.2 **Battery Racks**

Battery racks shall be constructed from good quality teakwood and painted with two coats of approved alkali resisting paint. The construction of the racks unless otherwise mentioned in Data Sheet-A shall be suitable for fixing to a flat concrete floor. The racks shall be rigid, freestanding type and free from warp and twist. The completed racks shall be suitable for being bolted end to end to form a continuous row. Insulators shall be provided below the legs of the stands.

9.3 **Ventilation**

The BIDDER shall indicate in the tender REQUIREMENTS OF VENTILATION IN THE BATTERY ROOM. The battery shall operate satisfactorily over the entire range of temperature indicated in Data Sheet without affecting its normal life. BIDDER shall indicate the percentage reduction in battery capacity at the lowest temperature compared to the standard temperature of 27°C. If any special ventilation requirements are necessary, the same shall be indicated.

10.0 CAPACITY

10.1 The standard ampere-hour capacity at specified rate of discharge of the battery has been based on the requirements of loads mentioned in Data Sheet-A and the minimum ambient temperature specified. BIDDER SHALL Guarantee that the capacity of the battery offered by him is adequate for the duty specified (all loads being co-incident from the instant of supply failure even at the minimum ambient temperature specified in Data Sheet-A). The end cell voltage after discharge shall be as mentioned in Data Sheet A.

11.0 CHARGING

11.1 The proposed method of charging of the battery is indicated in the Data Sheet -A. However, the bidder shall indicate the recommended mode of charging.

11.2 BIDDER shall state whether an equalising charge is recommended for the battery. If so, the equalising charging voltage, current, duration and the interval between the equalising charging shall be specified in Data Sheet-B. BIDDER SHALL also indicate the requirements for boost charging.

12.0 LIFE

The BIDDER shall quote in his offer the guaranteed life of the battery when operating under the conditions specified

13.0 TESTS

13.1 All tests shall be conducted as per the relevant standards. Tests shall include following Type & acceptance tests:

- Type Tests: Performed at MANUFACTURER's works
- Acceptance Test: Performed at site after installation and commissioning of the battery. All tests shall be witnessed by the Project Engineer cum Estate

Officer/Project Engineer cum Estate Officers' authorized representative, PURCHASER'S representative. Details of tests to be performed are given below:

13.2 Type Tests

13.2.1 Type tests shall comprise the following as applicable for the type of battery.

- a) Physical inspection
- b) Dimensional, mass and layout checks
- c) Marking
- d) Polarity and absence of short circuit
- e) Ampere-hour Capacity tests
- f) Retention of charge test
- g) Discharge performance at low temperature
- h) Ampere-hour and watt-hour efficiency tests.
- i) Test for short circuit current and internal resistance
- j) Endurance test in discharge-charge cycles
- k) Life cycle test
- l) Storage test

13.2.2 For VRLA batteries the following additional type tests shall be carried out:-

- a. Test for seal integrity
- b. Test for gas emission

13.2.3 Air pressure test shall be carried out for Ni-cad batteries.

13.2.5 Type tests shall be conducted on a minimum of one sample cell typical and identical with the cells forming the complete battery offered. However, the test cell shall not be one of the cells in the battery offered.

13.2.6 In applications where the first momentary discharge stated in Data Sheet-A is high and lasts for several minutes a high discharge test shall be conducted, in addition to the above tests, as a type test. This test shall ensure that at the end of the high discharge rate duty, end cell voltage does not fall below 1.6 V for lead acid and 1.1/1.05 V for Ni-Cd and the temperature rise of electrolyte shall be within 10°C.

13.3 Acceptance Test

Acceptance tests shall be conducted at site on completion of installation and commissioning and immediately prior to putting the battery in service. These tests shall comprise of:

- a) Physical inspection
- b) Dimensional, mass and Layout
- c) Marking
- d) Polarity and absence of short circuit
- e) Ampere-hour capacity test
- f) Test for voltage during discharge
- g) Retention of charge
- h) Insulation resistance

13.4 Routine Test

Routine tests shall be carried out as per applicable standards.

13.5 Tests Reports

Copies of routine and type test results shall be submitted for approval before the dispatch of batteries. Specified number of bound copies of complete test results shall be furnished with the batteries.

14 SPARE PARTS

14.1 BIDDER shall include the following items in his recommended list of spares along with item wise unit prices:

- a) Inter cell connectors
- b) Battery stand insulators and cell insulators
- c) Nuts, bolts, washers etc.
- d) Vent plugs cum level indicators
- e) Complete set of spare cell (without electrolyte for Ni-Cd cell)
- f) Battery inter row connector
- g) Battery inter-cell connector

15 IDENTIFICATION

15.1 Each cell shall be marked in a permanent manner to indicate the following information:

- a) Cell number
- b) Type of positive plate
- c) AH capacity at specified rate of discharge
- d) Type of container
- e) MANUFACTURER's name
- f) Month and year of manufacture.

16 CO-ORDINATION WITH BATTERY CHARGER VENDOR

16.1 When battery charger is procured separately, VENDOR shall coordinate with battery charger VENDOR in regard to layout, connections, charging voltage requirements etc.

17 TRANSPORT

- 17.1 The lead acid battery shall be transported without electrolyte. The electrolyte shall be supplied separately in non-returnable containers.
- 17.2 The Ni-Cd battery shall be transported without electrolyte in preferably dry charged condition. The electrolyte shall be supplied separately in non-returnable containers.
- 17.3 The VRLA battery shall be transported with the electrolyte immobilized, sealed and fully charged.

18 WARRANTY

VENDOR shall give a warranty period of 2 years for the battery and indicate the warranty terms and conditions.

11.10.2 BATTERY DATASHEETS

DATA SHEET - A1				
Sl. No.	Description		Unit	Data
1.0 GENERAL	1.1	Application		Control supply (SERC substation panel loads)
	1.2	Type of Battery	Lead Acid-vented	
			VRLA	SMF VRLA
			Ni-Cd	
	1.3	Number of batter banks required	No.	One
2.0 BATTERY RATINGS	1.4	Number of cells in each bank is series (Approximate)	No.	Nominal 12V x 9 Nos.
	1.5	Minimum Ambient temperature	°C	40 °C
	2.1	D.C. System voltage	Volts	110V
	2.2	Momentary load/ duration	A	
			Minutes	1
2.0 BATTERY RATINGS	2.3	Emergency load/ duration	A	
			Hours	2
	2.4	Continuous load/duration	A	
			Hours	8
	2.5	Ampere hour capacity calculated on the basis of		
2.0 BATTERY RATINGS	a)	Rated duration of discharge	Hours	10Hrs
	b)	End cell voltage at the end of discharge cycle	Volts	1.85
	2.6	Cell voltage	Initial	1.85V
			Final	2.00V
	2.7	Calculated ampere hour for above duty at 27 °C	Ah	150Ah minimum (Bidder to calculate the DC loads)
3.0 PERFORMANCE	2.8	Calculated ampere hour at site minimum ambient temperature	Ah	
	2.9	Specified ampere hour	Ah	
	3.1	Ah efficiency at rated load	%	90% or better
	3.2	Watt hour efficiency at rated load	%	90% or better
	3.3	No. Of charge-discharge cycle battery can give during its entire life	No.	4000 or better
4.0 BATTERY CHARGING	3.4	Expected life of battery	Years	10 years minimum
	4.1	Charging method proposed for		
	a)	Vented lead acid battery		
	b)	VRLA battery		Dual Redundant SMPS based Float cum Boost Charging (FCBC)

	c)	Nickel cadmium battery		
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DATA SHEET - A1				
Sl. No.	Description		Unit	Data
5.0 LAYOUT	5.1	Location		Indoor
	5.2	Available area in Battery room	L mm	Vendor to specify space requirement with Battery rack layout drawing with his bid
	5.3		W mm	
	5.4	Layout drawing enclosed	Yes/No	NIL
	6.0	Mounting Arrangement	Drg. No	Multitier
		Tentative size of cable to connect battery to external circuit		Manufacturer to specify and supply

DATA SHEET - A2				
APPLICABLE STANDARDS				
Sl. No.	Description		STANDARDS	
1	General requirements and methods of tests for Sealed lead acid storage batteries		IS-8320,1652	
	a)	Vented type lead acid battery	IS-8320, 1651,	IEC 60896-1
	b)	VRLA type lead acid battery	IS 1652 IS 15549	IEC 60896-2
	c)	Nickel-cadmium battery	IS 10918	IEC 60623
2	Quality Tolerance for Water for storage battery		IS-1069	
3	Sulphuric acid		IS-266	
4	Sealing compound for lead acid batteries		IS-3116	
5	Synthetic separator for lead acid batteries		IS-6071	
6	Rubber and plastic containers for lead acid storage batteries		IS-1146	

11.11.1 BATTERY CHARGER AND DCDB

1.0 SCOPE

1.1 This specification covers requirements of Battery Charger & DC Distribution Board (DCDB) equipment comprising rectifier, rectifier transformer and auxiliary equipment.

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 VENDOR of this responsibility.

2.2 Unless otherwise specified, equipment shall conform to the latest applicable standards as mentioned in Data Sheet-A2. Equipment complying with other authoritative standards such as British, American, VDE, will also be considered, if offered.

3.0 TYPE

3.1 The battery charger shall perform the following duties:-

- Supply DC loads as specified, continuously as long as AC power supply is available
- Float Charge the battery to keep it fully charged in accordance with the recommendations of the battery manufacturer.
- Boost Charge the battery following discharge during AC power supply failure in accordance with the recommendations of the battery manufacturer.

3.2 The battery Charger shall be one of the following two types as specified in data sheet A1:-

- Separate float charger (FC) and boost charger (BC) to perform the duties mentioned in Cl 3.1 above
- Composite float cum boost charger (FCBC) when one charger performs all the duties mentioned in Cl 3.1

3.3 The battery charger shall be static type composed of silicon controlled rectifiers (SCRs) connected in three-phase, full wave bridge circuit. Transducer control may be offered as an alternative for large sets if SCRs are not feasible.

3.4 The rectifier transformer shall be indoor cast resin, dry type, double wound with adequate number of primary and secondary taps. The insulation class of rectifier transformer winding shall be class H unless otherwise stated in data sheet A1.

4.0 RATING

4.1 The float charger shall be designed for supplying:

- The DC loads specified in Data Sheet-A.
- The float charging current of the battery as per recommendation of the battery vendor.

4.2 The boost charger shall be designed for supplying the boost charging current of the battery to recharge it as per recommendations of the battery manufacturer.

- 4.3 When a composite (Float cum Boost) charger is specified it shall be designed to meet the requirements specified in Clauses 4.1 and 4.2.
- 4.4 It shall be the responsibility of VENDOR to co-ordinate with the BATTERY MANUFACTURER and ascertain the float and boost charging currents and voltages required by the battery.

5.0 CHARGER & DCDB CUBICLE & WIRING

- 5.1 The construction details of chargers and DCDB shall be as specified in data Sheet A1.
- 5.2 Cubicle accessories and wiring shall conform to the requirements as stated in the following clauses and in data sheet A1. in the companion specification for Control Cabinets.

6.0 ACCESSORIES

- 6.1 Each battery charger shall include the following:
 - a) One (1) set - silicon controlled rectifiers connected in three phase full wave bridge circuit with ripple filtering device.
 - b) One (1) set - double wound dry type, Cast resin, main transformer of suitable rating with adequate no. of primary and secondary taps for the charger output voltage control.
 - c) One (1) set - booster transformers as required.
 - d) One (1) set - electronic SCR control module
 - e) One (1) set - automatic voltage regulator unit (for float chargers) with manual/ auto control switch and output current limiter.
 - f) One (1) Selector switch for auto and manual control.
 - g) One (1) set - course and fine control knobs for manual control.
 - h) One (1) - selector switch for modes of charging i.e. float charging/boost charging. This shall be as indicated in the diagram referred to in Data Sheet-A.
 - i) One (1) - off load tap changing switch for changing the primary taps of the transformer.
 - j) One (1) - D.C. voltmeter with MCB and selector switch for measuring the output voltage.
 - k) One (1) - D.C. ammeter with shunt
 - l) One (1) TPN incoming MCCB unit on A.C. side of each charger along with Short Circuit, Over Load and Earth Fault releases and alarm contacts.
 - m) One (1) DP MCCB on D.C. output side of each charger with SC, OL, EF and alarm contacts.
 - n) One (1) - center zero ammeter with shunt for battery circuit.
 - o) Two (2) sets - silicon diodes arranged in series for connection between the end cell tap on the battery and the positive bus of charger output.
 - p) One (1) DC contactor of adequate rating with one NO + one NC power contact for connecting the load across battery tap, in boost charging mode of Float cum Boost

Charger and to connect across the full battery when the charger is float mode and on AC supply failure while boost charging the battery.

- q) One (1) - cubicle space heater with control switch and MCB suitable for 240V AC 50 Hz. single phase supply.
- r) One (1) - 240 V AC lamp for cubicle internal lighting.
- s) Two (2) - On - Off switch with MCB for items _____
- t) Two (2) - silicon diodes in series in the float charger circuit.

6.2 Indication -& Protection

Each battery charger shall be provided with the following indications and protective devices:

- a) Three (3) cluster LED type indicating lamps (RYB) on the AC supply of the charger.
- b) One (1) cluster LED type indicating lamp (red) on the DC output side.
- c) Two (2) AC under voltage relays connected across fuses on the AC supply side with alarm contacts for Annunciator.
- d) Thermal overload elements on each phase of the AC contactor on the supply side with alarm contacts for Annunciator.

6.3 Instruments

The following instruments shall be provided:

- a) AC Ammeter for input supply
- b) Ammeter selector for above ammeter
- c) AC voltmeter for input supply
- d) Voltmeter selector switch for above voltmeter
- e) DC Ammeter for FC output
- f) DC Ammeter for BC output
- g) DC Ammeter-centre zero for charge / discharge current of battery
- h) DC voltmeter for FC, BC, Load and battery voltages
- i) Selector switch for above voltmeter.
- j) Any other instrument considered necessary by vendor.

6.4 Annunciation

6.4.1 Annunciation system shall be provided to give visual and audible signals for abnormal conditions of working for float and boost charger

6.4.2 The following abnormal conditions shall be annunciated:-

- a) AC input supply fail
- b) Float Charger:-
 - i) Input MCCB trip
 - ii) Output MCCB trip
 - iii) Charger fail
 - iv) DC over current

- v) Fuse (s) fail
- c) Boost charger
 - Items (i) to (v) as for float charger
- d) DC under voltage
- e) DC over voltage
- f) Battery earth fault
- g) Battery reverse polarity
- h) Battery MCCB trip
- i) Any other condition considered necessary by the vendor.

6.4.3 The following annunciations shall be provided for DCDB:

- a) DCDB incomer trip
- b) DCDB outgoing feeder trip (Group annunciation for all the feeders)

6.4.4 All devices to initiate the above fault conditions shall be provided.

6.4.5 All devices shall have spare contacts to provide group annunciations in the remote panel/ SCADA

6.4.6 Annunciation test, accept and reset push buttons shall be provided.

6.5 One (1) triple pole DC MCCB shall be provided for battery connections form (+) positive, (-) Negative and (TC) tap connection terminals.

7.0. PERFORMANCE

- 7.1. The automatic constant voltage regulator shall regulate the DC voltage within 1% of the set value from no load to full load under the supply voltage and frequency fluctuations of +/- 10% and +/- 5% respectively.
- 7.2. The float charger shall have built-in current limiting feature to drop the output voltage on currents more than 110% of the rated current.
- 7.3. Suitable ripple filtering circuits shall be provided to give a smooth DC output. The ripple content shall be limited to less than +/- 1% or less to meet the requirement of battery manufacturer on resistive load.
- 7.4. For VRLA battery, the float charging voltage and maximum float and maximum float charging current shall be limited as per battery manufacturer requirement to avoid over charging.

8.0. DC DISTRIBUTION BOARD(DCDB)

- 8.1. Battery charger shall include a DCDB for distribution of DC supply to various essential loads. DCDB shall be provided with MCCB for incomer & outgoing control. The detailed feeder ratings shall be as detailed at Data Sheet A
- 8.2. DCDB Construction Details:
 - 8.2.1 Switchgear shall be designed in such a way that all component equipment operate satisfactorily without exceeding their respective maximum permissible temperature rises under temperature conditions prevailing within the switchgear cubicles. Reference ambient temperature outside the switchgear cubicles is specified in Data Sheet -A.

- 8.2.2 Ventilating louvers are generally not preferred. If ventilating louvers are considered essential by the Vendor, these may be provided. However, all ventilating louvers shall be of G.I or non-ferrous metal and shall be provided with fine-screened meshes to prevent entry of Vermin.
- 8.2.3 Switchgear shall be provided with two bus bars for positive and negative. Bus bars shall be of uniform cross section throughout the length of the switchgear and up to the incoming terminals of feeder circuit breaker/switch.
- 8.2.4 The material of bus bars shall be as stated in Data sheet A
- 8.2.5 All bus bars, bus taps and joints shall be PVC taped.
- 8.2.6 Positive and negative bus bars shall be completely segregated from each other by sheet steel partition.
- 8.2.7 Bus bars shall be adequately supported and braced to withstand the stresses due to the specified short circuit currents for the associated switchgear. Bus bar supports shall be made of Hylam sheets, moulded plastic material or permali wood.
- 8.2.8 Separate supports shall be provided for bus bar of each polarity. If a common support is provided for both the bus bars, anti-tracking barriers shall be provided.
- 8.2.9 Bus bar joints shall be of the bolted type complete with Belleville washer. Bus bars shall be thoroughly cleaned at the joint locations and suitable contact grease shall be applied just before making a joint.

9.0. MOULDED CASE CIRCUIT BREAKER

- 9.1. Moulded case circuit breakers provided in the battery charger and DCDB shall comply with the requirements of the specification.

10.0. MINIATURE CIRCUIT BREAKERS

- 10.1. Miniature circuit breakers shall be provided in all control circuits in place of HRC fuses. MCB's shall be suitable for DC application and shall comply with the requirements of the specification.

11.0. CONTROL AND SELECTOR SWITCHES

- 11.1. Control and selector switches shall be:
 - i) Of the rotary type with enclosed contacts
 - ii) Adequately rated for the purpose intended (minimum acceptable rating is 10A)
 - iii) Provided with escutcheon plates clearly marked to show the positions.

12.0. INDICATING INSTRUMENTS AND METERS

- 12.1. Electrical indicating instruments shall be of the taut band type with 110-mm square dial and 240° scale.
- 12.2. Indicating instruments shall have provision for zero adjustment outside the cover.
- 12.3. Instrument dials shall be parallax free with black numerals on white dial.

13.0. INDICATING LAMPS

13.1. Indicating lamps shall be:

- a) Of the cluster LED type and of low watt consumption.
- b) Provided with translucent lamp covers of colours 'Red', 'Green' and 'Amber' as specified in Data Sheet-A or Control wiring diagrams

14.0. PUSH BUTTONS

14.1. Push buttons shall be:

- i) Of the momentary contact, push to actuator type, rated to carry 6A at 220V D.C.
- ii) Fitted with self reset NO and NC contacts
- iii) Provided with integral escutcheon plates marked with its function.
- iv) 'Start' push button shall be green in colour.
- v) 'Stop' push button shall be red in colour.
- vi) All other push button shall be black in colour.
- vii) 'Emergency stop' push button shall be of the lockable in the pushed position type and shall be shrouded to prevent accidental operation.

15.0. SPACE HEATERS

15.1. Space heaters shall be:

- a) Suitable for operation on 240 V, single phase, 50 Hz supply.
- b) Provided with rotary type 'ON-OFF' switches, double pole MCB's with overload and short circuit releases on the plain side.
- c) Provided with Humidistat to control the space heater, in order to maintain switchgear interior temperature above the ambient.

16.0. CABLE TERMINATIONS

- 16.1. Suitable double compression type brass cable glands mounted on a removable gland plate shall be provided to support all power and control cables entering the switchgear. Cable glands shall incorporate built-in facilities for earthing the wire armour of cables.
- 16.2. All cable cores shall be adequately supported at regular intervals inside the cable alleys by means of suitable, rubber or PVC lined clamps, up to the respective terminal blocks.
- 16.3. Necessary crimping type of cable lugs for connecting the individual cores to the respective terminals shall be provided.

17.0. INTERNAL WIRING

- 17.1. All wiring inside the switchgear shall be carried out with 1100/650V grade, FRLS PVC insulated, stranded conductor wires. Minimum size of conductor for power circuits is 6 sq. mm aluminium. Control circuits shall be wired with copper conductor wires of 2.5 sq. mm size.

- 17.2. Engraved identification ferrules, marked to correspond with the enclosed wiring diagrams shall be fitted to each wire. Ferrules shall be of yellow colour with black lettering.
- 17.3. All wires forming part of a tripping circuit shall be provided with an additional red ferrule marked 'T'.
- 17.4. Spare auxiliary contacts of all equipment forming part of the switchgear shall be wired up to the terminal blocks.
- 17.5. All wiring for equipment supplied by the Purchaser for which Vendor has to provide cutouts (where indicated in the Data Sheets) shall be provided up to the terminal blocks.
- 17.6. Spare and unassigned modules shall be complete with internal wiring.
- 17.7. All wiring shall be terminated on terminal blocks using crimping type of lugs.

