TENDER DOCUMENT
(National Competitive Bidding)
For

Upgradation of Common Effluent Treatment Plant (CETP) at Amburtec - Thuthipet sector, Ambur

TENDER – 8/2024

DESIGN, DETAILED ENGINEERING, SUPPLY, INSTALLATION, COMMISSIONING AND TRAIL RUN INCLUDING CIVIL WORKS ON TURNKEY BASIS OF 500 KG/HR. HOLLOW PADDLE SLUDGE DRYER BASED ON THERMIC FLUID HEATING SYSTEM

Volume-I

Instructions to Bidders

AMBUR ECONOMIC DEVELOPMENT ORGANISATION (AEDOL)

43/53, Raja Muthiah Road ,Periamet, Chennai-600 003

Telephone: 044-42041132/35528648

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PART I - INSTRUCTIONS TO TENDERERS

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1. GENERAL

1.1 Invitation for tenders

1.1.1 AMBUR ECONOMIC DEVELOPMENT ORGANISATION (AEDOL) , hereinafter referred to as the "Implementing Agency", in the framework of upgradation and strengthening of existing ZLD Plant in Thuthipet CETP, Ambur invites eligible firms to submit tenders for the:

Design, detailed engineering, supply, installation, commissioning and trail run including civil works on turnkey basis of 500 kg/hr. hollow paddle sludge dryer based on thermic fluid heating system

hereinafter called the "Works", as defined in these Tender Documents.

1.1.2 Scope of work to be performed:

Design, detailed engineering, supply, installation, commissioning and trail run including civil works on turnkey basis of 500 kg/hr. hollow shaft paddle sludge dryer based on thermic fluid heating system. The scope includes the construction of utility building/shed, sludge storage pit and shed supply installation and commissioning of sludge handling system like belt conveyer, silo, cyclone separator, scrubbers, thermic fluid heating system, Plumbing and insulation works etc., complete. Electrical items related to paddle dryer & thermic fluid heating system also to be supplied and installed. Foundation works, platforms etc. are also to be considered and quoted for.

This tender may be treated as **turnkey contract**. Any item or items required for successful commissioning of paddle dryer but not mentioned in the tender document is to be specifically mentioned in the technical bid and same should be quoted in the price bid.

In Chapter 2.1 the contents of the tender documents are listed. The scope of works is described in more detail in Volume III.

1.1.3 The bid must be received at the address given in Volume I, Part I, Section 4.1.2, not later than **04.02.2024 at 11.00 hrs.**

1.1.4 Opening of the Cover 1 – Technical Tender shall take place at 11.30 hrs. on **04.02.2024**.

1.1.5 The successful tenderer shall complete the Works on or before 31st March 2025. The Defect Notification Period is 12 months and will commence at the date of issuing the Taking-Over Certificate of the Works.

1.1.6 All documents contained in the Tender, as outlined in Volume I, Part I, Section 2.1, shall be treated as confidential and shall not be made accessible to third parties.

1.1.7 The Earnest money deposit (EMD), amounting to **Rs. 7.76 Lakhs (Rupees Seven Lakhs and Seventy Six Thousand Only)** in the form of DD payable at Chennai favouring, "**Ambur Economic Development Organization**" or Bank Guarantee Scheduled Bank authorized by Reserve Bank of India. The format of bank guarantee shall be as per annexure. Volume-II shall be submitted with the tender shall be submitted with the tender.

1.2 Subcontracting of works

The contractor cannot subcontract the work in whole or parts to any agency. In unavoidable

cases where the contractor proposes to get any part of the work done by any sub-agency, proper written justification for obtaining such services and the quantum along with value of such services shall be specified explicitly in the Technical Bid. At any case, the value of such services should not exceed 10% of the quoted amount.

Any sub-contracting after award of work shall not be allowed under any circumstances.

1.3 Eligibility Requirements

1.3.1 Participation in the tender shall be open on equal terms to natural and legal persons of all countries in the World.

1.3.2 A tenderer shall not be considered eligible for the award of contracts if:

a) he is bankrupt;

b) payments to him have been suspended in accordance with the judgement of a court or a judgement declaring bankruptcy and resulting, in accordance with his national laws, in total or partial loss of the right to administer and dispose of his property;

c) legal proceedings have been instituted against him involving an order suspending payments and which may result, in accordance with his national laws, in declaration of bankruptcy or in any other situation entailing the total or partial loss of the right to administer and dispose of his property;

d) he is guilty of serious misrepresentation with regard to information required for participation in an invitation to tender;

e) he is in breach of contract on another contract with the Implementing Agency or with similar companies in Republic of India.

f) he (including all vendors and design agencies) has any connection with a firm or entity which has provided consulting services during the preparatory stages of the Works or of the project of which the Works form a part, or which has been hired (or is intended to be hired) as the Implementing Agency's Representative for the Contract.

1.3.3 Tenderer shall certify through the Declaration of Eligibility, included in Volume I, Part II, and upon request, provide evidence satisfactory to the Implementing Agency that none of these situations applies to him.

1.3.4 In particular the tenderer shall meet and conform to the following criteria:

1. Bidders should have Permanent Account Number (PAN).
2. GST Registration (GSTIN) valid on date of Bid submission.
3. The company should have been in operation for a minimum period of **3 years** under Indian Companies Act.
4. The bidder should have satisfactorily completed a minimum of three similar works, each costing not less than the amount equal to Rs. 155.20Lakhs or two similar works, each costing not less than the amount equal to Rs. 232.80Lakhs or one similar work costing not less than the amount equal to Rs.310.40Lakhs within the last **7 years** as on 31.01.2024. Similar works means supply, installation and commissioning of paddle dryer or thermal evaporators such as MEE/ATFD. Necessary proof of documents needs to be attached along with tender documents.

5. The bidder should have satisfactorily completed at least one paddle dryer system of minimum 300 kg/hr capacity in the past five years 31.01.2024. and unit shall be in successful operation for minimum period of one year as on 31.01.2024.
6. Bidder should have minimum average annual turnover of Rs. 500.00Lakhs as per the audited balance sheet in the last 3 consecutive financial years.
7. Bidder should be a profit-making firm and should not have made loss in the last two financial years out of last five financial years.
8. Solvency Certificate of Rs. 156.00 Lakhs from nationalized (or) Scheduled Bank authorized by Reserve Bank of India.
9. Bidder should have total credit facility for a minimum of Rs.97.00 Lakhs.
10. Consortium or Joint-Venture is not allowed.
11. Bidder should not have been black listed/debarred by any Government organization

1.4.1. All Tenderers must supply the following information and documents with the tender in English:

a) A copy of documents showing the organisation chart, legal status, place of registration of the headquarters and written powers of attorney to the signatory to obligate

Form 1 - GENERAL INFORMATION ABOUT THE TENDERER, including general information about each main contractor.
Form 2 - ORGANISATION CHART/POWER OF ATTORNEY)

b) Evidence showing that the circulating capital is adequate for this Contract, confirmed by a financial statement for the last three years verified by a chartered accountant and powers to obtain a credit from a Bank.
Form 3 - FINANCIAL STATEMENT

c) Financial projections for the forthcoming 2 years.

d) Information about technical qualifications.
Form 4 - TECHNICAL QUALIFICATIONS AND DATA

It should contain the following data and the Questionnaire shall be supplemented with:

- Presentation of Firm's organisation and number of all staff employed.
- List of staff proposed to be employed for execution of the Contract including final table of key personnel, their CV's and signed statements of availability, all according to attached examples.
- Full profile of the Project Manager having at least 10 years relevant experience.
- List of major items of construction equipment for execution of the Contract.
- Information regarding Site Office.
- Work Programme with brief descriptions of major activities.
- Graphic Work Schedule (Bar chart) in relation to time and duties allocated for employees for this Contract.
- An outline of the Quality Assurance System to be used.
- Data concerning main Sub-contractors, Suppliers and subletting, and the percentage of works to be sublet.
- Document confirming registration of the Contractor and Sub-contractors to be qualified to carry out the Works specified in this Contract.
- Evidence of relevant experience in execution of works of similar nature, extent and value of the Contract.
- Details of other works in hand and contractually committed.

e) Principle drawings prepared by the Contractor, shall meet tender specification.

f) The Bill of Quantities including the data sheets according to Rates and Prices presented in the format of Volume IV. Attached shall be a detailed analysis of rates quoted by the Tenderer in this Tender according to market prices and fees of manpower and materials. The presented analysis shall be in essence a reproduction of the Tenderer's pricing calculations, and clearly indicate how the Tenderer has arrived at the unit prices used in the Bill of Quantities.

g) Mandatory Declaration of Eligibility as per the format given in Volume I Part II conforming that he fulfils all the pre-qualification Criteria specified in Tender document.

h) Mandatory Site Inspection Declaration.

The tenderer should visit the sites and fill in the Form attached to these Instructions to Tenderer for each site visited.

1.5 One Tender from one Tenderer

Each tenderer shall submit only one tender. A tenderer submitting or participating in more than one tender for the Contract shall be rejected.

1.6. Tender expenses

1.6.1 All costs associated with the preparation and submission of the tender shall be to the account of the tenderer and the Implementing Agency will not be responsible for, or pay for, expenses and losses which may be incurred by the tenderer in connection with visits to, and examination, of the site in the tendering.

Tenderers shall be solely responsible for examining with appropriate care, the Tender Documents, including any Addenda issued during the tendering period, and for obtaining reliable information with respect to any and all conditions and obligations which may in any way affect the amount or nature of the tender or the execution of the Works. In the event that the tenderer is successful, no claim for alteration of the Tender Amount will be entertained on the grounds of errors and omissions in the obligations of the tenderer described above.

1.7 Site Inspection

It is mandatory that the tenderer visits and inspects the project site (located in AMBUR 187km from Chennai) and its surroundings and obtain, at his own responsibility, expense and risk, all information which may be necessary to prepare his tender and sign the Contract for the Works. For inspection visit, the applicants may schedule the visit appointment directly with the Thuthipet CETP by sending email intimation to amburtec@gmail.com to the attention of

1. Mr. S.M. Faiyaz Ahmed
Executive Director, AMBURTEC
Mob: 94443 36335

2. Mr. D.B. Riyaz Ahmed
Project Manager
Mob: 91501 48628
THUTHIPET CETP
Periyavakam,Thuthipet,Ambur–635811.

A copy of the email request sent to Thuthipet CETP, may be marked to aedolchennai@yahoo.co.in ilifochennai@gmail.com

1.8 Rates, in figures and words

The tenderer shall quote in English both in figures as well as in words the rates and amounts tendered by him in the Price Schedule of items of Work forming part of the tender in such a way that interpolation is not possible. The amount for each item shall be worked out and entered and requisite totals given of all items. The tendered amount for the work shall be entered in the tender and duly signed by the Tenderer.

If some discrepancies are found between the rates given in words and figures or the amount shown in the tender, the following procedures shall be followed:

(i) where there is a discrepancy between the amounts in figures and in words, the amount in words will govern

(ii) 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 govern

(iii) where there is a discrepancy between figures and in words of a unit rate, the unit rate as quoted in words will govern.

(iv) In case, if any of the information / details /declaration furnished by the L1 bidder is not found to be in order with the tender conditions, the bid shall be rejected and action as mentioned below will be taken on the bidder.

(v) In case, the L1 bidder fails to submit requisite documents as per NIT or if any of the information / declaration furnished by L1 bidder is found to be wrong by Tender Committee during evaluation of documents submitted by the bidder, which changes the eligibility status of the bidder (for the first time), consider as defaulted, then his bid shall be rejected and EMD or Rs 1 Lakh, whichever is lower of L1 bidder will be forfeited.

(vi) If any of the bidder defaulted in two tenders, floated by the same Tender Inviting Authority, unit head within a span of one year (to be counted with respect to date of publication of NIT), his bid shall be rejected and the EMD of L-1 bidder will be forfeited.

1.9 All pages to be initialled

All signatures in tender documents shall be dated as well. All pages of all volumes and sections of tender documents shall be initialled at the lower right-hand corner or signed wherever required in the tender documents by the Tenderer or by a person holding Power of Attorney (copy to be enclosed with Part I of Tender) authorising him to sign on behalf of the Tenderer before submission of tender.

1.10 Rates to be all inclusive

The Tenderer shall quote for the jobs on the basis of the items entered in the Schedule of Items of Work and shall quote separately for each and every item entered in Schedule of Items of Work. The rates and prices quoted shall be all inclusive as provided for in the Schedule of Items of Work and any claim whatsoever for enhancement of rates or prices quoted on any account shall not be entertained.

2. TENDER DOCUMENTS

2.1 Content of Tender Documents

2.1.1 The set of Tender Documents comprises the following documents and should be read in conjunction with any Addenda issued in accordance with Volume I, Part I, Section 2.3.2. The Implementing Agency is providing semi detailed engineering drawings (for tender purpose only in volume 5) and designs to the extent demonstrated with the specifications included in Volume 3 & 4. The required remaining detailed drawings and calculations concerning the foundations of buildings and structures, as well as for the installation of mechanical and electrical equipment shall be provided by the Contractor(s). If the detailed engineering meets the requirements of this tender the Implementing Agency shall, by means of Implementing Agency's Engineer check, and after approval, accept the detailed calculations and drawings for construction.

Volume I Conditions of Tender
- Part I : Instructions to bidders
- Part II : Documents to be supplied by tenderer

Volume II General Conditions of Contract

Volume III Technical Specifications:
- Section 1: General Specifications
- Section 2: Technical Specifications
- Section 3: Technical Data sheets

Volume IV Bill of Quantities and Price bid

Volume V Drawings

2.1.2 Documents: all documents stated in Volume I, Part II, Volume II and Volume IV as well as the additional required documents mentioned in the Tender Document shall be filled in by the tenderer with no exceptions and strictly in accordance with the conditions and provisions contained within the tender documents and with no alterations made by the tenderer. Tenders, which are not compliant with the requirements of the Tender Documents will be rejected.

2.2 Explanations concerning Tender Documents

2.2.1. Should the tenderer want to obtain any explanations or clarification concerning the tender documents, he shall inform the Implementing Agency in writing, sending his request to the address of:

Ambur Economic Development Organization
43/53, Raja Muthiah Road ,Periamet, Chennai-600 003
Telephone: 044-42041132/35528648
email: aedolchennai@yahoo.co.in, aedolchennai@gmail.com

The copy of explanations or clarification concerning the tender documents also marked to Technical Agency

Indian Leather Industry Foundation (ILIFO)
New No. 29, Old No. 14 Second Main road
Gandhi nagar, Adyar, Chennai 600020
Email id: ilifochennai@gmail.com
Tel :+9144 24410563

All Tenderer's questions shall be received at least 2 days before the date fixed for Pre-bid

meeting .The Implementing Agency shall respond to such requests in the pre-bid meeting / pre-bid meeting minutes. Copies of responses given by the Implementing Agency with a description of the questions, but without indicating the source of them, shall be sent to all persons who have bought the Tender Documents.

The Implementing Agency shall call a pre-bid meeting **on 29.02.2024 at 11.00am,** to enable the Tenderers to seek clarification or obtain additional information on the project, these instructions or other tender documents.

2.3 Alterations made to Tender Documents

2.3.1 The Implementing Agency may alter the Tender Documents by publishing addenda before the date for submission of tenders.

2.3.2 Each addendum published shall be part of the Tender Documents and shall be sent, in writing, to all persons who have bought the Tender Documents. The Tenderers shall sign each page and attach them to the Tender Documents.

2.3.4 The Implementing Agency may, as necessary in accordance with Volume I, Part I, Section 4.2, extend the date for submission of tenders to give Tenderers sufficient time to take into account such addenda when preparing their Tenders.

3. PREPARATION OF TENDERS

3.1 Language of Tenders

3.1.1. The tender, and all correspondence and documents related to the tender exchanged by the tenderer and the Implementing Agency shall be written in English language. Supporting documents and printed literature furnished by the tenderer may be in another language provided they are accompanied by an accurate translation in the English language. For the purposes of interpretation of the tender, the English translation shall prevail.

3.2. Documents forming the Tender

3.2.1. The tender submitted by the tenderer shall comprise the following duly completed documents:

a) Letter of Tender and Appendix to Tender;
b) Earnest Money Deposit (EMD).
c) Qualification Documentation as stated in Volume I, Part I, Sections 1.4.1a to 1.4.1h
d) Principle drawings, datasheets with detailed specifications, design calculations and relevant information for evaluation of the tender as stated in Volume I, Part I, Section 1.4.1.e;
e) Completed Bill of Quantities with Analysis of Rates attached, as stated in Volume I, Part I, Section 1. 4.1.f;
f) Declaration of Eligibility, Volume I, Part I, Section 1.4.1.g;
g) Site Inspection Declaration, Volume I, Part I, Section 1.4.1.h;
h) Receipt of Payment for tender documents;
i) Addenda (if any)
j) Any other documentation required to be completed and submitted by Tenderers in accordance with the Instructions to Tenderers.

3.2.2. The above specified documents shall be signed on the relevant pages of these documents as indicated and all pages shall be initialled.

3.3. Tender Prices

3.3.1. The Contract shall comprise of the whole of the Works as described in Volume I, Part I, Section 1.1.2.

3.3.2 The Tenderer shall state the Tender Amount for the complete Works including design work of Civil and MEP works, execution, completion, contingencies, commissioning, trial run and remedying of all defects therein.

3.3.3 All prices shall be inclusive of all transportation cost, insurance, taxes and duties as applicable from time to time & overheads . No additional Cost will be paid by AEDOL from the quoted price.

3.3.4 Unit prices stated by the Tenderer shall be fixed for the whole period of the Contract and shall not be subject to variation.

3.4 Currency of Tender

The currency of the project is in Indian Rupees and all unit rates, amounts and sums in the Bills of Quantities and Questionnaires shall be expressed in Indian Rupees.

3.5 Period of Validity of Tenders

3.5.1 Tenders shall remain valid for a period of **90 days** after the date of submission.

3.5.2 In exceptional circumstances the Implementing Agency may request the Tenderers to extend the validity of Tenders for a specified time. Such request and answers concerning that extension shall be made in writing. The Tenderer may refuse to comply with such a request without forfeiture of the EMD. If the Tenderer complies with such a request, he shall neither be required to, nor shall he be allowed to modify his Tender.

3.6 Earnest Money Deposit

3.6.1 The Tenderer shall provide a EMD as security for an amount of **Rs. 7.76 lakhs**. The EMD should be in the form of DD/B.G will be accepted (as mentioned in the clause 1.1.7). All other forms of submission will be rejected.

3.6.2 The EMD only in the form of Demand draft is acceptable.

3.6.3 Any Tender not secured with an acceptable form of EMD shall be rejected by the Implementing Agency.

3.6.4 The EMD of the unsuccessful Tenderers shall be released, on award of work, in any case within 30 days after the expiration of the Period of Validity of the Tender as stated in Volume I, Part I, Sections 3.5.1 and 3.5.2.

3.6.5 The EMD of the successful Tenderer shall be refunded on receipt of the security deposit or adjusted against the security deposit.

3.6.6 The Tenderer shall forfeit his EMD:

a) If he withdraws his Tender during the Period of its Validity.
b) If he does not accept adjustments to his Tender Price made in accordance with section titled

Correction of errors in the Tender document.

c) If the Contract is awarded to him and within the time specified in Volume I, Part I, Section 6.3, he is not able to provide the required Security deposit.

3.7 Preparation and Signing of Tender

3.7.1 The Tenderer shall prepare one original and 2 copies of documents forming the Tender, with clear marking as “Original" or "Copy". In case of divergence between them the original shall prevail.

3.7.2 The original and all copies of the Tender shall be typewritten or written in indelible ink and signed by a person or persons authorised to sign on behalf of the Tenderer and returned with Technical Bid. The person or persons signing the Tender shall initial all pages where entries or amendments have been made.

3.7.3 No alterations, additions or deletions whatsoever shall be made to the printed text of any Tender Documents, unless specified in the Addenda. If any alteration, addition or deletion not specified in the Addenda is made or if the Tender Documents are incompletely or improperly filled in, the Tender will be rejected.

4. SUBMISSION OF TENDERS

4.1 Sealing and marking of Tenders

4.1.1 The Tenderer shall seal the original and the copies of the Tender in an internal and an external envelope, marking the internal envelopes "Original" or "Copy".

4.1.2 The inside and outside envelope shall be marked as described below and the original and 2 copies shall be sent to:

a) addressed to:

The Managing Director
Ambur Economic Development Organization
43/53, Raja Muthiah Road ,Periamet, Chennai-600 003
Telephone: 044-42041132/35528648
email: aedolchennai@yahoo.co.in, aedolchennai@gmail.com

b) and marked as follows:

Tender for DESIGN, DETAILED ENGINEERING, SUPPLY, INSTALLATION, COMMISSIONING AND TRAIL RUN INCLUDING CIVIL WORKS ON TURNKEY BASIS OF 500 KG/HR. HOLLOW PADDLE SLUDGE DRYER BASED ON THERMIC FLUID HEATING SYSTEM

DO NOT OPEN BEFORE OFFICIAL OPENING DATE AND TIME

Tenderers submitted by post shall be sent by “REGISTERED POST ACKNOWLEDGEMENT DUE” and shall be posted with due allowance for any postal delay. AEDOL takes no responsibility for delay, loss or non-receipt of tenders sent by post.

4.1.3 Apart from the markings described above the internal envelopes shall bear the name and address of the Tenderer to enable it to be returned in case of delay in delivery.

4.1.4 In the case the external envelope is not marked and sealed as above the Implementing Agency shall not be in any way responsible for inappropriate placing or for premature opening of the

envelope.

4.1.5 Procedure for submission of sealed bids

The Tenderers must submit their bids original and copies as required in Two Parts in separate sealed covers prominently superscribed as Part I **"Technical Bid"** and Part II **"Price Bid"** and also indicating on each of the covers the tender specification number and due date and time as mentioned in the tender notice.

COVER I (Technical Bid)
Excepting Rate Schedule, all other schedules, bill of quantities, data sheets, drawings and details called for in the specification shall be enclosed in Technical Bid only. All pages of tender document to be read and signed by the bidder and should be enclosed with the Tender document.

COVER II (Price Bid)
- All indications of price shall be given in this Price Bid required within this Volume,

These two separate sealed covers I & II shall together be enclosed in a third envelope **(Cover III)** as indicated. This sealed cover shall be marked and addressed, and submitted.

The tenderers will be intimated separately about the status of their offer. They will be intimated separately in case any clarifications are required.

4.2 Extension of time for submission of Tenders

The Implementing Agency may, at its discretion, extend the deadline for submission of Tenders by issuing an amendment. In such cases all rights and obligations of the Implementing Agency and the Tenderer regarding the original date shall be subject to the new date.

4.3 Delayed Tenders

All Tenders received after the deadline for submission, shall not be opened and will be returned to the Tenderers.

4.4 Tenders alterations and withdrawal

4.4.1 The Tenderer may alter or withdraw his Tender after it has been submitted, by written notification before the submission date.

4.4.2 Such notification about alteration or withdrawal shall be prepared, sealed, marked and submitted. The internal and external envelope shall, in addition, be marked as "Alteration" or "Withdrawal".

4.4.3 No Tender may be altered after the deadline for submission of Tenders.

4.4.4 The withdrawal of the Tender in the period between the deadline for submission of Tenders and the date of expiration of validity of the Tender will result in forfeiture of the EMD.

5. OPENING AND ANALYSIS OF TENDERS

5.1 Opening of Tenders

5.1.1 The Implementing Agency has constituted a Tender Evaluation Committee (TEC). The TEC will scrutinise in detail the information/documentation supplied by the Tenderers in compliance with Volume I, Part I, Section 1.4 and will formulate its judgement on the Tender.

5.1.2 The Implementing Agency shall open the Tenders in the presence of representatives of the Tenderers who wish to attend the opening ceremony. The minutes of the opening session will be recorded separately and may be made available to the Tenderers on their request.

5.1.3 Envelopes marked "Withdrawal" shall be opened and read out at first. Tenders for which an acceptable notice of withdrawal has been submitted.

5.1.4 The main cover containing Cover I and Cover II of the Tender shall be opened on the due date and the time. After opening the main cover, the envelope containing Cover I shall be opened first. The Implementing Agency shall announce during the opening session the names of the Tenderers and others particulars the Implementing Agency considers important.

Cover II shall not be opened until the Implementing Agency has evaluated and cleared the documents present in Cover I and has accepted the tender as a complying Tender.

5.2 Secrecy of procedure

Information concerning checking, explanation, opinions and comparison of Tenders, and also recommendations concerning the award of the Contract shall not be disclosed to the Tenderers or to any other person who is not officially concerned in the process until the name of the successful Tenderer is announced. Any efforts made by a Tenderer to influence the evaluation of Tenders carried out by the Implementing Agency or its decisions concerning the award of the Contract will result in the rejection of his Tender.

5.3 Clarification of Tenders

The Implementing Agency may, at its discretion, ask any Tenderer to clarify his Tender, provide additional technical information if any, relevant for the project and/or submit a breakdown of his unit prices, when this is required to check and compare Tenders. Such requests, and the relevant response, shall be made in writing or by using email. It shall not be allowed to propose, alter or try to change the price or content of the Tender, except for adjusting arithmetical errors discovered by the Implementing Agency when analysing Tenders.

5.4 Checking of Tenders and their compliance to the requirements

5.4.1 Before a detailed analysis of Tenders, the Implementing Agency shall determine if each Tender:
a) has been properly signed,
b) has the EMD,
c) in its substance complies with the requirements stated in the Instructions to Tenderers.

5.4.2 A complying Tender is one which conforms to the requirements and specifications described in the Tender Documents without essential deviations or reservations. Essential deviations and reservations include those which:
a) in any way influence the scope, quality and execution of Works,
b) essentially limit the rights of the Implementing Agency or the obligations of the Tenderer under the Contract in a way inconsistent with the Tender Documents,

c) or would affect competitiveness of other Tenderers submitting offers in the substance conforming to the requirements.

5.4.3 If the tender does not suit the requirements, it shall be rejected by the Implementing Agency.

5.5 Correction of errors

5.5.1 The Implementing Agency shall check the complying tenders for arithmetical errors, and, shall adjust errors as described below:

a) if there is a difference between a unit price and the amount resulting from multiplying the unit price by the relevant quantity, the unit price shall be valid except when an obvious error (such as misplacing decimal point) in the unit price has, in the opinion of the Implementing Agency, occurred. In such case the amount stated shall prevail and the unit price shall be adjusted;

b) if there is a discrepancy between the sum of the amounts and the subtotals or totals of the Schedule, then the amounts as quoted or corrected in accordance with this clause will govern and all derived subtotals or totals will be adjusted.

5.5.2 The amount stated in the Letter of Tender shall be adjusted by the Implementing Agency in accordance with the above-mentioned procedure and such adjusted amount shall be considered binding upon the Tenderer without price correction. If the Tenderer does not accept such adjustment, his Tender shall be rejected and he will forfeit the EMD.

5.6 Technical evaluation and comparison of Tenders

5.6.1 The Implementing Agency shall analyse and compare only Tenders determined as complying according to Volume I, Part I, Section 5.4. The decision of the IMPLEMENTING AGENCY to determine an offer as 'complying' or 'non-complying' shall be the sole discretion of the TEC and is binding on the Tenderer.

5.6.2 The IMPLEMENTING AGENCY will evaluate the technical qualifications and capability of the Tenderers according to the quality of information provided in fulfilment of the requirements which are summarised as follows:

- Experience of management and key personnel.
- Experience of the firm in similar assignments.
- Properly prepared work schedule.
- Quality Assurance System to be used.
- List of proposed equipment.
- List of proposed staff.
- Quality of drawings and design calculations.
- Quality and transparency of Tenderer's pricing calculations.

Tenders found to be insufficiently responsive to the criteria will be rejected. Only Tenders that have been found sufficiently responsive will be considered for the Price evaluation.

5.6.3 When conducting the Price evaluation, the IMPLEMENTING AGENCY shall determine the final Tender Price after adjusting the Tender Price, if required, as provided in Volume I, Part I, Section 5.5.

6. AWARD OF CONTRACT

6.1 Criteria of Award

Subject to Volume I, Part I, Section 6.2, the IMPLEMENTING AGENCY will select the Tenderer whose Tender has been determined to comply with the requirements of Volume I, Part I, Sections 3.6 and 5.6, and in addition has offered, in the opinion of the IMPLEMENTING AGENCY, the most economically advantageous offer. However, the IMPLEMENTING AGENCY reserves the right to select any of the offers respective of without it being not the lowest, without assigning any reason. Being the lowest, does not qualify any of the Tenderers to get the job automatically.

6.2 Right of the Implementing Agency to accept any Tender and to reject any or all Tenders

Notwithstanding the provisions of Volume I, Part I, Section 6.1, the Implementing Agency reserves the right to accept or reject any Tender and/or cancel the whole process of Tendering and reject all Tenders at any time before awarding the Contract without any liability to the Tenderers concerned and obligation to inform them about the reasons of such action. The Implementing Agency reserves the right to initiate a new Tendering procedure at any point of time during the tender.

6.3 Notification of Award

6.3.1 Prior to the expiration of the period of Tender Validity, prescribed in Volume I, Part I, Sections 3.5 and 4.3, the Implementing Agency will notify the successful Tenderer by facsimile, confirmed by registered letter, that his Tender will be accepted. This letter (hereinafter and in the Conditions of Contract called the "Letter of Acceptance") shall name the sum, which the Implementing Agency will pay the contractor in consideration of the execution, completion and maintenance of the Works as prescribed by the Contract (hereinafter and in the Conditions of Contract called the "Accepted Contract Amount").

6.3.2 The Letter of Acceptance will constitute the formation of the Contract, subject only to furnishing of a security deposit in accordance with the provisions of Volume I, Part I, Section 6.3.

6.3.3 Upon furnishing by the successful Tenderer of a security deposit, the Implementing Agency will promptly notify the other Tenderers that their Tenders have been unsuccessful.

6.4 Security Deposit

6.4.1 The Tenderer whose Tender has been selected will be required to provide a Security deposit amounting to 3% of the Contract value in the form of an irrevocable bank guarantee from any nationalised Bank in India within 7 days from the date of issuance of letter of Intent. The Security deposit shall be irrevocable and unconditional with payment on demand.

6.4.2 If the successful Tenderer fails to submit evidence to the Implementing Agency of the Security deposit within 7 days after receiving the Letter of Intent, then the Implementing Agency may consider the selection of the Tender to be cancelled without prejudice to any claims, rights, or remedies the Implementing Agency may have in respect of such failure and the Contractor shall have no claim whatsoever on the Implementing Agency or other interested parties. In such cases the EMD submitted by the Tenderer shall be forfeited.

6.4.3 After receipt of the evidence of the security deposit and all Requirements and Conditions of Contract are met, the Implementing Agency will issue the Notice of Commencement to the

Contractor.

6.4.4 Security deposit will be returned to the contractor along with final payment subject to fulfilment of successful performance run and other requirements.

6.5 Contract agreement

Upon receipt of the security deposit, the successful tenderer will make the final structural design (based on the soil investigation report) and other MEP design calculation, based on which the technical supervisor will draft an agreement in the prescribed format given in Volume 2: Conditions of contract, in due consultation with the Technical agency and Implementing Agency.

The contract agreement shall form the basis of all interpretations related to the Work and basis of payment etc.

6.6 Payment Terms

The payment schedule for the project shall be as follows:

For civil works:

80% of the payment against running bills in not more than 5 instalments.
10% of the payment against leak test/finishing of the civil works.
10% of the payment against handing over of the plant and against receipt of PBG along with retention money. (Retention money of 10% shall be deducted against each bill value)

For Electro-mechanical Works:

70% of the payment against delivery at site (not more than 3 lots)
10% of the payment against erection (not more than 2 bills)
10% of the payment against trial run and submission of all documentation including warranty card, O&M manuals, Test certificates, As built drawings etc.,
10% of the payment against handing over of the plant successful completion of the plant including completion of performance guarantee test run (PGTR) for 72 hours and reliability test run (RTR) for one month and against receipt of PBG along with retention money. (Retention money of 10% shall be deducted against each bill value)

6.7. Completion of commissioning

The Paddle dryer with all its accessories will be treated as successfully commissioned once it is operated continuously for a period of 72 hrs non-stop and reliability test run (RTR) for one month and should meet output standards given in the tender document.

ANNEX 1 SCHEMATIC ILLUSTRATION OF TENDERERS WORKS OBLIGATIONS

The tenderer's obligations include the execution of the following activities:

1. Civil works

- Preparation of final concrete and final foundation calculations based on the results of the soil investigations on the CETP site (see Volume 2, Part I.1, General Conditions Clause 4.10)
- Preparation of final construction drawings
- After approval of design calculations and drawings, execution of all civil works (including all materials, labour, equipment, etc.)
- After completion of the works, testing of all constructed items
- Leak testing of all civil structures;
- Repair of any defects identified during the testing period

2. Mechanical works

- preparation of final calculations and specifications for the mechanical equipment
- preparation of final drawings and specifications for installation of the selected equipment items
- after approval of calculations and drawings, execution of delivery installation and "ready for operation" on the delivery of all mechanical works
- after completion of the installation works, commissioning and testing of the equipment
- repair of any defects identified during the testing period.

3. Piping

- preparation of all documents according to the specifications for piping including MoC of piping.
- preparation of all final detailed drawings of the piping works.
- after approval of design specifications and drawings, execution of delivery, installation and in-situ testing.
- after completion of the installation works, commissioning and testing of the equipment
- repair of any defects identified during the testing period.

4. Electrical works and instrumentation

- preparation of all documents according to the specifications for electrical works and instrumentation
- preparation of all final detailed drawings of the electrical equipment and instruments
- after approval of design specifications and drawings, execution of delivery, installation and "ready for operation" of all electrical equipment and instruments
- after completion of the installation works, commissioning and testing of the equipment
- repair of any defects identified during the testing period.

ANNEX 2 APPENDIX TO TENDER

Item	Sub-Clause Conditions of Contract	Entry
Implementing Agency's name and address		The Managing Director AMBUR ECONOMIC DEVELOPMENT ORGANISATION (AEDOL) 43/53, Raja Muthiah Road ,Periamet, Chennai-600 003 Telephone: 044-42041132/35528648 email: aedolchennai@yahoo.co.in, aedolchennai@gmail.com
Contractor's name and address ……		_____
Engineer's name and address ……..		_____
Time for completion of the Works …..		31st March 2025
Defects Notification Period for date of successful commissioning ……		365 days
Electronic transmission system ……..		E-mail
Governing Law ……..		Law of the Peoples Republic of India
Ruling Language ……		English
Language for Communications ……..		English
Time for access to Site ……..		0 days after the Commencement Date
Amount of Security deposit ……		3 % of the Accepted Contract Amount, in the currencies and proportions in which the Contract Price is payable
Normal working hours ……		8 hours
Delay damages for the Works ……		0.2% of the final Contract Price per day, in the currencies and proportions in which the Contract Price is payable
Maximum amount of delay damages ..		10% of the final Contract Price
Number and timing of instalments		
Currencies and proportions		.....% in..... .....%in .....

Initials of signatory of Tender .....

Percentage of Retention ……	10 %
Limit of Retention Money ……..	10 % of the Accepted Contract Amount
Minimum amount of Interim Payment Certificates ……..	5% of the Accepted Contract Amount
Periods for submission of Insurance	
(a) evidence of insurance ……..	28 days
(b) relevant policies ……..	60 days
Maximum amount of deductibles for insurance of the Employer's risks ……..	Indian Rupees for each and any occasion and each and any person
Minimum amount of third party insurance ……	Indian Rupees 2,000,000 for each and any occasion and each and any person
Date by which the DAB shall be appointed ……..	28 days after the Commencement Date
The DAB shall be ……..	One sole Member / adjudicator

Initials of signatory of Tender _____

TENDER DOCUMENT
(National Competitive Bidding)

For

Upgradation of Common Effluent Treatment Plant (CETP) at Amburtec - Thuthipet sector, Ambur

TENDER – 8/2024

DESIGN, DETAILED ENGINEERING, SUPPLY, INSTALLATION, COMMISSIONING AND TRAIL RUN INCLUDING CIVIL WORKS ON TURNKEY BASIS OF 500 KG/HR. HOLLOW PADDLE SLUDGE DRYER BASED ON THERMIC FLUID HEATING SYSTEM

Volume-I

Part – II

Instructions to Bidders

AMBUR ECONOMIC DEVELOPMENT ORGANISATION (AEDOL)

43/53, Raja Muthiah Road ,Periamet, Chennai-600 003

Telephone: 044 - 42041132 / 35528648

email: aedolchennai@yahoo.co.in, aedolchennai@gmail.com

PART II - DOCUMENTS TO BE SUPPLIED BY THE TENDERER

VOLUME 1 - CONDITIONS OF TENDER

Part II: Documents to be supplied by the Tenderer:

Letter of Tender
Declaration of eligibility
Site inspection form
Questionnaire:

- General information about Tenderer
- Organisation chart / Power of attorney
- Financial statement from authorised Chartered Accountant
- Technical qualifications
- List of all personnel involved
- Profession experience record (Curricula Vitae)
- Workplan & Programme
- Experience as Contractor
- Pre-qualification documents: The bidder is to submit work order clearly mentioning the value of work, nature of work along with completion certificate, turnover, incorporation certificate, GST registration certificate.

LETTER OF TENDER

Name of contract: **Design, Detailed Engineering, Supply, Installation, Commissioning and Trail Run including civil works on Turnkey Basis of 500kg/hr hollow paddle sludge dryer complete with Thermic Fluid Heating System – Amburtec – Thuthipet**

to: AMBUR ECONOMIC DEVELOPMENT ORGANISATION (AEDOL)
43/53, Raja Muthiah Road, Periamet, Chennai-600 003

We have examined the Conditions of Contract; Specifications, Drawings, Bill of Quantities, the other Schedules, the attached Appendix and Addenda Nos. . for the execution of the above-named Works. We offer to design, execute and complete the Works and remedy any defects therein in conformity with this tender, which includes these documents, for the sum given in the price bid or such other sum as may be determined in accordance with the Conditions of Contract.

We agree to abide by this tender until _____ (*date*) and it shall remain binding upon us and may be accepted at any time before that date. We acknowledge that the Appendix forms part of this Letter of tender.

If this offer is accepted, we will provide the specified Security Deposit, commence the works as soon as is reasonably practicable after the commencement date, and complete the Works in accordance with the above-named documents within the time specified for completion.

Unless and until a formal Agreement is prepared and executed this Letter of tender, together with your written acceptance thereof, shall constitute a binding contract between us.

We understand that you are not bound to accept the lowest or any tender you may receive.

Signature _____ in the capacity of _____

duly authorised to sign tenders for and on behalf of _____

Address _____

_____

Date: _____

DECLARATION OF ELIGIBILITY

Name of contract: **Design, Detailed Engineering, Supply, Installation, Commissioning and Trail Run including civil works on Turnkey Basis of 500kg/hr hollow paddle sludge dryer complete with Thermic Fluid Heating System – Amburtec – Thuthipet**

Name and address of Employer AMBUR ECONOMIC DEVELOPMENT ORGANISATION (AEDOL)
43/53, Raja Muthiah Road, Periamet, Chennai-600 003

_____(together with successors and assigns, all as defined in the Contract as the Employer)

Name and address of Tenderer: _____

Whereas the tenderer declares in accordance of Instructions to tenderers; Conditions of tender; that all eligibility criteria set forth in tender document and Instructions to Tenderers; Conditions of Tender are met, namely that:

(i) none of the following applies to us, that:

a) We are bankrupt;

b) Payments to us have been suspended in accordance with the judgement of a court or a judgement declaring bankruptcy and resulting, in accordance with our national laws, in total or partial loss of the right to administer and dispose of our property;

c) Legal proceedings have been instituted against us involving an order suspending payments and which may result, in accordance with our national laws, in declaration of bankruptcy or in any other situation entailing the total or partial loss of the right to administer and dispose of our property;

d) We are guilty of serious misrepresentation with regard to information required for participation in an invitation to tender;

e) We are in breach of contract on another contract with the Employer and/or the State of Tamil Nadu;

f) We (including all partners of a joint venture and all subcontractors of a tenderer) have any connection with a firm or entity which has provided consulting services during the preparatory stages of the works or of the project of which the works form a part, or which has been hired (or is intended to be hired) as the Employer's Representative for the Contract.

(ii) The above criteria also apply to our Sub-Contractors and Suppliers.

(iii) In particular we meet and conform to the following criteria:

1. We have Permanent Account Number (PAN) and GST registration (GSTIN) valid on date of bid submission.
2. The bidder should have satisfactorily completed a minimum of three similar works, each costing not less than the amount equal to Rs. 155.20Lakhs or two similar works, each costing not less than the amount equal to Rs. 232.80Lakhs or one similar work costing not less than the amount equal to Rs.310.40Lakhs within the last 7 **years** as on 31.01.2024.
3. We have satisfactorily completed at least one paddle dryer system of minimum 300 kg/hr capacity in the past five years 31.01.2024. and unit shall be in successful operation for minimum period of one year as on 31.01.2024.
4. We have minimum average annual turnover of Rs. 500.00Lakhs as per the audited balance sheet in the last 3 consecutive financial years.
5. We are not a part of any Consortium or Joint-Venture.
6. We have not been black listed/debarred by any Government organization.
7. Our company should is an registered company (under Indian Companies Act) operating in INDIA for a period of more than 3 years.

Signature(s) for and on behalf of the Tenderer _____

Date _____

SITE INSPECTION DECLARATION

Name of contract: **Design, Detailed Engineering, Supply, Installation, Commissioning and Trail Run including civil works on Turnkey Basis of 500kg/hr hollow paddle sludge dryer complete with Thermic Fluid Heating System – Amburtec – Thuthipet**

Name and address of Employer AMBUR ECONOMIC DEVELOPMENT ORGANISATION (AEDOL)
43/53, Raja Muthiah Road, Periamet, Chennai-600 003

_____(together with successors and assigns, all as defined in the Contract as the Employer)

Name and address of Tenderer: _____

We/I as tenderer declare that; we have inspected the Site on _____ (*date)* represented by Messrs

_____
_____
_____
_____(*names and addresses representatives)*

We have familiarised ourselves, so far as practicable, with the local conditions in general, and the situation with regard to the supply of local materials and electricity, gas, water and other services, and we fully understand the nature and scope of the Works.

We have also acquainted ourselves with the conditions in the State of Tamil Nadu, and the access and transport routes and facilities to the Sites

Signature(s) for and on behalf of the Tenderer _____

Date _____

FORMAT OF BID GUARANTEE

NOTE:

1. This guarantee should be furnished by a Nationalised Bank/ Scheduled Bank, authorized by RBI, in the format as given below.
2. The bank guarantee should be furnished on stamp paper of value not less than Rs. 100/- as per Stamp Act.
3. The stamp paper shall have been purchased in the Name of the Bank executing the Guarantee.
4. This Document is not required to submit, if the bidder submitting the bid Guarantee as Demand Draft

---

REF: …… DATE
BANK GUARANTEE NO:

To
AEDOL,
Chennai.

Dear Sirs,

In accordance with your "Invitation to Bid" under your Tender No……. M/s…….. herein after called the Bidder, with the following Directors on their Board of Directors/partners of the firm:

1…….	2……..
3…….	4……..
5……	6……..
7……	8……..
9…….	10…….

wish to participate in the said bid for furnishing the following:-

As an irrevocable Bank Guarantee against Bid Guarantee for a sum of INR .....(in words and figures) valid for 10 months from ……(the date of bid opening) is required to be submitted by the Bidder as a condition precedent for participation in the said bid, which amount is liable to be forfeited on the happening of any contingencies mentioned in the Bid documents.

We the ……. Bank at ……. Having our Head Office at …….(local address) guarantee and undertake to pay immediately on demand by AEDOL, stating that

a) the bid has been unilaterally revoked/revised/modified/withdrawn before expiry of bid validity period, by the Bidder(s);or
b) the price(s) have been unilaterally increased or altered after the bid opening and during validity of the offer, by the Bidder; or
c) On issue of LOA by AEDOL to the bidder, the bidder has omitted or refused to accept the said LOA within the stated period and/or execute the Contract agreement; or
d) The Bidder, after issue of LOA, omitted or failed to submit Contract Performance Guarantee within the specified period,
e) The Bidder furnished Forged/Bogus Certificates

The amount of …. to the said AEDOL without any reservation, protest demur and recourse. Any such demand by the AEDOL shall be conclusive and binding on the bank irrespective of any dispute or difference raised by the bidder.

The guarantee shall be irrevocable and shall remain valid upto ……If any further extension to this guarantee is required the same shall be extended to such required period (not exceeding one year) on receiving instruction from M/s ..... on whose behalf this guarantee is issued. Notwithstanding anything contained herein:

a. Our liability under this bank guarantee shall not exceed..... (in words)
b. This bank guarantee shall be valid upto ..... and
c. We are liable to pay the guaranteed amount or any part thereof under this bank guarantee only and only if you serve upon us a written claim or demand on or before……..

In witness whereof the Bank, through its authorized Officer has set its hand and stamp on this ……..day of …. at …….

WITNESS (Signature)

1. Signature…….. Name in

Block Letters Name in (Block Letters)

Occupation

Address (Designation)……

2. Signature Staff Code No……..

Name in Block Letters (Bank's Seal) Occupation

Address Attorney as per Power of

Attorney No.

Dated.

QUESTIONNAIRE

(SCHEDULES OF SUPPLEMENTARY INFORMATION)

1. **General information about the tenderer**

2. **Organisation chart/Power of Attorney of tenderer**

3. **Organisation chart/Power of Attorney of site operation staff**

4. **Financial statement tenderer**

5. **Technical qualifications tenderer**

   5.1 Number of Staff
   5.2 Personnel to be employed on the Contract for the execution of Mechanical Works
   5.3 Equipment for Mechanical fabrication

6. **List of all personnel involved**

7. **Workplan & Programme**

8. **Experience as contractor**

9. **Additional information**

QUESTIONNAIRE

ADDITIONAL NOTICE TO TENDERERS

1. All questions comprised in the Forms shall be answered.
2. Additional sheets may be attached as necessary.
3. If a question does not apply to the applicant "Not applicable" shall be written.
4. Every page of individual form shall be numbered at the space provided in the upper right corner.
5. Financial data and declarations presented by the tenderer shall be given in Indian Rupees. Original bank statements can also be attached for the reference.
6. Attached documentation/certificates must always be accompanied with relevant translation into English, at least for those parts and wordings necessary to render their content unequivocally understandable.
9. The signatory of this questionnaire guarantees the truth and accuracy of all the statements made.
10. Accuracy in the filling in of the questionnaire, its completeness and attached documentation will be duly taken into account in the tender evaluation. The attention of the Tenderers is also drawn to the fact that absence of some data may cause minimum scoring in the related item of evaluation.

1. GENERAL INFORMATION ABOUT THE TENDERER

i - Name of Company .....
.....

ii - Registered Address .....
.....
.....
Tel. .....
Telefax..... .....
E-mail .....
Telex .....

iii - Name of Principals/Directors & Associates
(Nationality to be stated in the case of personnel not a citizen of India)
.....
.....
.....
.....

iv - Type of Company
(Individual, Partnership, Corporation, Joint Venture, etc.)
.....

v - Company's Original Nationality .....

vi - Number of Years in Business as Contractor .....

vii - Registration Particulars .....
.....
(Please attach copy of the Registration Certificate)

viii - Participation in the Company Share (%)
.....
.....
.....

ix - Name(s) and address(es) of associated Company(ies) to be involved in the project and whether parent/subsidiary/other:
.....
.....
.....

x - Foreign Companies shall indicate whether or not they are established in India in accordance with applicable regulations

Initials of signatory of Tenderer: _____

2. ORGANISATION CHART/POWER OF ATTORNEY OF TENDERER

i - Please give details hereafter of the **Organisation Chart** of your Company, showing the position of directors, key personnel and functions.

ii - Please attach here the **Power of Attorney** of the signatory of the Questionnaire and tender documentation.

Initials of signatory of Tenderer: _____

3. ORGANISATION CHART/POWER OF ATTORNEY OF SITE OPERATION STAFF

Please give details hereafter of the **Organisation Chart** of site operation staff for execution of the project showing the position of directors, key personnel and functions.