18.0. TERMINAL BLOCKS

- 18.1. All terminal blocks (both for power and control circuits) shall be of the 650V grade stud type, comprising finely threaded pairs of brass studs of at least 6 mm diameter, links between each pair of studs, washers, nuts and lock nuts. The studs shall be securely locked within the mounting base to prevent its turning. Insulated barriers shall be provided between adjacent terminals.
- 18.2. All terminals shall be shrouded. Terminal blocks shall be grouped and suitably segregated depending on circuit voltage. Different voltage groups of terminal blocks shall be segregated.
- 18.3. Terminal blocks shall be adequately rated to carry the current of the associated circuit. Minimum rating of the terminal block shall be 10A
- 18.4. Provision shall be made to insert terminal labels between two successive insulating barriers.
- 18.5. Terminals shall be numbered for identification and grouped according to function. Engraved white-on-block labels shall be provided on the terminal blocks, describing the function of the circuit.
- 18.6. Where duplication of a terminal block is necessary, it shall be achieved by solid bonding links.
- 18.7. Terminal blocks for CT secondary lead wires shall be provided with short-circuiting and earthing facilities.
- 18.8. Terminal blocks shall be arranged with at least 100-mm clearance between two sets of terminal blocks.

19.0. LABELS

- 19.1. All labels shall comprise white letters on a black background.
- 19.2. Labels shall be made of non-rusting metal or 3-ply lamicoid.
- 19.3. Labels shall be properly fixed, with provision to prevent distortion due to expansion.
- 19.4. Sizes of labels and lettering are subject to Purchaser's approval.

20.0. EARTHING

- 20.1. The switchgear shall be provided with an earth bus bar running along the entire length of the board. Material and size of the earth bus bar shall be as specified in Data Sheet-A.
- 20.2. Earth bus bars shall be supported at suitable intervals.
- 20.3. Positive connection between all the frames of equipment mounted in the switchboard and earth bus bar shall be provided by using insulated copper wires/bare bus bars of cross section equal to that of the bus bar or equal to half the size of circuit load current carrying conductor.
- 20.4. All instrument and relay cases shall be connected to the earth bus bar using 1100/650V grade PVC insulated 2.5 sq. mm stranded, tinned copper earthing conductor.

21.0. TESTS

21.1. FACTORY TESTS

All type and routine tests as listed in applicable standards shall be carried out at MANUFACTURER's works

21.2. ACCEPTANCE TEST

Acceptance tests as per applicable standards will also be carried out on the assembled unit at site.

DATA SHEET - A1				
Sl. No	Description		Unit	Data
1.0 GENERAL	1.1	Designation		Dual redundant FCBC with DCDB
	1.2	Number required		No.
	1.3	Type	Separate Float and boost chargers	Composite float cum boost charger
		Composite float cum boost charger		
	1.4	Separate Transformers required for float and boost chargers		Yes/No
	1.5	DC System Voltage		Volts DC
	1.6	Battery	Type	SMF VRLA
		Capacity		Refer Section- 6.10.2
2.0 AC SYSTEM DATA	1.7	Design ambient temperature		°C
	1.8	Location		Indoor
	2.1	Rated voltages, phases and frequency		415V, TPN, 50Hz
	2.2	Variation in supply	Voltage	±%
		Frequency		±5%
	2.3	Type of system earthing		EE
3.0 CONSTRUCTIONAL REQUIREMENTS	2.4	Short circuit level	Current	kA
		Duration		Sec
	2.5	Space heater supply		240V AC
	3.1	Type of mounting (floor/Pedestal/column/wall)		Floor
	3.2	Degree of protection of the cubicle	IP class as per IS	IP 52
	3.3	Sheet Steel	Type	Cold/Hot rolled
3.4		Thickness		mm
		Frame 2mm ; Others 1.5 mm Gland 3mm		
		Cable Entry		Top/Bottom
		Glands/Conduits		Glands
3.5	Purchaser's Earthing conductors	Material		GS
		Size		75 x 10 mm
	3.6	Earthing Bus	Material	Copper
		Size		40 x 6 mm

11.11.2 BATTERY CHARGER AND DCDB DATASHEETS

DATA SHEET - A1					
Sl. No	Description			Unit	Data
	3.7	Colour	Outside Inside		RAL 7032 Glossy White
	3.8	Control scheme & Bill of Material, enclosed	Yes Ref No.		No, to be furnished by Vendor
4.0 DC BUS LOAD	4.1	Momentary			*
	4.2	Emergency			*
	4.3	Continuous			*
	4.4	Float charging current of Battery			*
	4.5	Boost charging current of Battery (Starting and Finishing Rates) (maximum float charging current)			*
	4.6	Maximum time for boost charging of battery			*
		*to be verified with battery vendor and confirmed by Bidder.			
5.0 PERFORMANCE	5.1	Automatic voltage regulator		Yes/ No	Yes
	5.2	Regulation with AVR			+ / - 2%
	5.3	Permissible harmonics at rated continuous load		%	+ / - 3 (total)
	5.4	Minimum permissible power factor at rated continuous load			0.90
	5.5	Permissible ripple at rated continuous load at out put		%	1%
6.0 ACCESSORIES	6.1	Rectifiers			
		type			
	6.2	Rectifier Transformers			
	a)	Type			Dry Type cast Resin
	b)	Number of phases			3
	c)	Insulation class for windings			H

7.0 DCDB SWITCHGEAR PARTICULARS

Designation	Busbar Details			Single Front (SF) Double Front (DF)	Fully drawout (FD) Fixed (F)	Cable Entry Top (T) Bottom (B)
	Amp s	Cu/A 1	DP	SF/DF	FD/ F	T/ B
DCDB		AL	DP	SF	F	B

DATA SHEET-A1**8.0 DCDB FEEDER DETAILS**

Description	Designation	Income Feeders	Outgoing Feeders
			110V DC 16A - 12 Nos.

Sl. No	Description	Unit	Data	
9.0			AC	DC
9.1	Voltage frequency & No. Phases/ poles		TPN	DP
9.2	Rated Operating duty			
9.3	Rated service breaking capacity (Ics)	kA (rms)/DC	65KA	20 KA
9.4	Rated making current	kA (peak)		
9.5	Rated current at site ref. Ambient temperature (in panel rating)	Amps		
9.6	On/Off Operation			
a)	Manual	Yes/ No	Yes	Yes
b)	Power closing device for remote operation	Yes/ No	No	No
c)	Shunt trip	Yes/ No	Yes	Yes
9.7	Release required			
a)	Overload inverse time		Yes	Yes
b)	Short circuit		Yes	Yes
c)	Earth fault	Yes/ No	Yes	Yes
9.8	Accessories required			
a)	Breaker Auxiliary contacts		Yes	Yes
b)	Fault signalling contact for breaker auto trip through releases	Yes/ No	Yes	Yes
9.9	Standards applicable		As per Data Sheet A2	
10.0			AC	DC
10.1	Voltage frequency & No. Of Phases/ poles		As applicable	
10.2	Rated operating duty			
10.3	Rated service breaking current (Ics)	kA (rms)/DC		
10.4	Rated current at site ref. Ambient temperature	Amps		
10.5	Tripping characteristic curve for			
a)	For Lighting & small power application		B Curve	
b)	For UPS Power application		D Curve	
c)	For DC application		D Curve	

				(DCMC B)	
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DATA SHEET - A1					
Sl. No		Description	Unit	Data	
10.0 MCB	10.6	Positive Switch Operated Indication		Require d	
	10.7	Fault signalling contact for breaker auto trip	Yes/No	Require d	
	10.8	Standards applicable		As per Data Sheet A2	
11.0 CONTACTOR				AC	DC
	11.1	Voltage frequency & No. Of phases/ poles		As applicable	
	11.2	Rated Operating duty			
	11.3	Rated current at site ref. Ambient temperature	A		
	11.4	On/Off Operation			
	a)	Auto	Yes/ No		
	b)	Manual	Yes/ No		
	c)	Remote power operated	Yes/ No		
	11.5	Control voltage for coil	Volts		
	11.6	Standards applicable		As per Data Sheet A2	
12.0 EARTH LEAKAGE CIRCUIT BREAKER (RCCB/RCBO)	12.1	Type	RCCB/ RCBO	RCBO	
	12.2	Application			
	a)	For Motor circuits	Yes/ No		
	b)	For Lighting circuits	Yes/ No		
	c)	For other circuits	Yes/ No		
	12.3	Enhanced immunity to unwanted tripping (type 'i') required	Yes/ No		
	12.4	Voltage, frequency & No. Of Phases			
	12.5	Rated operating duty			
	12.6	Rated Breaking capacity at 0.5 PF	kA (rms)		
	12.7	Rated current at site ambient temperature	A		
	12.8	Leakage current setting for protection			
	a)	For human safety	mA	30	
	b)	For Fire safety	mA		
	12.9	Positive switch operated indication		Yes	
	12.10	Applicable standard		As per Data Sheet	

DATA SHEET - A2				
APPLICABLE STANDARDS				
Sl. No	Description	STANDARDS		
01	Switchgear general requirements, contactors, motor starters, Disconnections, switches		IS:13947	
02	AC circuit breakers		IS:13947 Part 2	IEC 60947-2
03	Factory built assemblies of Switchgear and control gear for voltages up to and including 1000V AC & 1200V DC		IS:8623	
04	Air break switches		IS:4064 IS:13947 Part 3	
05	Miniature circuit breakers		IS:13032	IEC-60898
06	Contactors & Starters		IS:13947 Part 4	
07	Control switches/ push button		IS:13947 Part 5	
08	Current transformers		IS:2705	
09	Voltage transformers		IS:3156	
10	Relays		IS:3231	
11	Indicating instruments		IS:1248	
12	Arrangement for busbars main connections and accessories		IS:5578 IS:11353	
13	AC electricity meters		IS:8530,72 2,13010,13 779,11448	
14	Degree of protection		IS:2147	
15	The performance of AC control gear equipment rated up to 600V for use on high prospective fault current system			
16	Code of practice for installation and maintenance of switchgear		IS:10118	
17	Code of practice for phosphating iron & steel		IS:6005 BS:3189	
18	Wrought aluminium & aluminium alloys for electrical purposes		IS:5082	
19	Control transformer for switchgear and control gear for voltage not exceeding 1000V AC		IS:12021	
20	Contactors		IS:2959	
21	Control switches / push buttons		IS:6875	

NOTE: Equivalent IEC standards are also acceptable.

11.12.1 MV SHUNT CAPACITORS

1.0 SCOPE

This specification covers requirements of shunt capacitors for AC power systems having a rated voltage not exceeding 650 Volts.

2.0 CODES AND STANDARDS

2.1 The design manufacture and performance of the shunt capacitors and accessories shall comply with the requirements of the applicable standards and with all currently applicable statutory regulations and safety codes in the locality where the equipment will be installed. Nothing in this specification shall be construed to relieve vendor of the responsibility.

2.2 Equipment shall conform to the latest applicable standards as mentioned in 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 REQUIREMENT

3.1 Rated voltage (U_n)

The rated voltage of the capacitor shall be based on highest system voltage plus voltage rise at the capacitor terminals due to series reactor, harmonics and the capacitor itself.

3.2 Maximum permissible power frequency over voltages

The capacitor units shall be suitable for operation at voltage levels as follows:-

$1.10 \times U_n$ for 12 hours in every 24 hours.

$1.15 \times U_n$ for 30 minutes in every 24 hours.

$1.20 \times U_n$ for 5 minutes.

$1.30 \times U_n$ for 1 minute.

3.3 Maximum permissible current.

3.3.1 The capacitor units shall be suitable for continuous operation at 1.3 times of the rated current.

3.3.2 The capacitor units shall be able to withstand inrush currents up to 100 times nominal current.

3.4 Discharge device.

3.4.1 Each capacitor unit shall be provided with a discharge device for discharging to 50 volts or less from an initial peak rated voltage ($\sqrt{2} U_n$).

3.4.2 The maximum discharge time to 50V (line to line) shall be one minutes or less for both capacitor units and banks.

3.4.3 Discharge circuits shall have adequate current carrying capacity to discharge the capacitor from peak $1.3U_n$.

3.5 Capacitor bank connection

3.5.1 Single phase capacitors shall be provided to form three phase banks.

3.5.2 The capacitor bank shall be connected in single Star or Delta.

3.6 Protection

3.6.1 Capacitor bank protection.

The following protection shall be provided:-

- a) Over current, short circuit and earth fault protection.
- b) Over voltage protection.
- c) Under voltage protection.
- d) Time delay protection against re-switching. In case the capacitor bank trips due to system under voltage, the bank shall not be reenergised within the preset time as stated in data sheet A.

3.6.2 The location of relays for the above protection (switchgear/ capacitor panel) shall be as shown in SLD and/or Data sheet A.

3.7 Temperature rise.

The category of ambient temperature shall be as stated in Data sheet A.

The permissible temperature rise shall be as per applicable standards in accordance with the category of ambient temperature.

4.0 SERIES REACTOR

- 4.1 The capacitor bank shall be provided with series reactor. The rating of the reactor shall be as specified in data sheet A.
- 4.2 The reactors shall either be detuning type, or current limiting type as stated in Data Sheets-A.
- 4.3 The reactor shall be capable of operating continuously at maximum operating voltage as stated in Data Sheet A.
- 4.4 The reactors shall have overvoltage and overload capacity same as the connected capacitor bank.
- 4.5 The reactor shall have linear V-I characteristic over the entire range of operation.
- 4.6 Calculations for sizing the reactor shall be furnished with the bid.

5.0 COOLING SYSTEM

- 5.1 The capacitor banks shall preferably be naturally cooled. If the Bidder considers that forced cooling is necessary to limit the temperature rise of the capacitor banks to be within the specified limits, cooling system with adequate number of fans shall be provided.
- 5.2 Necessary MCCB/MCB, contactors, auxiliary relays, timers etc., shall be provided. Cooler shall automatically start whenever the capacitor bank is switched on. Temperature switch shall be provided for annunciation when temperature inside the panel goes above permissible limits due to failure of fans.
- 5.3 The proposed cooling arrangement for the capacitors and reactors shall be detailed in the bid.
- 5.4 The cooling system shall have adequate standby facility.

6.0 CONSTRUCTIONAL FEATURES

6.1 Capacitor units.

- 6.1.1 Each unit shall be self contained. The unit sizes shall be selected to give the capacitor bank rating as stated in data sheet-A. Other things being equal, larger size units shall be provided.

- 6.1.2 Dry type capacitor is preferred, otherwise the capacitor shall be impregnated with biodegradable, non PCB fluid with high insulation strength. The impregnating material shall not be of such material that must not be dispersed into environment as per statutory requirements.
- 6.1.3 The capacitor shall have very low dielectric losses and partial discharge.
- 6.1.4 The capacitor shall have built in discharge resistor as described in para 3.4 above.
- 6.1.5 The capacitor container shall be constructed from high grade stainless steel or Aluminium and shall be fully welded such that there shall be no risk of leakage. The container shall be provided with a connection capable of carrying the fault current in the event of breakdown to the container.
- 6.2 Series reactor.
- 6.2.1 The reactor shall be dry type with class of insulation as stated in data sheet A.
- 6.3 Capacitor bank
- 6.3.1 The capacitors shall be mounted in MV switchgear or separate capacitor panel as indicated in Data Sheet A1. The switchgear/panel shall meet the specification ~~PCPL 4 S4 153~~ section - 6.6.1 and associated Data sheets.
- 6.3.2 The capacitor bank 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.
- 6.3.3 The capacitor bank shall be complete with the required capacitors along with the supporting post insulators, steel rack assembly, copper busbars, copper connecting strips, fuses, fuse clips, etc.
- 6.3.4 The capacitor bank may comprise suitable number of single phase units in parallel combination.
- 6.4 If specified in Data Sheet 'A', the complete banks with its accessories shall be metal enclosed (in sheet steel cubicle), indoor floor mounting and freestanding type.
- 6.5 The assembly of the bank shall be such that it provides sufficient ventilation for each unit. Necessary louvers shall be provided in the cubicle to ensure proper ventilation.
- 6.6 If called for in Data sheet 'A' cable termination facilities as required, shall be provided at the top/bottom for receiving Purchaser's cable/busbar as mentioned in the Data Sheet A.

7.0 AUTOMATIC POWER FACTOR CONTROLLER

- 7.1 Automatic Power Factor Control (APFC) relay shall be provided when specified in Data Sheet A1.
- 7.2 The capacitor bank in each group shall be auto controlled in optimum combination as required by the system.
- 7.3 The APFC relay shall have adequate number of steps for the proposed capacitor banks plus three spare steps for future addition of capacitor banks.
- 7.4 The APFC relays shall be micro processor based and include the following features:-
 - a) Auto and manual controls.
 - b) True RMS measurements.

- c) Automatic disconnection of Capacitors during over voltages and power failures conditions.
- d) Display of measured power factors and settings.
- e) Local and remote fault annunciations.
- f) RS. 485 port connection (IEC-61850 Protocol on TCP-IP network with CB Open/Close Control functionality) for communication with SCADA.

8.0 TESTS AND TEST REPORTS

The following tests shall be carried out as per applicable standards on the capacitor banks.

8.1 Type tests.

- a) Thermal stability test.
- b) Measurement of the tangent of loss angle ($\tan \delta$) at elevated temperature.
- c) AC voltage tests between terminals and between terminals and container.
- d) Lightning impulse voltage test between terminals and container.
- e) Short circuit discharge test.
- f) Self-healing test.
- g) Ageing test.
- h) Destruction test.

8.2 Routine Test

- a) Measurement of capacitance and output of individual units and capacitor bank.
- b) Measurement of $\tan \delta$.
- c) AC Voltage test between terminals.
- d) AC voltage test between terminals and container.
- e) Test for discharge device.
- f) Sealing test.

8.3 Acceptance test.

The following tests shall be repeated on specified number of samples if specified in Data Sheet A.

- a) Visual examination.
- b) Measurement of capacitance and output of individual units and capacitor bank.
- c) AC voltage test between terminals.
- d) AC voltage test between terminals and container.
- e) Test for discharge devices.
- f) Capacitance loss tangent ($\tan \delta$) measurement.
- g) Sealing test.

8.4 Test reports.

- 8.4.1 All test reports shall be subject to purchaser's approval.

8.4.2 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.

11.12.2 MV SHUNT CAPACITORS DATASHEETS

DATA SHEET - A1				
SI No	Description	Unit	Data	
1.0. GENERAL AND SYSTEM PARTICULARS	1.1 Application/ Designation		APFC panel	
	1.2 Item no.		1	2
	1.3 Rated System Voltage	Volts	415V	
	1.4 Frequency	Hz	50	
	1.5 No. of Phases	No.	3	
	1.6 Type of System Earthing	EE/ NEE	EE	
	1.7 Fault level of the System	kA (rms)	65	
		MVA		
	1.8 Fault withstand time	Sec	1	
	1.9 One minute power frequency withstand voltage	kV	2.5	
	1.10. Ambient temperature	°C	45	
2.0 CAPACITOR BANKS	2.1 Location		Indoor	
	2.2 Mounting Arrangement		Free standing floor mounted	
	2.3. Quantity	Nos	1	1
	2.4 Rated Voltage (Line to Line)	Volts	415	415
	2.5 Rated three phase output at rated system voltage as per item 1.3		765-KVAR 415-Volts	465- KVAR 415-Volts
	2.6 Capacitor Bank Connection	Star/ Delta	Delta	
	2.7 If star connected, mode of neutral connection		NA	
	2.8 Type of Switching	Manual/ Automatic	Both features	
	2.9 If automatic, type of control	Voltage control	Yes/ No	Yes
		Power factor control	Yes/ No	Yes
	2.10 Cooling System		Naturally cooled preferred	
	2.11 Protection		As per clause 3.6.1 of the specification	
3.0 CAPACITOR UNITS	3.1 Type			
	3.2 Maximum permissible power frequency overvoltage		As per clause 3.2 of the specification	
	3.3 Maximum permissible current for continuous operation.		1.3 times of the rated current	
	3.4 Category of ambient temperature and minimum temperature		45 oC / 12 oC	

DATA SHEET - A1

Sl No	Description		Unit	Data
4.0 SERIES REACTOR	3.5	Built in discharge resistor	Yes/ No	Yes as per Bidders recommendation
	3.6	Container		As per clause 6.1 of the specification
	3.6.1	Type		
	4.1	Application		Detuning type
	4.2	Type		Dry type
	4.3	Thermal class of winding insulation		F
	4.4	Magnetic characteristic		
	4.5	Rated Voltage & Frequency		
	4.6	Maximum operating voltage		
	4.7	No. of phases		
DISCHARGE DEVICE	4.8	Reactance in percentage of Capacitance value	%	7%
	4.9	Rated Current	A	Calculation to be submitted for selection of series reactance for each capacitor ratings
	4.10	Winding conductor material		Copper
	5.1	Type		Discharge Resistor
	5.2	Rated voltage		As per Capacitor voltage rating
6.0 CONTACTOR	5.3	Discharge voltage from initial peak voltage of 1.3Un.	Volts	50 Volts or less
	5.4	Maximum Discharge Time	Minutes	1(one)
	6.1	Type		Capacitor duty
	6.2	Application		Switching control of capacitor bank steps
	a)	Capacitor Switching		Yes
	6.3	Voltage, Frequency and Number of Phases		
	6.4	Utilization Category		AC-6b (Capacitor duty)
	6.5	Rated current	Amps	Twice the capacitor bank current
	6.6	On / Off Operation	Manual	Yes/ No
			Automatic	Yes/ No
7.0 APFC RELAY	6.7	Control Voltage		
	a)	Coil Voltage	Volts AC	240 V
	7.1	Automatic Power Factor Control (APFC) relay required	Yes/ No	Yes
	7.2	Relay Type		APFC
	7.3	Features of APFC relay		
	a)	Auto and Manual control	Yes/ No	Yes
	b)	Number Of Steps		
	c)	Display of Power factor	Yes/ No	Yes

DATA SHEET - A1				
SI No	Description		Unit	Data
7.0 APFC RELAY	d)	Display of settings	Yes/ No	Yes
	e)	Over voltage Protection	Yes/ No	Yes
	f)	Protection Against Power Failure	Yes/ No	Yes
	g)	Fault Annunciation	Local	Yes/ No
			Remote	Yes/ No
	h)	h) RS 485 port connection	Yes/ No	(IEC-61850 Protocol on TCP-IP network with CB Open/Close Control functionality)

DATA SHEET - A2		
SI No	Description	Standards
01	Power Capacitors of self healing type for AC power System having rated voltage up to 650 Volts	IS 13340
02	Shunt Capacitors for power system	IS 13925 / IEC-60871
03	Guide for improvement of power factor	IS 7752

11.13.1 Addendum to Earthing & Lightning Protection

ADDENDUM TO DOCUMENT NO: Section 6.13.2

1. **Clause Nos. 4.6:** These clauses are not applicable for this tender.
2. **Clause No.4.12:** In second line in addition to the words wall/column, it may be also read as building/structurs.
3. **Clause No. 5, 5:** This clause is not applicable for this tender.
4. **Clause No.6.3. Sub-Clause Nos. (b) and (c) are not applicable for this tender**
5. **Clause No. 6.4:** This clause is not applicable for this tender.
6. **Clause No. 6.7: Sub-Clause Nos. (f) are not applicable for this tender.**
7. **Clause No. 6.9: This clause is not applicable for this tender.**

11.13.2 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 construed 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-7.1). 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-7.1).
- 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-7.1), 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-7.1) 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 from 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-7.1).