- for overall coordination and execution

- for execution of mechanical works

- for execution of electrical works

- for execution of civil works

Initials of signatory of Tenderer: _____

4. FINANCIAL STATEMENT TENDERER

i - Basic Capital:
Authorised:
Issued:

ii - Annual value of works undertaken for each of the last three years (as on 31 March)

	2021-2022	2022-2023	2023-2024	TOTAL
Home				
Abroad				
Total				

iii - Approximate value of Work in hand (home + abroad)……

iv - Please attach copies of the Company's previous three years certified statements of account (with translation in English) from which the following basic data shall be abstracted:

Financial Year	2021-2022	2022-2023	2023-2024
1. Total Assets 2. Total Liabilities *Net Value (1-2)*	…… ……	…… ……	…… ……
4. Current Assets 5. Current Liabilities *Circulating Capital (4-5)*	…… ……	…… ……	…… ……
6. Profit (before taxation) 7. Loss	……	……	……

v - Name and address of Bankers:
……
……
……

vi - Please enclose a reference/certificate about the financial situation of the Company and access to credit facilities (maximum amount of credit facility to be stated):
…… *(equivalent of Indian Rupees).*

vii - Please provide financial projections for the forthcoming 2 years.

Initials of signatory of Tenderer: _____

5. TECHNICAL QUALIFICATIONS OF TENDERER

5.1 Number of Staff

i - Overall		
a - Directors and Management		……..
b - Administrative Staff		……..
c - Technical Staff		
- Engineers	……..	
- Foremen	……..	
- Machine Operators	……..	
- Surveyors	……..	
- Mechanics	……..	
- Drivers	……..	
- Other skilled staff	……..	
- Labour and unskilled staff	……..	
Sub total technical staff		……..
Total overall staff		……..

ii - Site Operative Staff to be employed on the Contract (if relevant)	
- Engineers	……..
- Foremen	……..
- Machine operators	……..
- Surveyors	……..
- Mechanics	……..
- Drivers	……..
- Other skilled staff	……..
- Labour and unskilled staff	……..
Total	……..

5.2 Personnel to be employed on the Contract for the Execution of Mechanical Works

Key Personnel (Site Management)

Position/Name	Nationality	Age	Education / Degree	Years of experience (with the company / in proposed position)	Major works for which responsible (Project/Value)
			/	/	/
			/	/	/
			/	/	/
			/	/	/
			/	/	/
			/	/	/
			/	/	/
			/	/	/

For each of the listed person, the following **PROFESSIONAL EXPERIENCE RECORD** has to be filled out and submitted.

5.3 Equipment for Mechanical Works

Equipment proposed and available for the execution of the Contract)

DESCRIPTION (Type/Make/Model)	Power/ Capacity	No. of Units	Age (years)	Owned (O) or hired (H) / % of ownership
				/
				/
				/
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				/
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				/

not the whole fleet of equipment owned by the Contractor

Note: For each subcontractor, additional sheets should be enclosed.

6. WORKPLAN & PROGRAMME

i - State the proposed location of your **Main Site Office**, plant (steel structure/ concrete /asphalt) yard, laboratory, site accommodation, etc. (sketches to be attached as required)
ii - Give a brief outline of your **programme** for the completion of the Works in accordance with the required method of construction and stated time of completion
iii - Present a detailed outline of the **Quality Assurance System** to be used.
iv - Attach a critical **bar chart** (schedule of Execution) representing the Construction Programme and detailing the relevant activities, dates, allocation of labour and plant resources, etc. of civil works and electrical works
v - **Subletting:** if the tenderer intends to sub-contract part of the works as a special case under the Contract he is required to present a copy of the registration certificate of subcontractors and suppliers and provide the following details:

Work intended to be sub - contracted	Name and details of Sub-contractor	Value of Sub-contract as % of total construction cost	Experience of the subcontractor in similar work

7. EXPERIENCE AS SUPPLIER

i. List of Contracts of similar nature and extent performed during the past 12 years as principle (main or leading) contractor **on the Indian Sub-Continent**

Client and capacity	Total Value of Works the Contractor was responsible for	Type of effluent treated	Period of Contract	Commencement	Completion	Client with Contact person and phone No,	Country/Place

ii. Please attach here available references and certificates from the Clients.

8. ADDITIONAL INFORMATION

i. The tenderer may add here any **further information** that he may deem to be useful for the evaluation of his tender.

ii. **Tender Fee**: please attach here a photocopy of the receipt of payment of the Tender Fee.

TENDER DOCUMENT
(National Competitive Bidding)

for

Upgradation of Common Effluent Treatment Plant (CETP) of Thuthipet, Ambur

TENDER – 2/2024

Design, Detailed Engineering, Supply, Installation, Commissioning and Trail Run including civil works on Turnkey basis of 500kg/hr. hollow paddle sludge dryer based on Thermic fluid heating system

Volume II

General Condition of Contract

AMBUR ECONOMIC DEVELOPMENT ORGANISATION (AEDOL)
43/53, Raja Muthiah Road ,Periamet, Chennai-600 003

Telephone: 044-42041132

email: aedolchennai@yahoo.co.in,
aedolchennai@gmail.com

Schedule F

GENERAL RULES & DIRECTIONS:

Any Bank guarantee bonds submitted by the Contractor should be issued by the any Nationalized Bank in 100 rupees stamp paper

Officer inviting tender: Managing Director, AEDOL

Definitions

2(v) Engineer-in-Charge : Represented by AEDOL

2(viii) Accepting Authority : Represented by AEDOL

Clause 1

Time allowed for submission of Security Deposit

From the date of issue of letter of acceptance : 15 days

Clause 1A

Recovery of retention money : 10 % in each running bill

Clause 2

Penalty for delay in completion : Yes

Compensation 0.2% of the final Contract Price per day subject to maximum of 10%.

Clause 5

Time allowed for execution of works : 12 months

Number of days from the date of issue of letter of acceptance for reckoning date of start : 10 days

Authority to decide for:

(i) Extension of time : Managing Director (MD), AEDOL

(ii) Rescheduled of milestones: Managing Director, AEDOL

Clause 16 (Settlement of Disputes & Arbitration)

In the case of any arbitration, it is to be settled within the jurisdiction of Chennai

Constitution of Dispute Redressal Committee (DRC)	Competent Authority to appoint DRC
DRC shall constitute one Chairman and two members	Managing Director, AEDOL, Chennai

Assistant Engineers retired from Government services that are holding Diploma will be treated at par with Graduate Engineers.

CONDITIONS OF CONTRACTS

Definitions

The Contract means the documents forming the tender and acceptance thereof and the Formal the Contractor, together with the documents referred to therein including these conditions, the specifications, designs, drawings and instructions issued from Time to Time by the Engineer-in-Charge and all these documents taken together, shall be deemed To form one contract and shall be complementary to one another.

In the contract, the following expressions shall, unless the context otherwise requires, have the meanings, here by respectively assigned to them:-

The expression works or work shall, unless there be something either in the subject or context repugnant to such works, to be carried out and taken to mean the works by or by virtue of the contract contracted to be executed whether temporary or permanent, and whether original, altered, substituted or additional.

The Site shall mean the building/land /or other places on, in to or through which work is to be executed under the contract which may be allotted or used for the purpose of carrying out the contract.

The Contractor shall mean the individual, firm or company, whether incorporated or not, undertaking the works and shall include the legal personal representative of such individual or the persons composing such firm or company, or the successors of such firm or company and the permitted assignees of such individual, firm or company.

The AEDOL means the Managing Director, AMBUR ECONOMIC DEVELOPMENT ORGANISATION (AEDOL), Chennai and his/her successors.

The Engineer-in-charge means the representative of AEDOL.

Accepting Authority shall mean AEDOL.

Excepted Risk are risks due to riots (other than those on account of contractor's employees),war (whether declared or not) invasion, act of foreign enemies, hostilities, civil war, rebellion revolution, insurrection, military or usurped power, any acts of Government, damages from aircraft, acts of God , such as earthquake, lightening and unprecedented floods, and other causes over which the contractor has no control and accepted as such by the Accepting Authority

Schedule(s) referred to in these conditions shall mean the relevant Proforma of schedule(s) annexed to the tender papers of the AEDOL mentioned in Schedule 'F' hereunder, with the amendments there to issued up to the date of receipt of the tender.

Department means AEDOL which invites tenders as specified in schedule 'F'.
District Specifications means the specifications followed by the State Government in the area where the work is to be executed.
Tendered value means the value of the entire work as stipulated in the letter of award.

Date of commencement of work: The date of commencement of work shall be the date of start as specified in schedule 'F' or the first date of handing over of the site, whichever is later, in accordance with the phasing if any, as indicated in the tender document.

Scope and Performance

Where the context so requires, words imparting the singular only also include the plural and vice versa. Any reference to masculine gender shall whenever require include feminine gender and vice versa.

Headings and Marginal notes to these General Conditions of Contract shall not be deemed to form part thereof or be taken into consideration in the interpretation or construction thereof or of the contract.

The contractor shall be furnished, free of cost one certified copy of the contract documents except standard specifications and such other printed and published documents, together with all drawings as may be forming part of the tender papers. None of these documents shall be used for any purpose other than that of this contract.

Works to be carried out

The work to be carried out under the Contract shall, except as otherwise provided in these conditions, include all labour, insurance for men and materials, tools, plants, equipment and transport which may be required in preparation of and for and in the full and entire installation, testing and commissioning of the tendered mechanical and electrical works. The descriptions given in the Schedules shall, unless otherwise stated, be held to include wastage on materials, carriage and cartage, carrying and return of empties, hoisting, setting, fitting and fixing in position and all other labours necessary in and for the full and entire installation, testing and commissioning of the work as aforesaid in accordance with good practice and recognized principles.

Sufficiency of Tender

The Contractor shall be deemed to have satisfied himself before tendering as to the correctness and sufficiency of his tender for the works and of the rates and prices quoted in the Schedule of Quantities, which rates and prices shall, except as otherwise provided, cover all his obligations under the Contract and all matters and things necessary for the proper completion of the works.

Discrepancies and Adjustment

The several documents forming the Contact are to be taken as mutually explanatory of one another, detailed drawings being followed in preference to small scale drawing and figured dimensions in preference

of Errors

to scale and special conditions in preference to General Conditions.

In the case of discrepancy between the schedule of Quantities, the Specifications and / or the Drawings, the following order of preference shall be observed:-
Description of Schedule of Quantities.

Particular Specification and Special Condition, if any.

If there are varying or conflicting provisions made in any one document forming part of the contract, the Accepting Authority shall be the deciding authority with regard to the intention of the document and his decision shall be final and binding on the contractor.

Any error in description, quantity or rate in Schedule of Quantities or any omission there from shall not vitiate the Contractor release the Contractor from the execution of the whole or any part of the works comprised there in according to drawings and specifications or from any of his obligations under the contract.

Signing of Contract

The successful tenderer / contractor, on acceptance of his tender by the Accepting Authority, shall, within 7 working days from the stipulated date of start of the work, sign the contract consisting of:-

The notice inviting tender, all the documents including drawings, if any, is forming the tender as issued at the time of invitation of tender and acceptance thereof together with any correspondence leading thereto.

Standard Form as mentioned in Schedule 'F 'consisting of:

Various standard clauses with corrections up to the date stipulated in Schedule 'F' along with annexures thereto.

C.P.W.D. Safety Code.

Model Rules for the protection of health, sanitary arrangements for workers employed by AEDOL, or its contractors.

Contractor's Labour Regulations of the Government.

List of Acts and omissions for which fines can be imposed.

No payment for the work done will be made unless contract is signed by the contractor.

CLAUSES OF CONTRACT

CLAUSE 1

Security deposit

The contractor shall submit an irrevocable security deposit of 3% (Three percent) of the contract value in addition to other deposits mentioned elsewhere in the contract for his proper performance of the contract agreement, (notwithstanding and / or without prejudice to any other provisions in the contract) within period specified in Schedule 'F' from the date of issue of letter of acceptance. This period can be further extended by the AEDOL up to a maximum period as specified in schedule 'F' on written request of the contractor stating the reason for delays in procuring the security deposit, to the satisfaction of the Engineer-in-Charge. Security deposit shall be in the form of an irrevocable bank guarantee from any nationalised Bank in India.

The security deposit shall be valid up to the completion of the contract. In case the time for completion of work gets enlarged, the contractor shall get the validity of security deposit extended to cover such enlarged time for completion of work.

The Engineer-in-Charge shall not make a claim under the security deposit except for amounts to which the Managing Director, AEDOL is entitled under the contract (not withstanding and /or without prejudice to any other provisions in the contract agreement)in the event of:

Failure by the contractor to extend the validity of the security deposit as described here in above, in which event the Engineer-in-Charge may claim the full amount of the Performance Guarantee.

Failure by the contractor to pay Managing Director, AEDOL any amount due, either as agreed by the contractor or determined under any of the Clauses / Conditions of the agreement, within 30 days of the service of notion to this effect by Engineer-in-Charge.

In the event of the contract being determined or rescinded under provision of any of the Clause / Condition of the agreement, the security deposit shall stand forfeited in full and shall be absolutely at the disposal of the Managing Director, AEDOL. Earnest money shall be adjusted first in the security deposit

CLAUSE 1A

Recovery of Retention money

The person / persons whose tender(s) may be accepted (herein after called the contractor) shall permit AEDOL at the time of making any payment to him for work done under the contract to deduct a sum at the rate of 10 % of the gross amount of each bill. Such deductions will be made and held by AEDOL by way of

retention money.

The retention money shall be paid to the contractor on submission of performance guarantee.

Performance guarantee

CLAUSE 1B

On successful completion of commissioning, the contractor shall provide performance guarantee for a period of 12 months to the tune of 10% of contract value by way of irrevocable bank guarantee from a nationalised bank.

After recording of the warranty period which is one year from the date of commissioning by the competent authority, the security deposit may be converted as performance security for a period of one year from the date of handing over and returned after 60 days to the contractor, without any interest.

CLAUSE 2

Penalty for delay in completion

If the contractor fails to maintain the required progress in terms of clause 5 or to complete the work and clear the site on or before the contract or extended date of completion, he shall, without prejudice to any other right or remedy available under the law to the AEDOL on account of such breach, pay as agreed compensation the amount calculated at the rates stipulated below as the authority specified in schedule 'F' (whose decision in writing shall be final and binding) may decide on the amount of tendered value of the work for every completed day / month (as applicable) that the progress remains below that specified in Clause 5 or that the work remains in complete.

This will also apply to items or group of items for which a separate period of completion has been specified.

(i) Compensation 0.2% of the final Contract Price per day

Provided always that the total amount of compensation for delay to be paid under this Condition shall not exceed 10% of the Tendered Value of work or of the Tendered Value of the item or group of items of work for which a separate period of completion is originally given.

The amount of compensation may be adjusted or set-off against any sum payable to the Contractor under this or any other contract with the AEDOL. In case, the contractor does not achieve a particular miles tone mentioned in schedule F, or there-scheduled milestone(s) in terms of Clause5.4, the amount shown against that mile stone shall be withheld, to be adjusted against

the compensation levied at the final grant of Extension of Time. With-holding of this amount on failure to achieve a milestone, shall be automatic without any notice to the contractor. However, if the contractor catches up with the progress of work on the subsequent milestone(s), the withheld amount shall be released. In case the contractor fails to make up for the delay in subsequent milestone(s), amount mentioned against each milestone missed subsequently also shall be withheld. However, no interest, what so ever, shall be payable on such withheld amount.

CLAUSE 3

When Contract can be determined

Subject to other provisions contained in this clause, the Engineer-in-Charge may, without prejudice to his any other rights or remedy against the contractor in respect of any delay, inferior workmanship, any claims for damages and / or any other 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:

If the contract or having been given by the Engineer-in-Charge a notice in writing to rectify, reconstruct or replace any defective work or that the work is being performed in an in efficient or otherwise improper or un workman like manner shall omit to comply with the requirement of such notice for a period of seven days thereafter.

If the contractor has, without reasonable cause, suspended the progress of the work or has failed to proceed with the work with due diligences so that in the opinion of the Engineer-in-Charge (which shall be final and binding) he will be unable to secure completion of the work by the date for completion and continues to do so after a notice in writing of seven days from the Engineer-in-Charge.

If the contractor fails to complete the work within the stipulated date or items of work with individual date of completion, if any stipulated, on or before such date(s) of completion and does not complete them within the period specified in a notice given in writing in that behalf by the Engineer-in-Charge.

If the contractor persistently neglect to carry out his obligations under the contract and / or commits default in complying with any of the terms and conditions of the contract and does not remedy it or take effective steps to remedy it within 7days after a notice in writing is given to him in that behalf by the Engineer-in-Charge.

If the contractor shall offer or give or agree to give to any person

in service or to any other person on his behalf any gift or consideration of any kind as an inducement or reward for doing or for bearing to do or for having done or for borne to do any act in relation to the obtaining or execution of this or any other contract for AEDOL.

If the contractor shall enter into a contract with AEDOL in connection with which commission has been paid or agreed to be paid by him or to his knowledge, unless the particular of any such commission and the terms of payment thereof have been previously disclosed in writing to the Engineer-in-Charge.

If the contractor shall obtain a contract with AEDOL as a result of wrong tendering or other non-bonafide method of competitive tendering or commits breach of integrity.

If the contractor being an individual, or if a firm, any partner there of shall at any time be adjudge in solvent or have a receiving order or order for administration of his estate made against him or shall take any proceedings for liquidation or composition (other than a voluntary liquidation for the purpose of amalgamation or reconstruction) under any Insolvency Act for the time being in force or make any conveyance or assignment of his effects or composition or arrangement for the benefit of his creditors or purport so to do, or if any application be made under any Insolvency Act for the time being in force for the sequestration of his estate or if a trust deed be executed by him for benefit of his creditors.

If the contractor being a company shall pass a resolution or the court shall make an order that the company shall be wound up or if a receiver or a manager on behalf of a creditor shall be appointed or if circumstances shall arise which entitle the court or the credit or to appoint a receiver or a manager or which entitle the court to make a winding up order.

If the contractor shall suffer an execution being levied on his goods and allow it to be continued for a period of 21days.

If the contractor assigns, transfers, sublets (engagement of labour on a piece-work basis or of labour with materials not to be incorporated in the work, shall not be deemed to be subletting) or otherwise parts with or attempts to assign, transfer, sublet or otherwise parts with the entire works or any portion thereof without the prior written approval of the Engineer-in-Charge.

When the contractor has made himself liable for action under any of the cases aforesaid, the Managing Director, AEDOL shall have powers:

To determine the contract as aforesaid (of which termination notice in writing to the contractor under the hand of the Engineer-in-Charges hall be conclusive evidence). Upon such determination, the Earnest Money Deposit, Security Deposit already recovered and Performance Guarantee under the contract shall be liable to be forfeited and shall be absolutely at the disposal of the AEDOL.

After giving notice to the contractor to measure up the work of the contractor and to take such whole, or the balance or part thereof, as shall be un-executed out of his hand sand to give it to another contractor to complete the work. The contractor, whose contract is determined as above, shall not be allowed to participate in the tendering process for the balance work.

In the event of above courses being adopted by the Engineer-in-Charge, the contractor shall have no claim to compensation for any loss sustained by him by reasons 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 provision aforesaid, the contractor shall not be entitled to recover or be paid any sum for any work thereof or actually performed under this contract unless and until the Engineer-in-Charge has certified in writing the performance of such work and the value payable in respect thereof and he shall only been titled to be paid the values so certified.

CLAUSE 4

Contractor liable to pay Compensation even if action not taken under Clause 3

In any case in which any of the powers conferred upon the Engineer-in-Charge by Clause-3 thereof, shall have become exercisable and the same are not exercised, the non-exercise thereof shall not constitute a waiver of any of the conditions here of and such powers shall not withstanding be exercisable in the event of any future case of default by the contractor and the liability of the contract or for compensation shall remain unaffected. In the event of the Engineer-in-Charge putting in force all or any of the powers vested in him under the preceding clause he may, if he so desires after giving a notice in writing to the contractor, take possession of (or at the sole discretion of the Engineer-in-Charge which shall be final and binding on the contractor) use as on hire all or any tools, plant, materials and stores, in or upon the works, or the site there of belonging to the contractor, or procured by the contractor 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 these not being applicable, at current market rates to be certified by the Engineer-in-Charge, whose certificate thereof shall be final, and binding on the contractor, clerk of the works,

foreman or other authorized agent to remove such tools, plant, materials, or stores from the premises (with in a time to be specified in such notice) in the event of the contract or failing to comply with any such requisition, the Engineer-in-Charge may remove them at the contractor's expense or sell them by auction or private sale on account of the contractor and his risk in all respects and certificate of the Engineer-In-Charge as to the expenses of any such removal and the amount of the proceeds and expenses of any such sales shall be final and conclusive against the contractor.

CLAUSE 5

Time and Extension for Delay

The time allowed for execution of the Works as specified in the Schedule 'F' or the extended time in accordance with these conditions shall be the essence of the Contract. The execution of the works shall commence from such time period as mentioned in schedule 'F' or from the date of handing over of the site whichever is later. If the Contract or commits default in commencing the execution of the work as aforesaid, AEDOL shall without prejudice to any other right or remedy available in law, beat liberty to forfeit the earnest money & performance guarantee absolutely.

As soon as possible after the Contract is concluded, the Contractor shall submit a Time and Progress Chart for each milestone and get it approved by AEDOL. The Chart shall be prepared in direct relation to the time stated in the Contract documents for completion of items of the works. It shall indicate the forecast of the dates of commencement and completion of various trades of sections of the work and may be amended as necessary by agreement between the Engineer-in-Charge and the Contractor within the limitations of time imposed in the Contract documents, and further to ensure good progress during the execution of the work, the contractor shall in all cases in which the time allowed for any work, exceeds one month(save for special jobs for which a separate programme has been agreed upon) complete the work as per Milestones given in Schedule F'.

If the work(s) be delayed by:-
Force majeure, or
Abnormally bad weather, or
Serious loss or damage by fire, or
Civil commotion, local commotion of workmen, strike or lockout, affecting any of the trades employed on the work, or
Delay on the part of other contractors or tradesmen engaged by Engineer-in-Charge in executing work not forming part of the Contract, or
Any other cause which, in the absolute discretion of the Engineer-in-Charge is beyond the Contractor's control.

Then upon the happening of any such event causing delay, the Contractor shall immediately give notice thereof in writing to the authority as indicated in Schedule 'F' but shall never the less use constantly his best end favour to prevent or make good the delay and shall do all that may be reasonably required to the satisfaction of the Engineer-in-Charge to proceed with the works.

Request for rescheduling of Milestones and extension of time, to be eligible for consideration, shall be made by the Contractor in writing within fourteen days of the happening of the event causing delay on the prescribed form to the authority as indicated in Schedule 'F'. The Contractor may also, if practicable, indicate in such are quest the period for which extension is desired.

In any such case the authority as indicated in Schedule 'F' may give a fair and reasonable extension of time and reschedule the milestones for completion of work. Such extension shall be communicated to the Contractor by the authority as indicated in Schedule 'F' in writing, within 3 months of the date of receipt of such request. Non application by the contractor for extension of time shall not be a bar for giving a fair and reasonable extension by the authority as indicated in Schedule 'F' and this shall be binding on the contractor.

CLAUSE 6

Payment of Final Bill

The final bill shall be submitted by the contractor in the same manner as specified in interim bills within three months of physical completion of the work or within one month of the date of the final certificate of completion furnished by the Engineer-in-Charge whichever is earlier. No further claims shall be made by the contractor after submission of the final bill and these shall be deemed to have been waived and extinguished. Payments of those items of the bill in respect of which there is no dispute and of items in dispute, for quantities and rates as approved by Engineer-in-Charge, will, as far as possible be made within the 6 months, the period being reckoned from the date of receipt of the bill by the Engineer-in-Charge or his authorized representative, complete with account of dismantled materials.

CLAUSE 6A

Payment of Contractor's Bills

Payments due to the contractor will be made to him in the form of Cheque/ online transfer

CLAUSE 7

Materials supply

This is turnkey lump sum basis and no materials or any other requirement will be provided by AEDOL. It is the sole

responsibility of the contractor.

CLAUSE 7A

Materials to be provided by the Contractor

The contractor shall, at his own expense, provide all materials, required for the works completely.

The contractor shall, at his own expense and without delay, supply to the Engineer-in-Charge samples of materials to be used on the work and shall get these approved in advance. All such materials to be provided by the Contractor shall be in conformity with the specifications laid down or referred to in the contract. The contractor shall, if requested by the Engineer-in-Charge furnish proof, to the satisfaction of the Engineer-in-Charge that the materials so comply. The Engineer-in-Charge shall within thirty days of supply of samples or within such further period as he may require intimate to the Contractor in writing whether samples are approved by him or not. If samples are not approved, the Contractor shall forth with arrange to supply to the Engineer-in-Charge for his approval, fresh samples complying with the specifications laid down in the contract. When materials are required to be tested in accordance with specifications, approval of the Engineer-in-Charge shall be issued after the test results are received.

The Contractor shall at his risk and cost submit the samples of materials to be tested or analyzed and shall not make use of or incorporate in the work any materials represented by the samples until the required tests or analysis have been made and materials finally accepted by the Engineer-in-Charge. The Contractor shall not be eligible for any claim or compensation neither arising out of any delay in the work or due to any corrective measures required to be taken on account of and as a result of testing of materials.

The contractor shall, at his risk and cost, make all arrangements and shall provide all facilities as the Engineer-in-Charge may require for collecting and preparing the required number of samples for such tests at such time and to such place or places as may be directed by the Engineer-in-Charge and bear all charges and cost of testing. The Engineer-in-Charge or his authorized representative shall at all times have access to the works and to all workshops and places where work is being prepared or from where materials, manufactured articles or machinery are being obtained for the works and the contractor shall afford every facility and every assistance in obtaining the right to such access.

The Engineer-in-Charge shall have full powers to require the removal from the premises of all materials which in his opinion are not in accordance with the specifications and in case of

	default, the Engineer-in-Charge shall be at liberty to employ at the expense of the contractor, other persons to remove the same without being answerable or accountable for any loss or damage that may happen or arise to such materials. The Engineer-in-Charge shall also have full powers to require other proper materials to be substituted thereof and in case of default, the Engineer-in-Charge may cause the same to be supplied and all costs which may attend such removal and substitution shall be borne by the Contractor. The contractor shall at his own expense, provide a material testing lab at the site for conducting routine field tests. The lab shall be equipped at least with the testing equipment as specified in schedule F.
Payment on Account of Increase in Prices / Wages due to Statutory Order(s)	Under No circumstances the escalation of rates on any account will be entertained. It is the contractor's fullest responsibility. Only the agreement value will be paid on completion of the project.
Dismantled Material, If any	CLAUSE 7B The contractor shall treat all materials obtained during excavation of the site for a work, etc. as Government's property and such materials shall be handed over AEDOL according to the instructions in writing issued by the Engineer-in-Charge
Work to be Executed in Accordance with Specifications Drawings Orders etc.	CLAUSE 8 The contractor shall execute the whole and every part of the work in the most substantial and workman like manner both as regards materials and otherwise in every respect in strict accordance with the specifications. The contractor shall also conform exactly, fully and faithfully to the design, drawings and instructions in writing in respect of the work signed by the Engineer-in-Charge and the contractor shall be furnished free of charge one copy of the contract documents together with specifications, designs, drawings and instructions as are not included in the standard specifications of Central Public Works Department specified in Schedule 'F' or in any Bureau of Indian Standard or any other, published standard or code or, Schedule of Rates or any other printed publication referred to elsewhere in the contract. The contractor shall comply with the provisions of the contract and with the care and diligence execute and maintain the works and provide all labour and materials, tools and plants including for measurements and supervision of all works, structural plans and other things of temporary or permanent nature required for such execution and maintenance in so far as the necessity for

providing these, is specified or is reasonably inferred from the contract. The Contractor shall take full responsibility for adequacy, suitability and safety of all the works and methods of construction. A code of safety is provide in Annex.

CLAUSE 9

Contractor to Supply Tools & Plants etc.

The contractor shall provide at his own cost all materials (except such special materials, if any, as may in accordance with the contract be supplied from the Engineer-in-Charge's stores), machinery, tools & plants as specified in schedule F. In addition to this, appliances, implements, other plants, ladders, cordage, tackle, scaffolding and temporary works required for the proper execution of the work, whether original, altered or substituted and whether included in the specifications or other documents forming part of the contract or referred to in these conditions or not, or which may be necessary for the purpose of satisfying or complying with the requirements of the Engineer-in-Charge 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 the measurement for examination at any time and from time to time of the work or materials. Failing his so doing, the same may be provided by the Engineer-in-Charge at the expense of the contractor and the expenses may be deducted, from any money due to the contractor, under this contract or otherwise and/or from his security deposit or the proceeds of sale thereof, or of a sufficient portions thereof.

CLAUSE 9 A

Recovery of Compensation paid to Workmen

In every case in which by virtue of the provisions sub-section (1) of Section 12, of the Workmen's Compensation Act, 1923, AEDOL is obliged to pay compensation to a workman employed by the contractor, in execution of the works, AEDOL will recover from the contractor, the amount of the compensation so paid; and, without prejudice to the rights of the AEDOL under sub-section (2) of Section 12, of the said Act, AEDOL shall be at liberty to recover such amount or any part thereof by deducting it from the security deposit or from any sum due by AEDOL to the contractor whether under this contract or otherwise. AEDOL shall not be bound to contest any claim made against it under sub-section (1) of Section 12, of the said Act, except on the written request of the contractor and upon his giving to AEDOL full security for all costs for which AEDOL might become liable in consequence of contesting such claim.

CLAUSE 9 B

Ensuring Payment and Amenities to Workers if Contractor fails

ln every case in which by virtue of the provisions of the Contract Labour (Regulation and Abolition) Act, 1970, and of the Contract Labour (Regulation and Abolition) Central Rules, 1971, AEDOL is obliged to pay any amounts of wages to a workman employed by the contractor in execution of the works, or to incur any expenditure in providing welfare and health amenities required to be provided under the above said Act and the rules under Clause 19H or under the C.P.W.D. Contractor's Labour Regulations, or under the Rules framed by Government from time to time for the protection of health and sanitary arrangements for workers employed by C.P.W.D. Contractors, AEDOL will recover from the contractor, the amount of wages so paid or the amount of expenditure so incurred; and without prejudice to the rights of the AEDOL under sub-section(2) of Section 20, and sub-section (4) of Section 21, of the Contract Labour (Regulation and Abolition) Act, 1970, AEDOL shall be at liberty to recover such amount or any part thereof by deducting it from the security deposit or from any sum due by AEDOL to the contractor whether under this contract or otherwise AEDOL shall not be bound to contest any claim made against it under sub-section (1) of Section 20, sub-section (4) of Section 21, of the said Act, except on the written request of the contractor and upon his giving to the AEDOL full security for all costs for which AEDOL might become liable in contesting such claim.

CLAUSE 10

Labour Laws to be complied by the Contractor

The contractor shall obtain a valid license under the Contract Labour (R&A) Act, 1970, and the Contract Labour (Regulation and Abolition) Central Rules, 1971, before the commencement of the work, and continue to have a valid license until the completion of the work. The contractor shall also abide by the provisions of the Child Labour (Prohibition and Regulation) Act, 1986.

The contractor shall also comply with the provisions of the building and other Construction Workers (Regulation of Employment & Conditions of Service) Act, 1996 and the building and other Construction Workers Welfare Cess Act, 1996.

Any failure to fulfil these requirements shall attract the penal provisions of this contract arising out of the resultant non-execution of the work.

CLAUSE 10A

No labour below the age of fourteen years shall be employed on the work

CLAUSE 10 B

Payment of wages:

The contractor shall pay to labour employed by him either directly or through subcontractors, wages not less than fair wages as defined in the C.P.W.D. Contractor's Labour Regulations or as per the provisions of the Contract Labour (Regulation and Abolition) Act, 1970 and the contract Labour (Regulation and Abolition) Central Rules, 1971, wherever applicable.

The contractor shall, notwithstanding the provisions of any contract to the contrary, cause to be paid fair wage to labour indirectly engaged on the work, including any labour engaged by his sub-contractors in connection with the said work, as if the labour had been immediately employed by him.

In respect of all labour directly or indirectly employed in the works for performance of the contractor's part of this contract, the contractor shall comply with or cause to be complied with the Central Public Works Department contractor's Labour Regulations made by Government from time to time in regard to payment of wages, wage period, deductions from wages recovery of wages not paid and deductions unauthorizedly made, maintenance of wage books or wage slips, publication of scale of wages and other terms of employment, inspection and submission of periodical returns and all other matters of the like nature or as per the provisions of the Contract Labour (Regulation and Abolition) Act, 1970, and the Contract Labour (Regulation and Abolition) Central Rules, 1971, wherever applicable.

(a) The Engineer-in-Charge concerned shall have the right to deduct from the moneys due to the contractor any sum required or estimated to be 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 their wages which are not justified by their terms of the contract or non-observance of the Regulations.

(b) Under the provision of Minimum Wages (Central) Rules, 1950, the contractor is bound to allow to the labours directly or indirectly employed in the works one day rest for 6 days continuous work and pay wages at the same rate as for duty. In the event of default, the Engineer-in-Charge shall have the right to deduct the sum or sums not paid on account of wages for weekly holidays to any labours and pay the same to the persons entitled thereto from any money due to the contractor by the Engineer-in-Charge concerned.

The contractor shall comply with the provisions of the Payment

of Wages Act, 1936, Minimum Wages Act, 1948, Employees Liability Act, 1938, Workmen's Compensation Act, 1923, Industrial Disputes Act, 1947, Maternity Benefits Act, 1961, and the Contractor's Labour (Regulation and Abolition) Act 1970, or the modifications thereof or any other laws relating thereto and the rules made thereunder from time to time.

The contractor shall indemnify and keep indemnified AEDOL against payments to be made under and for the observance of the laws aforesaid and the C.P.W.D. Contractor's Labour Regulations without prejudice to his right to claim indemnity from his sub-contractors.

The laws aforesaid shall be deemed to be a part of this contract and any breach thereof shall be deemed to be a breach of this contract.

Whatever is the minimum wage for the time being, or if the wage payable is higher than such wage, such wage shall be paid by the contractor to the workmen directly without the intervention of Jamadar and that Jamadar shall not be entitled to deduct or recover any amount from the minimum wage payable to the workmen as and by way of commission or otherwise.

The contractor shall ensure that no amount by way of commission or otherwise is deducted or recovered by the Jamadar from the wage of workmen.

CLAUSE 10C

In respect of all labour directly or indirectly employed in the work for the performance of the contractor's part of this contract, the contractor shall at his own expense arrange for the safety provisions as per C.P.W.D. Safety Code framed from time to time and shall at his own expense provide for all facilities in connection therewith. In case the contractor fails to make arrangement and provide necessary facilities as aforesaid, he shall be liable to pay a penalty of Rs.200/- for each default and in addition, the Engineer-in- Charge shall be at liberty to make arrangement and provide facilities as aforesaid and recover the costs incurred in that behalf from the contractor.

CLAUSE 10 D

The contractor shall submit by the 4th and 19th of every month, to the Engineer-in-Charge, a true statement showing in respect of the second half of the preceding month and the first half of the current month respectively the number of labourers employed by him on the work,their working yours, the wages paid to them,
the accidents that occurred during the said fortnight showing the circumstances under which they happened and the extent of

damage and injury caused by them, and 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 to AEDOL, a sum not exceeding Rs.200/- for each default or materially incorrect statement. The decision of the Divisional Officer shall be final in deducting from any bill due to the contractor, the amount levied as fine and be binding on the contractor.

CLAUSE 10E

In respect of all labour directly or indirectly employed in the works for the performance of the contractor's part of this contract, the contractor shall comply with or cause to be complied with all the rules framed by Government from time to time for the protection of health and sanitary arrangements for workers employed by the Central Public Works Department and its contractors.

CLAUSE 10 F

Leave and pay during leave shall be regulated as follows:-

Leave :

in the case of delivery - maternity leave not exceeding 8 weeks, 4 weeks up to and including the day of delivery and 4 weeks following that day, in the case of miscarriage - upto 3 weeks from the date of miscarriage.

Pay :

in the case of delivery - leave pay during maternity leave will be at the rate of the women's average daily earnings, calculated on total wages earned on the days when full time work was done during a period of three months immediately preceding the date on which she gives notice that she expects to be confined or at the rate of Rupee one only a day whichever is greater.

in the case of miscarriage - leave pay at the rate of average daily earning calculated on the total wages earned on the days when full time work was done during a period of three months immediately preceding the date of such miscarriage.

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 six months immediately preceding the date on which she proceeds on leave.

The contractor shall maintain a register of Maternity (Benefit) in the Prescribed Form as shown in appendix -I and II, and the same shall be kept at the place of work.

CLAUSE 10 G

In the event of the contractor(s) committing a default or breach of any of the provisions of the Contract, Contractor's Labour Regulations and Model Rules for the protection of health and sanitary arrangements for the workers as amended from time to time or furnishing any information or submitting or filing any statement under the provisions of the above Regulations and' Rules which is materially incorrect, he/they shall, without prejudice to any other liability, pay to the AEDOL a sum not exceeding Rs.200/- for every default, breach or furnishing, making, submitting, filing such materially incorrect statements and in the event of the contractor(s) defaulting continuously in this respect, the penalty may be enhanced to Rs.200/- per day for each day of default subject to a maximum of 5 per cent of the estimated cost of the work put to tender. The decision of the Engineer-in-Charge shall be final and binding on the parties.

Should it appear to the Engineer-in-Charge that the contractor(s) is/are not properly observing and complying with the provisions of the C.P.W.D. Contractor's Labour Regulations and Model Rules and the provisions of the Contract Labour (Regulation and Abolition) Act 1970, and the Contract Labour (R& A) Central Rules 1971, for the protection of health and sanitary arrangements for work-people employed by the contractor(s) (hereinafter referred as "the said Rules") the Engineer-in-Charge shall have power to give notice in writing to the contractor(s) requiring that the said Rules be complied with and the amenities prescribed therein be provided to the work-people within a reasonable time to be specified in the notice. If the contractor(s) shall fail within the period specified in the notice to comply with and/observe the said Rules and to provide the amenities to the work-people as aforesaid, the Engineer-in-Charge shall have the power to provide the amenities hereinbefore mentioned at the cost of the contractor(s). The contractor(s) shall erect, make and maintain at his/their own expense and to approved standards all necessary huts and sanitary arrangements required for his/their work-people on the site in connection with the execution of the works, and if the same shall not have been erected or constructed, according to approved standards, the Engineer-in-Charge shall have power to give notice in writing to the contractor(s) requiring that the said huts and sanitary arrangements be remodelled and/or reconstructed according to approved standards, and if the contractor(s) shall fail to remodel or reconstruct such huts and sanitary arrangements according to approved standards within the period specified in the notice, the Engineer-in-Charge shall have the power to remodel or reconstruct such huts and sanitary arrangements according to approved standards at the cost of the contractor(s).

CLAUSE 10 H

Due to insufficient space at the site, the workmen huts are not allowed within the site area. The contractor shall provide outside the boundary area of the CETP at his / their own cost.

Drainage - The contractor(s) shall provide efficient arrangements for draining away sullage water so as to keep the camp neat and tidy.

The contractor(s) shall make necessary arrangements for keeping the camp area sufficiently lighted to avoid accidents to the workers.

Sanitation - The contractor(s) shall make arrangements for conservancy and sanitation in the labour camps according to the rules of the Local Public Health and Medical Authorities.

CLAUSE 10 I

The Engineer-in-Charge may require the contractor to dismiss or remove from the site of the work any person or persons in the contractors' employ upon the work who may be incompetent or misconduct himself and the contractor shall forthwith comply with such requirements.

CLAUSE 10 J

It shall be the responsibility of the contractor to see that the site is not occupied by anybody unauthorizedly during construction, and is handed over to the Engineer-in-Charge with vacant possession of complete building. If such building though completed is occupied illegally, then the Engineer-in-Charge shall have the option to refuse to accept the said building/buildings in that position. Any delay in acceptance on this account will be treated as the delay in completion and for such delay, a levy upto 5% of tendered value of work may be imposed by the Superintending Engineer whose decision shall be final both with regard to the justification and quantum and be binding on the contractor. However, the Superintending Engineer, through a notice, may require the contractor to remove the illegal occupation any time on or before construction and delivery.

CLAUSE 10 K

Employment of skilled/semi-skilled workers

The contractor shall, at all stages of work, deploy skilled/semi-skilled tradesmen who are qualified and possess certificate in particular trade from Industrial Training Institute or any similar reputed and recognized Institute managed/ certified by State/Central Government. The number of such qualified tradesmen shall not be less than 20% of total skilled/semi-skilled workers required in each trade at any stage of work. The

contractor shall submit number of man days required in respect of each trade, its scheduling and the list of qualified tradesmen along with requisite certificate from recognized Institute to Engineer in charge for approval. Notwithstanding such approval, if the tradesmen are found to have inadequate skill to execute the work of respective trade, the contractor shall substitute such tradesmen within two days of written notice from Engineering-Charge. Failure on the part of contractor to obtain approval of Engineer-in-Charge or failure to deploy qualified tradesmen will attract a compensation to be paid by contractor at the rate of Rs. 100 per such tradesman per day. Decision of Engineer in Charge as to whether particular tradesman possesses requisite skill and amount of compensation in case of default shall be final and binding.

Provided always, that the provisions of this clause, shall not be applicable for works with estimated cost put to tender being less than Rs. 5 crores.

CLAUSE 11

Minimum Wages Act to be complied with

The contractor shall comply with all the provisions of the Minimum Wages Act, 1948, and Contract Labour (Regulation and Abolition) Act, 1970, amended from time to time and rules framed thereunder and other labour laws affecting contract labour that may be brought into force from time to time.

CLAUSE 12

Work not to be sublet. Action in case of insolvency

The contract shall not be assigned or sublet without the written approval of the Engineer-in-Charge. And if the contractor shall assign or sublet his contract, or attempt to do so, or become insolvent or commence any insolvency proceedings or make any composition with his creditors or attempt to do so, or if any bribe, gratuity, gift, loan, perquisite, reward or advantage pecuniary or otherwise, shall either directly or indirectly, be given, promised or offered by the contractor, or any of his servants or agent to any public officer or person in the employ of AEDOL in any way relating to his office or employment, or if any such officer or person shall become in any way directly or indirectly interested in the contract, the Managing Director, AEDOL shall have power to adopt the course specified in Clause 3 hereof in the interest of AEDOL and in the event of such course being adopted, the consequences specified in the said Clause 3 shall ensue.

CLAUSE 13

All sums payable by way of compensation under any of these conditions shall be considered as reasonable compensation to be applied to the use of AEDOL without reference to the actual loss or damage sustained and whether or not any damage shall have been sustained

CLAUSE 14

Changes in firm's Constitution to be intimated

Where the contractor is a partnership firm, the previous approval in writing of the Engineering-Charge shall be obtained before any change is made in the constitution of the firm. Where the contractor is an individual or a Hindu undivided family business concern, such approval as aforesaid shall likewise be obtained before the contractor enters into any partnership agreement where under the partnership firm would have the right to carry out the works hereby undertaken by the contractor. If previous approval as aforesaid is not obtained, the contract shall be deemed to have been assigned in contravention of Clause 21 hereof and the same action may be taken, and the same consequences shall ensue as provided in the said Clause 21.

CLAUSE 15

All works to be executed under the contract shall be executed under the direction and subject to the approval in all respects of the Engineer-in-Charge who shall be entitled to direct at what point or points and in what manner they are to be commenced, and from time to time carried on.

CLAUSE 16

Settlement of Disputes & Arbitration

Except where otherwise provided in the contract, all questions and disputes relating to the meaning of the specifications, design, drawings and instructions here-in before mentioned and as to the quality of workmanship or materials used on the work or as to any other question, claim, right, matter or thing whatsoever in any way arising out of or relating to the contract, designs, drawings, specifications, estimates, instructions, orders or these conditions or otherwise concerning the works or the execution or failure to execute the same whether arising during the progress of the work or after the cancellation, termination, completion or abandonment thereof shall be dealt with as mentioned hereinafter:

If the contractor considers any work demanded of him to be outside the requirements of the contract, or disputes any drawings, record or decision given in writing by the Engineer-in-Charge on any matter in connection with or arising out of the contract or carrying out of the work, to be unacceptable, he shall promptly within 15 days request the AEDOL in writing for written instruction or decision. Thereupon, the AEDOL shall give his written instructions or decision within a period of one month from the receipt of the contractor's letter.

If AEDOL fails to give his instructions or decision in writing within the aforesaid period or if the contractor is dissatisfied with the instructions or decision of AEDOL, the contractor may, within 15

days of the receipt of AEDOL's decision, appeal to the MD, AEDOL who shall afford an opportunity to the contractor to be heard, if the latter so desires, and to offer evidence in support of his appeal. AEDOL shall give his decision within 30 days of receipt of contractor's appeal.

If the contractor is dissatisfied with the decision of the AEDOL, the contractor may within 30 days from the receipt of the AEDOL decision, appeal before the Dispute Redressal Committee (DRC) along with a list of disputes with amounts claimed in respect of each such dispute and giving reference to the rejection of his disputes by the AEDOL. The Dispute Redressal Committee (DRC) shall give his decision within a period of 90 days from the receipt of Contractor's appeal. The constitution of Dispute Redressal Committee (DRC) shall be as indicated in Schedule 'F'.

If the Dispute Redressal Committee (DRC) fails to give his decision within the aforesaid period or any party is dissatisfied with the decision of Dispute Redressal Committee (DRC), then either party may within a period of 30 days from the receipt of the decision of Dispute Redressal Committee (DRC), give notice to the AEDOL for appointment of arbitrator on prescribed proforma as per Appendix XV of CPWD, failing which, the said decision shall be final binding and conclusive and not referable to adjudication by the arbitrator.

Except where the decision has become final, binding and conclusive in terms of Sub Para (i) above, disputes or difference shall be referred for adjudication through arbitration by a sole arbitrator appointed by The Managing Director, AEDOL. If the arbitrator so appointed is unable or unwilling to act or resigns his appointment or vacates his office due to any reason whatsoever, another sole arbitrator shall be appointed in the manner aforesaid. Such person shall be entitled to proceed with the reference from the stage at which it was left by his predecessor.

It is a term of this contract that the party invoking arbitration shall give a list of disputes with amounts claimed in respect of each such dispute along with the notice for appointment of arbitrator and giving reference to the rejection by the AEDOL of the appeal.

It is also a term of this contract that no person, other than a person appointed by such AEDOL, as aforesaid, should act as arbitrator and if for any reason that is not possible, the matter shall not be referred to arbitration at all.

It is also a term of this contract that if the contractor does not make any demand for appointment of arbitrator in respect of any

claims in writing as aforesaid within 120 days of receiving the intimation from the Engineer-in-charge that the final bill is ready for payment, the claim of the contractor shall be deemed to have been waived and absolutely barred and the AEDOL shall be discharged and released of all liabilities under the contract in respect of these claims.

The arbitration shall be conducted in accordance with the provisions of the Arbitration and Conciliation Act, 1996 (26 of 1996) or any statutory modifications or re-enactment thereof and the rules made thereunder and for the time being in force shall apply to the arbitration proceeding under this clause.

It is also a term of this contract that the arbitrator shall adjudicate on only such disputes as are referred to him by the appointing authority and give separate award against each dispute and claim referred to him and in all cases where the total amount of the claims by any party exceeds Rs. 1,00,000/-, the arbitrator shall give reasons for the award.

It is also a term of the contract that if any fees are payable to the arbitrator, these shall be paid equally by both the parties.

It is also a term of the contract that the arbitrator shall be deemed to have entered on the reference on the date he issues notice to both the parties calling them to submit their statement of claims and counter statement of claims. The venue of the arbitration shall be such place as may be fixed by the arbitrator in his sole discretion. The fees, if any, of the arbitrator shall, if required to be paid before the award is made and published, be paid half and half by each of the parties. The cost of the reference and of the award (including the fees, if any, of the arbitrator) shall be in the discretion of the arbitrator who may direct to any by whom and in what manner, such costs or any part thereof shall be paid and fix or settle the amount of costs to be so paid.