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 trades. 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.

11.13.3 Earthing & Lightning Protection - Datasheets

DATA SHEET - A1				
SL.NO	Description		Unit	Data
1.0 GENERAL	1.1	Type of Soil		As per Site Survey by bidder
	1.2	Soil Resistivity	Ohm-m	As per Site Survey by bidder
2.0 CONDUCTORS BURIED IN EARTH	2.1	Material		Galvanized Steel (GS) / Copper (Cu)
	2.2	Size	mm x mm	50 x 8 (Cu), 75 x 12 (GS)
	2.3	Quantities	Meter	Refer BOQ -Section-7.1 (Minimum) (Bidder shall calculate and specify)
	a)	Required to be supplied	Yes/No	Yes
	b)	Required to be installed	Yes/No	Yes
	2.4	Depth of Burial	mm	600
	2.5	Excavation in earth	Depth Width	mm mm
3.0 CONDUCTORS EMBEDDED IN CONCRETE	2.6	Type of Jointing: Welding/ Braze / CADD Welding		Refer earthing & Lightning Protection Installation notesSection-6.16
	3.1	Material		GS
	3.2	Size	mm x mm	75 x 10, (GS)
	3.3	Quantities	meters	Refer BOQ -Section-7.1 (Minimum) (Bidder shall calculate and specify)
	a)	Required to be supplied	Yes/No	Yes
	b)	Required to be installed	Yes/No	Yes
	3.4	Type of Jointing: Welding / Braze / CADD Welding		
4.0 CONDUCTORS ABOVE GROUND	4.1	Material		GS
	4.2	Size		75 x 10, 50x6 (GS) 16sq.mm. Cu conductor for electronic earthing
	4.3	Quantities	Meters	Refer BOQ -Section-7.1 (Minimum) (Bidder shall calculate and specify)

a)	Required to be supplied		Yes/No	Yes
b)	Required to be installed		Yes/No	Yes
4.4	Special paint or coating required			GI
4.5	Type of Jointing			
a)	At Riser Connection			
b)	At equipment connections			

DATA SHEET - A1

5.0 EARTH ELECTRODES	5.1	Type of Earth Pit			Treated pits complete with chamber as per IS 3043
	5.2	Type of Electrode	GS / MS Rod (See Note 1)		
			CI Pipe		
			GS / MS Plate (see Note 1)		
	5.3	Size of GS / MS Rod	Diameter	mm	
			Length	mm	
	5.4	Size of CI Pipe	Inner diameter	mm	
			Thickness	mm	
			Length	mm	
	5.5	Size of Plate	Length x width	mm x mm	
			Thickness	mm	
6.0 LIGHTNING PROTECTION	5.6	Quantities		Nos	Refer
	a)	Required to be Supplied		Yes/No	
	b)	Required to be Installed			
	6.1	Air Termination Systems			Yes
	6.1.1	Horizontal Roof Conductors	Material		GI / AL
			Size	mm x mm	25x3 GI / ALstrip
			Quantity	meters	Refer BOQ -Section-7.1 (Minimum) (Bidder shall calculate and specify)
	6.1.2	Vertical Rods	Material		
			Size (Dia xLength)		
			Quantity	Nos	Refer
	6.2	Down Conductors	Material		GI / AL
			Size	mm x mm	25x3 GI / AL strip
			Quantity	meters	Refer
	6.3	Special Paint or Coating Required			
	6.4	Test links	Material		
			Details of enclosure		Weather proof FRP
			Quantity	Nos	Refer BOQ -Section-7.1 (Minimum) (Bidder shall calculate and specify)

6.5	Test Link to Earth electrode connection	Material		GI
		Size		25x6 GI strip
		Quantity		Refer
6.6	Treated earth pits complete with chamber as per IS 3043			Requirements are included in clause 5.0
6.7	All materials as per clauses 6.1 to 6.6 are required to be : a) Supplied b) Installed			

DATA SHEET - A1

7.0	RECOMMENDED SIZES OF EARTHING CONDUCTORS FOR MOTORS			NA
	MOTOR RATING (KW)			MATERIAL
7.1				
7.2				
7.4				
7.5				
7.6				
7.7				
7.10				
8.0	NOTES			
8.1	The MS Rod and plate shall have cross sectional area equal to the area of the main earthing grid conductor.			

DATA SHEET-A2**1.0 APPLICABLE STANDARDS**

SL.NO	DESCRIPTION	IS	IEC
1	CODE OF PRACTICE FOR EARTHING	3043	
2	PROTECTION OF BUILDINGS AND ALLIED STRUCTURES AGAINST LIGHTENING	2309	61024/61312 62305
3	ELECTRICAL WIRING INSTALLATIONS (SYSTEM VOLTAGE NOT EXCEEDING 650 V)	732	
4	HOT DIP GALVANISING	2629, 2633	
5	CODES FOR WELDING		
6	GALVANISED ROUND STEEL WIRE	3975	
7	COPPER CONDUCTORS	191,2982	

8	ELECTRICAL INSTALLATIONS IN BUILDINGS		60364
NOTES:			

11.14.1 Addendum to Electrical Contract Works

ADDENDUM TO DOCUMENT No: Section 6.14.2

1. Clause No.3.3: This clause is not applicable for this tender.
2. Clause No.4.9 : These clauses are not applicable for this tender.
3. Clause No.7.0 : These clauses are not applicable for this tender.
4. Clause No. 8.3.8, 8.3.9(h), 8.6.11, 8.7, 8.9, 8.12: These clauses are not applicable for this tender.
5. 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, Battery, Chargers, DCDB, Cables, Busducts, etc., shall be carried out by the CONTRACTOR as part of the installation work. Typical check lists for some of the aforesaid equipment are given in the subsequent clauses.

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).
- 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. The CONTRACTOR shall make his own arrangement for lifting of the equipment when the OWNER'S crane or cranes are not available. 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, valves, 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.

4.8.4 Relay setting calculations shall be carried out and relays shall be set in accordance with the instructions of the OWNER/MANUFACTURER.

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
 - c) Conduit 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).

6.0 EARTHING AND LIGHTNING PROTECTION SYSTEM INSTALLATION

- 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, 6.13 and schedule of prices (Section-7.1).
 - 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 data sheets.
 - c) 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). 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, 6.13) and schedule of prices (Section-7.1).

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 The supply and installation work shall be carried out in accordance with the following specifications:-

- a) Lighting system equipment
- b) Lighting system equipment data sheet
- c) Lighting system Installation work
- d) Lighting system installation work data sheets.
- e) Lighting installation notes
- f) Conduit installation notes

7.4 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).

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 The test results shall be recorded. These shall be reviewed by the authorised person.

8.3 **Commissioning checklist for HV and MV switchgear**

8.3.1 Preliminary checks

- a) Check name plate details of all equipment and devices according to specification
- b) Check for physical damage, cleanliness of internal parts.
- c) Check for tightness of all bolts, clamps and connecting terminals using torque wrench
- d) Check cleanliness of panels, insulators, switchgear
- e) Check proper termination of all power and control cables.
- f) Check earth connections to earth bus for individual equipment/ devices, sheet metal work, hinged doors and earth bus to earth grid.
- g) Check that labels for circuit designation have been put on the front and rear of each cubicle.
- h) Check for proper cable tags and ferrules
- i) Whether breaker can be inserted properly
- j) Breaker contacts should be fixed tightly with fixed contacts

8.3.2 Check withdrawable breaker truck for free movement, safety interlocks, correct operation of shutters.

8.3.3 Check/test each breaker for

- a) Closing and opening operations manually and electrically, local and remote operations if applicable.
- b) Breaker closing and tripping times.
- c) Trip free and antipumping operation.
- d) Electrical and mechanical interlocks.
- e) Operation of spring charging motor, if provided. Correct operation of limit switches and time of charging.

8.3.4 Functional checking of controls, interlocks, protection, instrumentation and status indicating lamps of each incoming, bus coupler and outgoing circuits as per approved schematic drawings.

8.3.5 Test each current and voltage transformer for polarity, ratio, insulation resistance, secondary winding resistance for CTs.

8.3.6 Check/test each relay for:-

- a) Operating characteristics by secondary injection.
- b) Minimum pick up voltage of D.C coils.
- c) Operation of electrical/mechanical targets.
- d) Relay settings and set the relays accordingly.
- e) Check CT and VT connections..

8.3.7 Insulation resistance measurement on

- a) Power Circuits
- b) Control Circuits
- c) Auxiliary Circuits

8.3.8 Functional tests on each motor starter with the specified mode of starting.

8.3.9 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

8.4 Commissioning checklist for busducts

8.4.1 Preliminary checks

- a) Check for Physical damage, cleanliness.
- b) Check busbar fastener tightness of bus joints, terminal connections using torque wrench.
- c) Check busbar fixing insulators for any damage, crack, chipping etc.,
- d) Check CT secondary wiring and fixing support
- e) Check ventilation plug
- f) Check breather
- g) Cleanliness of duct inside enclosure

8.4.2 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)
- d) Check each CT for ratio, polarity, insulation resistance, Secondary Winding resistance.

8.5 Commissioning Check List for Oil Immersed Transformer

8.5.1 Physical Checks

- a) Check name plate details with the approved drawings.
- b) Check for any physical damage, in particular of bushings, cleanliness of bushings, tightness of terminal connection.
- c) Check oil leakage and oil level.
- d) Breathing condition, check whether, breathing line is free, silicate is reactivated.
- e) Check for clearances, particularly in case of bus ducts.
- f) Check earthing of transformer tank, neutral bushing, marshalling box, separately mounted radiated bank etc.
- g) Release air from bushing if applicable (very important) and buchholz relay.
- h) Check the bushing horn gap, if applicable.
- i) Check that the transformer is correctly installed with reference to its phasing.

8.5.2 Carry out commissioning tests as listed under para 8.7 for Transformers.

8.6 Commissioning checklist for Transformer

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 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.

8.6.2 Commissioning checks

- a) Insulation test of windings and polarisation index (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, if OLTC is provided
- f) Measurement of ground clearances from primary terminals
- g) Test the transformer oil for dielectric strength tan-delta, acidity, resistivity and dissolved gases.
- h) BDV testing of insulating oil before and after filtration.
- i) Check for operation of all relays, protection devices and interlocks
- j) Polarity check
- k) Hipot test on 11kV terminations

- 1) Capacitance and tan delta test of condenser type of bushing before assembly, wherever such bushings are provided

8.6.3 Test the transformer for the following

- a) Voltage/turns ratio at all the taps.
- b) Winding resistance at the taps
- c) Short circuit impedance at full winding
- d) Capacitance and tan delta
- e) Vector group.

8.6.4 Current transformer, if any, for ratio, polarity, insulation resistance, Secondary winding resistance.

8.6.5 Line connections as per phasing diagram

8.6.6 Insulation resistance of control wiring

8.6.7 Buchholz relay operation (for alarm and trip)

8.6.8 OLTC control, indicating and alarm circuits if OLTC is provided

8.6.9 Operation test of all protection devices and interlocks.

8.6.10 Calibration of oil and winding temperature indicators.

8.6.11 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.

8.7 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 nameplate details and terminal markings

- b) Check for physical damages
- c) Check for specific gravity during charge and discharge
- d) Check for cell voltage during charge and discharge
- e) Conduct Capacity rest as per IS

8.8.2 Battery charger

- a) Check Nameplate details according to specification.
- b) Check for physical damage
- c) Insulation test of all circuits
- d) Functional check of all controls, alarms and indications etc.,
- e) Measurement of voltage regulation
- f) 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 details as per specification
- b) 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 terminal 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.

8.13 **Checklist for Cabling accessories**

8.14 **Commissioning checklist for SCADA**

11.15.1 Addendum to Cabling System

ADDENDUM TO DOCUMENT No: Section 11.15.2

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."

11.15.2 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 and Data Sheet A. 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 indicated in Data sheet.

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-6.3.2 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:

- Mounting arrangements for cable trays. Any cable trays junction bends, which are non-standard, shall be fabricated as racks to suit installation drawings.
- 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 water proof/fireproof sealing of pipe inserts shall be as per the typical enclosed 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.

11. 16. 1 Addendum to Earthing & Lightning Protection

ADDENDUM TO DOCUMENT NO: Section 6.16.2

8. **Clause Nos. 7.1 (b,c), 7.2, 8.3 :** These clauses are not applicable for this tender.
9. **Clause No.7.5 (a,b,c):** Component sizes shall be as per layout drawaings and BOQ (section-7.1).

11. 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. Min.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

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. Down Comers will be connected to test links by bolted connections.
- 8.4. The lead from test link to Earth electrodes shall have bolted connection at both ends.
- 8.5. Individual Earth electrodes in turn shall be connected to station earthing system by welded joint at grid and bolted joint at electrodes.
- 8.6. The brazing/welding shall be done in accordance with stipulations under clause 4.0.

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 comers 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 comers 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°C. If parallel routing is unavoidable minimum distance of 2m shall be ensured.

10.0 Specific Requirements

- a) 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.

- b) 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°C. If parallel routing is unavoidable minimum distance of 2 M shall be ensured.
- c) Lighting conductors shall not pass through any GS conduit/pipe
- d) All metallic structures within the vicinity of 2000mm in air shall be bonded to the conductors of lightning protection system.
- e) Interconnection with station earth grid, Each earth pit for the lightning protection down comers shall be connected to the station earth grid below grade level.

11.0 SURGE ARRESTORS:

- 11. 1. All important circuits catering to expensive appliances shall be protected by 415/240 V, 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. 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 utilised 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 460 mm 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 2.5 M 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 specified in Data Sheet A2 & 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°C, they shall be heated to about 10°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 75 mm sand at the bottom of the trench and covering it with additional sand of minimum 75 mm 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 meters. 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 TRAYS - CONSTRUCTION:

- 4.1. Cable trays of ladder and perforated types and the associated accessories such as coupler plates, tees, elbows etc., shall be fabricated from 12 gauge (2.5 mm thick) mild steel sheets. Cable tray covers shall be fabricated from 16 gauge perforated (1.60 mm thick) M.S. sheets.
- 4.2. Typical construction details of Cable trays shall be as per drawings
- 4.3. The cable trays shall be supplied in standard lengths of 2500 mm and clear inside widths of trays shall be as follows:
 - a) Perforated type trays: 150, 300, 450 and 600 mm.
 - b) Ladder type trays : 300, 450, 600 and 750 mm.
- 4.4. Cable trays, accessories and covers shall be painted with one shop coat of red oxide zinc chromate primer and two site coats of aluminium alkyd paint for indoor use.
- 4.5. For outdoor use, cable trays, accessories and covers shall be either galvanised or made of aluminium as specifically mentioned in the layout drawings.
- 4.6. For use in corrosive atmospheres both indoors and outdoors, the cable trays, accessories and covers shall be as per note no. 4.5 above.
- 4.7. The spacing of rungs for ladder type of trays shall be 250 mm unless otherwise noted.
- 4.8. All finished cable trays and accessories shall be free from sharp edges, corners, burrs and unevenness.
- 4.9. The details of accessories shown in the enclosed standard drawings are typical and do not cover the entire range of the same. Fabrication of accessories not covered here shall be done with the help of relevant project drawings.

5.0 CABLE TRAY INSTALLATION

- 5.1. The type & sizes of cable trays shall be as indicated in the specification, drawings and BOQ.
- 5.2. Cable trays shall be run in concrete trenches or run overhead supported from building steel, floor slab, pipe rack etc.,
- 5.3. Vertical trays/race ways shall be covered by removable 16 gauge MS/GS sheet covers wherever shown in project drawings.
- 5.4. 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.

6.0 CABLE TRAYS - INSTALLATION:

- 6.1.1. Cable trays shall be installed generally at the elevations shown in respective cable tray layout drawings. If any major modifications in the drawings are envisaged in the field, these should be carried out after getting approval from design office. It shall be the responsibility of the electrical contractor to mark up all the field modifications on the latest issues of the drawings and return two copies of all such "as constructed" drawings to consultants design office for updating the relevant tracings.
- 6.2. Unless otherwise specifically mentioned, all cable tray mounting works shall be carried out as per dwgs.
- 6.3. When cable trays are used in trenches and tunnels, the carrier structure for mounting the trays shall be supplied and installed as per drawings
- 6.4. The type and size of tray to be used shall be as mentioned in the individual layout drawings.
- 6.5. The maximum size of cable tray when used in trenches and tunnels shall be of 600 mm width.
- 6.6. Cable trays shall be welded to the mounting/carrier structures.
- 6.7. Vertical trays (raceways) and all outdoor cable trays shall be provided with removable 16 gauge painted M.S. perforated sheet covers wherever shown in Project drawings/ BOQ.
- 6.8. Each continuous laid out length of cable tray shall be earthed at minimum two places by M.S. flats of minimum size 25x3 mm (unless otherwise noted) to the purchaser's earthing system. The distance between earthing points shall not exceed 10 metres.
- 6.9. All cable trays and vertical cable raceways shall have identification designation, as per drawings, painted at each end of the tray and raceways. For long lengths of trays, the identification shall be painted at intermediate points also.
- 6.10. The following shall be checked before laying the cables on trays.
 - a) Check for proper painting and identification nos. of the trays.
 - b) Check for continuity of cable trays over the entire route.
 - c) Check that all sharp corners, burrs and waste materials have been removed from the tray.
- 6.11. Obtain clearances from piping contractor/ engineer that no piping will be taken in the way of cable trays.
- 6.12. Check for earth continuity & earth connection of cable trays.

- 6.13. The type & sizes of cable trays shall be as indicated in the specification, drawings and BOQ.
- 6.14. Cable trays shall be run in concrete trenches or run overhead supported from building steel, floor slab, pipe rack etc..
- 6.15. Vertical trays/race ways shall be covered by removable 16 gauge MS/GS sheet covers wherever shown in project drawings.
- 6.16. 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

7.0 CABLES IN TRAYS/ON RACKS:

- 7.1. 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.
- 7.2. Control cables shall be run in a separate tray, similarly, Instrument cables shall be run in a separate tray.
- 7.3. 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 Core 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 and so on.
 (1) (2) (3) (4)

- 7.4. 1100V grade power cables of 120 mm² 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.
- 7.5. Smaller 1100V grade power cables below 120 mm² may be run in double layers, where required, due to space restrictions.
- 7.6. Control and instrumentation cables can be laid unto a minimum of three layers in each tray/rack.
- 7.7. 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.
- 7.8. Instrumentation cables shall be run in perforated type cable trays.

8.0 BENDING RADII FOR CABLES:

- 8.1. 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	Multi-core Un-Armoured
a) XLPE insulated up to	11 kV	20D	15D	15D
b) XLPE insulated up to	22 kV	20D	15D	15D
c) XLPE insulated	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 V	-	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).

- 8.2. The above values may be reduced to 70% when making only one bend such as in case of installing an end termination.

9.0 TERMINATION, CLAMPING AND MISCELLANEOUS DETAILS

- 9.1. 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.
- 9.2. Identification tags made from aluminium sheet shall be attached to each end of each cable by means of GI binding wire as shown on drawing. Tags shall be additionally put at an interval of 30 meters on long runs of cables and in pull boxes.