CLAUSE 17

Contractor to indemnify AEDOL against Patent Rights

The contractor shall fully indemnify and keep indemnified the Managing Director, AEDOL against any action, claim or proceeding relating to infringement or use of any patent or design or any alleged patent or design rights and shall pay any royalties which may be payable in respect of any article or part thereof included in the contract. In the event of any claims made under or action brought against AEDOL in respect of any such matters as aforesaid, the contractor shall be immediately notified thereof and the contractor shall be at liberty, at his own expense, to settle any dispute or to conduct any litigation that may arise therefrom, provided that the contractor shall not be liable to indemnify the AEDOL if the infringement of the patent or design or any alleged

patent or design right is the direct result of an order passed by the Engineer-in-Charge in this behalf.

CLAUSE 18

Action where no Specifications are specified

In the case of any class of work for which there is no such specifications as referred to in Clause 11, such work shall be carried out in accordance with the Bureau of Indian Standards Specifications. In case there are no such specifications in Bureau of Indian Standards, the work shall be carried out as per manufacturers' specifications, if not available then as per District Specifications. In case there are no such specifications as required above, the work shall be carried out in all respects in accordance with the instructions and requirements of the Engineer-in-Charge.

CLAUSE 19

Withholding and lien in respect of sum due from contractor

Whenever any claim or claims for payment of a sum of money arises out of or under the contract or against the contractor, the Engineer-in-Charge or the AEDOL shall be entitled to withhold and also have a lien to retain such sum or sums in whole or in part from the security, if any deposited by the contractor and for the purpose aforesaid, the Engineer in-Charge or the AEDOL shall be entitled to withhold the security deposit, if any, furnished as the case may be and also have a lien over the same pending finalization or adjudication of any such claim. In the event of the security being insufficient to cover the claimed amount or amounts or if no security has been taken from the contractor, the Engineer-in-Charge or the AEDOL shall be entitled to withhold and have a lien to retain to the extent of such claimed amount or amounts referred to above, from any sum or sums found payable or which may at any time thereafter become payable to the contractor under the same contract or any other contract with the Engineer-in-Charge of the AEDOL or any contracting person through the Engineer- in-Charge pending finalization of adjudication of any such claim.

It is an agreed term of the contract that the sum of money or moneys so withheld or retained under the lien referred to above by the Engineer-in-Charge or AEDOL will be kept withheld or retained as such by the Engineer-in-Charge or AEDOL till the claim arising out of or under the contract is determined by the arbitrator(if the contract is governed by the arbitration clause) by the competent court, as the case may be and that the contractor will have no claim for interest or damages whatsoever on any account in respect of such withholding or retention under the lien referred to above and duly notified as such to the contractor. For the purpose of this clause, where the contractor is a partnership firm or a limited company, the Engineer-in-Charge or the AEDOL shall be entitled to withhold and also have a lien to retain towards

such claimed amount or amounts in whole or in part from any sum found payable to any partner/limited company as the case may be, whether in his individual capacity or otherwise.

AEDOL shall have the right to cause an audit and technical examination of the works and the final bills of the contractor including all supporting vouchers, abstract, etc., to be made after payment of the final bill and if as a result of such audit and technical examination any sum is found to have been overpaid in respect of any work done by the contractor under the contract or any work claimed to have been done by him under the contract and found not to have been executed, the contractor shall be liable to refund the amount of over-payment and it shall be lawful for AEDOL to recover the same from him in the manner prescribed in sub-clause (i) of this clause or in any other manner legally permissible; and if it is found that the contractor was paid less than what was due to him under the contract in respect of any work executed by him under it, the amount of such under payment shall be duly paid by AEDOL to the contractor, without any interest thereon whatsoever.

Provided that the AEDOL shall not be entitled to recover any sum overpaid, nor the contractor shall be entitled to payment of any sum paid short where such payment has been agreed upon between the Superintending Engineer or Executive Engineer on the one hand and the contractor on the other under any term of the contract permitting payment for work after assessment by the Superintending Engineer or the Executive Engineer.

CLAUSE 20

Lien in respect of claims in other Contracts

Any sum of money due and payable to the contractor (including the security deposit returnable to him) under the contract may be withheld or retained by way of lien by the Engineer-in-Charge or the AEDOL or any other contracting person or persons through Engineer-in-Charge against any claim of the Engineer-in-Charge or AEDOL or such other person or persons in respect of payment of a sum of money arising out of or under any other contract made by the contractor with the Engineer- in-Charge or the AEDOL or with such other person or persons.

It is an agreed term of the contract that the sum of money so withheld or retained under this clause by the Engineer-in-Charge or the AEDOL will be kept withheld or retained as such by the Engineer-in-Charge or the AEDOL or till his claim arising out of the same contract or any other contract is either mutually settled or determined by the arbitration clause or by the competent court, as the case may be and that the contractor shall have no claim for interest or damages whatsoever on this account or on any other ground in respect of any sum of money withheld or

retained under this clause and duly notified as such to the contractor.

CLAUSE 21

Hire of Plant & Machinery

The Plants and Machinery required for the Project should be arranged by the contractor completely.

CLAUSE 22

Levy/Taxes payable by Contractor

Sales Tax/ GST, Building and other Construction Workers Welfare Cess or any other tax or Cess in respect of this contract shall be payable by the contractor and AEDOL shall not entertain any claim whatsoever in this respect. However, in respect of service tax, same shall be paid by the contractor to the concerned department on demand and it will be reimbursed to him by the Engineer-in-Charge after satisfying that it has been actually and genuinely paid by the contractor.

CLAUSE 23

Conditions for reimbursement of levy/taxes if levied after receipt of tenders

All tendered rates shall be inclusive of all taxes like GST, Customs duty if any, antidumping duty if any,etc and levies payable under respective statutes. However, if any further tax or levy or cess is imposed by Statute, after the last stipulated date for the receipt of tender including extensions if any and the contractor thereupon necessarily and properly pays such taxes/levies/cess, the contractor shall be reimbursed the amount so paid, provided such payments, if any, is not, in the opinion of the AEDOL (whose decision shall be final and binding on the contractor) attributable to delay in execution of work within the control of the contractor.

The contractor shall keep necessary books of accounts and other documents for the purpose of this condition as may be necessary and shall allow inspection of the same by a duly authorized representative of the AEDOL and/or the Engineer-in-Charge and shall also furnish such other information/document as the Engineer-in-Charge may require from time to time.

The contractor shall, within a period of 30 days of the imposition of any such further tax or levy or cess, give a written notice thereof to the Engineer-in-charge that the same is given pursuant to this condition, together with all necessary information relating thereto.

CLAUSE 24

If relative working in AEDOL then the contractor not allowed to tender

The contractor shall not be permitted to tender for works in the AEDOL responsible for award and execution of contracts in which his near relative is posted as Divisional Accountant or as an officer in any capacity or the any grades. He shall also intimate the names of persons who are working with him in any capacity or are subsequently employed by him and who are near relatives

to any Gazetted Officer in the AEDOL or in the Ministry of Commerce. Any breach of this condition by the contractor would render him liable to be removed from the approved list of contractors of AEDOL. If however the contractor is registered in any other department, he shall be debarred from tendering in AEDOL for any breach of this condition.

NOTE: By the term "near relatives" is meant wife, husband, parents and grandparents, children and grandchildren, brothers and sisters, uncles, aunts and cousins and their corresponding in-laws.

CLAUSE 25

Compensation during warlike situations

The work (whether fully constructed or not) and all materials, machines, tools and plants, scaffolding, temporary buildings and other things connected therewith shall be at the risk of the contractor until the work has been delivered to the Engineer-in-Charge and a certificate from him to that effect obtained. In the event of the work or any materials properly brought to the site for incorporation in the work being damaged or destroyed in consequence of hostilities or warlike operation, the contractor shall when ordered (in writing) by the Engineer-in-Charge to remove any debris from the site, collect and properly stack or remove in store all serviceable materials salvaged from the damaged work and shall be paid at the contract rates in accordance with the provision of this agreement for the work of clearing the site of debris, stacking or removal of serviceable material and for reconstruction of all works ordered by the Engineer-in-Charge, such payments being in addition to compensation upto the value of the work originally executed before being damaged or destroyed and not paid for. In case of works damaged or destroyed but not already measured and paid for, the compensation shall be assessed by the Divisional Officer upto Rs.5,000/- and by the Superintending Engineer concerned for a higher amount. The contractor shall be paid for the damages/destruction suffered and for restoring the material at the rate based on analysis of rates tendered for in accordance with the provision of the contract. The certificate of the Engineer-in-Charge regarding the quality and quantity of materials and the purpose for which they were collected shall be final and binding on all parties to this contract.

Provided always that no compensation shall be payable for any loss in consequence of hostilities or warlike operations (a) unless the contractor had taken all such precautions against air raid as are deemed necessary by the A.R.P. Officers or the Engineer-in-Charge (b) for any material etc. not on the site of the work or for any tools, plant, machinery, scaffolding, temporary building and other things not intended for the work.

In the event of the contractor having to carry out reconstruction as aforesaid, he shall be allowed such extension of time for its completion as is considered reasonable by the Divisional Officer.

CLAUSE 26

Apprentices Act provisions to be complied with

The contractor shall comply with the provisions of the Apprentices Act, 1961 and the rules and orders issued thereunder from time to time. If he fails to do so, his failure will be a breach of the contract and the AEDOL may, in his discretion, cancel the contract. The contractor shall also be liable for any pecuniary liability arising on account of any violation by him of the provisions of the said Act.

CLAUSE 27

Release of Security Deposit of the work shall not be refunded till the contractor produces a clearance deposit after labour certificate from the Labour Officer. As soon as the work is virtually complete the contractor clearance shall apply for the clearance certificate to the Labour Officer under intimation to the Engineer-in-Charge. The Engineer-in-Charge, on receipt of the said communication, shall write to the Labour Officer to intimate if any complaint is pending against the contractor in respect of the work. If no complaint is pending, on record till after 3 months after completion of the work and/or no communication is received from the Labour Officer to this effect till six months after the date of completion, it will be deemed to have received the clearance certificate and the Security Deposit will be released if otherwise due.

CLAUSE 28

Inspection and Testing

28.1. The AEDOL or its authorized representative including appointed Consultant for the project shall have, at all times, access to the Contractor's premises and also shall have the power to inspect and examine the materials and workmanship of project work during its manufacture, shop assembly and testing. If part of the plant is required to be manufactured in the premises other than the Contractor's, the necessary permission for inspection shall be obtained by the Contractor on behalf of AEDOL or its duly authorized representative.

28.2. AEDOL shall have the right to serve notice in writing to the Contractor on any grounds of objections, which he may have in respect of the work. The Contractor has to satisfy the objection, otherwise, the Company at his liberty may reject all or any component of plant or workmanship connected with such work.

28.3. The Contractor shall issue request letter to AEDOL or his authorized representative for testing of any component of the plant, which is ready for testing at least Seven (7) days in advance from the date of actual date of testing at the premises of the Contractor or elsewhere. When the inspection and the tests have been satisfactorily completed at the Contractor's works, AEDOL shall issue a certificate to that effect. However, the AEDOL at its own discretion may waive the inspection and testing in writing under very special circumstances. In such case, the Contractor may proceed with the tests which shall be deemed to have been made in AEDOL's presence, and it shall forthwith forward six (6) sets of duly certified copies of test results and certificates to the AEDOL for approval. The Contractor, on receipt of written acceptance from AEDOL, may dispatch the equipment for erection and installation.

28.4. For all tests to be carried out, whether in the premises of the Contractor or any Subcontractor or the supplier, the Contractor, shall provide labour, materials, electricity, fuel, water, stores, apparatus and instruments etc. free of charge as may reasonably be demanded to carry out such tests of the plant in accordance with the Contract. The Contractor shall provide all facilities to AEDOL or its authorized representative to accomplish such testing.

28.5. AEDOL or his authorized representative shall have the right to carry out inward inspection of the items on delivery at the Site and if the items have been found to be not in line with the approved specifications, shall have the liberty to reject the same.

28.6. If AEDOL desires, testing of any component(s) of the plant be carried out by an independent agency, the inspection fee, if any, shall be paid by the Company. However, the Contractor shall render all necessary help to AEDOL whenever required free of charge.

28.7. The Contractor has to provide the necessary testing reports to AEDOL as and when required.

28.8. Neither the waiving of inspection nor acceptance after inspection by AEDOL shall, in anyway, absolve the Contractor of the responsibility of supplying the plant and equipment strictly in accordance with specification and drawings etc.

CLAUSE 32

Deduction from Contract Price

32.1 All costs, claims, damages or expenses, which the Company may have paid for which the Contractor is liable, will be deducted by the Company from deposited bank guarantees

or from any money due or which become due to him under this Contract or any contract are being executed elsewhere with the Company.

32.2 Any sum of money due and payable to the Contractor, as per the Contract Agreement, may be appropriated by the Company and set off against any claim of the Company, for the payment of a sum of money arising out of or under any other contract made by the Contractor with the Company. It is an agreed term of the Contract that the sum of money, withheld or obtained under this clause by the Company, will be kept withhold or retained as such by the Company or till this claim arising out of in the same Contract is either mutually settled or determined by the arbitrator, or by competent court, as the case may be, and that the Contractor shall have no claim for interest or damages whatsoever on this account or any other account in respect of any sum of money withheld or retained under this clause and duly notified as such to the Contractor.

Annex

SAFETY CODE

1. Necessary work permit shall be obtained from the beneficiary for Excavation works, and other works to be carried at site.

2. Suitable scaffolds shall be provided for workmen for all works that cannot safely be done from the ground, or from solid construction except such short period work as can be done safely from ladders. When a ladder is used, an extra mazdoor shall be engaged for holding the ladder and if the ladder is used for carrying materials as well suitable footholds and hand - hold shall be provided on the ladder and the ladder shall be given an inclination not steeper than ¼ to 1 (1/4 horizontal and 1 vertical).

3. Scaffolding of staging more than 3.6m (12ft) above the ground or floor, swung or suspended from an overhead support or erected with stationary support shall have a guard rail properly attached or bolted, braced and otherwise secured at least 90cm. (3ft) high above the floor or platform such scaffolding or staging and extending along the may be necessary for the delivery of materials. Such scaffolding or staging shall be so fastened as to prevent it from swaying from the building or structure.

4. Working platforms, gangways and stairways should be so constructed that they should not sag unduly or unequally, and if the height of the platform or the gangway or the stairway is more than 3.6m (12ft.) above ground level or floor level, they should be closely boarded, should have adequate width and should be suitably fastened.

5. Every opening in the floor of a building or in a working platform shall be provided with suitable means to prevent the fall of person or materials by providing suitable fencing or railing whose minimum height shall be 90 cm. (3 ft)

6. Safe means of access shall be provided to all working platforms and other working places. Every ladder shall be securely fixed. No portable single ladder shall be over 9m. (30ft) in length while the width between side rails in rung ladder shall in no case be less than 29 cm. (11 ½") for ladder up to and including 3 m. (10 ft) in length. For longer ladders, this width should be increased at least ¼" for each additional 30 cm. (1 foot) of length. Uniform step spacing of not more than 30 cm shall be kept. Adequate precautions shall be taken to prevent danger from electrical equipment. No materials on any of the sites or work shall be so stacked or placed as to cause danger or inconvenience to any person or the public. The contract shall provide all necessary fending and lights to protect the public from accident and shall be bound to bear the expenses of defense of every suit, action or other proceedings at law that may be brought by any person for injury sustained owing to neglect of the above precautions and to pay any damaged and cost which may be awarded in any such suit; action or proceedings to any such person or which may, with the consent of the contractor be paid to compensate any claim by any such person.

7. Demolition - Before any demolition work in commenced and also during the progress of the work,

8. All roads and open areas adjacent to the work site shall either be closed or suitably protected.

9. No electric cable or apparatus which is liable to be a source of danger or a cable or apparatus used by the operators shall remain electrically charged.

10. All practical steps shall be taken to prevent danger to persons employed from risk of fire or explosion or flooding. No floor, roof or other part of the building shall be so overloaded with debris or materials as to render it unsafe.

11. All necessary personal safety equipment as considered adequate by the Engineer - in - Charge should be kept available for the use of the person employed on the site and maintained in a condition suitable for immediate use, and the contractor should take adequate steps to ensure proper use of equipment by those concerned:-
    a. The following safety equipment shall invariably be provided.

12. Workers employed on mixing asphaltic materials, cement and lime mortars shall be provided with protective footwear and protective goggles.

13. Those engaged in welding works shall be provided with welder's protective eye - shields.

14. Stone breaker shall be provided with protective goggles and

15. Before entry, presence of Toxic gases should be tested by inserting wet lead acetate paper which changes colour in the presence of such gases and gives indication of their presence.

16. Presence of Oxygen should be verified by lowering a detector lamp into the manhole. In case, no Oxygen is found inside the sewer line, workers should be sent only with Oxygen kit.

17. Safety belt with rope should be provided to the workers. While working inside the manholes, such rope should be handled by two men standing outside to enable him to be pulled out during emergency.

18. The area should be barricaded or cordoned off by suitable means to avoid mishaps of any kind. Proper warning signs should be displayed for the safety of the public whenever cleaning works are undertaken during night or day.

19. Gas masks with Oxygen Cylinder should be kept at site for use in emergency.

20. Air - blowers should be used for flow of fresh air through the manholes. Whenever called for, portable air blowers are recommended for ventilating the manholes. The Motors for these shall be vapour proof and of totally enclosed type. Non sparking gas engines also could be used but they should be leeward side protected from wind so that they will not be a source of friction on any inflammable gas that might be present.

21. The workers shall be provided with Gumboots or non-sparking shoes bump helmets

and gloves non sparking tools safety lights and gas masks and Portable air blowers (when necessary). They must be supplied with barrier cream for anointing the limbs before working inside the sewer lines.

22. Workmen descending a manhole shall try each ladder stop or rung carefully before putting his full weight on it to guard against insecure fastening due to corrosion of the rung fixed to manhole well.

23. If a man has received a physical injury, he should be brought out of the sewer immediately and adequate medical aid should be provided to him.
24. The extent to which these precautions are to be taken depend on individual situation but the decision of the Engineer - in - Charge regarding the steps to be taken in this regard in an individual case will be final.

25. When the work is done near any place where there is risk of drowning, all necessary equipment's should be provided and kept ready for use and all necessary steps taken for prompt rescue of any person in danger and adequate provision, should be made for prompt first aid treatment of all injuries likely to be obtained during the course of the work.

26. Use of hoisting machines and tackle including their attachments, anchorage and supports shall conform to the following standards or conditions

27. These shall be of good mechanical construction, sound materials and adequate.

28. Every rope used in hoisting or lowering materials or as a means of suspension shall be of durable quality and adequate strength, and free from patent defects.

29. Every crane driver or hoisting appliance operator shall be properly qualified and no person under the age of 21 years should be in charge of any hoisting machine including any scaffolding winch or give signals to operator.

30. In case of every hoisting machine and of every chain ring hook, shackle swivel and pulley block used in hoisting or as means of suspension, the safe working load shall be ascertained by adequate means. Every hoisting machine and all gear referred to above shall be plainly marked with the safe working load. In case of a hoisting machine having a variable safe working load each safe working load and the condition under which it is applicable shall be clearly indicated. No part of any machine or any gear referred to above in this paragraph shall be loaded beyond the safe working load except for the purpose of testing.

31. In case of departmental machines, the safe working load shall be notified by the Electrical Engineer - in - Charge. As regards contractor's machine the contractors shall notify the safe working load of the machine to the Engineer - in - charge whenever he brings any machinery to site of work and get it verified by the Electrical Engineer concerned.

32. Motors, gearing, transmission, electric wiring and other dangerous parts of hoisting appliance should be provided with such means as will reduce to the minimum the risk

of accidental descent of the load. Adequate precautions should be taken to reduce to the minimum the risk of any part of a suspended load becoming accidently displaced. When workers are employed on electrical installations which are already energized, insulating mats, wearing apparel, such as gloves, sleeves and boots as may be necessary should be provided. The worker should not wear any rings, watches and carry keys or other materials which are good conductors of electricity.

33. All scaffolds, ladders and other safety devices mentioned or described herein shall be maintained in safe condition and no scaffold, ladder or equipment shall be altered or removed while it is in use. Adequate washing facilities should be provided at or near places of work.

34. These safety provisions should be brought to the notice of all concerned by display on a notice board at a prominent place at work spot. The person responsible for compliance of the safety code shall be named therein by the contractor.

Safety code – electrical

The following safety code is extracted from IS : 732 – 1989 (Reaffirmed 2005).

Fundamental Requirements for Safety—The requirements for protection for safety of persons, livestock and property involve protection against electric shock, thermal effects, overcurrent, overvoltage and undervoltage and a measure of isolation and switching of electric circuits. The protective measures may be applicable to the entire installation or a part or an item of equipment. The requirements stated below in this section are based on the following basic principles.

5.0.1
Protection against Direct Contact—Persons and livestock shall be protected against dangers that may arise from contact with live parts of the installation.
This protection can be achieved by one of the following methods:
Preventing a current from passing through the body of any person or any livestock; and
Limiting the current which can pass through a body to a value lower than the shock current.

5.0.2
Protection against Indirect Contact—Persons and livestock shall be protected against dangers that may arise from contact with exposed conductive parts.
This protection can be achieved by one of the following methods:
preventing a fault current from passing through the body of any person or any livestock;

Limiting the fault current which can pass through a body to a value lower than the shock current; and
Automatic disconnection of the supply on the occurrence of a fault likely to cause a current to flow through a body in contact with exposed conductive parts, where the value of that current is equal to or greater than the shock current.

5.0.3

Protection against Thermal Effects in Normal Service—The electrical installation shall be so arranged that there is no risk of melting besides ignition of flammable materials due to high temperature or electric arc. Also during normal operation of the electrical equipment, there shall be no risk of persons or livestock suffering burns.

5.0.4
Protection against Overcurrent—Persons or livestock shall be protected against injury and property shall be protected against damage due to excessive temparatures or electromechanical stresses caused by any overcurrents likely to arise in live conductors. This protection can be achieved by one of the following methods:
Automatic disconnection on the occurrence of an overcurrent before this overcurrent attains a dangerous value taking into account its duration; and
Limiting the maximum overcurrent to a safe value and duration.

5.0.4.1
Overcurrent protection devices—Where necessary to prevent danger, every installation and every circuit thereof shall be protected against overcurrent by devices which:
will operate automatically at values of current which are suitably related to the safe current ratings of the circuit;
are of adequate breaking capacity and, where appropriate, making capacity; and
are suitably located and are constructed so as to prevent danger from overheating, arcing or the scattering of hot particles when they come into operation and to permit ready restoration of the supply without danger.
Note—Where the supply undertaking provides switchgear or fusegear at the origin of the installation it may not be necessary to duplicate the means of overcurrent protection for that part of the installation between its origin and the main distribution point of the installation where the next step for overcurrent protection is provided. In domestic installations the protection and isolating functions are combined in the same device.

5.0.5
Protection Against Fault Currents—Conductors, other than live conductors, and any other parts intended to carry a fault current shall be capable of carrying that current without assuming excessive temperature, until the protective gear operates.
Note 1—Particular attention should be given to earth fault currents.
Note 2—For live conductors, compliance with 5 assures their protection against any fault currents, including overcurrents.

5.0.5.1
Precautions against earth leakage and earth fault currents—Where metalwork of electrical equipment, other than current-carrying conductors, may become charged with electricity in such a manner as to cause danger if the insulation of a conductor should become defective or if a fault should occur in any equipment:
the metalwork shall be earthed in such a manner as will cause discharge of electrical energy without danger, or
other equally effective precautions shall be taken to prevent danger.

Every circuit shall be arranged so as to prevent the persistence of dangerous earth leakage currents.

Where metalwork is earthed, the circuits concerned shall be protected against the persistence of dangerous earth fault currents by:
the overcurrent protective devices required by **5.0.4.1**, or a residual current operated device or equally effective device.

The method described in (b) above shall be used whenever the prospective earth fault current is insufficient to cause prompt operation of the overcurrent protective devices.

Where necessary to prevent danger and where metalwork of electrical equipment is earthed for compliance with (a) above and is accessible simultaneously with substantial exposed metal parts of other services, the latter parts shall be effectively connected to the main earthing terminal of the installation.

5.0.6
Protection against Overvoltage—persons or livestock shall be protected against injury and property shall be protected against any harmful effects of a fault between live parts of circuits supplied at different voltages.
Persons or livestock shall be protected against injury and property shall be protected against damage from any excessive voltages likely to arise due to other causes (for example, atmospheric phenomena or switching voltages).