9.3. **Cable glands**

- 9.3.1. The cable glands shall be made from solid drawn brass rods, machined for smooth finish, Cadmium, Nickel plated and passivity to protect against corrosion.
- 9.3.2. Cable glands for armoured cables shall be double seal cone grip compression (**Double compression**) type unless otherwise stated in Data Sheet A1. The cone and clamping ring for armour shall be suitable to accommodate armouring wire/strip/tape.
- 9.3.3. Cable glands for unarmoured cables shall be single seal compression type similar to above but without the cone and clamping ring for the armour.

9.4. **Cable lugs**

- 9.4.1. Cable lugs shall be tinned copper for both Copper and Aluminium cables. For Aluminium cables, bi-metallic paste shall be applied.
- 9.4.2. All cable terminations shall be soldering 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.
- 9.5. 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.
- 9.6. 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 3mm 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.
- 9.7. 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.

10.0 **CONDUIT AND PIPE INSTALLATION**

- 10.1. All conduit/pipe sleeves shall be sealed at both ends against ingress of water after the cables have been pulled.
- 10.2. All conduit/pipes sleeves shall be extended at least 50 mm on both sides of wall/floor/ceiling.
- 10.3. Exposed conduit/pipe runs shall be adequately clamped at an interval of 2 metre.
- 10.4. All installed conduits/pipes shall have their ends temporarily closed by caps or other approved means until cable in pulled.
- 10.5. 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.
- 10.6. GI pull wires of adequate size shall be laid in all conduits before installation.
- 10.7. 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.
- 10.8. Conduits embedded in floor shall have a minimum 50 mm concrete cover.
- 10.9. The internal area of the conduit/pipe, unless otherwise specified, shall be two and half times the total area of cables to be laid through the conduit/ pipe.

11.0 TESTING AND COMMISSIONING OF CABLES

11.1. 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:

<u>Voltage grade of cable</u>	<u>Meggar rating</u>
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

11.2. High Voltage Testing

11.2.1. All cables of 1.1kV grade 400 mm² 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 6 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.

11.2.2. 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.

11.2.3. In each test, the metallic sheath/screen/armour should be connected to earth.

11.3. 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.

12.0 EARTHING

12.1. Earthing of cables

12.1.1. Metallic sheaths, screens and armour of all multicore cables shall be earthed at both equipment and switchgear end.

12.1.2. 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 such as cross bonding may have to be adopted to safeguard against the presence of standing voltages under normal as well as fault conditions.

12.1.3. Earthing of power cable with core balance CT shall be as shown in the drawing.

12.2. Earthing of CT neutral lead shall be at one end only, as indicated in respective control wiring drawings.

12.3. 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.

12.4. 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.

13.0 PAINTING

- 13.1. 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.
- 13.2. 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.

14.0 DATA TO BE FURNISHED BY THE CONTRACTOR AFTER AWARD OF CONTRACT

- 14.1. 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.
- 14.2. Test certificates of cables tested at site.
- 14.3. Catalogue/material specification of the type of fireproof compound used.

11.18.1 SUPERVISORY CONTROL AND DATA ACQUISITION SYSTEM (SCADA)

1.0 Software - General:

1.1 Furnish a dedicated, edge control, software platform (The Software Platform) that is purpose-built to be the operational interface for a Energy and Power Management and Control System whose primary purpose is to support the provision and management of safe, reliable and efficient power within buildings and facilities. The Software Platform shall have specialized data acquisition, visualization, analysis and reporting tools specifically designed for Power Management applications such as:

- Source and Network Control.
- Electrical Distribution System Monitoring and Alarming.
- Electrical System Capacity Management.
- Power Quality Monitoring and Compliance.
- Multi Source Management.
- Continuous Electrical Thermal Monitoring.
- Breaker Setting Monitoring.
- Backup Power Testing.
- Power Events Analysis.
- Energy Usage Analysis and Energy Benchmarking.
- Utility Bill Verification and Cost Allocation.
- Energy Performance Analysis and Verification.
- Active Arc Flash Protection.

1.2 The Software Platform shall natively support (no additional installation or configuration of the software required) at least 80 devices specifically designed for power distribution and power quality monitoring including: programmable power analysers, power meters, branch and multi-circuit meters, protection relays, electrical distribution thermal sensors.

- All registers shall be pre-mapped to standard measurement names - no additional register mapping required.
- All native device types have been factory-tested and proven to perform.

1.3 The Software Platform shall be certified as part of an Energy Data Management System according to the sections of the following ISO standards:

- ISO 50001
 - Energy review
 - Energy baseline
 - Energy performance indicators

- Monitoring, measurement, and analysis
- Input to management review
- ISO 50002
 - Data collection
 - Measurement plan
 - Analysis
 - Energy audit reporting
- ISO 50006
 - Obtain relevant energy performance information from the energy review
 - Identify energy performance indicators

1.4 The Software Platform shall follow secure product development lifecycle practices as defined by IEC62443-4-1 as well be certified to the IEC62443-4-1 standard.

1.5 The Software Platform shall be certified to comply at the component level with cybersecurity standard IEC62443-4-2 at Security Level 2.

1.6 The Software Platform supports compliance with cybersecurity standards IEC62443-2-4 and IEC62443-3-3.

1.7 The Software Platform shall be designed to streamline the process of checking and maintaining EN50160 and IEEE 519 Power Quality compliance.

1.8 The functionality of the Software Platform shall be extensible whereby additional capabilities may be added via software license activation codes without the need to install additional software modules or add-ons.

1.9 The Software Platform shall natively support the vendor's active arc flash protection system with the ability to detect and then distinctively indicate, classify and display alarm information as an arc flash alarm.

2.0 Software - Real Time Monitoring and Control:

2.1 The Software Platform shall have a graphical monitoring and analysis application with support for custom graphics/images for the purposes of:

- Creating graphical diagrams of the Power Monitoring system, including electrical one-line diagrams, facility maps, plan views, floor layouts, equipment representations, and mimic displays.
- Displaying electrical network status through real-time electrical one-line diagram animation based on a tag value expression.
- Monitoring complex auto-transfer schemes in real time.

2.2 The Software Platform shall be capable of writing to device registers for operations such as resetting, triggering, toggling, switching, manual waveform capture, controlling remote devices, equipment and circuit breakers for power management applications such as Source and Network Control and Multi Source Management.

2.3 The Software Platform shall have a web-enabled, real-time tables application that provides interactive side-by-side visualization of real-time measurements.

2.4 The Software Platform shall have a power monitoring trending application with graphical charts for real-time trending of power usage (kW, Volt, Amp, and kWh) or any measurement supported by metered equipment such as generators and MV/LV switchgear.

2.5 The Software Platform shall support the following as it relates to graphical monitoring:

- HTML5 enabled graphics.
- Graphics should resize based on whatever monitor or viewing device is being used.
- Ability to automatically display additional graphics and graphic details as operators zoom in.
- It shall be possible to use JavaScript to customize the behavior of each graphic.
- The Software Platform graphics editor shall be able to import Scalable Vector Graphics (SVG) technology.
- A built-in library of ANSI and IEC Power graphics symbols shall be provided with the Software Platform.
- Operators must be able to change from one graphic to another by selecting an object with a mouse - no menus will be required.
- It shall be possible to create and save graphical components and JavaScript code in reusable and transferrable, customized libraries.
- The ability to have multiple instances of a graphic and edit one instance to change all.
- Ability to import .gif, .png, .bmp, .jpeg, .tif, and CAD generated picture files as background displays, and layering shall be possible.

2.6 The Software Platform shall support arc flash protection devices with a built-in set of real-time graphical indicators for use in electrical one-line diagrams that indicate occurrence of arc flash incidents.

2.7 The Software Platform shall continuously monitor the health status of the arc flash sensors and the sensor's interconnection between different devices. In case of bad health state the operator shall receive an alarm in the Software Platform.

3.0 Software - Alarm and Event Analysis and Notification:

3.1 The Software Platform shall have a mechanism to create standard, user-defined alarm hierarchy views that fit user defined criteria.

3.2 The Software Platform shall support the following as it relates to alarm performance:

- Maximum 10s response time from event capture in a device and display in the software alarm viewer.
- Retrieve and display timestamped alarms directly from devices that support onboard alarm logging.

- Retrieve and display timestamps to 1ms resolution from devices that support 1ms timestamp resolution.
- Create PC-based alarms to 1ms resolution from reading device values.
- Multiple alarm types, including: Timestamped, Digital, Analog, Advanced, Multi-Digital, Timestamped Digital, Timestamped Analog.

3.3 The Software Platform shall have a mobile alarm notification component that will use the native high availability, hot-standby failover redundancy of the platform, not its own separate redundancy mechanism.

3.4 The Software Platform shall provide a web based power events analysis application that includes but is not limited to the following features:

- Automatic, intelligent clustering of events into alarms and multiple alarms from multiple devices into “incidents” to simplify the analysis of multiple cascading events.
- Automatic categorization of alarms and incidents into predefined categories such as Arc Flash and Other.
- Predefined views for events, alarms and incidents with intuitive navigation and easy to use, configurable filters based on priority, status, source and categories.
- Popup window with detailed information about where, what and when an alarm or incident happened and a thumbnail summary view of all waveforms associated with the alarm or incident.
- For Power Quality alarms or incidents captured by Disturbance Direction Detection (DDD) compliant devices there shall be clear graphical indication of the direction of the disturbance (upstream or downstream relative to the DDD compliant device).
- Percentage impact of load lost due to power event to allows for faster prioritization of alarms most impacting system

3.5 The Software Platform shall provide a graphical timeline view of alarms and events that constitute an “incident” in the electrical distribution network. The timeline view shall:

- Display alarms/events stacked by order of time for sequence of events analysis.
- Display the start and end of alarms/events with color-coded dots.
- Indicate if there are captured waveforms associated with the incident.
- Have a configurable analysis window with a color-coded time slider that uses color to indicate areas in the timeline where there are greater numbers of alarms.

3.6 The Software Platform shall include a web-based Smart Waveform Analyzer interface with the following capabilities:

- Toggle on/off Voltage/Current channels.
- RMS calculation, zoom, pan, export to CSV.

- Interactive phasor and harmonic (voltage and current) diagrams.
- Allow multiple waveforms to be compared to each other.
- Support for waveforms in COMTRADE format (IEEE Std C37.111-1999 and C37.111-2013)

3.7 The Software Platform shall include an alarm annunciator to display the total number of unacknowledged alarms with a breakdown of how many are high, medium and low priority and shall allow easy navigation to the alarm viewer with a single click.

3.8 The Software Platform shall be able to acquire specialized, high speed power disturbance data directly from onboard advanced power quality meters for the purpose of Power Events Analysis, including:

- Timestamped Power Events with Disturbance Direction Detection (DDD).
- Pre/post event waveform captures (Voltage and Current all phases).

3.9 The Software Platform shall automatically perform analytics upon captured waveforms and when possible provide natural language description of the likely cause of the Power Quality event to the operator.

4.0 Software - Data Analytics and Visualization:

4.1 The Software Platform shall include an interactive, web-based Dashboard application that provides auto-updating dashboard views that may contain not only energy and power data but water, air, gas, electric, and steam (WAGES), historical data trends, power quality, images, and content from any accessible URL address.

4.2 Users shall be able to create, modify, view, and share their dashboards (including graphics, labels, scaling, measurements, date ranges, etc.) using only a browser and without the need for a separate software application to design, create, modify or publish dashboards.

4.3 The Software Platform shall support kiosk slideshow displays by assigning individual dashboards to slideshows to run in unattended mode, scrolling through designated dashboards at a configurable time interval.

4.4 Any number of kiosk slideshow displays may be created and configured to run independently on any computer using a browser.

4.5 The Dashboard application shall provide a library of standard graphical objects (gadgets) including Bar, Pie, Trend, Real Time and Web Portal

4.6 The Dashboard application shall provide a library of specialized energy usage graphical objects (gadgets) including Period Over Period Comparison, Pareto Charts, Heat Map / Carpet Plot and Sankey Diagrams.

4.7 The Dashboard application shall provide a library of specialized Power Quality graphical objects (gadgets) including PQ Downtime Impact, PQ Rating, PQ Incident Breakdown and Location.

4.8 The Software Platform shall provide an interactive, web-enabled Reports application that allows users to generate, modify, save and manage reports based on pre-formatted report templates (up to 64 templates) that are designed to support the following:

- Energy Billing, Verification and Allocation.
- Energy Management and Performance.
- Power Quality Performance and Compliance (EN50160 and IEEE 519).
- Electrical Equipment Operation and Performance (Breakers, UPS's and Generators).

4.9 The reporting tool shall support automatic distribution (via email or shared folder) on a schedule basis or based on event or manual export using the following output formats: .csv, .xlsx, .pdf, .tiff, .html, .xml.

5.0 Software - Technical Infrastructure:

5.1 The Software Platform shall be able to be installed on a physical computer or virtual machine and shall support a variety of Windows operating systems including Server and non-Server class Windows operating systems.

5.2 The Software Platform shall be developed and designed to help secure power monitoring and control operations and comply to cybersecurity policies by adhering to the following:

- Must follow Secure Development Lifecycle product development processes.
- Minimum of two-factor authentication.
- Two-factor or multi-factor authentication does not require Internet access and may be used on an isolated network.

5.3 The Software Platform shall be able to operate in a network environment with configurable firewalls that perform deep packet inspection for Modbus communications.

5.4 The Software Platform shall support the following cybersecurity features:

- Encrypt the transmission of data between the Software Platform Server and its Web Clients using Transport Layer Security (TLS) version 1.3.
- Establish secure authentication between the Software Platform Server and its Web Clients using Certification Authority (CA) certificates.
- Encryption and hashing of system credentials using AES256 and SHA-512 respectively.
- Capable of installing into a Federal Information Processing Standard (FIPS) compliant environment.
- Application Whitelisting.
- Encrypt the transmission of data between the Software Platform primary node and secondary node using Transport Layer Security (TLS) version 1.3.
- Security events in SYSLOG format
- Digitally signed files to allow for verification of authenticity of installed software

5.5 The Software Platform shall support the integration of Windows Active Directory for users and groups from across multiple domains to facilitate the following:

- Login to the Software Platform using Windows credentials.
- Enforce password policies via Windows (complexity and expiration).
- Role-Based Access Control (RBAC).

5.6 The Software Platform shall support definition and mass deployment of Role-Based Access Control (RBAC) settings for the software itself and connected devices in the system.

5.7 The Software Platform shall be able to log up to 100,000 tags of historical data at a 1-minute interval and store this amount of data for up to 2 years.

- The historical 1-minute interval data shall be accessible to the user in a web interface via the following reports that can be formatted as XML, Excel, Word or PDF documents: Single Device Usage, Multi Device Usage, Trend and Tabular reports.

5.8 The Software Platform shall intelligently and automatically acquire data from devices, including onboard events, trends and waveforms from natively-supported device types:

- Without any need for software configuration or data upload scheduling.
- Onboard, high resolution timestamps (1ms) shall be retrieved without degradation or modification even for devices that support clock synchronization via GPS, IRIG-B, NTP or PTP (Precision Time Protocol).
- Timestamp Quality status shall be retrieved directly from devices that support this data quality attribute.

5.9 The Software Platform shall support device-level Modbus integration with the following capabilities:

- Dynamic scaling of register values and not require a separate scaling register to perform value scaling for power and energy data.
- Modbus master to read/write registers in Modbus devices for monitoring and control applications.
- The software shall be capable of Modbus device definition (device drivers) creation to enable integration of third-party Modbus protocol devices.

5.10 The Software Platform shall support a specialized diagnostics user interface designed for power management that shows all power devices, automatically highlighting errors and potential causes of under performance.

5.11 The Software Platform shall support OPC AE Server alarm and event data sharing applications amongst OPC AE systems.

5.12 The Software Platform shall support OPC DA Server 2.01 with the following capabilities:

- Provide default OPC Server tag mappings for all natively supported device types without the need to select, configure, or program the mapping of device registers to OPC tags.
- Provide a flexible means to add or change OPC mappings and shall support the ability to add custom measurements.

5.13 The Software Platform shall support OPC DA Client 2.01 real-time data interoperability.

5.14 The Software Platform shall support OPC UA Client 1.01 for data sharing between OPC UA compliant systems.

5.15 The Software Platform shall support ability to integrate other web applications into its web interface via use of pluggable web content widgets.

5.16 The Software Platform's Reporting and Dashboard web applications shall be simultaneously accessible from their own individual web addresses so that they may be embedded in other web-based software environments.

5.17 The Software Platform shall support Web Services interoperability with the following capabilities:

- Web Services Server for sharing real-time, historical (i.e. timestamped trend data), and alarm data (i.e. timestamped event strings) from the Software Platform to other Web Services Client applications.
- User interface for Web Services configuration and mapping.
- Provide the ability to acknowledge alarms by authenticated and authorized clients.

5.18 The Software Platform shall have an Extract, Transform, and Load (ETL) engine for exchanging data between files, databases and systems with the following capabilities:

- User Interface for specifying connection information, data formats, measurement mappings and schedules.
- Support for importing data from .csv and .xml data files, Wonderware Historian databases and other 3rd party databases via OleDb connections.

5.19 The Software Platform shall function without disruptions (including communications, logging, and alarming) in the following ways:

- Software components can be installed and available on both primary and secondary nodes.
- Software components on the secondary node are up but will not process data or requests to avoid double polling of connected devices.
- Data is mirrored in near real time and both nodes will have identical data. Data replication is done through the software's capabilities and provides a recovery time of a few seconds automatically in case of the primary node being unavailable.
- The software shall provide the ability to achieve up to eight times device redundancy per connected device.

- Historical data shall be synchronized and backfilled in a data historian following a primary node failover recovery.

5.20 The Software Platform shall have a single, end user software application specifically designed for integrating Modbus, IEC 61850 Ed1, IEC 61850 Ed2, IEC 60870-5-104 and DNP3 device types and shall have the following capabilities:

- Simple creation and management of device definitions (device drivers).
- Pre-defined, default measurement system (Common Data Model) for consistent mapping of Modbus, IEC 61850, IEC 60870-5-104 and DNP3 tags to standard measurements.

5.21 The Software Platform shall allow integration of IEC 61850, Modbus or IEC 60870-5-104 devices via an import of System Configuration Document (SCD) file compliant with IEC 61850-6 standard.

5.22 The Software Platform shall support offline software configuration management for efficient system deployments and upgrades.

5.23 The Software Platform shall support internationalization and regional settings.

5.24 The Software Platform shall provide factory support for the following languages: English

5.25 The Software Platform supplier shall make self-paced training content and documentation accessible over the Internet. This training and documentation will outline how to configure and operate the Software Platform.

11.19 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


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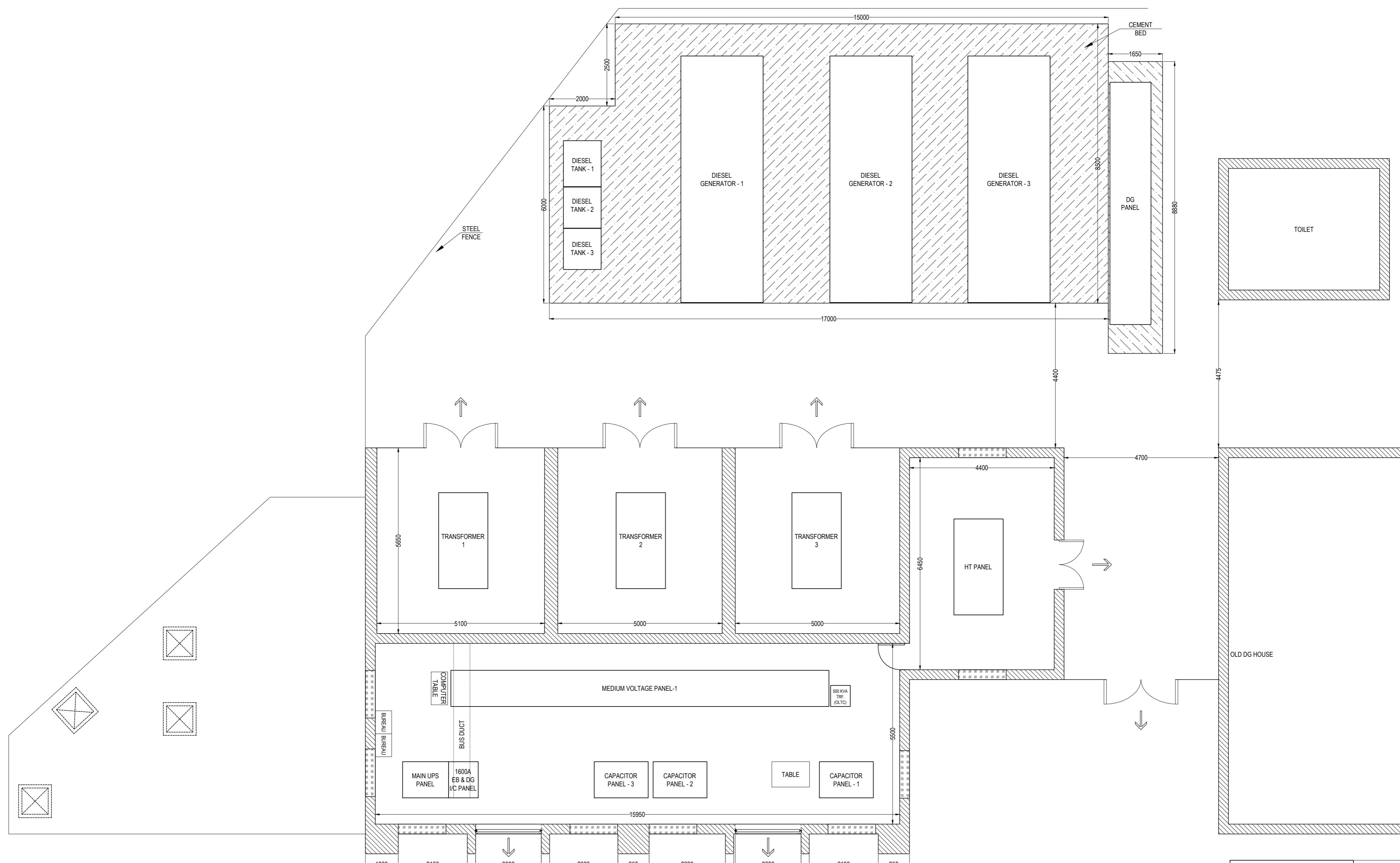
NAME

DESIGNATION

COMPANY

DATE





FOR TENDER PURPOSE EXHIBIT - 2

NOTE :

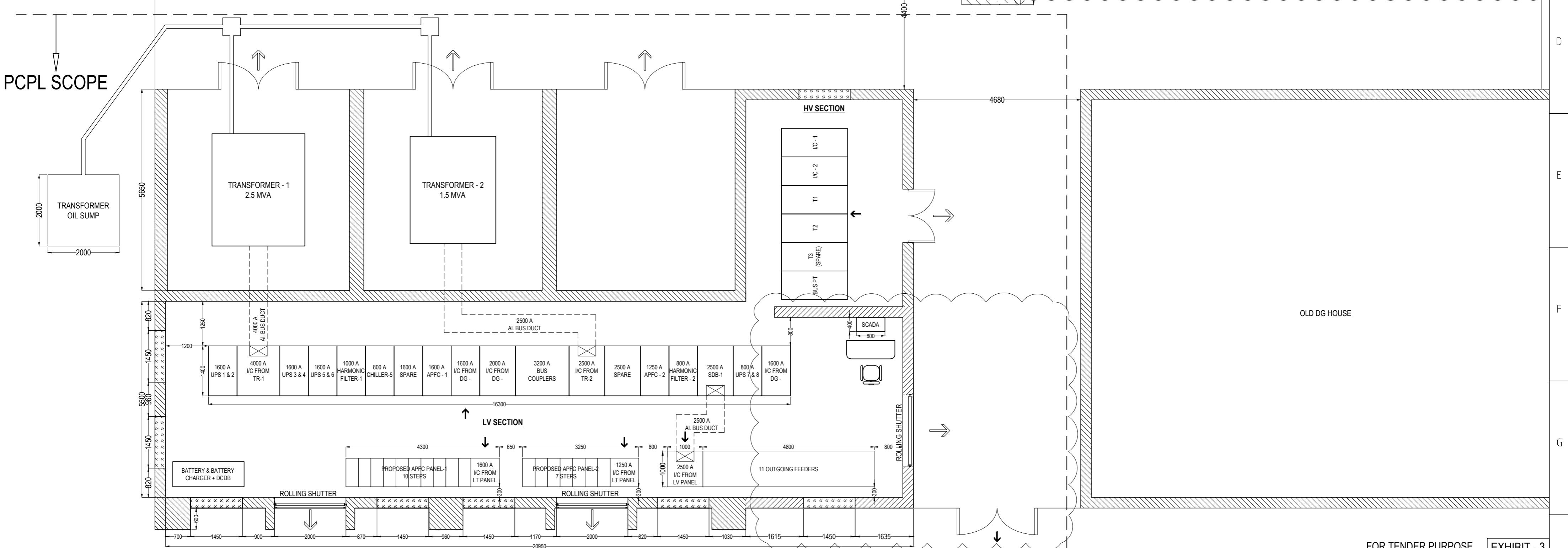
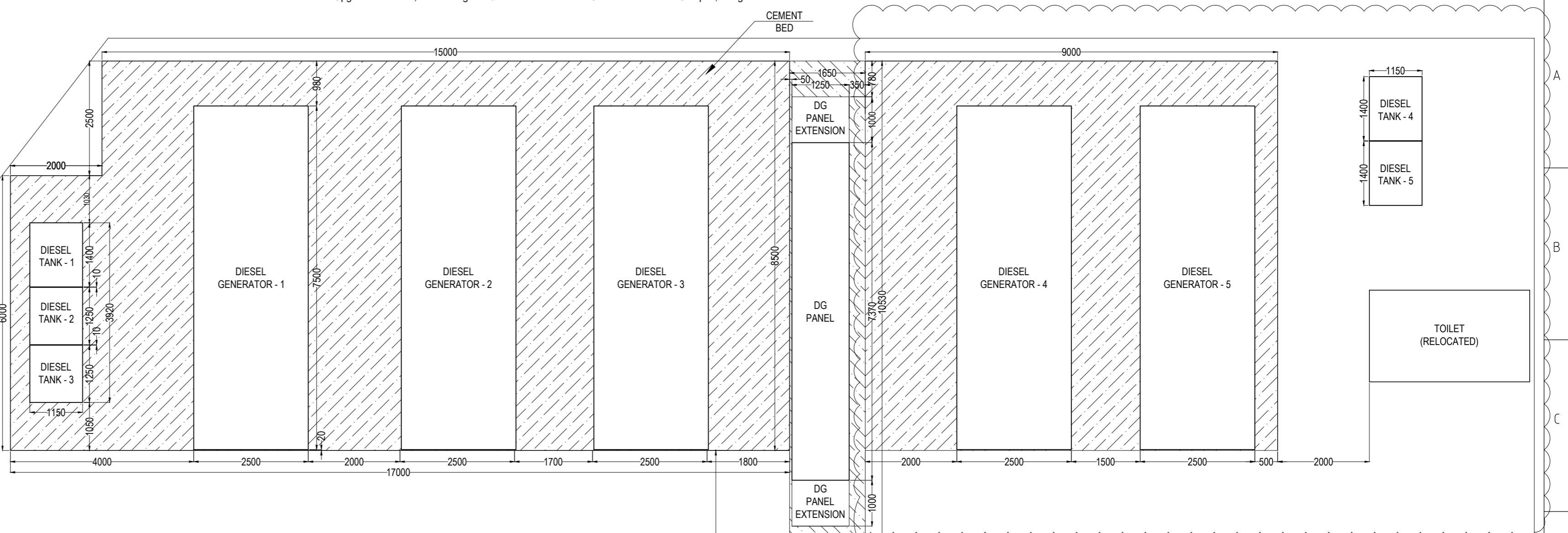
1. Drawings issued are for Bid Purpose only.

Contractor

ISSUE	REVISIONS	BY	CKD	APPD	DATE	CLIENT
PO	ISSUED FOR CONCEPT NOTE	ADS	PAS	R.V	20.04.21	M/S. INDIAN INSTITUTE OF SCIENCE, SERC
						PROJECT : UPGRADATION OF HV/LV SWITCHGEARS & TRANSFORMERS
						SCALE : 1 : 75
						DATE : 19.11.20
						DRAWN : ADS
						CHKD : PAS
						DRAWING NO : PCPL-2013-4-GA-001
						APPD : R.V
						JOB NO. : 2013 DATE: 28.10.20 REV: PO 01 OF 01
						CONSULTANT : POET CONSULTANTS PVT LTD., BANGALORE



Upgradation of HV, LV Switchgears & Transformers in SERC Substation at IISc Campus, Bangalore



NOTE ·

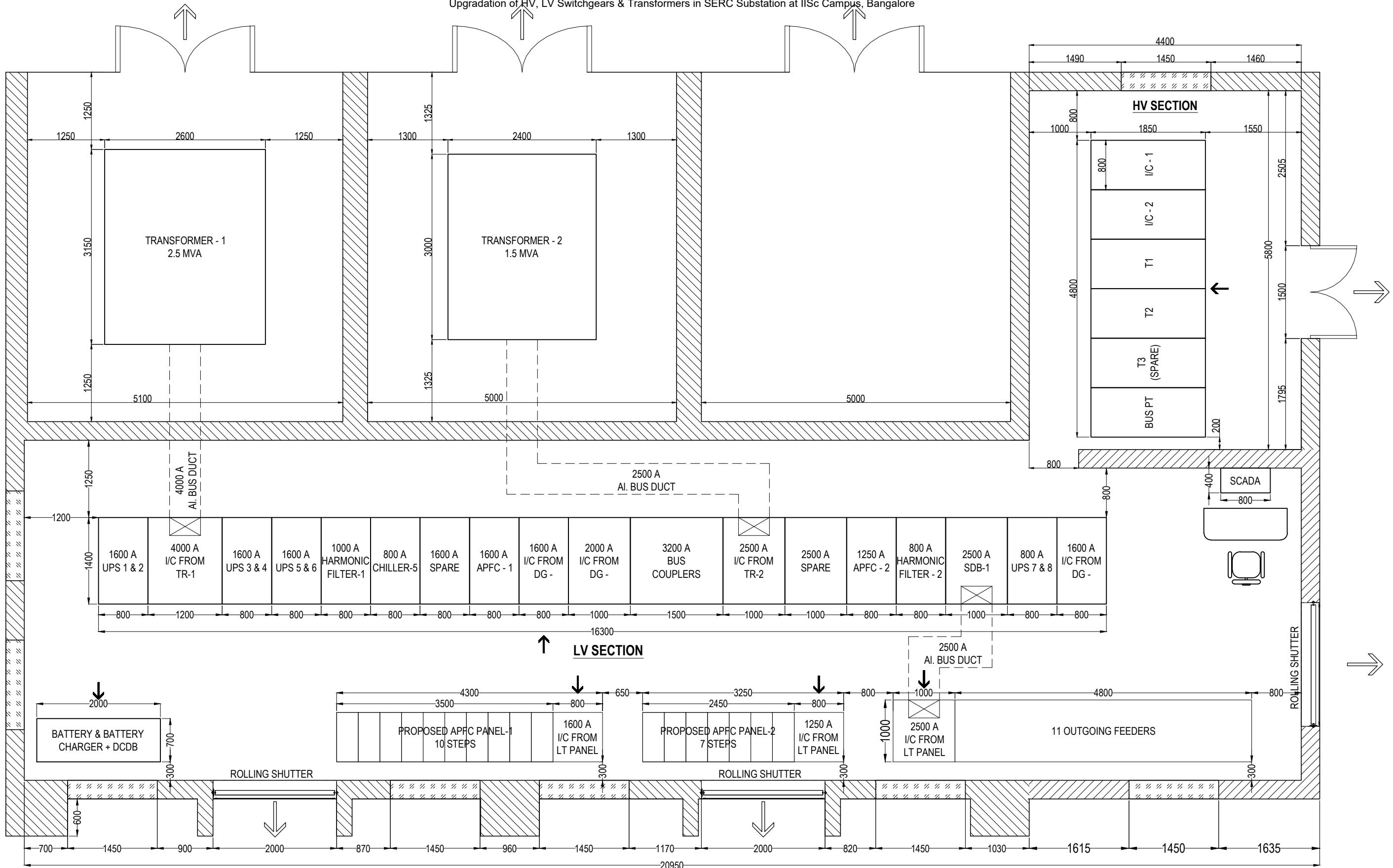
NOTE :

1. Drawings issued are for Bid Purpose only.
2. Clouded part in the GA shows the proposed extension of existing room.
3. Dimensions shown here is tentative and may change during the actual construction

Page 326 of 342

ISSUE	REVISIONS	BY	CKD	APPD	DATE	CLIENT : M/S. INDIAN INSTITUTE OF SCIENCE, SERC	H	
PO	ISSUED FOR CONCEPT NOTE	ADS	PAS	R.V	20.04.21	PROJECT : UPGRADATION OF HV/LV SWITCHGEARS & TRANSFORMERS		
						SCALE : 1 : 75		TITLE: GENERAL ARRANGEMENT PROPOSED KEY PLAN
						DATE : 19.11.20		
						DRAWN : ADS		
						CHKD : PAS	DRAWING NO : PCPL-2013-4-GA-002	
						APPD : R.V	JOB NO.: 2013 DATE: 28.10.20 REV: PO	
						CONSULTANT : POET CONSULTANTS PVT LTD., BANGALORE	SHEET NO. 01 OF 01	

Upgradation of HV, LV Switchgears & Transformers in SERC Substation at IISc Campus, Bangalore



Note :

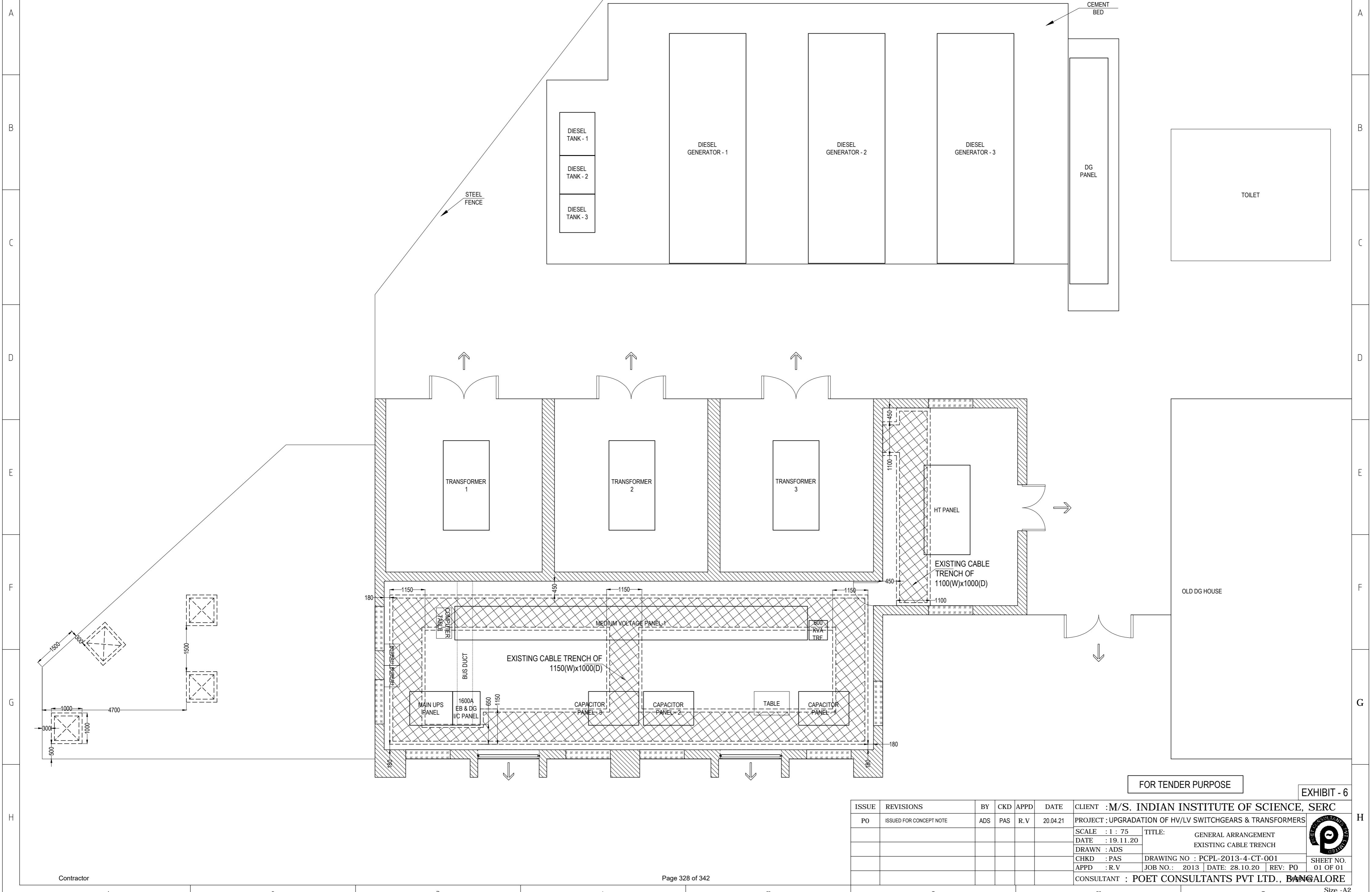
Note :

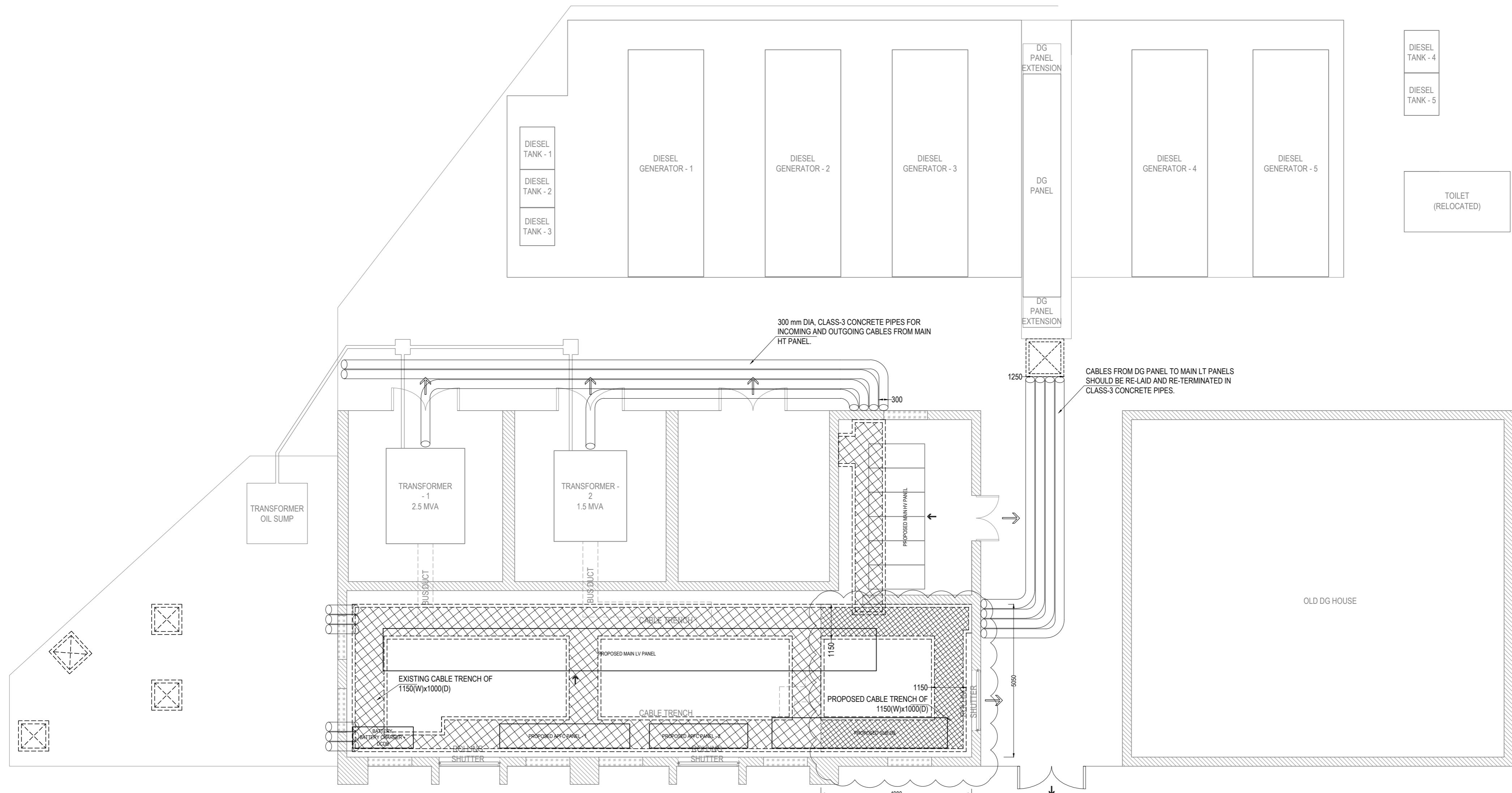
1. Drawings issued are for Bid Purpose only.
2. Dimensions shown here is tentative and may change during the actual construction
Contractor.