PROTECTION AGAINST ELECTRIC SHOCK

5.1 Requirements for Protection against Electric Shock

5.1.1 Protection against Both Direct and Indirect Contact

5.1.1.1
General—One of the following basic protective measures for protection against both direct contact and indirect contact shall be used:
Protection by safety extra low voltage,
Protection by functional extra low voltage, and
Protection by limitation of discharge of energy.

5.1.1.2
Protection by safety extra low voltage—Protection against electric shock is provided when all the following requirements are fulfilled:
The nominal voltage of the circuit concerned does not exceed extra low voltage.
The supply is from one of the safety sources listed in (1) below.
The conditions of (2) below arc fulfilled.
Note—Lower voltage limits may be required for certain conditions of external influences.
Safety sources—The safety source shall be one of the following:
A class II safety isolating transformer, the. Secondary-winding being isolated from earth.
A source of current providing a degree of safety equivalent to that of the safety isolating transformer specified in (a) above (for example, a motor generator with windings providing equivalent isolation).
An electrochemical source (for example, a battery) or another source independent of a higher voltage circuit (for example, a engine-driven generator).
Electronic devices where measures have been taken so that even in the case of an internal

fault the voltage at the outgoing terminals cannot exceed extra low voltage.
Arrangement of Circuits
Live parts of safety extra low voltage circuits shall not be connected to earth or to live parts or protective conductor forming part of other circuits.
Exposed conductive parts of safety extra low voltage circuits shall not intentionally be connected to any of the following:
Earth,
Protective conductors or exposed conductive parts of another system, or
Extraneous conductive parts, except that where electrical equipment is inherently required to be connected to extraneous conductive parts it shall be verified, that those parts cannot attain a voltage exceeding the limit of the safety extra low voltage circuit. If the exposed conductive parts of safety extra low voltage circuits are liable to come into contact fortuitously with exposed conductive parts of other circuits, the protection no longer depends solely on the measure for protection by safety extra low voltage and shall be in accordance with the requirements for the measures applicable to the latter exposed conductive parts.
Live parts of safety extra low voltage equipment other than cables shall be electrically separate from those of higher voltage circuits. The electrical separation between live parts of safety extra low voltage circuits and higher voltage circuits shall be not less than that between the input and output windings of safety isolating transformers.
Safety extra low voltage circuit conductors shall preferably be physically separated from those of any other circuit. Where this requirement is impracticable, one of the following arrangements is required:
Safety extra low voltage circuit conductors shall be insulated in accordance with the requirements of this code for the highest voltage present.
Safety extra low voltage circuit cables shall be non-metallic sheathed cables.
Conductors of circuits at different voltages shall be separated from those at safety extra low voltage by an earthed metallic screen or an earthed metallic sheath.
Circuits at different voltages may be contained in a multicore cable or other grouping of conductors but the conductors of safety extra low voltage circuits shall be insulated, individually or collectively, for the highest voltage present. Note—In arrangements (2) and (3) basic insulation of any conductor need be sufficient only for the voltage of the circuit of which it is a part.
Plugs and socket outlets of safety extra low voltage circuits shall comply with all of the following requirements:
The plugs shall not be capable of entering socket outlets of other voltage systems in use in the same premises.
The socket outlets shall exclude plugs of other voltage systems in use in the same premises.
The socket outlets shall not have a protective conductor connection.
Mobile safety sources shall be selected or erected in accordance with **5.1.3.2.**
If the nominal voltage exceeds 25 V ac rms 50 Hz, or 60 V ripple-free dc, protection against direct contact shall be provided by one or more of the following:
Barriers or enclosures affording at least the degree of protection IP 2X.
Insulation capable of withstanding a test voltage 500 V dc for one minute.

If the nominal voltage does not exceed 25 V ac rms 50 Hz, or 60 v ripple-free dc, protection against direct contact is not required by this code except as specified below:

Application of Protective Measure—Safety extra-low voltage
Where the use of safety extra-low voltage (SELV) is relied upon for protection against direct contact, that is, where live parts are not insulated or provided with barriers and enclosures in accordance with **5.1.1.2**(2) (vii), the nominal voltage shall not in any event exceed 25 V rms ac or 60 V ripple-free dc. These voltage limits are applicable only to conditions where simultaneously accessible parts may be touched by a person having a body resistance assumed as conventionally normal, and shall be appropriately reduced in conditions where reduced or very low body resistance is to be expected.
Where SELV is used for protection against indirect contact only, and where the live parts of the SELV circuit are insulated or provided with barriers and enclosures in accordance with **5.1.1.2**(2)(vii), the nominal voltage shall not in any event exceed 50 V rms ac or 120 V ripple-free dc. These voltage limits are applicable only to conditions where simultaneously accessible parts may be touched by a person having a conventionally normal body resistance, and shall be appropriately reduced in conditions where reduced or very low body resistance is to be expected.

Note—conventionally normal body resistance relates to a contact involving one hand and both Feet, the skin being dry or moist with perspiration (but not wet). Reduced body resistance may be expected in situations where the hands and/or feet are likely to be wet or where the shock current path may not be through the extremities, and very low body resistance (of the order of one quarter of the conventionally normal body resistance) is to be expected in locations where a person is immersed in water or working in confined conductive locations.

5.1.1.3 Functional extra low voltage systems

If for functional reasons extra low voltage is used but not all the requirements of **5.1.1.2** regarding safety extra low voltage are fulfilled, the appropriate measures described in (b) to (e) below shall be taken in order to ensure protection against electric shock. Systems employing these measures are termed 'functional extra low voltage systems'. Note—Such conditions may, for example, be encountered in extra low voltage circuits when one point of the extra low voltage circuit is connected to earth or if the circuit contains components (such as transformers, relays, remote-control switches, contactors) insufficiently insulated with respect to circuits at higher voltages.

if the extra low voltage system complies with the requirements of **5.2.1.2** for safety-extra low voltage except that live or exposed conductive parts are connected to earth or to the protective conductors of the systems [see **5.1.1.2**(b)(i) and (ii)] protection against direct contact shall be provided by one or more of the following:
Enclosures giving protection at least equivalent to IP 2X.
Insulation capable for resisting a test voltage of 500 V rms for one minute. Such a system is connected to afford protection against indirect contact. This requirement does not exclude the installation or the use without supplementary protection of equipment conforming to the relevant standard, providing an equivalent degree of safety.

If the extra low voltage system does not generally comply with the requirements of **5.1.1** for safety extra low voltage, protection against direct contact shall be provided by one or

more of the following:
Barriers or enclosures according to **5.1.2.2.**
Insulation corresponding to the minimum test voltage required for the primary circuit. In addition, protection against indirect contact shall be provided in accordance with (d) below. The extra low voltage circuit may be used to supply factory built equipment whose insulation does not comply with the minimum test voltage required for the primary circuit provided that the accessible insulation of that equipment is reinforced during erection to withstand a test voltage of 1 500 V rms for one minute.

If the primary circuit of the functional extra low voltage source is protected by automatic disconnection, exposed conductive parts of the equipment in the functional extra low voltage circuit shall be connected to the protective conductor of the primary circuit. Note—This does not exclude the possibility of connecting a conductor of the functional extra low voltage circuit to the protective conductor of the primary circuit. If the primary circuit of the functional extra low voltage source is protected by electrical separation, the exposed conductive parts of equipment in the functional extra low voltage circuit shall be connected to the non-earthed protective conductor of the primary circuit. Note—This latter requirement does not contravene **5.1.3.5**(c), the combination of the electrically separated circuit and the extra low voltage circuit being regarded as one electrically separated circuit.

The socket outlet of functional extra low voltage systems shall not admit plugs intended for use with other systems in use in the same premises. Application of Protective Measure—Functional extra-low voltage *Where, for functional reasons, extra-low voltage is used but*:
One point of the extra-low voltage circuit is required to be earthed, or
Live parts or exposed conductive parts of the extra-low voltage circuit are connected to the protective conductors of other systems (whether those protective conductors are earthed or not; or
The insulation between the extra-low voltage circuits and other circuits is not equivalent to that provided by a safety source.
The system shall be treated as a functional extra-low voltage system and **5.1.1.3** apply.

5.1.1.4
Protection by limitation of discharge of energy—For equipment complying with the appropriate standard, protection against electric shock is afforded when the equipment incorporates means of limiting the current which can pass through the body of a person or livestock to a value lower than the shock current, Circuits relying on this protective measure shall be separated from other circuits in a manner similar to that specified in **5.1.1.2**(2) (iii) and (iv) for safety extra low voltage circuits.

Application of protective measure—Limitation of discharge of energy
This measure shall be applied only to individual items of current-using equipment complying with an appropriate Indian Standard, where the equipment incorporates means of limiting to a safe value the current that can flow from the equipment through the body of a person or livestock. The application of this measure may be extended to a part of an installation derived from such items of equipment, where the relevant Indian Standard concerned provides specifically for this, for example, to electric fences supplied

from electric fence controllers.

5.1.2 Protection against Direct Contact

5.1.2.0
General—One or more of the following basic protective measures for protection against direct contact shall be used:
Protection by insulation of live parts,
Protection by barriers or enclosures,
Protection by obstacles, and
Protection by placing out of reach.

5.1.2.1
Protection by insulation of live parts—Live parts shall be completely covered with insulation which can only be removed by destruction and which is capable of durably withstanding the mechanical, electrical, thermal and chemical stresses to which it may be subjected in service.

Note 1—Where insulation is applied during the erection of the installation, the quality of the insulation should be confirmed by tests similar to those which ensure the quality of the insulation of similar factory built equipment.

Note 2—General purpose, paints, varnishes, lacquers and similar products without additional insulation do not provide adequate insulation for protection against direct contact.

Application of protective measure—Insulation of live parts

This measure relates to basic insulation, and is intended to prevent contact with live parts. It is generally applicable for protection against direct contact, in conjunction with a measure for protection against indirect contact.

5.1.2.2 Protection by barriers or enclosures

Live parts shall be inside enclosures or behind barriers providing at least the degree of protection IP 2X except that, where an opening larger than that admitted for IP 2X is necessary to allow the replacement of parts or to avoid interference with the proper functioning of electrical equipment both of the following requirements apply:
Suitable precautions shall be taken to prevent persons or livestock from unintentionally touching live parts, and
It shall be established as far as practicable, that persons will be aware that live parts can be touched through the opening and should not be touched.

Horizontal top surfaces of barriers or enclosures which are readily accessible shall provide a degree of protection of at least IP 4X.

Barriers and enclosures shall be firmly secured in place and have sufficient stability and durability to maintain the required degrees of protection and appropriate separation from live parts in the known conditions of normal service.

Where it is necessary to remove barriers or to open enclosures or to remove parts of enclosures, one or more of the following requirements shall be satisfied:
The removal or opening shall be possible only by use of a key or tool,
The removal or opening shall be possible only after disconnection of the supply to live parts against which the barriers or enclosures afford protection, restoration of the supply being possible only after replacement or reclosure of the barriers or enclosures, and
An intermediate barrier shall be provided to prevent contact with live parts, such barrier affording a degree of protection of at least IP 2X and removable only by the use of a tool. This requirement does not apply to ceiling roses or to ceiling switches operated by a cord.

Application of Protective Measure—Barriers or enclosures

This measure is intended to prevent or deter any contact with live parts It is generally applicable for protection against direct contact in conjunction with a measure for protection against indirect contact.

The exception in **5.1.2.2**(a) allowing for openings larger than IP 2X in barriers or enclosures shall be applied only to items of equipment or accessories complying with an Indian Standard where compliance with the generality of **5.1.2.2**(a) is impracticable by reason of the function of those items, for example, to lampholders. Wherever that exception is used, the opening shall be as small as is consistent with the requirements for proper functioning and for replacement of parts.

5.1.2.3 Protection by obstacles

Obstacles shall prevent, as appropriate, the following:
Unintentional bodily approach to live parts, or
Unintentional contact with live parts when operating equipment live in normal use.

Obstacles shall be so secured as to prevent unintentional removal but may be removable without using a key or tool.

Application of Protective Measure—Obstacles

This measure is intended to prevent unintentional contact with live parts, but not intentional contact by deliberate circumvention of the obstacles. It shall be used only for protection against direct contact in areas accessible only to skilled persons, or instructed persons under direct supervision.

5.1.2.4 Protection by placing out of reach

Bare or PVC covered overhead lines for distribution between buildings and structures shall be installed in accordance with good practice.

Bare live parts shall not be within arm's reach.

Where bare live parts other than overhead lines are out of arm's reach but nevertheless may be accessible, they shall not be within 2.5 m of any of the following:
Exposed conductive parts,
Extraneous conductive parts, and
Bare live parts of other circuits.

If a normally occupied position is restricted in the horizontal plane by an obstacle (for example, handrail mesh screen) affording a degree of protection less than IP 2X, arm's reach shall extend from that obstacle. In the overhead direction, arm's reach is 2.5 m from the surface *S* not taking into account any intermediate obstacle providing a degree of protection less than IP 2X (*see* Fig. 1). Note—The values of arm's reach refer to bare hands without any assistance, for example, from tools or a ladder.

In places where bulky or long conducting objects are normally handled, the distances required by (b) to (d) shall be increased accordingly.

Application of Protective Measure—Placing out of reach

This measure is intended only to prevent unintentional contact with live parts and shall be applied only for protection against direct contact. The application of the provisions

5.1.2.4(b) to (d) shall he limited to locations accessible only to skilled persons, or instructed persons under direct supervision.

5.1.3 Protection against Indirect Contact

5.1.3.0

General—one or more of the following basic protective measures for protection against Indirect contact shall be used:
Earthed equipotential bonding and automatic disconnection of supply,
Use of Class II equipment or equivalent insulation,
Non-conducting location,
Earth free local equipotential bonding, and
Electrical separation.

5.1.3.1

Protection by earthed equipotential bonding and automatic disconnection of supply
General
In each installation main equipotential bonding conductors complying with IS : 3043-1987* shall connect extraneous conductive parts including the following to the main earthing terminal for that insulation:
Main water pipes,
Main gas pipes,
Other service pipes and ducting,
Risers of central heating and air-conditioning systems, and
Exposed metallic parts of the building structure. Note 1—This bonding is intended to create a zone in which any voltages between exposed conductive parts and extraneous

conductive parts are minimised. Note 2—Compliance with (a) (i) will normally satisfy the relevant requirements of the protective multiple earthing. Note 3—Additional equipotential bonding may be required [*see* **5.1.3.1**(a) (v)].
*Code of practice for earthing (*first revision*).
The characteristics of the protective devices for automatic disconnection, the earthing arrangements for the installation and the relevant impedances of the circuits concerned shall be coordinated so that during an earth fault the voltages between simultaneously accessible exposed and extraneous conductive parts occurring any where in the installation shall be of such magnitude and duration as not to cause danger. Note 1—For information on types of earthing arrangements, *see* IS 3043-1987*. Note 2—For the conditions of connection of exposed conductive parts *see* **5.1.3.1**(b) to (d) and as appropriate to the earthing arrangement concerned.
The provisions of (ii) above are considered to be satisfied if the automatic disconnection provided for occurs within the duration not permitting the touch voltage to exceed the safe value.
Where protection is afforded by an overcurrent protective device, and the nominal voltage to earth (U_0) is 240 V rms ac, the earth fault loop impedance (Z_B), compliance with (iii) above, shall not exceed safe values.
Where compliance with the disconnection times of (iii) above is afforded by a residual current device in an installation, the product of the rated residual operating current in amperes and the earth fault loop impedance in ohms shall not exceed the values given in IS : 3043-1987* for different types of system earthing.
Within the zone formed by the main equipotential bonding, local supplementary bonding connections shall be made to metal parts, to maintain the equipotential zone, where those parts:
are extraneous conductive parts,
are simultaneously accessible with exposed conductive parts or other extraneous conductive parts, and
are not electrically connected to the main equipotential bonding by permanent and reliable metal-to-metal joints of negligible impedance. Note—Where local equipotential bonding is provided in accordance with (vi) above, metalwork which may be required to be bonded includes baths and exposed metal pipes, sinks, taps, tanks and radiators and, where practicable, accessible structural metalwork.

Installations which are part of a TN system:
All exposed conductive parts of the installation shall be connected by protective conductors to the main earthing terminal of the installation and that terminal shall be connected to the earthed point of the supply source in accordance with IS : 3043-1987*.
*code of practice for earthing.
The protective devices shall be of one or more of the following type:
Overcurrent protective devices, and
Residual current devices. Provided that where the neutral and the protective functions are combined in one conductor (PEN conductor) a residual current device shall not be used.

Installations which are part of a TT system:
Where protection is afforded by over-current protective devices or residual current devices, exposed conductive parts shall be connected by protective conductors

individually, in groups or collectively to an earth electrode or electrodes.
The protective devices shall be of one or more of the following types:
Residual current devices, and
Overcurrent protective devices.

Installations which are part of an IT system:
No live conductor of the installation shall be directly connected to earth. Note—To reduce overvoltage or to damp voltage oscillations, it may be necessary to provide earthing through impedances or artificial neutral points and the characteristics of these should be appropriate to the requirements of the installation.
Exposed conductive parts shall be earthed either individually, in groups or collectively. Simultaneously accessible exposed conductive parts and associated extraneous conductive parts shall be connected only to an earth electrode common to those parts.
The protective devices shall be residual current devices.
An insulation monitoring device shall be provided to indicate the occurrence of first fault from a live part to exposed conductive parts or to earth. The device shall automatically disconnect the supply, or initiate an audible and/or visual signal. Note—First fault should be eliminated as quickly as practicable.
After the occurrence of first fault, conditions for disconnection of supply, as specified for TN and TT systems, shall apply.

Application of protective measure—Automatic disconnection of supply

This measure is generally applicable, and is intended to prevent the occurrence of voltage of such magnitude and duration between simultaneously accessible conductive parts that danger could arise. It includes all methods involving the earthing of exposed conductive parts. The limiting values of earth fault loop impedance specified in **5.1.3.1** (a)(iv) shall be applied where the conditions are such that conventionally normal body resistance applies. In conditions where reduced or very low body resistance is to be expected, either the earth fault loop impedance values shall be appropriately redacts or another protective measure shall be used. Note—Conventionally normal body resistance relates to a contact involving one hand and both feet, the skin being dry or moist with perspiration (but not wet). Reduced body resistance may be expected in situations where the hands and/or feet are likely to be wet or where the shock current path may not be through the extremities, and very low body resistance (of the order of one quarter of the conventionally normal body resistance) is to be expected in locations where a person is immersed in a water or working in confined conductive locations.

The limiting values of earth fault loop impedance specified in **5.1.3.1** (a) (iv) are applicable only where the exposed conductive parts of the equipment concerned and any extraneous conductive parts are situated within the zone created by the main equipotential bonding [see **5.1.3.1**(a) (i)]. Where a circuit originating in that zone is specifically intended to supply equipment to be used outside the zone, and that equipment may be touched by a person in contact directly with the general mass of earth, the following requirements apply:
For solidly grounded system it shall be sufficient to check whether the provisions of **5.1.3.1** are complied with in general;
It shall be verified whether the main over-current protection device affords the degree of

protection envisaged by **5.1.3.1**(a) (iv ;
Where the overcurrent protective device did not afford the degree of protection in **5.1.3.1**(a) (iv) and where the earthing is inadequate, a separate residual current device shall be installed, affording a protection in compliance with **5.1.3.1**(a)(iv); and
The automatic disconnecting device shall be so installed that proper discrimination between the circuits being protected is available.

Where the measure is used in a household or similar installation forming part of a TT system or where the earthing is not effective, every socket outlet circuit shall be protected by a residual current device having a rated residual operating current not exceeding 30 mA.

Automatic disconnection using residual current devices shall not be applied to circuits incorporating a PEN conductor. The measure is otherwise generally applicable, provided that the device is selected to have a residual operating current ensuring compliance with **5.1.3.1** (a)(ii) and (v). The use of such devices is preferred where the value of earth fault loop impedance prevents the use of overcurrent devices to obtain compliance with the disconnection times specified in **5.1.3.1**(a)(iii). Note—If a residual current device affording protection against indirect contact has a rated residual current equal to or less than 30 mA and an operating time of 40 ms or less at a residual current of 250 mA, it may also be used to reduce the risk associated with direct contact in case of failure of other protective measures. Such a device cannot be used as a sole means of protection against direct contact and does not obviate the need to apply one of the protective measure specified in **5.1.2.0.**

Automatic disconnection using fault voltage operated protective devices is recognised for use in TT and IT systems and is suitable where the impedance of the earth fault loop prevents compliance with **5.1.2.2**(b) and (c) by the use of overcurrent protective devices.

5.1.3.2

Protection by use of Class II equipment or by equivalent insulation
Protection shall be provided by one or more of the following:
Electrical equipment of the following types, type tested and marked to the relevant standards:
Electrical equipment having double or reinforced insulation (Class II equipment).
Factory built assemblies of electrical equipment having total insulation.
Supplementary insulation applied to electrical equipment having basic insulation only, as a process in the erection of an electrical installation, providing a degree of safety equivalent to that of electrical equipment according to (i)(1) above and complying with (b) to (j) below.
Reinforced insulation applied to uninsulated live parts, as a process in the erection of an electrical installation, providing a degree of safety equivalent to electrical equipment according to (i)(1) above and complying with (b) to (j), such insulation being recognized only where constructional features prevent the application of double insulation.

The installation of equipment described in item (a)(i) above (for example the fixing and

connection of conductors) shall be effected in such a way as not to impair the protection afforded in compliance with the equipment specification, Class II equipment shall be so installed that basic insulation is not the only protection between live parts of the installation and exposed metalwork of that equipment.

The electrical equipment being ready for operation, all conductive parts separated from Jive parts by basic insulation only shall be contained in an insulating enclosures affording at least the degree of protection IP 2X.

The insulating enclosure shall be capable of resisting the mechanical, electrical and thermal stresses to which it is likely to be subjected. Note—Coatings of paint, varnish and similar products are generally considered not to comply with (d).

If the insulating enclosure has not previously been tested, a suitable test shall be carried out (*see* Section 5).

The insulating enclosure shall not be pierced by conductive parts, other than circuit conductors, likely to transmit a potential. The insulating enclosure shall not contain any screws of insulating material, the replacement of which by metallic screws could impair the insulation provided by the enclosure. Note—Where the insulating enclosure must be pierced by mechanical joints or connections (for example, for operating handles of built-in equipment, and for fixing screws) these should be arranged in such a way that protection against indirect contact is not impaired.

Where lids or doors in the insulating enclosure can be opened without the use of a tool or key, all conductive parts which are accessible if the lid or door is open shall be behind an insulating barrier which prevent persons from coming into contact with those parts; this insulating barrier shall provide a degree of protection of at least IP 2X and be removable only by use of a tool.

Conductive parts enclosed in the insulating enclosure shall not be connected to a protective conductor. However, provision may be made for connecting protective conductors which necessarily run through the enclosure in order to serve other items of electrical equipment whose supply circuit also runs through the enclosure. Inside that enclosure, any such conductors and their terminals or joints shall be insulated as though they were live parts and their terminals shall be appropriately marked.

The enclosure provided for this measure shall not adversely affect the operation of the equipment protected.

Application of protective measure—Class II equipment or equivalent insulation

This measure is intended to prevent the appearance of a dangerous voltage on the exposed metalwork of electrical equipment through fault in the basic insulation. It is generally applicable to items of equipment, either by the selection of equipment complying with an appropriate Indian Standard where that standard provides for the use of Class II construction or total insulation, or by the application of suitable supplementary

insulation during erection.

Where a circuit supplies items of Class II equipment, a means of connection to the protective conductor of the circuit shall nevertheless be provided at every point for the supply of current-using equipment likely to be changed by the user, and at terminations for accessories similarly likely to be changed by the user. This requirement need not be observed where (c) below applies. Note—Exposed metal work of Class II equipment should preferably be mounted so that it is not in electrical contact with any part of the installation connected to a protective conductor. Such a contact may impair the Class II protection provided by the equipment specification.

Where this measure is to be used as a sole means of protection against indirect contact (that is, where a whole installation or circuit is intended to consist entirely of Class II equipment or the equivalent), it shall be verified that the installation or circuit concerned will be under effective supervision in normal use so that no change is made that would Impair the effectiveness of the Class II or equivalent insulation. The measure shall not therefore be so applied to any Circuit which includes socket outlets or where a user may change items of equipment without authorisation. Cables having a non-metallic sheath or a non-metallic enclosure shall not be described as being of Class II construction. However, the use of such cables installed in accordance with relevant standard is considered to afford satisfactory protection against direct and indirect contact.

5.1.3.3 Protection by non-conducting location

Exposed conductive parts shall be arranged so that under ordinary circumstances a person will not come into simultaneous contact with:
two exposed conductive parts, or
an exposed conductive part and any extraneous conductive part, If these parts are liable to be at different potentials through failure of the basic insulation of live parts.

In a non-conducting location there shall be no protective conductors, and any socket outlets shall not incorporate an earthing contact.

The resistance of insulating floors and walls at every point of measurement under the conditions specified in **12.3** shall be not less than:
50 kΩ where the supply voltage does not exceed 500 V, or
100 kΩ where the supply voltage exceeds 500 v but does not exceed 1 000 V. If at any point the resistance is less than the specified value, the floors and walls are extraneous conductive parts for the purposes of protection against shock. Note—Steps may need to be taken so that humidity will not effect the resistance of floors and walls to such an extent that they do not comply with **5.1.3.3**(c).

The arrangements made shall be permanent. They shall also afford protection where the use of mobile or portable equipment is envisaged. Note—Attention is drawn to the risk that where electrical installations are not under effective supervision, further conductive parts may be introduced at a later date (for example, mobile or portable Class I equipment or metallic water pipes), which may invalidate compliance with (d).

Precautions shall be taken so that a potential on extraneous conductive parts in the location cannot be transmitted outside that location. Requirement of 5.1.3.3(a) is fulfilled if the location has an insulating floor and walls and one or more of the following arrangements applies:
Relative spacing of exposed conductive parts and of extraneous conductive parts as well as spacing of exposed conductive parts: This spacing is sufficient if the distance between two parts is not less than 2 m; this distance may be reduced while out of the zone of arm's reach.
Interposition of effective obstacles between exposed conductive parts and extraneous conductive parts: Such obstacles are sufficiently effective if they extend the distances to be surmounted to the values stated in (1) above. They shall not be connected to earth or to exposed conductive parts; as far as possible they shall be of insulating materials.
Insulation or insulating arrangement of extraneous conductive parts: The insulation shall be of adequate electrical and mechanical strength.

Application of Protective Measure—Non-conductive location
This measure is intended to prevent simultaneous contact with parts which may be at different potentials through failure of the basic insulation of live parts, it is not recognised in these clauses for general use, but may be applied in special situations under effective supervision, where specified by a suitably qualified electrical engineer.

5.1.3.4 Protection by earth free local equipotential bonding

Equipotential bonding conductors shall connect together all simultaneously accessible exposed conductive parts and extraneous conductive parts.
The local equipotential bonding conductors shall not be in electrical contact with earth directly, or through exposed conductive parts or through extraneous conductive parts.
Note—Where (b) cannot be observed, requirements for protection by automatic disconnection of supply are applicable [*see* **5.1.3.1** (a) to(d)].
Precautions shall be taken so that persons entering the equipotential location cannot be exposed to dangerous potential difference, in particular, where a conductive floor insulated from earth is connected to the earth free equipotential bonding conductors.

Application of Protective Measure—Earth free local equipotential bonding
This measure is intended to prevent the appearance of a dangerous voltage between simultaneously accessible parts in the event of failure of the basic insulation. It shell be applied only in special situations which an earth free and under effective supervision and where specified by a suitably qualified electrical engineer.

5.1.3.5

Protection by electrical separation—The voltage of the electrically separated circuit shall not exceed 500 V:
Protection by electrical separation shall be afforded by compliance with (b) and (c) below and with (d) below for a supply to one item of equipment, or (e) below for a supply to more than one item of equipment.

The source of supply to the circuit shall comply with the following requirements:
It shall be either:

a safety isolating transformer, the secondary winding being isolated from earth; or
a source of current providing a degree of safety equivalent to that of the safety isolating transformer referred to above (for example, a motor generator with windings providing equivalent isolation).
Mobile sources of supply fed from a fixed installation shall be selected or installed in accordance with **5.1.3.2**(a) to (j), or
Equipment used as a fixed source of supply, shall be either:
selected and installed in accordance with **5.1.3.2**(a) to (j), or
such that the output is separated from the input and from the enclosure by an isolation satisfying the conditions of **5.1.3.2**(a) to (j). If such a source supplies several items of equipment, exposed metalwork of that equipment shall not be connected to the metallic enclosure of the source.

The separated circuit shall comply with the following requirements:
Live parts of the separated circuit shall not be connected at any point to another circuit or to earth and to avoid the risk of a fault to earth, particular attention shall be given to the insulation of such parts from earth especially for flexible cables and cords.
Flexible cables and cords shall be visible throughout every part of their length liable to mechanical damage.
A separate wiring system shall preferably be used for the separated circuit. Alternatively, multicore cables without metallic sheath, or insulated conductors in insulating conduit shall be used, their rated Voltage being not less than the highest voltage likely to occur, and each circuit shall be protected against over-current.
Live parts of the separate circuit shall be electrically separated from other circuits. Arrangements shall ensure electrical separation not less than that between the input and output of a safety isolating transformer. Note—In particular, electrical separation is necessary between the live parts of electrical equipment such as relays, contactors, auxiliary switches and any part of another circuit.

For a circuit supplying a single item of equipment, no exposed metalwork of the separated circuit shall be connected intentionally either to the protective conductor or to exposed conductive parts of other circuits.

If precautions are taken to protect the separated circuit from damage and insulation failure, a source of supply complying with **5.1.3.5**(b)(i) to (iii) may supply more than one item of equipment provided that all the following requirements are fulfilled:
The exposed metalwork of the separated circuit shall be connected together by insulated and non-earthed equipotential bonding conductors. Such conductors shall not be connected to the protective conductors or exposed conductive parts of other circuits or to any extraneous conductive parts.
All socket outlets shall be provided with protective contacts which shall be connected to equipotential bonding conductors provided in accordance with (i) above.
All flexible cables of equipment other than Class II equipment shall embody a protective conductor for use as an equipotential bonding conductor.
It shall be verified that, if two faults to exposed metalwork occur and these are fed by conductors of different polarity, an associated protective device will meet the requirements of **5.1.3.1**(a)(ii).

Application of Protective Measure—Electrical separation

This measure is intended, in the individual circuit, to prevent shock currents through contact with exposed conductive parts which might be energised by a fault in the basic insulation of that circuit. It may be applied to the supply of any individual item of equipment by means of a transformer the secondary of which is not earthed, or a source of equivalent safety. Its use to supply several items of equipment from a single separated source is recognised in these clauses only for special situations under effective supervision, where specified by a suitably qualified electrical engineer.

5.1.4 Special Provisions and Exemptions

5.1.4.1

For areas to which only skilled persons, or instructed persons under direct supervision, have access it is sufficient to provide against unintentional contact with live parts by use of obstacles in accordance with **5.1.2.3**, or by placing of live parts out of reach in accordance with **5.1.2.4**, subject also to **5.1.4.2** to **5.1.4.4**.

5.1.4.2

The dimensions of passage-ways and working platforms for open type switchboards and other equipment having exposed live parts shall comply with relevant standards, as appropriate to the nominal voltage of the live parts.

5.1.4.3

For areas which arc accessible only to skilled persons by the use of a safety ward lock key or tools, the measures of protection against electric shock specified in this section may be totally dispensed with, where this is permitted by the appropriate authority.

5.1.4.4

Areas reserved for skilled or instructed persons shall be clearly and visibly indicated by suitable warning signs.

5.1.4.5

It is permissible to dispense with measures of protection against indirect contact in the following instances:
Overhead line insulator wall brackets and metal parts connected to them if such parts are not situated within arm's reach.
Steel reinforced concrete poles in which the steel reinforcement is not accessible.
Exposed conductive parts, which owing to their reduced dimensions or their disposition cannot be gripped or cannot be contacted by a major surface of the human body, provided that connection of these parts to a protective conductor cannot readily be made or cannot be reliably maintained. Note—This clause applies to small isolated metal parts such as bolts, rivets, nameplates and cable clips. For the purposes of (c) above a major surface of the human body is considered to be 50 mm × 50 ram.

Fixing screws for non-metailic accessories provided that there is no appreciable risk of the screws coming into contact with live Parts.
Short lengths of metal conduit for mechanical protection of cables having a non-metallic sheath, or other metal enclosures mechanically protecting equipment.

5.1.5 Automatic Disconnection and Reduced System Voltages

5.1.5.1
Where for functional reasons the use of extra-low voltage is impracticable and there is no requirement for the use of safety extra-low voltage, a reduced low voltage system may be used as specified in **5.1.5.2** to **5.1.5.7**.

5.1.5.2
The nominal voltage of the reduced low voltage circuit shall not exceed 110 V rms ac between phases (three phase 65 V to earthed neutral, single phase 55 V to earthed midpoint).

5.1.5.3
The source of supply to reduced low voltage circuits shall be one of the following:
—a double wound isolating transformer;
—a motor generator having windings providing isolation equivalent to that provided by the windings of an isolating transformer; or
—a source independent of other supplies, for example a diesel generator.

5.1.5.4
The neutral (star) point of the secondary windings of three-phase transformers and generators, or the midpoint of the secondary windings of single-phase transformers and generators, shall be connected to earth.

5.1.5.5
Protection against direct contact shall be provided by insulation or by barriers or enclosures.

5.1.5.6
Protection against indirect contact by automatic disconnection shall be provided by means of an overcurrent protective device in each phase conductor or by a residual current device, and all exposed conductive parts of the reduced low voltage system shall be connected to earth. The earth fault loop impedance at every point of utilisation, including socket outlets, shall be such that the disconnection time does not exceed 5 seconds. Where a residual current device is used, the product of the rated residual operating current in amperes and the earth fault loop impedance in ohms shall not exceed 50.

5.1.5.7
Plugs, socket outlets and cable couplers of reduced low voltage systems shall have a protective conductor contact and shall not be inter-changeable with, plugs, socket outlets and cable couplers for use at other voltages in the same installation.

5.1.6

Protective Measures for Particular Locations—In certain, locations the susceptibility of persons, and livestock where present, to electric shock may be so high as to necessitate special combinations of protective measures and supplementary precautions as specified in the following clauses.

5.1.6.1 Bathrooms and showers
In a room containing a fixed bath or shower, there shall be no socket outlets and there shall be no provision for connecting portable equipment. Where shower cubicles are located in rooms other than bathrooms, any socket outlets shall be situated at least 2.5 m from the shower cubicle. These requirements do not apply to shaver supply units complying with (d) below.
In a room containing a fixed bath or shower, supplementary equipotential bonding shall be provided between simultaneously accessible exposed conductive parts and simultaneously accessible extraneous conductive parts, and between simultaneously accessible extraneous conductive parts.

For circuits supplying equipment in a room containing a fixed bath or shower, where the equipment is simultaneously accessible with exposed conductive parts of other equipment or with extraneous conductive parts, the characteristics of the protective devices and the earthing arrangements shall be such that in the event of an earth fault, disconnection occurs within 0.4 seconds.

In a room containing a fixed bath or shower, electric shavers shall be connected only by means of a shaver supply unit complying with the relevant Indian Standard. The earthing terminal of the shaver Supply unit shall be connected to the protective conductor of the final circuit from which the supply is derived.

In a room containing a fixed bath or shower cubicle, parts of a lampholder within a distance of 2.5 m from the bath or shower cubicle shall be constructed of or shrouded in insulating material. Bayonet type (B22) lampholder shall be fitted with a protective shield. As an alternative, totally enclosed luminaries may be used.

Every switch or other means of electrical control or adjustment shall be so situated as to be normally inaccessible to a person using a fixed bath or shower. This requirement does not apply to electric shaver supply units installed in accordance with (d) above or to insulating cords of cord-operated switches, or to controls incorporated in instantaneous water heaters. No stationary appliance having heating elements which can be touched shall be installed within reach of a person using the bath or shower. For the purpose of this standard the sheath of a silica glass sheathed element is regarded as part of the element.

5.1.6.2 Agricultural installations
In situations accessible to livestock in and around agricultural buildings, electrical equipment shall, so far as is practicable, be of Class II construction, or constructed of or protected by suitable insulation material. Where protection against indirect contact is provided by automatic disconnection in such situations, the limiting values of earth fault loop impedance prescribed in **5.1.3.1** (a)(iv) are not applicable and shall be reduced as appropriate to the type of livestock whose presence is envisaged. Note—The very low

body resistance of horses and cattle, for example, makes them susceptible to electric shock at voltages lower than 25 V rms ac.
Where protection by the use of safety extra-low voltage is used in situations accessible to livestock in and around agricultural buildings, the upper limit of nominal voltage specified in **5.1.1.2** does not apply and shall be reduced as appropriate.

SECTION 3B PROTECTION AGAINST THERMAL EFFECTS

5.2 Requirements for Protection against Thermal Effects

5.2.1 General

5.2.1.1
Protection against thermal effects caused by fixed electrical equipment shall be Provided by the appropriate measures specified in this section.

5.2.1.2
All switchgear shall be selected and erected in accordance with the requirements of Section 4 so as to prevent danger from overheating, arcing, or the scattering of hot particles during operation.

5.2.2 Protection against Fire

5.2.2.1
Fixed equipment shall be selected, located and erected so that its Intended heat dissipation is not inhibited and it does not present a fire hazard to adjacent building materials.

5.2.2.2
Fixed equipment which in normal operation has a surface temperature exceeding 90°C shall be adequately ventilated and be mounted so that no material constituting a fire hazard is within 300 mm above or 150 mm laterally from or below the equipment (*see* Fig. 2), except that these distances may be reduced if a suitable fire-resistant shield or enclosure is installed between the equipment and any such material.
This does not apply to lamps, luminaires and appliances installed in accordance with the manufacturer's instructions and considered to comply with this requirement.

5.2.2.3
Where a distribution board is constructed without a back or without one or more of the other enclosing surfaces it shall be fitted only to surfaces of materials or to other equipment in such a way as to complete the enclosure.

5.2.2.4
All fixed luminaires and lamps shall be placed or guarded so as to prevent ignition of any material which in the conditions of use foreseen arc likely to be placed in proximity to the luminaires or lamps. Any shade or guard used for this purpose shall be suitable to withstand the heat from the luminaire or lamp.
Fixed luminaires mounted in accordance with the manufacturer's installation

instructions comply with this requirement.
Application of Protective Measure—under *consideration*

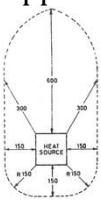

Fig. 2 Clearances from Equipment

5.2.3
Protection Against Burns—Where the temperature of any part of the enclosure of fixed equipment is liable to exceed 80°C, the enclosure shall be so located or guarded as to accidental contact therewith.

SECTION 3C PROTECTION AGAINST OVERCURRENT

5.3 Requirements for Protection against Overcurrent

5.3.1 General

5.3.1.1
Live conductors shall be protected by one or more devices for automatic interruption of the supply in the event of overload (*see* **5.3.3**) and short circuits (*see* **5.3.4**) except in cases where the overcurrent is limited in accordance with **5.3.6.**
Note 1—Live conductors protected against overload in accordance with 5.3.3 are considered to be protected also against faults likely to cause over currents of a magnitude similar to overload currents.
Note 2—Protection of conductors in accordance with this clause does not necessarily protect the equipment connected to the conductors or flexible cables connecting such equipment to fixed installations through plugs and socket outlets.

5.3.1.2
The protection against overload and the protection against short circuits shall be coordinated in accordance with **5.3.5**.

5.3.2 Nature of Protective Devices

5.3.2.1
General—The protective devices shall be of the appropriate types indicated in

5.3.2.2
Protection against both overload and short-circuit currents—Devices providing protection against both overload current and short-circuit current shall be capable of breaking (and, for circuit breakers, making) any overcurrent up to and including the prospective short-circuit current at the point where the device is installed. They shall satisfy the requirements of **5.3.3** and **5.3.4.3** (b) and (c). Such protective devices may be circuit breakers incorporating overload release, or fuses, or circuit breakers in conjunction with fuses.

Note—The use of a projective device having rated breaking capacity below the value of the prospective short circuit current at its place of installation subject to the requirements of 5.3.4.3. b).

5.3.2.3
Protection against overload current only—Devices providing protection against overload currents shall satisfy the requirements of **5.3.3**. Such devices may have a breaking capacity below the value of the prospective short-circuit current at the point where the device is installed.

5.3.2.4
Protection against short-circuit current only—Devices providing protection against short-circuit currents shall satisfy the requirements of **5.3.4**. Such devices shall be capable of breaking (and, for circuit breakers, making) short-circuit currents up to and including the prospective short-circuit current. Such devices may be circuit breakers with short-circuit release, or fuses.

5.3.3 Protection against Overload Current

5.3.3.1
Protective devices shall be provided to break any overload current flowing in the circuit conductors before such a current could cause a temperature rise detrimental to insulation, joints, terminations, or surroundings of the conductors.

5.3.3.2
Coordination between conductors and protective devices—The characteristics of a device protecting a circuit against overload shall satisfy the following conditions:
Its nominal current or current setting (I_n) is not less than the design current (I_B) of the circuit.
Its nominal current or current setting (I_n) does not exceed the lowest of the current carrying capacities (I_z) of any of the conductors of the circuit.
The current causing effective operation of the protective device (I_2) does not exceed 1.45 times the lowest of the current carrying capacities (I_z) of any of the conductors of the circuit.
Where the device is a fuse or a circuit breaker, compliance with condition (b) also results in compliance with condition (c).
Where the device is a semi-enclosed fuse, compliance with condition (c) is afforded if its nominal current (I_n) does not exceed 0.725 times the current-carrying capacity of the lowest rated conductor in the circuit protected.
Note 1—The conditions of **5.3.3.2** may be stated as formulae as follow:

$I_B \leq I_n < I_z$

$I_2 \leq 1.45 \times I_z$

Note 2—It is expected that the, circuit is so designed that small overloads of long duration will not frequently occur (*see* **3.1.1**).

5.3.3.3
Protection of conductors in parallel—When the same protective device protects conductors in parallel, the value of I_z is the sum of the current-carrying capacities of those conductors. This provision is applicable only if those conductors are of the same type,

cross-sectional area, length and disposition, have no branch circuits throughout their length and are arranged so as to carry substantially equal currents. This does not apply to ring circuits.
Application of protective measure against overcurrent
Position of devices for overload protection
A device for protection against overload shall be placed at the point where a reduction occurs in the value of current-carrying capacity of the conductors of the installation. This requirement does not apply where the arrangements mentioned in (ii) below are adopted, and no overload protective device need be provided where (b) below applies.
Note—A reduction in the value of current-carrying capacity may be caused by a change in cross-sectional area, method of installation, type of cable or conductor, or in environmental conditions.
The device protecting conductors against overload may be placed along the run of those conductors, provided that the part of run between the point where the value of current-carrying capacity is reduced and the position of the protective device has no branch circuits or outlets for the connection of current-using equipment.

Omission of devices for overload protection—Devices for protection against overload need not be provided for:
conductors situated on the load side of the point where a reduction occurs in the value of current-carrying capacity, where the conductors are effectively protected against overload by a protective device placed on the supply side of that point;
conductors which because of the characteristics of the load, are not likely to carry overload current;
circuits supplying equipment where unexpected opening of the circuit could cause a greater danger than an overload condition for example, supply circuits of lifting magnets, exciter circuits of rotating machines; and
secondary circuits of current transformers. Note—The omission of overload protection is recommended for the circuits described in (iii) above, but in such cases the provision of an overload alarm should be considered.

Overload protective device in IT systems
The provisions of (a) (ii) and (b) are applicable to installations forming part of an IT system, only where the conductors concerned are protected by a residual current protective device, or all the equipment supplied by the circuit concerned (including the conductors) complies with the protective measure described in **5.1.3.2**.

5.3.4
Protection against Short-Circuit Current—This clause deals only with the case of short circuits anticipated between conductors belonging to the same circuit.

5.3.4.1
General—Protective devices shall be provided to break any short-ciruit current in the conductors of each circuit before such current could cause danger due to thermal and mechanical effects produced in conductors and connections. The nominal current of such a protective device may be greater than current-carrying capacity of the conductor being protected.

5.3.4.2

Determination of prospective short-circuit current—The prospective short-circuit current at every relevant point of the complete installation shall be determined. This may be done either by calculation or by measurement of the relevant impedances.
Note—If the prospective short-circuit current at the origin of so installation is less than the breaking capacity rating of the smallest rated protective device to be used in the installation, no further assessment of the prospective short-circuit current is necessary.

Each short-circuit protective device shall meet the requirements of (b) and (c) below;
The breaking capacity rating shall be not less than the prospective short-circuit current at the point at which the device is installed. A lower breaking capacity is permitted if another protective device having the necessary breaking capacity is installed on the supply side. In that case the characteristics of the devices shall be coordinated so that the energy let-through of these two devices does not exceed that which can be withstood without damage by the device on the load side and the conductors protected by these devices. Other characteristics may need to be taken into account, such as dynamic stresses and arcing energy, for the device on the load side. Note—Details of the characteristics needing coordination should be obtained from the manufacturers of the devices concerned. Coordination with regard to their operating times is of importance.
Where an overload protective device complying with **5.3.3** is to be used also for short circuit protection, and has a rated breaking capacity not less than the value of the prospective short-circuit current at its point of installation, it may generally be assumed that the requirements are satisfied as regards short-circuit protection of the conductor on the load side of that point. Note For certain types of circuit breakers, especially non-current-limiting types, this assumption may not be valid for the whole range of short-circuit currents; in case of doubt, its validity Should be checked in Accordance with the requirements of (d) below.
Where (c) above does not apply, it shall be verified as follows that all currents caused by a short-circuit occurring at any point of the circuit shall be interrupted in a time not exceeding that which brings the cable conductors to the admissible limiting temperature. In addition it shall be verified for larger installations that the cable is unlikely to be damaged mechanically. For short-circuits of duration up to 5 seconds the time. *t* in which a given short-circuit current will raise the conductors from the highest permissible temperature in normal duty to the limit temperature, can as an approximation be calculated from the formula: $t = \frac{k^2 S^2}{I^2}$ where

t	=	duration in seconds;	
S	=	cross-sectional area in mm^2;	
I	=	effective short-circuit current in amperes expressed, for ac, as the rms value;	
k	=	115	for copper conductors insulated with PVC;
		134	for copper conductors insulated with 60°C rubber, 85°C rubber;
		143	for copper conductors with 90°C thermosetting insulation;
		108	for copper conductors insulated with impregnated paper;
		135	for mineral-insulated cables with copper conductors;
		76	for aluminium conductors insulated with PVC;

		89	for aluminium conductors insulated with 60°C rubber, 85°C rubber;
		94	for aluminium conductors with 90°C thermosetting insulation;
		71	for aluminium conductors insulated with impregnated paper;
		87	for mineral-insulated cables with aluminium conductors;
		100	for tin-soldered joints in copper conductors, corresponding to a temperature of 160°C.

Note—For very short durations (less than 0.1 second) where a symmetry of the current is of importance and for current limiting devices, the value of k^2S^2 for the cable should be greater than the value of let-through energy (I^2t) of the device as quoted by the manufacturer.

5.3.4.4
Protection of conductors in parallel—A single device may protect several conductors in parallel against short circuit provided that the operating characteristics of the device and the method of installation of the parallel conductors are suitably coordinated.
Note—Account should be taken of the conditions that would occur in the event of a short circuit which does not affect all of the conductors.
Application of protective measure **5.3.4**
Position of devices for short-circuit protection
A devices far protection against short-circuit shall be placed at the point where a reduction occurs in the value of current-carrying capacity of the conductors of the installation. This requirement does not apply where the arrangements mentioned in (ii) or (iii) below ere adopted, and no short-circuit protective device need be provided where (b) below applies. Note—A reduction in the value of current-carrying capacity may be caused by a change in cross-sectional area, method of installation, type of cable or conductor, or in environmental conditions.
The short-circuit protective device may be placed at a point on the load side of that specified in (i) under the following conditions: between the point where the value of current-carrying capacity is reduced and the position of the protective device, the conductors shall:
not exceed 3 m in length,
be erected in such a manner as to reduce the risk of short circuit to a minimum, and
be erected in such a manner as to reduce the risk of fire or danger to persons to a minimum.
Note 1—The condition specified in (2) above may be fulfilled for example, by reinforcing the protection of the conductors against external influences.Note 2—the provisions of (ii) cannot be applied to any part of an installation in respect of which the short circuit protective device is intended also to afford protection against indirect contact.
The short-circuit protective device may be placed at a point other than that specified in (i), where a protective device on the supply side of that point possesses an operating characteristic such that it protects against short circuit, in accordance with **5.3.4.3**(d), the conductors on the load side of that point.