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FOR TENDER PURPOSE **EXHIBIT - 4**

ISSUE	REVISIONS	BY	CHKD	APPD	DATE	CLIENT : M/s INDIAN INSTITUTE OF SCIENCE	
PO	ISSUED FOR CONCEPT NOTE	ADS	PAS	R.V	20.04.21	PROJECT : UPGRADATION OF HV,LV SWITCHGEARS & TRANSFORMERS	
						SCALE : 1 : 60	TITLE: GENERAL ARRANGEMENT PROPOSED LV, HV AND TRAFO. SECTION
						DATE : 19.11.20	
						DRAWN : ADS	
						CHKD : PAS	DRAWING NO : PCPL-2013-4-GA-003
						APPD : R.V	JOB NO.: 2013 DATE: 13.11.20 REV: PO
327 of 342						CONSULTANT : POET CONSULTANTS PVT LTD., BANGALORE	SHEET NO. 01 OF 01





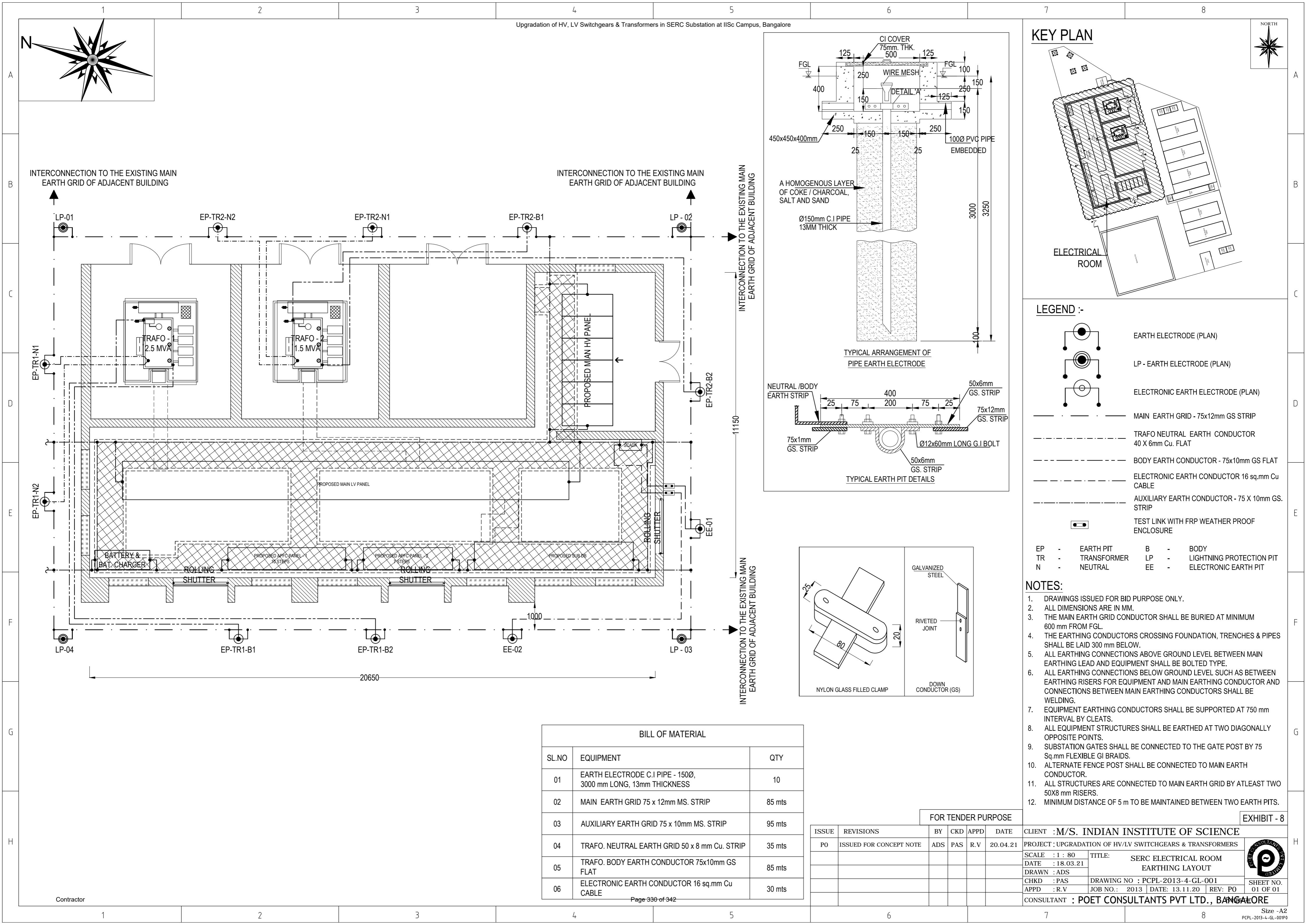
FOR TENDER PURPOSE

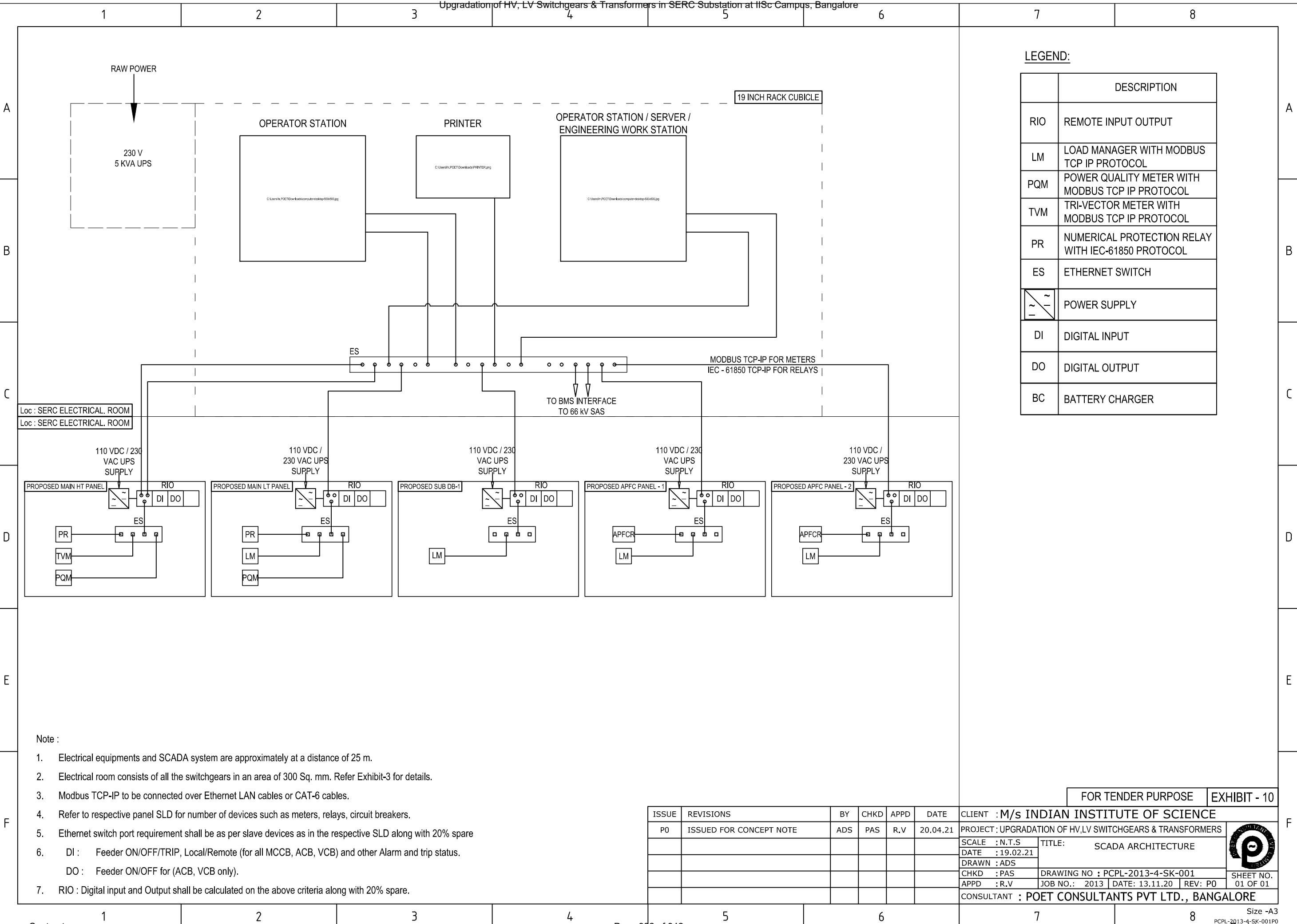
EXHIBIT - 7

ISSUE	REVISIONS	BY	CKD	APPD	DATE	CLIENT	M/S. INDIAN INSTITUTE OF SCIENCE, SERC		
PO	ISSUED FOR CONCEPT NOTE	ADS	PAS	R.V	24.04.21	PROJECT : UPGRADATION OF HV/LV SWITCHGEARS & TRANSFORMERS			
						SCALE : 1 : 90	TITLE:	GENERAL ARRANGEMENT	
						DATE : 19.11.20		PROPOSED CABLE TRENCH	
						DRAWN : ADS			
						CHKD : PAS	DRAWING NO :	PCPL-2013-4-CT-002	
						APPD : R.V	JOB NO.:	2013 DATE: 28.10.20	REV: PO
									01 OF 01
						CONSULTANT :	POET CONSULTANTS PVT LTD.,	BANGALORE	

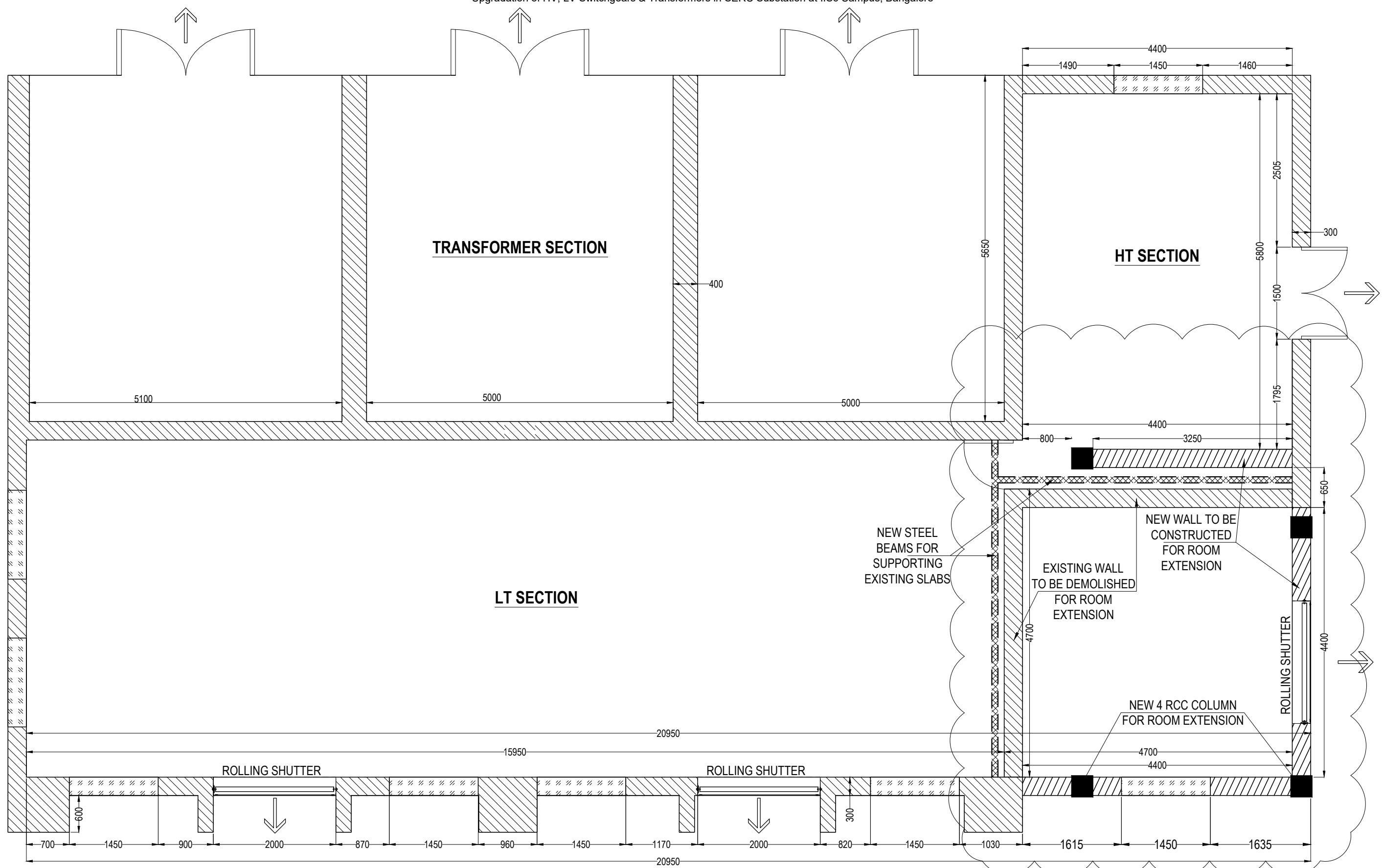
NOTE :

1. DRAWINGS ISSUED FOR BID PURPOSE ONLY
2. PORTIONS CLOUDED ARE THE PROPOSED CABLE TRENCH EXTENSION FOR BUILDING EXTENSION





Upgradation of HV, LV Switchgears & Transformers in SERC Substation at IISc Campus, Bangalore



Note :

1. Drawing issued for Bid Purpose only.
2. All the dimensions shown are tentative and may change during Detailed engineering Drawing.

Contractor

FOR TENDER PURPOSE EXHIBIT - 5

ISSUE	REVISIONS	BY	CHKD	APPD	DATE	CLIENT : M/s INDIAN INSTITUTE OF SCIENCE
PO	ISSUED FOR CONCEPT NOTE	ADS	VPK	R.V	20.04.21	PROJECT : UPGRADATION OF HV,LV SWITCHGEARS & TRANSFORMERS
						SCALE : 1 : 60
						TITLE: SCHEME FOR
						DATE : 07.04.21
						DRAWN : ADS
						CHKD : VPK
						DRAWING NO : PCPL-2013-C-RC-001
						APPD : R.V
						JOB NO.: 2013 DATE: 13.11.20 REV: PO
						CONSULTANT : POET CONSULTANTS PVT LTD., BANGALORE
						SHEET NO. 01 OF 01

Item Wise BoQ

Tender Inviting Authority: The Registrar, IISc, Bangalore

Name of Work: Upgradation of HV, LV Switchgears & Transformers in SERC Substation at IISc Campus, Bangalore.

Tender No: IISc/Tender-ELE-1/2021-22

Bidder Name :	
---------------	--

Notes for bidder.

Rates offered shall include the scope and services : (Supply+IT&C) Basic engineering, Design, Drawing preparation / Submission for Approval, Manufacture, Routine Testing (Factory Acceptance Testing), Packing, Supply, delivery up to site and Unloading at site. Temporary Storage, Positioning, Erection/Installation, Testing and Commissioning, Load Trials and As Built Documentation, Training of O&M Personnel and Handing over. Detailed scope is as per the Specification. Bidder shall visit the site and make himself acquainted with site conditions and existing equipment before submitting the bids. Bidder shall submit the Catalogues/GA Drawings and datasheets duly filled along with Bid.

- 1) The bidder shall quote rates for all the items. Rates quoted shall be firm and valid even if the contract is split.
- 2) The quantities of various items indicated are only approximate and payment will be made on the basis of actual quantity executed. The quantities of the individual items can vary to any extent and the purchaser is at liberty to delete any item.
- 3) Drawings enclosed with this specification are meant only for bidding purpose and are meant only to give the bidder general idea about the nature of work, various items of work involved etc. The actual execution of the work is to be done as per "Released for construction" (RFC) drawings. RFC drawings will be issued later to the contractor. RFC drawings may vary from the bid drawings to any extent. No claim is admissible in the quoted rate on this account.
- 4) Bidder in the event of contract shall submit GA/Layout/SLD/Scheme/Bill Of Materials/ Supporting calculations etc for approval and only after the approval shall commence manufacturing work.
- 5) Equipment shall be complete as per Single Line Diagram(SLD)/Specification/Datasheet, complying to IS / IEC Standards, Approved Makes, inclusive of Routine Tests and as directed by Engineer-in-charge.
- 6) All the equipment shall undergo Routine Tests at Factory as per respective equipment IS/IEC Standards. Purchaser shall have right to witness these tests during Factory Acceptance Test. The Vendor shall be intimated 2 weeks in advance.
- 7) Project nature being a Renovation and Modernisation of existing facility, execution of complete Design, Supply, Installation & Testing work shall be undertaken in a sequential manner so as to have minimum shutdown period. The relevant contingency planning, arrangement of temporary power supply, temporary interconnection works, direct and indirect cost shall be born by the Bidder.
- 8) This BOQ template must not be modified/replaced by the bidder and the same should be uploaded after filling the relevant columns, else the bidder is liable to be rejected for this tender.
- 9) Bidders are allowed to enter the Bidder Name, Basic Rate and GST percentage for each item only.
- 10) For all general notes full description and other details Bidder must refer BOQ in tender document and quote accordingly.

NUMBER #	TEXT #	TEXT #	NUMBER #	TEXT #	NUMBER #	NUMBER #	NUMBER	NUMBER	NUMBER #
Sl. No.	Item Description	Item Code / Make	Quantity	Unit	Basic rate per unit (Figures To be entered by the Bidder)	GST Rate %	Basic rate per unit inclusive of GST	Amount inclusive of GST	
1 Cat (A) -Items to be supply and installation									
1.1	OIL FILLED POWER TRANSFORMER: Design, Supply, Installation, Testing & Commissioning of 11/0.433 kV, Delta/Star, Outdoor type, 2.5 MVA Power Transformer suitable for 3-Phase, 3 Wire, 50Hz AC supply & 75 kVp BIL. The transformer shall be Copper wound having oil cooled system suitable for ONAN cooling. The Vector group shall be Dyn11 with neutral brought from LV for earthing. Off Load tap changing arrangements on HV side. The OCTC 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. The tap changer shall be provided for variation of HV voltage with a tap setting of (+) 5% and (-5%) at 11 kV side of each 2.5% steps. The impedance of transformer shall be 8.0% on 2.5 MVA base at nominal tap. The temperature rise of the transformer shall be 45 deg by Winding Temperature and 40 deg by Oil Temperature. The neutral terminal of the star connected winding shall be brought to the ground through externally installed NCT by a copper flat of size minimum 50 x 8 mm which shall be supported on the transformer tank including First Fill of Oil+10% Spare qty of oil, Oil Filtration and testing of oil. Supply of essential Spares as listed in Data Sheets Note: The bidder has to specify the losses as called for in the technical specifications. The transformer losses shall be as per level-3 of IS1180. Equipment shall be complete as per Single Line Diagram(SLD)/Specification/Datasheet, complying to IS / IEC Standards, Approved Makes, inclusive of Routine Tests and as directed by Engineer-in-charge.	Item1	1	Nos.			0	0.00	
1.2	Design, Supply, Installation, Testing & Commissioning of 11/0.433 kV, Delta/Star, Outdoor type, 1.5 MVA Power Transformer suitable for 3-Phase, 3 Wire, 50Hz AC supply & 75 kVp BIL. The transformer shall be Copper wound having oil cooled system suitable for ONAN cooling. The Vector group shall be Dyn11 with neutral brought from LV for earthing. Off Load tap changing arrangements on HV side. The OCTC 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. The tap changer shall be provided for variation of HV voltage with a tap setting of (+) 5% and (-5%) at 11 kV side of each 2.5% steps. The impedance of transformer shall be 6.0% on 1.5 MVA base at nominal tap. The temperature rise of the transformer shall be 45 deg by Winding Temperature and 40 deg by Oil Temperature. The neutral terminal of the star connected winding shall be brought to the ground through externally installed NCT by a copper flat of size minimum 50 x 8 mm which shall be supported on the transformer tank. .. Including First Fill of Oil+10% Spare qty of oil, Oil Filtration and testing of oil. Supply of essential Spares as listed in Data Sheets Note: The bidder has to specify the losses as called for in the technical specifications. The transformer losses shall be as per level-3 of IS1180. Equipment shall be complete as per Single Line Diagram(SLD)/Specification/Datasheet, complying to IS / IEC Standards, Approved Makes, inclusive of Routine Tests and as directed by Engineer-in-charge.	Item2	1	Nos.			0	0.00	
1.3	Type tests and Special tests as per IS during Factory Acceptance Test for 2.5MVA and 1.5MVA Transformers.	Item3	1	lump sum			0	0.00	
1.4	Installation Materials for all the above Distribution Transformers (Foundation Channels/ Bolts/Anchor Bolts/Any other items as required) excluding civil foundation.	Item4	1	lump sum			0	0.00	

2.1	11kV HV SWITCHGEAR-MAIN HV PANEL: Design, Supply, Installation, Testing and Commissioning of Free standing, Floor Mounting 11kV HV Switch gear Panel with, Bottom Cable Entry provision, Two Nos Incomer EDO VCB(630A)+CT+Line PT+Surge arrester, 25kA rated Copper Bus bar with 11kV Rated Heat Shrink sleeving and Three Nos outgoing EDO VCB feeders (630A) with CT and 1No Bus PT Panel complete with IEC 61850 Numerical Protection Relays, Metering, and other controls. 11kV Switchgear complete assembly and manufacturing shall be at OEM/ or Any OEM Authorised System Integrator or Channel partner with valid approval letter and type test reports. Equipment shall be complete as per Single Line Diagram(SLD)/Specification/Datasheet, complying to IS / IEC Standards, Approved Makes, inclusive of Routine Tests and as directed by Engineer-in-charge. 11kV Switchgear Panel shall be SCADA Compatible. Fibre-Optic loop based Arc Flash sensor with Relay included. Including Installation Materials for all the 11kV Switchgear (Foundation Channels/ Bolts/Anchor Bolts/Any other items as required) excluding civil foundation.110VDC Control Voltage shall be provided by External Battery and Battery Charger. Commissioning shall include Protection Relay/Meter/Controller settings review, testing by secondary injection kits such as Doble/Omicron / other equivalent makes by third party testing agency including necessary Hardware and Software tools for above 11kV Switchgear. All the tests shall be witnessed by Engineer in Charge (IISc).	Item5	1	Set			0	0.00
2.2	Design, Supply, Installation, Testing & Commissioning of Special Tool-Cable Earthing Truck for above 11kV Switchgear	Item6	1	Nos.			0	0.00
2.3	Design, Supply, Installation, Testing & Commissioning of Special Tool-Bus Earthing Truck for above 11kV Switchgear	Item7	1	Nos.			0	0.00
2.4	Design, Supply, Installation, Testing & Commissioning of Special Tool-CB Handling Trolley for above 11kV Switchgear	Item8	1	Nos.			0	0.00
3.1.1	11kV HV POWER CABLES AND ACCESSORIES: Design, Supply, Installation, Testing & Commissioning of following 11kV Power Cable in already excavated trench / directly buried / masonry duct / encasing in pipe / fixing on wall using necessary M.S clamps etc., 11kV(UE) Grade XLPE Insulated, Stranded Aluminium conductor with Single Layer Flat strip Armoured, PVC Sheathed cables Cable complete as per Single Line Diagram(SLD)/Specification/Datasheet, complying to IS / IEC Standards, Approved Makes, inclusive of Routine Tests and as directed by Engineer-in-charge. 3C x 400 sq. mm Al XLPE-A from MRS to SERC 11kV HT panel	Item9	1000	meter			0	0.00
3.1.2	Supply and installation / laying of of RCC Hume Pipe NP3 class of 300mm dia including Civil Works, excavation of earth, PCC bed around hume pipe inserts and back filling, compacting the earth as per specification. Including PVC Caution Tape throughout the lenght, Route Marker at regular intervals.	Item10	1000	meter			0	0.00
3.1.3	3C x 185 sq. mm Al XLPE-A from SERC 11kV HT panel to 2.5MVA & 1.5MVA Transformers	Item11	50	meter			0	0.00
3.1.4	Supply and installation / laying of of RCC Hume Pipe NP3 class of 300mm dia including Civil Works, excavation of earth, PCC bed around hume pipe inserts and back filling, compacting the earth as per specification.	Item12	50	meter			0	0.00
3.2.1	Design, Supply, Installation, Testing & Commissioning of following of Indoor type Heat-Shrinkable type Cable End Terminations kits with crimping type tinned copper lugs, double compression brass cable glands with earth tags, cable shield earthing, with all required like hardware like bolts, nuts and consumables etc, complete in all respects for the following size Aluminium XLPE insulated 11kV(UE) Armoured HT cable. (a) 3C x 400 sq. mm Al XLPE-Armoured cable from MUSS to SERC 11kV HT Switchgear Panel	Item13	4	Set			0	0.00
3.2.2	(b) 3C x 185 sq. mm Al XLPE-Armoured cable from SERC 11kV HT Switchgear Panel to 1.5MVA and 2.5MVA Transformer	Item14	4	Set			0	0.00
4.1.1	415V LV SWITCHGEAR PANEL: Design, Supply, Installation, Testing and Commissioning of following Free standing, Floor Mounting 415V LV Switch gear Panel with complete with ACB/MCCB feeders, Protection Relays, Meters, Controls, Indication and interlocking requirement. 415V Switchgear Panel complete assembly shall comply to IEC-61439 standards and manufacture shall have Fully Type Tested/ Compliance by Documentation and design measures. Equipment shall be complete as per Single Line Diagram(SLD)/Specification/Datasheet, complying to IS / IEC Standards, Approved Makes, inclusive of Routine Tests and as directed by Engineer-in-charge. 415V Switchgear Panel shall be SCADA Compatible. Fibre-Optic loop based Arc Flash sensor with Relay included. 110VDC Control Voltage shall be provided by External Battery and Battery Charger Including Installation Materials for all the 415V LV Switchgear (Foundation Channels/ Bolts/Anchor Bolts/Any other items as required) excluding civil foundation.Commissioning shall include Protection Relay/Meter/Controller settings review, testing by secondary injection kits such as Doble/Omicron / other equivalent makes by third party testing agency including necessary Hardware and Software tools for above 415V Switchgear. All the tests shall be witnessed by Engineer in Charge (IISc) 415V MAIN LT PANEL with Top Busduct Entry/Bottom Cable Exit provision, Multiple EB and DG Incomer EDO ACBs, 65kA rated 4000A Aluminium Bus Bar, Bus coupler EDO ACB and multiple EDO ACB Outgoing feeders as per SLD. Note : Feeder disposition shall match the existing cables at site.	Item15	1	Nos.			0	0.00
4.1.2	415V SUB DB with Bottom Cable Exit provision, Incomer EDO ACB, 65kA rated 2500A Aluminium Bus Bar and multiple manually operated fixed MCCB outgoing feeders as per SLD. Note : Feeder disposition is shall match the existing cables at site and restricted rear access.	Item16	1	Nos.			0	0.00
4.1.3	415V Automatic Power Factor Correction Panel -1 (765 kVar) complete with Incomer EDO ACB, Intelligent Automatic Power Factor Correction Relay, 7% Detuned Series Reactor, Capacitor Duy Contactor, and Capacitor Banks. Note : Restricted rear access.	Item17	1	Nos.			0	0.00
4.1.4	415V Automatic Power Factor Correction Panel -2 (465 kVar) complete with Incomer EDO ACB, Intelligent Automatic Power Factor Correction Relay, 7% Detuned Series Reactor, Capacitor Day Contactor, and Capacitor Banks. Note : Restricted rear access.	Item18	1	Nos.			0	0.00
4.2.1	110V BATTERY, BATTERY CHARGER AND DC DISTRIBUTION BOARD: Design, Supply, Installation, Testing and Commissioning of Free standing, Floor Mounting 110VDC, Dual Float cum Boost SMPS based Battery Charger Panel Microprocess based Controller, LCD Display , with minimum of 120Ah Capacity 12V SMF Battery Bank along with Mild steel duly painted Battery Stand, Battery MCCB Junction Box, Interconnection DC Cabling work (Battery Ah Sizing shall be done by bidder to serve the loads of Panels). Integral DC Distribution Board with minimum of 12Nos 16A DP MCB so as feed panel loads.	Item19	1	Set			0	0.00

5.1.1	LV POWER, CONTROL CABLES AND ACCESSORIES: Design, Supply, Installation, Testing and Commissioning of following cables in already excavated Cable Trench/Cable Tray/Directly buried complete with necessary Clamps and hardware : 1100V Grade, XLPE Insulated, Armoured, PVC Sheathed Power Cables complete as per Single Line Diagram(SLD)/Specification/Datasheet, complying to IS / IEC Standards, Approved Makes, inclusive of Routine Tests and as directed by Engineer-in-charge. (a) 3.5C X 400Sqmm AI XLPE from MAIN LT PANEL to APFCP-1 (5 Runs X 8 meters each)	Item20	40	meter			0	0.00
5.1.2	(b) 3.5C X 400Sqmm AI XLPE from MAIN LT PANEL to APFCP-2 (3 Runs X 7 meters each)	Item21	21	meter			0	0.00
5.1.3	(c) 3.5C X 240Sqmm AI XLPE from XXX to YYY(Reserved)	Item22	1	meter			0	0.00
5.1.4	(d) 3.5C X 185Sqmm AI XLPE from XXX to YYY(Reserved)	Item23	1	meter			0	0.00
5.1.5	(e) 3.5C X 120Sqmm AI XLPE from XXX to YYY(Reserved)	Item24	1	meter			0	0.00
5.1.6	(f) 3.5C X 70Sqmm AI XLPE from XXX to YYY(Reserved)	Item25	1	meter			0	0.00
5.1.7	(g) 4C X 25 AI XLPE from SDB-1 to Battery Charger	Item26	20	meter			0	0.00
5.2.1	Supply, Installation, Testing and Commissioning of Cable End Termination of 1100V grade for armoured 415V Power Cables to Switchgear including Supply of Double Compression Brass cable glands with earth tags, Crimping type Tinned copper lugs for Copper cables & Heavy duty Aluminium lugs for AL cables, Outdoor/Indoor Heat Shrinkable cable sealing kits and consumables for the following size of cables. 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, 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 shall be supplied & installed by the CONTRACTOR as part of cable termination work. 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. (a) 3.5C x 400 AI XLPE. Note : Removal of Cables from Existing Panel and Re-terminating to New Panels	Item27	60	Nos.			0	0.00
5.2.2	(b) 3.5C x 300 AI XLPE Note : Removal of Cables from Existing Panel and Re-terminating to New Panels	Item28	10	Nos.			0	0.00
5.2.3	(c) 3.5C x 240 AI XLPE Note : Removal of Cables from Existing Panel and Re-terminating to New Panels	Item29	3	Nos.			0	0.00
5.2.4	(d) 3.5C x 185 AI XLPE Note : Removal of Cables from Existing Panel and Re-terminating to New Panels	Item30	2	Nos.			0	0.00
5.2.5	(e) 3.5C x 70 AI XLPE Note : Removal of Cables from Existing Panel and Re-terminating to New Panels	Item31	2	Nos.			0	0.00
5.2.6	(f) 4C X 25 AI XLPE from SDB-1 to Battery Charger	Item32	2	Nos.			0	0.00
5.3.1	Supply, Installation, Testing and Commissioning of Cable Straight Through Joint Kits of 1100V grade for armoured 415V Power Cables , Crimping type Tinned copper lugs for Copper cables & Heavy duty Aluminium lugs for AL cables, Outdoor/Indoor Heat Shrinkable cable sealing kits and consumables for the following size of cables. To be used with prior approval from Engineer in Charge (IISc) (a) 3.5C x 400 AI XLPE.STRAIGHT THROUGH JOINTS	Item33	5	Nos.			0	0.00
5.3.2	(b) 3.5C x 300 AI XLPE.STRAIGHT THROUGH JOINTS	Item34	4	Nos.			0	0.00
5.3.3	(c) 3.5C x 240 AI XLPE.STRAIGHT THROUGH JOINTS	Item35	3	Nos.			0	0.00
5.3.4	(d) 3.5C x 185 AI XLPE.STRAIGHT THROUGH JOINTS	Item36	2	Nos.			0	0.00
5.4.1	Design, Supply, Installation, Testing and Commissioning of following LV Control cables in already excavated Cable Trench/Cable Tray/Directly buried complete with necessary Clamps and hardware : 1100V Grade, XLPE Insulated, Armoured, PVC Sheathed Control Cables complete as per Specification/Datasheet, complying to IS / IEC Standards, Approved Makes, inclusive of Routine Tests and as directed by Engineer-in-charge. (a) 3C X 2.5 sq.mm Cu. Cable for 110VDC Power Distribution to all equipment from DC Distribution Board	Item37	500	meter			0	0.00
5.4.2	(b) 3C X 2.5 sq.mm Cu. Cable for Current Transformer Interconnections	Item38	500	meter			0	0.00
5.4.3	(c) 5C X 2.5 sq.mm Cu. Cable for Current Transformer Interconnections	Item39	25	meter			0	0.00
5.4.4	(d) 7C X 2.5 sq.mm Cu. Cable for Current Transformer Interconnections	Item40	25	meter			0	0.00
5.4.5	(e) 12C X 2.5 sq.mm Cu. Cable for Transformer Marshalling Box Interconnection	Item41	200	meter			0	0.00

5.5.1	Supply, Installation, Testing and Commissioning of Cable End Termination of 1100V grade for armoured Control Cables to Switchgear including Supply of Double Compression Brass cable glands with earth tags, Crimping type Tinned copper lugs for Copper cables & Heavy duty Aluminium lugs for AL cables, Outdoor/Indoor Heat Shrinkable cable sealing kits and consumables for the following size of cables. 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, 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 shall be supplied & installed by the CONTRACTOR as part of cable termination work. 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. (a) 3C X 2.5 sq.mm Cu. Cable	Item42	40	Nos.			0	0.00
5.5.2	(b) 5C X 2.5 sq.mm Cu. Cable	Item43	6	Nos.			0	0.00
5.5.3	(c) 7C X 2.5 sq.mm Cu. Cable	Item44	6	Nos.			0	0.00
5.5.4	(d) 12C X 2.5 sq.mm Cu. Cable	Item45	20	Nos.			0	0.00
6.1.1	Air Insulated BUSDUCT : Design, Supply, Installation, Testing and Commissioning of following Indoor & Outdoor Air Insulated type, Metal enclosed 415 V, 4000A, 65kA,3Phase +Neutral, Aluminum Conductor Bus duct in a standard straight length with accessibility at both sides of the duct. The supply should consists of all the straight lengths, vertical & horizontal elbows, flanges, disconnecting links, accessories like inspection covers, drain vents & plugs etc. Supporting arrangement like wall frame assembly & hanger supports for indoor with seal off bushing to prevent air interchange. The conductor used in the busduct should have 100% purity. The enclosure shall be made out of minimum of 3mm thick non-magnetic Aluminium alloy or CRCA Sheet steel rectangular in shape. The Enclosure shall be IP-54/IP-66 based weatherproof construction for Indoor/Outdoor respectively with automatically controlled space heaters. The exterior finish of enclosure shall be RAL-7032 & black matt finish for interiors. The outdoor busducts shall be provided with Rain Hood.. complete as per Single Line Diagram(SLD) /Specification /Datasheet, complying to IS / IEC Standards, Approved Makes, inclusive of Routine Tests and as directed by Engineer-in-charge. Bus duct shall be preferably be supplied from the same supplier as that of 415V Switchgear so as to ensure the compatibility of End terminations. (a) Straight Length - Indoor IP-54-Measured over Centre line of Duct	Item46	2	meter			0	0.00
6.1.2	(b) Straight Length - Outdoor IP-66-Measured over Centre line of Duct	Item47	2	meter			0	0.00
6.1.3	(c) 90 Deg Bend (Vertical / Horizontal)-Extra-Measured over and above straight length	Item48	2	Nos.			0	0.00
6.1.4	(d) Adaptor Box at 415V Main LT Panel End+Rubber Bellows along with Phase Cross over/matching assembly with in the panel	Item49	1	Nos.			0	0.00
6.1.5	(e) Adaptor Box at Transformer End+Rubber Bellows	Item50	1	Nos.			0	0.00
6.1.6	(f) 3Phase +Neutral Braided copper flexibles at Transformer end	Item51	1	Set			0	0.00
6.1.7	(g) 3Phase +Neutral Braided copper flexibles at Switchgear end	Item52	1	Set			0	0.00
6.1.8	(h) Space Heaters Assembly	Item53	4	Set			0	0.00
6.1.9	(i) Busduct Hanger Supports	Item54	8	Set			0	0.00
6.1.10	(j) Silica Gel Breathers	Item55	2	Set			0	0.00
6.1.11	(k) Wall frame Assembly with Fire Barrier	Item56	1	Set			0	0.00
6.2.1	Design, Supply, Installation, Testing and Commissioning of following Indoor & Outdoor Air insulated type, Metal enclosed 415 V, 2500A, 65kA,3Phase +Neutral, Aluminum Conductor Bus duct in a standard straight length with accessibility at both sides of the duct. The supply should consists of all the straight lengths, vertical & horizontal elbows, flanges, disconnecting links, accessories like inspection covers, drain vents & plugs etc. Supporting arrangement like wall frame assembly & hanger supports for indoor with seal off bushing to prevent air interchange. The conductor used in the busduct should have 100% purity. The enclosure shall be made out of 3mm thick non-magnetic Aluminium alloy or CRCA Sheet steel . The Enclosure shall be IP-54/IP-66 based weatherproof construction for Indoor/Outdoor respectively with automatically controlled space heaters. The exterior finish of enclosure shall be RAL-7032 & black matt finish for interiors. The outdoor busducts shall be provided with Rain Hood.. complete as per Single Line Diagram(SLD)/Specification/Datasheet, complying to IS / IEC Standards, Approved Makes, inclusive of Routine Tests and as directed by Engineer-in-charge. Bus duct shall be preferably be supplied from the same supplier as that of 415V Switchgear so as to ensure the compatibility of End terminations. (a) Straight Length - Indoor IP-54-Measured over Centre line of Duct	Item57	7	meter			0	0.00
6.2.2	(b) Straight Length -Outdoor IP-66-Measured over Centre line of Duct	Item58	3	meter			0	0.00
6.2.3	(c) 90 Deg Bend (Vertical / Horizontal)-Extra-Measured over and above straight length	Item59	4	Nos.			0	0.00
6.2.4	(e) Adaptor Box at 415V Main LT Panel End Rubber Bellows along with Phase Cross over/matching assembly with in the panel	Item60	3	Nos.			0	0.00
6.2.5	(f) Adaptor Box at Transformer End+Rubber Bellows	Item61	1	Nos.			0	0.00
6.2.6	(g) 3Phase +Neutral Braided copper flexibles at Transformer end	Item62	1	Set			0	0.00

6.2.7	(h) 3Phase +Neutral Braided copper flexibles at Switchgear end	Item63	3	Set			0	0.00
6.2.8	(i) Space Heaters Assembly	Item64	4	Set			0	0.00
6.2.9	(j) Busduct Hanger Supports	Item65	20	Set			0	0.00
6.2.10	(k) Silica Gel Breathers	Item66	2	Set			0	0.00
6.2.11	(l) Wall frame Assembly with Fire Barrier	Item67	1	Set			0	0.00
7.1.1	SUPERVISORY CONTROL AND DATA ACQUISITION (SCADA): Design, Supply, Installation, Testing and Commissioning of SCADA system end-comprising the newly proposed equipment such as Transformers, 415V Main LT Panel, Sub-distribution Board, APFC Panels. SCADA system shall be with Two number PC Based Server cum Operating Work Cum Engineering Station in Hot-standby mode along with Laser jet Printer and associated Cubicle/Rack/Furniture. Ethernet Switch as required shall be provided as part of the respective switchgear panels. Remote Input/output modules (RIO/ RTU/Flexi IO) shall be used with Digital input and outputs such as CB Status monitoring and Control. These modules are to be envisaged to be part of the respective switchgear panels. All the Protection relays are Numerical type with IEC-61850 Protocol on TCP-IP Network with CB Open/Close Control functionality. All the TVM/LM/PQM meters shall be with Modbus Protocol on TCP-IP Network with measured value acquisition. Basic functionality of SCADA shall be Energy Management, Power Quality Analysis, Remote Operation of equipment, Interface for Building Management System and 66kV Substation Automation System. Complete as per SCADA Architecture / Single Line Diagram(SLD)/Specification/Datasheet, complying to IS / IEC Standards, Approved Makes, inclusive of Routine Tests. SCADA shall be compatible with the third party Building Management System (BMS) by any Open Protocols. (a) Redundant PC Workstation (Hot Standby) Industrial Grade PC Server /Operating / Engineering Work Station.	Item68	2	Set			0	0.00
7.1.2	(b) LCD Monitor-21 Inch Colour, Key Board, Mouse	Item69	2	Set			0	0.00
7.1.3	(c) Laser Jet Colour Printer-A4	Item70	1	Nos.			0	0.00
7.1.4	(d) Rittal make 19 inch based Rack along with Floor mounting Free Standing Cabinet, Glass Door to house Server Ethernet switch, PC and other accessories	Item71	1	Nos.			0	0.00
7.1.5	(e) APC make 230VAC UPS, 19inch Rack mountable, of sufficient rating but with minimum of 5kVA with 12V SMF Battery Bank sized for 30minutes of Battery Back up.	Item72	1	Set			0	0.00
7.1.6	(f) Industrial Ethernet Switches with 110VDC or 230VAC Powered, as required shall be provided as part of the respective switchgear panels as per SCADA Architecture Drawing. Qty shall be decided by bidder along with 20% Spare ports in each switch	Item73	1	Set			0	0.00
7.1.7	(g) Remote Input/output modules (RIO/ RTU/Flexi IO) 110VDC or 230VAC Powered, shall be used with Digital input and outputs such as CB Status monitoring and Control. These modules are to be envisaged to be part of the respective switchgear panels as per SCADA Architecture Drawing. Qty shall be decided by bidder along 20% Spare I/O points	Item74	1	Set			0	0.00
7.1.8	(h) Cat-5 or /6 Cable-Industrial Grade Ethernet cable to be used to interconnect all the above devices to the server, to be laid in the PVC Duct-External to the Panel-Bidder to estimate the Quantity required.	Item75	1	lump sum			0	0.00
7.1.9	(i) SCADA System License-Number of Tags shall be as per the connected Devices with minimum of 100 Tags per Device-One Time Buy	Item76	1	Set			0	0.00
7.1.10	(j) Integrated Site Acceptance and Demonstration of SCADA functionality at Site-7 Working Days minimum and Training of O&M Personnel	Item77	1	Set			0	0.00
8.1.2	EARTHING AND LIGHTNING PROTECTION SYSTEM: Design, Supply, Installation, Testing and Commissioning of Earthing System with Centrifugally Cast Iron earth pipe 3 meter long, 150mm dia, wall thickness of 13mm including GI Clamps, Funnel, accessories, and Excavation in earth and back filling, compacting the earth, providing masonry enclosure with cover plate having locking arrangement and watering pipe treated with charcoal/ coke and salt as required for below mentioned earthing complete in all respect. (a) Body earthing	Item78	4	Nos.			0	0.00
8.1.3	(b) Transformer Neutral earthing	Item79	4	Nos.			0	0.00
8.1.4	(c) Lightning Protection	Item80	4	Nos.			0	0.00
8.1.5	(d) Electronic Earthing for SCADA System	Item81	2	Nos.			0	0.00
8.2.1	Supplying and laying of below mentioned strips on surface or in recess for connections including mounting supports, PVC sleeves terminating with nut, bolt, spring, washer etc. as required. (Jointing shall be done by overlapping and with 2 sets of nut bolt & spring washer spaced at 50 mm). (a) 75mm X 12 mm Hot Dip GI strip for Earthing	Item82	85	meter			0	0.00
8.2.2	(b) 75mm X 10 mm Hot Dip GI strip for Earthing	Item83	180	meter			0	0.00
8.2.3	(c) 50mm X 8mm Copper Strip or Earthing	Item84	35	meter			0	0.00
8.2.4	1.1kV Grade, 16Sqm Single Core Copper Conductor PVC Insulated (Yellow-Green coloured Cable) for Electronic / SCADA System Earthing	Item85	50	meter			0	0.00

8.3.1	Supply, laying and termination of the following sizes of Hot dip GS Earthing Flats on building roof / wall as per specifications including all support clamps and fixings. All joints in the run of conductor shall be done by overlapping and with 2 sets of nut bolt & spring washer spaced at 50 mm). (a) 25 x 3 mm Hot Dip GI strip for Roof Conductor and Down Conductor	Item86	145	meter			0	0.00
8.3.2	(b) 25 x 6 mm Hot Dip GI strip	Item87	20	meter			0	0.00
8.3.4	(c) Test link complete with weather proof FRP enclosure for Lightning Protection Earth Pit	Item88	4	Nos.			0	0.00
9.1.1	Below mentioned items shall be operated as per the Engineer in Charge (IISc) discretion: Supplying and installing following size of perforated Hot Dipped Galvanised steel cable tray (galvanization thickness not less than 50 microns) in convenient sections, joined with connectors, including horizontal and vertical bends, reducers, tees, cross members suspended from the ceiling with G.I. suspenders or supported with Angle iron in Trenches including G.I. bolts & nuts, etc. as required. (a) Ladder Type Cable Tray-600mm Wide	Item89	20	meter			0	0.00
9.1.2	b) Ladder Type Cable Tray-300mm Wide	Item90	20	meter			0	0.00
9.2.1	Supplying and installing following size of perforated Hot Dipped Galvanised Steel cable tray (galvanization thickness not less than 50 microns) with perforation not more than 17.5%, in convenient sections, joined with connectors, suspended from the ceiling with G.I. suspenders or supported with Angle iron in Trenches including G.I. bolts & nuts, etc. as required, The Exposed portion of the tray shall be provided with covers. (a) 300 mm width X 62.5 mm depth X 2.0 mm thickness	Item91	20	meter			0	0.00
9.2.2	(b) 150 mm width X 50 mm depth X 1.6 mm thickness	Item92	20	meter			0	0.00
9.2.3	(c) 75 mm width X 50 mm depth X 1.6 mm thickness	Item93	20	meter			0	0.00
9.3	Supply & Installation of Structural steel of various sections to form Cable carrier system and other such work including MS Angles, Channels, Rounds, Plates, and Flats complete with fabrication, Powder Coating and painting as directed by Engineer in Charge (IISc). Drawing / Sketch shall be approved by Engineer in Charge (IISc).	Item94	200	kg			0	0.00
9.4.1	Safety relevant: Providing and fixing of 11kV Grade Safety Insulation Mats as per IS:15652, Anti Skid type for entire Switchgear Room	Item95	40	sq. m			0	0.00
9.4.2	Providing and fixing of 4.5kG Class CO2 type Portable Fire Extinguisher on wall	Item96	2	Nos.			0	0.00
9.4.3	Providing and fixing of Set of Sand Buckets with Stand	Item97	2	Nos.			0	0.00
9.4.4	Providing and fixing of First Aid Box complete with all standard first aid materials	Item98	2	Nos.			0	0.00
9.4.5	Providing cable trench cover with lifting arrangements and any other openings with Mild Steel Plates of approved design and thickness wherever required as advised by Engineer in Charge (IISc). Drawing / Sketch shall be approved by Engineer in Charge (IISc).	Item99	250	kg			0	0.00
10.1	Miscellaneous Works: Providing and fixing of A1 size Drawing Display Board with Laminated drawing	Item100	2	Nos.			0	0.00
10.2	Providing and fixing of Shock Treatment Chart in English and Local Language	Item101	3	Nos.			0	0.00
10.3	Providing and fixing 415V danger notice plate of 200 mm X 150 mm, made of mild steel, at least 2 mm thick, and vitreous enamelled white on both sides, and with inscription in single red colour on front side as required.	Item102	5	Nos.			0	0.00
10.4	Providing and fixing 11kV danger notice plate of 250 mm X 200 mm, made of mild steel, at least 2 mm thick, and vitreous enamelled white on both sides, and with inscription in single red colour on front side as required.	Item103	3	Nos.			0	0.00
10.5	One inch Height Bold Painted Text Labelling and marking of all the supplied equipment like Transformers, Panels., etc.,	Item104	1	lump sum			0	0.00
11	Temporary Power supply: Providing Compact RMU Substation with 11kV VCB Transformer and 415V Outgoing Feeders as a Temporary Power Supply Arrangement to IISc SERC Building and other Critical loads identified by Engineer In Charge and making all temporary cabling interconnection for the duration as required for project re-vamping. Rates shall be offered on daily rental basis. Power at 11kV level shall be provided at one place by IISc. Make of RMU Substation shall be preferably SIEMENS/ SCHNEIDER / EATON.	Item105	10	Days			0	0.00
12.1	DG Synchronisation Panel Outgoing feeder Revamping: Removal of existing Directly Buried 415V Cables-4Runs of 3.5C X 400Sqmm-3 Feeders and Re-laying of the same in below mentioned Hume pipes. (Note : Supply : Nil as the existing cables shall continue to be in service .. Only Installation, Testing and Commissioning shall be offered.)	Item106	1	lump sum			0	0.00
12.2	Supply and installation / laying Of RCC Hume Pipe NP3 class of 300mm dia including Civil Works, excavation of earth, PCC bed around hume pipe inserts and back filling, compacting the earth as per specification.	Item107	60	meter			0	0.00
13.1	Civil Works: Providing and injecting chemical emulsion for Pre-constructional anti-Termite treatment, creating continuous chemical barrier under and around the column pits, walls, trenches, basement excavation, top surface of the plinth filling, junction of wall and floor, along the external perimeter of building, expansion joints, over the top surface of consolidated earth on which apron is to be laid, surrounding of pipes and conduits, with chlorpyriphos emulsifiable concentrates of 20 % concentration, including cost of chemical, diluting in water to one percent concentration, labour, HOM of equipments. complete as per specifications (Plinth area of building at ground floor only will be measured.)	Item108	38.85	sq. m			0	0.00

13.2	Dismantling of existing structures like culverts, bridges, retaining walls and other structure comprising of masonry, cement concrete, wood work, steel work, including T&P and scaffolding wherever necessary, sorting the dismantled material, disposal of unserviceable material and stacking the serviceable material with all lifts complete as per specifications. Dismantling RCC M20 of existing transformer foundations.	Item109	15.75	Cum			0	0.00
13.3	Dismantling of existing structures like culverts, bridges, retaining walls and other structure comprising of masonry, cement concrete, wood work, steel work, including T&P and scaffolding wherever necessary, sorting the dismantled material, disposal of unserviceable material and stacking the serviceable material with all lifts complete as per specifications. Dismantling brickwork between ion of bldg.	Item110	9.87	Cum			0	0.00
13.4	Providing and constructing granite / trap / basalt rubble stone masonry in foundation with cement mortar 1:6 (uncoursed), bond stones at two m. apart in each course including cost of materials, labour, curing complete as per specifications.	Item111	2.1	Cum			0	0.00
13.5	Providing and laying in position plain cement concrete of mix 1:4:8 with OPC cement @180kgs, with 40mm and down size graded granite metal coarse aggregates @ 0.85cum and fine aggregates @ 0.57cum machine mixed, machine mixed, concrete laid in layers not exceeding 15cms. thick, well compacted, in foundation, including cost of all materials, labour, HOM of machinery, curing complete as per specifications.	Item112	4.725	Cum			0	0.00
13.6	Providing and laying in position reinforced cement concrete of design mix M25 with OPC cement @ 340kgs, with 20mm and down size graded granite metal coarse aggregates @ 0.70cum and fine aggregates @ 0.47cum, with super plasticisers @ 3 litres conforming to IS 9103-1999 reaffirmed-2008 at machine mixed, concrete laid in layers not exceeding 15cms thick, vibrated for all works in foundation for footings, pedestals, retaining walls, return walls, walls (any thickness) including attached pilasters, columns pillars, posts, struts, buttresses, bed blocks, anchor blocks & plinths etc., including cost of all materials, labour, HOM of machinery, curing, complete as per specifications.	Item113	68.943	Cum			0	0.00
13.7	Providing and removing centring, shuttering, strutting, propping etc., and removal of form work for foundations, footings, bases of columns for mass concrete including cost of all materials, labour complete as per specifications.	Item114	37.8	sq. m			0	0.00
13.8	Providing and removing centring, shuttering, strutting, propping etc., and removal of form work for columns, pillars, post and struts, circular or curved in plan including cost of all materials, labour complete as per specifications.	Item115	169.3125	sq. m			0	0.00
13.9	Earth work excavation for foundation of structures as per drawing and technical specification, including setting out, construction of shoring and bracing, removal of stumps and other deleterious matter, dressing of sides and bottom , backfilling the excavation earth to the extent required and utilising / transporting the remaining earth locally up to 1.00km lead. (Depth up to 3.00Mts)-Ordinary / Hard soil - Mechanical Means	Item116	75.6	Cum			0	0.00
13.10	Earth work excavation for foundation of structures as per drawing and technical specification, including setting out, construction of shoring and bracing, removal of stumps and other deleterious matter, dressing of sides and bottom , backfilling the excavation earth to the extent required and utilising / transporting the remaining earth locally up to 1.00km lead. (Depth up to 3.00Mts)-Hard Rock (requiring blasting) - Mechanical Means	Item117	7.35	Cum			0	0.00
13.11	Refilling available earth around pipe lines, cables in layers not exceeding 20 cms in depth compacting each deposited layer by ramming after watering with lead up to 50 m and lift up to 1.5 m including cost of labour complete as per specification.	Item118	35.7	Cum			0	0.00
13.12	Providing T.M.T steel reinforcement for R.C.C work including straightening, cutting, bending, hooking, placing in position, lapping and/or welding wherever required, tying with binding wire and anchoring to the adjoining members wherever necessary complete as per design (laps, hooks and wastage shall not be measured and paid) cost of materials , labour, HOM of machinery complete as per specifications. T.M.T bars Fe 500	Item119	8.295	Tonne			0	0.00
13.13	Supplying, fabricating and fixing in position as in drawings MS curb angles, channel frames, insert plates anchor bolts ,rungs, etc., including split anchors for equipment foundations etc at all levels.	Item120	1611.75	kg			0	0.00
13.14	Drilling and / or making holes / openings in concrete of any grade in slabs, beams, or walls at all locations any grade in slabs, beams, or walls at all locations	Item121	10.5	Nos.			0	0.00
13.15	Providing and Constructing burnt brick masonry with approved quality of modular bricks of standard size of class designation 5.0 Newton per sqmm (table moulded) with cement mortar 1:6 for basement and superstructure including cost of materials, labour charges, scaffolding, curing complete as per specification.	Item122	27.4575	Cum			0	0.00
13.16	Construction of partition wall 11.2cms thick with nonmodular ground moulded burnt bricks of class designation 5.0 Newton per sqmm with cement mortar 1:4 including providing and fixing plaster mesh manufactured out of hot dipped galvanised iron of nominal thickness 0.35mm. 100mm wide as per I.S. 2212/1991 at 7.5m.c to c including cost of materials, labour charges, scaffolding, curing complete as per specifications.	Item123	19.95	sq. m			0	0.00
13.17	Providing 12mm thick cement plaster in single coat with cement mortar 1:4 to brick masonry including round off corners wherever required smooth rendering. Providing and removing scaffolding , including cost of materials, labour, curing complete as per specifications.	Item124	67.2	sq. m			0	0.00
13.18	Providing 18mm thick cement plaster in single coat with cement mortar 1:4, to brick masonry including rounding off corners wherever required smooth rendering, Providing and removing scaffolding, including cost of materials, labour, curing complete as per specifications.	Item125	131.04	sq. m			0	0.00
13.19	Providing 13mm thick cement plaster in single coat with cement mortar 1:3, to ceiling including rounding off corners wherever required smooth rendering, Providing and removing scaffolding, including cost of materials, labour, curing complete as per specifications.	Item126	24.15	sq. m			0	0.00
13.20	Providing and finishing external walls in two coats with water proof cement paint of approved brand and shade to give an even shade after thoroughly brooming the surface to remove all dirt and loose powdered material ,free from mortar drops and other foreign matter with primer cost of material ,labour, complete as per specification.	Item127	107.1	sq. m			0	0.00

13.21	Providing and applying two coats with oil bound washable distemper of approved brand and shade on wall surface including priming coat with distemper primer after thoroughly brooming the surface free from mortar drops and other foreign matter including preparing the surface even and sand paper smooth, cost of materials, labour, complete as per specifications.	Item128	67.2	sq. m			0	0.00
13.22	Providing chain link fencing 50 mm size of 8 gauge properly stretched between rectangular poles and fixed with suitable bolts and nuts, the free ends shall be welded to the pole and block pipe at top and bottom as required including cost of all materials, labour, lead and lifts and as per the directions of the Engineer-in-charge of work including two coats of approved quality paint over one coat of shop paint.	Item129	15.75	sq. m			0	0.00
13.23	Providing and fixing M.S.gate as per drawing using 50 mm X 50 mm 14 gauge M.S. hollow pipe frame work bent to ornamental shape as shown in the drawing and 35 mm X 6 mm and 16 mm X 16 mm square rods for verticals alternatively spaced at 4 cms c/c in two halves and 40 mm X 6 mm M.S. flats for horizontal member and at the top cast iron spikes are provided at alternate vertical members as shown in the drawing etc complete. All the steel surface should be thoroughly cleaned free of rust and painted with anti corrosive paint (shop paint) etc. complete. The work includes cost of all materials, labour charges for all items of work, hire charges for welding, cutting and grinding equipment, and electricity charges with lead and lift, loading and unloading charges etc complete as per specifications	Item130	6.3	sq. m			0	0.00
13.24	Providing and filling 40 mm downgraded coarse aggregates in the transformer foundation and in the substation area	Item131	18.9	Cum			0	0.00
13.25	Providing and placing in position precast reinforced cement concrete waffle units, square or rectangular, as per design and shape for trench covers, poles etc., in 1:1½ : 3 (1 Cement : 1½ coarse sand : 3 graded stone aggregate 10mm nominal size), including flush or deep ruled pointing at joints in cement mortar 1:2 (1 cement : 2 Fine sand), making necessary holes of required sizes for carrying through service lines etc., providing steel hooks for lifting etc, form work in precasting, handling, hoisting, centering and erection complete for all floor levels but excluding the cost of reinforcement.	Item132	2.1	Cum			0	0.00
13.26	Supplying & Fixing pressed steel door frames size 125 X 65 mm manufactured from 1.25 mm thick carbon steel or imported steel strips with mitred joints of 900 for door openings and shutters made out of seasoned Honne wood, styles of 30 mm thick with lock rail of 160 mm width top and side rails of 100 mm width and bottom rail of 250 mm width and panel filling with 12 mm thick particle board of exterior grade bonded with phenol formaldehyde resin and the shutter shall be rot proof, vermin proof, heat resistant guaranteed against shrinkage, warpage and such other defects for a period of 3 years. This shall be as per approved drawings, specifications and direction including cost of conveyance, manufacturing, painting with enamel paint 2 coats over primer coat, cost of labour for all items of work, machinery, equipment and all other incidental charges with lead ,lift, loading and unloading etc., complete. The hollow portion of the frame to be filled with cement concrete 1:2:4	Item133	2.1	sq. m			0	0.00
13.27	Supply and fixing pressed steel window frames of size 100x50 mm manufactured from 1.25mm thick carbon steel or imported steel strips with neat mitred joints at 900degree for window opening and shall be suitable to fix M.S. grills as per design and drawings using 12mm dia rods at 100mm Centre to Centre horizontally and two members of M.S flats of 6mmx40mm size at 150mm apart, welded into a frame of 6mmx40mm size M.S. flats with 16mm size lugs, and 8 Nos. of 100mm size hinges, 4Nos of butt stay pins and 4 Nos. Tower bolts and shutters half panelled and half glazed with shutters made out of seasoned hone wood, styles of 30mm thick and 100mm width and rails of 30mm thick and 100mm width and using 4mm thick pin headed glass and panel, filling with 12mm thick particle board of exterior grade bonded with phenol formal decide resin and the shutter shall be rot proof vermin proof, heat resistant guaranteed against shrinkage, wrap age and such other defects for a period of 3 years. This shall be as per approved drawing, Specification and direction including cost of conveyance, manufacturing painting with2 coats enamel paint over one coat of prime, cost of labour for all items of work, machinery, equipment and all other incidental charges with all lead , lift loading and unloading etc., complete. The Hollow portion of the frame to be filled with cement concre1:2:4	Item134	2.52	sq. m			0	0.00
13.28	Providing and Fixing rolling shutters of approved make out of 18 gauge ,75 mm wide cold rolled steel laths of convex corrugation with side guides and bottom rail, with interlocking arrangements for steel laths by means of alternate clips, suspension shaft with high tension coil type springs two numbers, mounted on specially designed pipe shaft, with bracket plates, guide channels ,ball bearing arrangements ,for inside and outside locking with push and pull operations complete including pulling hooks,4 nos.,handles with all fittings and accessories etc complete	Item135	9.45	sq. m			0	0.00
13.29	Providing white washing to ceiling and /or sloping roof surface in two coats with lime of approved quality, to give an even shade including cost of materials, labour complete as per specifications	Item136	24.15	sq. m			0	0.00
13.30	Providing and applying Polymer based water proofing slurry having chemical resistance properties, capable of self curing within 3 to 4 hours of its application in normal atmospheric conditionable of withstanding a Temperature of 200 degree Celsius for protective negative coating for water dampness and seepages comprising of Portland cement, lime stone, silica sand, alumina cement, sodium aluminate in the form of powder composition at 3.30 kgs mixed with 1 litre of acrylic emulsion, applied on 0.64 sqm area /litre of slurry on a cleaned surface free of loose materials etc. Complete on roof slab, masonry structures filling the joints capable of self curing within 3 to 4 hours of its application in normal atmospheric conditions including cost of materials, labour etc complete.	Item137	31.5	sq. m			0	0.00
13.31	Providing and laying flooring 40mm thick, with an under layer of 30mm thick M-15 cement concrete, using broken granite metal of 12.5mm nominal size and top layer of 10mm thick plaster with cement mortar 1:3, finished with floating coat of neat cement, including cost of materials, labour, curing complete as per specification	Item138	21	sq. m			0	0.00
13.32	Providing Ceramic tiles of Size 15 cm X 15 Cm ,6 mm thick, approved make, shade and size for flooring, treads of steps and landings laid on a bed of 12mm thick, cement mortar 1:3 mix, flush pointing with white cement using colour pigment, including cost of materials, labour, curing complete as per specifications.	Item139	10.5	sq. m			0	0.00
13.33	Providing skirting,dadoing ,risers of steps with colour glazed tiles on 10 mm thick cement plaster 1:3 and jointed with white cement slurry over existing rough plaster surface using glazed tiles of approved make and size including cost of materials, labour, complete as per specifications	Item140	5.25	sq. m			0	0.00
13.34	Supplying and laying HDPE Pipe 160 mm external dia inside the excavated trench as per the specifications and drawing including butt welding of ends of pipes for continuity complete as directed by the Engineer-in-charge.	Item141	21	Rm			0	0.00
13.35	Providing and filling sand in foundation plinth to required depth for sub soil treatment including watering remming with all lead and lift complete as per specifications.	Item150	21	Cum			0	0.00

14	Cat (B) - Buy Back Items								
14.1	Buy-Back (ie minus) - 11/0.433 kV 1000 kVA Transformer		Item151	1	Nos.			0	0.00
14.2	Buy-Back (ie minus) - 11/0.433 kV 500 kVA Transformer		Item152	2	Nos.			0	0.00
14.3	Buy-Back (ie minus) - 11kV Switchgear Panel		Item153	1	Nos.			0	0.00
14.4	Buy-Back (ie minus) - 415V PCC / MAIN LT Panel		Item154	1	Nos.			0	0.00
14.5	Buy-Back (ie minus) - APFC Panels		Item155	2	Nos.			0	0.00
14.6	Buy-Back (ie minus) - OLTC Panel		Item156	1	Nos.			0	0.00
14.7	Buy-Back (ie minus) - Interconnection bus duct		Item157	7	meter			0	0.00
14.8	Buy-Back (ie minus) - Un used Cables Al Conductor after identification by Engineer in Charge (IISc)		Item158	4000	kg			0	0.00
14.9	Buy-Back (ie minus) - Un used Cables Copper Conductor after identification by Engineer in Charge (IISc)		Item159	100	kg			0	0.00
14.11	Buy-Back (ie minus) - Iron/Steel Scrap Materials after identification by Engineer in Charge (IISc)		Item160	500	kg			0	0.00
Total in Figures									0.00
Quoted Rate in Words								INR Zero Only	