Omission of devices for short-circuit protection
Devices for protection against short circuit need not be provided for:
Conductors connecting generators, transformers, rectifiers or batteries with their control panels, where short-circuit protective devices are placed on those panels,
Certain measuring circuits, and
Circuits where disconnection could cause danger in the operation the installation

concerned. Provided that the conductors thus not protected against short circuit comply with. The conditions specified in (a)(ii)(2) and (3) above.

5.3.5
Coordination of Overload and Short-Circuit Protection—The characteristics of devices for overload protection and those for short-circuit protection shall be coordinated so that the energy let-through by the short-circuit protective device does not exceed that which can be withstood without damage by the overload protective device.
Note—For circuits incorporating motor starters, the advice of the manufacturer of the starter should be sought.

5.3.6
Limitation of Overcurrent by Characteristics of Supply—Conductors are considered to be protected against overload and short-circuit currents where they are supplied from a source incapable of supplying a current exceeding the current carrying capacity of the conductors.

5.3.7 Protection According to the Nature of Circuits and Distribution System

5.3.7.1
Phase conductors—Means of detection of overcurrent shall be provided for each phase conductor, and shall cause the disconnection of the conductor in which the overcurrent is detected, but not necessarily the disconnection of other live conductors. Where the disconnection of one phase could cause danger, for example in the supply to three-phase motors, appropriate precautions shall be taken.

5.3.7.2 Neutral conductor—TN or TT systems
In TN or TT systems, where the cross-sectional area of the neutral contractor is less than that of the phase conductors, overcurrent detection for the neutral conductor shall be provided unless both the following conditions are satisfied:
The neutral conductor is protected against short circuit by the protective device for the phase conductor of the circuit,
The load is shared as evenly as possible between the various phases of the circuit.
Where either or both of the conditions specified in (b) above are not met, over-current detection shall be provided for the neutral conductor, appropriate to the cross-sectional area of that conductor, and the means of detection shall cause the disconnection of the phase conductors but not necessarily of the neutral conductor. Note—The cross-sectional area of the neutral conductor should in any event comply with Section 4.

5.3.7.3 Neutral conductor—IT systems
In IT systems, the distribution of the neutral conductor shall be avoided wherever practicable. Where distribution of the neutral conductor is unavoidable, means of detection of overcurrent shall be provided for the neutral conductor of every circuit, which shall cause disconnection of all the live conductors of the circuit concerned including the neutral conductor. This requirement does not apply where the arrangements described in (b) below are adopted.
In IT systems where the neutral is distributed, means of detection of overcurrent for the neutral conductor need not be provided if either of the following conditions is satisfied:
the neutral conductor concerned is effectively protected against short circuit by a

protective device placed on the supply side, for example at the origin of the installation, in accordance with the requirements of **5.3.4.3**(b); and
the circuit concerned is protected by a residual current device having a rated residual operating current not exceeding 0.15 times the current-carrying capacity of the neutral conductor concerned and the device is arranged to disconnect all the live conductor of the circuit concerned including the neutral conductor.

SECTION 3D PROTECTION AGAINST OVERVOLTAGE

5.4 Requirements for Protection against Overvoltage
Note—This clause it set aside to cover rules concerning protective measures against overvoltage which could be due to several reasons such as:
Insulation fault between live parts of circuits supplied at different voltages, and
Atmospheric phenomena or switching voltages.

SECTION 3E PROTECTION AGAINST UNDERVOLTAGE

5.5 Requirements for Protection against Undervoltage

5.5.1 General Requirements

5.5.1.1
Where a drop in voltage, or a loss and subsequent restoration of voltage could imply dangerous situations for persons or property, suitable precautions shall be taken. Also, precautions shall be taken where a part of the installation or current-using equipment may be damaged by a drop in voltage.
An undervoltage protective device is not required if damage to the installation or to current-using equipment is considered to be an acceptable risk, provided that no danger is caused to persons.

5.5.1.2
The operation of undervoltage protective devices may be delayed if the operation of the appliance protected allows without danger a brief interruption or loss of voltage.

5.5.1.3
If use is made of contractors, delay in their opening and reclosing shall not impede instantaneous disconnection by control or protective devices.

5.5.1.4
The characteristics of the undervoltage protective device shall be compatible with the requirements of the Indian Standards for starting and use of equipment.

5.5.1.5
Where the reclosure of a protective device is likely to create a dangerous situation, the reclosure shall not be automatic.
Application of protective measure **5.5**—*Under consideration*.

SECTION 3F ISOLATION AMD SWITCHING

5.6 Requirements for Isolation and Switching

5.6.0 General

5.6.0.1
Means shall be provided for non-automatic isolation and switching to prevent or remove hazards associated with the electrical installation or electrically powered equipment and machines. These means shall comply with the appropriate requirements of this section.

5.6.0.2
In TN-C systems the PEN conductor shall not incorporate means of isolation or switching. In TN-S systems the protective conductor shall not incorporate a means of isolation or switching and provision need not be made for isolation of the neutral conductor except where this is specifically required.
Application of protective measure—Isolation and switching
Every installation shall be provided with means of isolation. In addition, means of electrical switching off for mechanical maintenance, or means of emergency switching, or both shall be provided for any parts of the installation to which Section 4 applies.
Where more than one of these functions are to be performed by a common device, the arrangement and characteristics of the device shall satisfy all the requirements of these clauses for the various functions concerned Devices for functional switching may serve also for isolation, switching off for mechanical maintenance or emergency switching where they satisfy the relevant requirements.
Note—Clauses for selection and erection of devices for isolation and switching are contained in Section 4.

5.6.1 Isolation

5.6.1.1
Every circuit shall be provided with means of isolation from each of the live supply conductors, except as provided in 5.6.0.2. It is permissible to isolate a group of circuits by a common means, due consideration being given to service conditions.

5.6.1.2
Adequate provision shall be made so that precautions can be taken to prevent any equipment from being unintentionally energised.

5.6.1.3
Where an item of equipment or enclosure contains live parts that are not capable of being isolated by a single device, a warning notice shall be placed in such a position that any person gaining access to live parts will be warned of the need to use the appropriate isolating devices, unless an interlocking arrangement is provided so that all the circuits concerned are isolated.

5.6.1.4
Where necessary to prevent danger, adequate means shall be provided for the discharge of capacitive electrical energy.

5.6.1.5

All devices used for isolation shall be clearly identifiable for example, by marking, to indicate the circuit which they isolate.
Application for protective measure—Isolation
Means of isolation complying with **5.6.1** shall be provided at a point as near as. Practicable to the origin of every installation, without the intervention, of any other equipment on which work might need to be done.
Where an isolator is to be used in conjunction with a circuit-breaker as a means of isolating main, switchgear for maintenance, it shall be interlocked with the circuit-breaker; alternatively, it shall be so placed and/or guarded that it can be operated only by skilled persons.
Where isolating devices for particular circuits are placed remotely from the equipment to be isolated, provision shall be made that the means of isolating can be secured against inadvertent reclosure during the operation for which it is intended. Where this prevision takes the form of a lock or removable handle, the key or handle shall be non-interchangeable with any other used for a similar purpose within the installation.
Every motor circuit shall be provided with an isolating device or devices which shall disconnect the motor and all equipment, including any automatic circuit breaker, used therewith
For electric discharge lighting installations using an open-circuit voltage exceeding low voltage, one or more of the following means shall be provided for the isolation of every self-contained luminaire, or alternatively cf every circuit supplying luminaires at a voltage exceeding low voltage:
an interlock on a self contained luminaire, so arranged that before access can be had to live parts the supply is automatically disconnected such means being additional to the switch normally used for controlling the circuit,
effective local means for the isolation of the circuit from the supply, such means being additional to the switch normally used controlling the circuit, and
a switch having a lock or removable handle, or a distribution board which can be locked, in either case complying with (c) above.

5.6.2 Switching Off for Mechanical Maintenance

5.6.2.1
Means of switching off for mechanical maintenance shall be provided where mechanical maintenance may involve a risk of physical injury.

5.6.2.2
Devices for switching off for mechanical maintenance shall be suitably placed, readily identifiable (for example by marking if necessary) and convenient for their intended use.

5.6.2.3
Suitable means shall be provided so that precautions can be taken to prevent any equipment from being unintentionally or inadvertently reactivated.
Application of protective measure prescribed in **5.6.2**
A means of switching off for mechanical maintenance shall be provided for every circuit supplying an electric motor, or equipment having electrically heated surfaces which can be touched, or electromagnetic equipment for operations from which mechanical accidents could arise.
Where a switch mounted on an appliance or luminaire is intended to serve as a means of

switching off for mechanical maintenance, the connections shall be so arranged that the appliance or luminaire can be dismantled to the extent necessary for mechanical maintenance without thereby exposing any parts which, remain live when the switch is open. Any conductors or cables which then remain live shall be as short as possible, and separated from any other live conductors or cables by screens or earthed metal or suitable barriers of insulating material.

5.6.3 Emergency Switching

5.6.3.1
For every part of an installation which it may be necessary to disconnect rapidly from the supply in order to prevent or remove a hazard, a means of emergency switching shall be provided.

5.6.3.2
Means for emergency switching shall act as directly as possible on the appropriate supply conductors, and shall be such that a single initiative action will cut off the appropriate supply.

5.6.3.3
The arrangement of emergency switching shall be such that its operation does not introduce a further hazard or interfere with the complete operation necessary to remove the hazard.

5.6.3.4
Devices for emergency switching shall be readily accessible and suitably marked.

5.6.3.5
Means of emergency stopping shall be provided where movements by electrical means may give rise to danger.
Application of protective measure—Emergency switching
For every emergency switching device, account shall be taken of the intended use of the premises so that access to the device is not likely to be impeded in the conditions of emergency foreseen.
Where greater danger would arise from incorrect operation of emergency switching (as for example by inadvertent disconnection of safety services), the means of emergency switching may be arranged so as to be suitable for operation by skilled persons or instructed persons only.
Means of emergency switching shall be provided in every place where a machine driven by electric means may give rise to danger, and shall be readily accessible and easily operated by the person in charge of the machine. Where more than one means of manually stopping the machine is provided and danger might be caused by unexpected restarting, means shall be provided to prevent such restarting.
A fireman's emergency switch shall be provided for

—exterior discharge lighting installations operating at a voltages exceeding low voltage, and

—interior discharge lighting installations operating unattended at a voltage exceeding low voltage. For the Purpose of this requirement, an installation in a closed market or in an arcade is considered to be an exterior installation. A temporary

installation in a permanent building used for exhibitions is considered not to be an exterior installation. This requirement does not apply to a portable discharge lighting luminaire or sign of rating not exceeding 100 W and fed from a readily accessible socket outlet.
Every fireman's emergency switch provided for compliance with (d) shall comply with all the relevant requirements of the following items:
For exterior installations, the switch shall be outside the building and adjacent to the discharge lamp (s), or alternatively a notice indicating the position of the switch shall be placed adjacent to the discharge lamp(s) and a nameplate shall be fixed near the switch so as to render it clearly distinguishable.
For interior installations, the switch shall be in the main entrance to the building or in another position to be agreed with the local fire authority.
The switch shall be placed in a conspicuous position, reasonably accessible to firemen and except where otherwise agreed with the local fire authority, at not more than 2.75 m from the ground.
Where more than one switch is installed on any one building, each switch shall be clearly marked to indicate the installation or part of the installation which it controls, and the local fire authority shall be notified accordingly. Note—Wherever practicable, all exterior installations on any one building should be controlled by a single fireman's switch. Similarly all internal installations in any one building should be controlled by a single fireman's switch independent of the switch for any external installation.

5.6.4 Other Requirements for Switching for Safety

5.6.4.1
In situations where the requirements of **5.6.3** for emergency switching are not-applicable, the requirements of **5.6.4.2** to **5.6.4.7** shall be satisfied, either;
—by means of isolation and/or the means of switching off for mechanical maintenance provided for compliance with **5.6.1** and **5.6.2.** or
—by the arrangements for switching of equipment for its normal service (functional switching), or
—by the provision of suitable additional means of switching.

5.6.4.2
A main switch or circuit-breaker shall be provided for every installation which shall interrupt all live conductors of the installation, provided that for a 4-wire three-phase ac supply the linked switch or linked circuit-breaker may be arranged to disconnect the phase conductors only and a link may be inserted in the neutral conductor; such a link shall be arranged such that it is in contact before the linked switch can be closed, or shall be securely fixed by bolts or screws.

5.6.4.3
Every circuit and final circuit shall be provided with means of interrupting the supply on load and in any fault conditions foreseen. A group of circuits may be switched by a common device. Additionally, such means shall be provided for every circuit or other part of the installation which it may be necessary for safety reasons to switch independently of other circuits or other parts of the installation. This regulation does not apply to short connections between the origin of the installation and the consumer's main switchgear.

5.6.4.4
Every appliance or luminaire connected to the supply other than by means of a plug and socket outlet complying with Section 4, shall be provided with a means of interrupting the supply on load. The means of interruption shall be separate from the appliance and in a readily accessible position, subject to the provisions of **5.6.4.5** and **5.6.4.6** where applicable. For an appliance fitted with heating elements which can be touched, the means of interruption shall be a linked switch arranged to break all the circuit conductors including the neutral. For the purpose of this regulation the sheath of silica-glass sheathed element is regarded as part of the element. Where the means of interruption is also intended to serve as a means of switching off for mechanical maintenance, it shall comply with the requirements of Section **4.**

5.6.4.5
The means of interrupting the supply required by **5.6.4.4** may be a device mounted on the appliance or lurninaire, as in **5.6.2** where the device is intended to serve as a means of switching off for mechanical maintenance.

5.6.4.6
The means of interrupting the supply on load to comprehensive heating or lighting installations comprising more than one appliance or lurninaire, may be installed in separate room.

5.6.4.7
Every fixed or stationary household cooking appliance shall be controlled by a switch separate from the appliance and placed within 2 m of the appliance. Where two stationary cooking appliances are installed in one room of household premises, one switch may be used to control both appliances provided that neither appliance is more than 2 m from the switch.

TENDER DOCUMENT
(National Competitive Bidding)
For

Upgradation of Common Effluent Treatment Plant (CETP) at Amburtec - Thuthipet sector, Ambur

TENDER – 8/2024

DESIGN, DETAILED ENGINEERING, SUPPLY, INSTALLATION, COMMISSIONING AND TRAIL RUN INCLUDING CIVIL WORKS ON TURNKEY BASIS OF 500 KG/HR. HOLLOW PADDLE SLUDGE DRYER BASED ON THERMIC FLUID HEATING SYSTEM

Volume-III, Section 1

General Specification

AMBUR ECONOMIC DEVELOPMENT ORGANISATION (AEDOL)

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1 SECTION 1: GENERAL

1.1 Project description

1.1.1 Introduction

Ambur is one of the major and important leather clusters in Tamilnadu located at a distance of about 185 Km from Chennai and 175 Km from Bengaluru. The town is also well connected with other parts of the country by the Chennai – Bangalore broad gauge rail route passing through Ambur.

Ambur is located on the National Highway NH-46 connecting Ranipet and Krishnagiri, which is part of the "Golden Quadrilateral" scheme of the Central Government. In the last decade, the township has witnessed a tremendous growth rate of 31.54%, which is very high when compared to the state or national growth rate. This in addition to natural growth can be attributed to the migration of population in search of employment opportunities due to the growth of the leather industry.

Leather industry dominates the economic base of Ambur. In terms of workforce, the participation ratio has almost remained same for the past three decades at about 29% of the total population in Ambur. Of the total workforce, about 50% fall under secondary sector and 41% under the tertiary sector. This clearly indicates the dominance of the industrial sectors.

The history of tanning industry in Ambur dates back to British rule. With abundant water available for tanning operations through the Palar River system, Ambur developed as one of the first centers for leather tanning.

1.1.2 Basic data on CETP

The tanneries set up a Common effluent treatment company namely, AMBUR TANNERY EFFLUENT TREATMENT COMPANY LTD (AMBURTEC) incorporated in the year 1989 with the aim of providing waste water treatment utilities for the benefit of its member tanneries. AMBURTEC pioneered the establishment of CETP concept in leather industry thereby supporting the survival and growth of Small & Medium industries and established two CETPs in the region, viz., Maligaithope and Thuthipet. Amburtec- Thuthipet CETP services the wastewater needs of its 49 members, of which 38 are active now, through CETP and has a consented capacity of 2219 kl of effluent per day.

Since 2006, the Company proceeded in converting the existing CETP from a conventional system to a more sophisticated Zero Liquid Discharge (ZLD) project capital cost of which was Rs.2900 lakhs

The operation & Maintenance expenditure on the ZLD system established by AMBURTEC Thuthipet CETP cost the small-scale industries in Ambur a sum of Rs.14.5 Crores per annum before IFLADP scheme upgradation.

The establishment and operation of a Zero Liquid Discharge Plant is both a technological and financial challenge. It is made mandatory by the regulatory authority in Tamil Nadu and it is the

only State in the Union of India that carries this mandate. Therefore, it would be appropriate if the Government supports us to the maximum extent by way of capital grants and not be treated on par with other such entities across the other States of India as the levels of treatment are basic when compared to ZLD systems.

The basic data on CETP is in the Table below:

Basic data on Maligaithope CETP

Total number of tanneries	49
Number of tanneries operating now	38
Raw material processed	Raw skins
Designed flow rate to the CETP	2219 m^3/day
Commissioning date of the CETP	1995

The satellite view of the CETP is shown in the following Figure 1

Figure 1: Location of Thuthipet CETP site

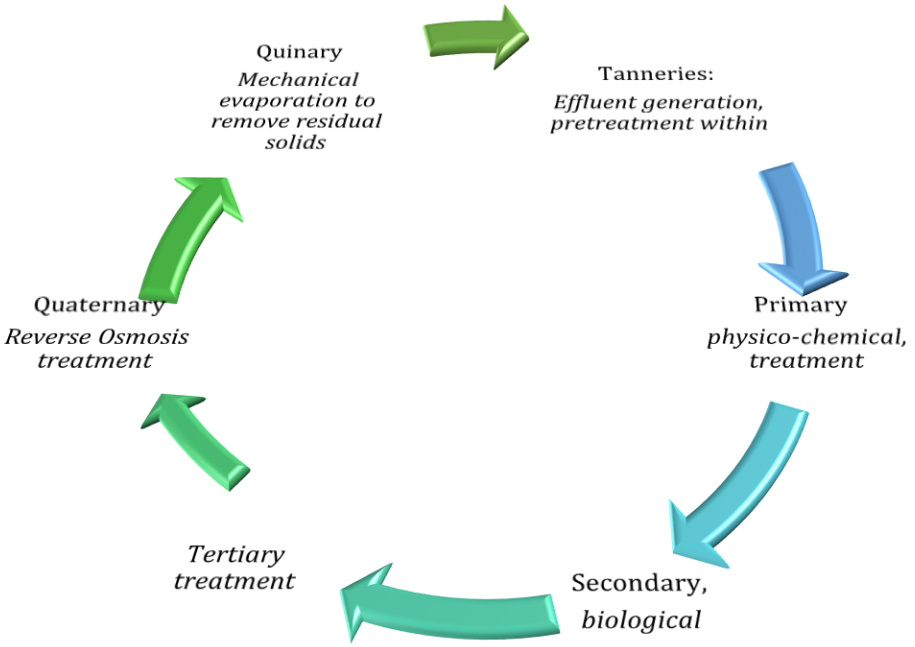
1.1.3 Treatment stages in Thuthipet CETP

Maligaithope CETP, like many other CETPs in Tamil Nadu, has the following stages of treatment:

- Primary treatment: physical-chemical treatment, in which majority of suspended and colloidal particulate pollution load is treated
- Secondary treatment: biological treatment
- Tertiary treatment: chemical and filtration to make the effluent treatable in reverse osmosis
- Quaternary treatment: Reverse osmosis treatment consisting of Ultra-filtration followed by three stages reverse osmosis
- Quinary treatment: Mechanical evaporation of reject saline effluent

In addition, to the above-mentioned treatment stages, the CETP has the following facilities:

- Recovered water distribution system consisting of overhead water tanks and water distribution pipelines
- The impervious Storage Yard for salt-laden solid residue from evaporator.



In addition, to the above-mentioned treatment stages, the CETP has the following facilities:

- Recovered water distribution system consisting of overhead water tanks and water distribution pipelines
- Special landfill Impervious Storage Yard for salt-laden solid residue from evaporator.

1.2 IFLDP Project

The CETP is planning to have a upgradation of the CETP. The upgradation is supported by Department for Promotion of Industry and Internal Trade, Government of India through the scheme Indian Footwear And Leather Development Programme (IFLDP). The Central Leather Research Institute (CLRI) is the PAMC for DIPP of the IFLADP projects.

1.3 Scope of work

1.3.1 Scope of Civil Works

Work to be undertaken for the execution of this tender shall include, but is not limited to:

Construction, installation, inspection & testing at works, supply at site, erection, final check-up, painting of all RCC structures, PEB building as detailed in the Volume 3 & Volume 5 as shown in the drawings (being part of this tender document) and labour to hand over the property.

1.3.2 Scope of mechanical works

Work to be undertaken for the execution of this tender shall include, but is not limited to:

Design, construction, installation, inspection & testing at works, supply at site, erection, final check-up, painting, testing & commissioning of all mechanical equipments as detailed in the bill of quantities with all additional equipments as shown in the drawings (being part of this tender document) and labour to hand over a properly working paddle dryer and sludge handling mechanical equipment.

1.3.3 Scope of electrical works

Work to be undertaken for the execution of this tender shall include, but is not limited to:

Design, manufacture, inspection & testing at works, supply at site, erection, final check-up, painting, testing & commissioning of all electrical equipments as detailed in the bill of quantities with all additional equipments as shown in the drawings (being part of this tender document) and labour to hand over a properly working paddle dryer. The scope of work also includes civil work such as excavation, laying of sand and protective covers on cables, making earthing chambers, foundation and pedestal for electrical equipments, grouting of cable tray supports in walls, making entry for cable conduits in walls and making good the surface to original one, embedding concealed conduits, junction boxes etc. In wall, ceiling and making good the surface, foundation for street lighting poles, providing covers, chequered plates on cable trenches etc. with all additional materials and labour included to meet the requirements as stated in this tender and common practice.

- Arrangement for Power Supply
- Switch boards and distribution boards / panel boards
- Installation of Motor control centre
- Power factor controller
- Distribution Wiring Systems
- Earthing Systems
- Testing

The contractor shall submit the information as requested at the data sheets for each equipment.

Co-ordination with local authorities, such as electricity board, chief electrical inspectorate to state government, chief electrical authority etc. for obtaining all the statutory approvals needed, preparing, submitting and obtaining approval of all electrical drawings and documents as well as obtaining approval of the electrical installation from these authorities in such that connection to the high voltage grid is granted and power supply is certain including all activities and duties involved.

Preparation and submission of approved As-Built drawings on paper and pen drive, as well as installation - operation - and maintenance manuals of all equipments supplied along with their catalogues data shall also be furnished.

1.4 General Site Data

The following data may be used as guidance. However, the Tenderer shall ascertain the exact details for design.

1.4.1 Weather conditions

a) CLIMATE: Temperate with peak monsoon during October to November.
b) TEMPERATURE: Maximum 43°C / Minimum 20°C
d) RAINFALL: Average rainfall per year : 905 mm.

1.4.2 Level Datum and General Topography of the Plant Area

The Tenderer shall carry out all survey including establishment of reference levels and benchmarks.

The Contractor shall set in the ground on the Sites steel temporary benchmarks that shall be securely concreted in. He shall establish the levels of these benchmarks and obtain the agreement of the Engineer. All levels used in the construction of the works shall be referred to these benchmarks.

Where any benchmark is situated within the working area, the Contractor shall, on written agreement from the Engineer, locate and establish new benchmarks outside the working areas.

1.4.3 Existing Services

The Contractor shall take every precaution to ensure protection of all existing pipes or other services. In principle at this site – none. Any damage due to the Contractor's operations or to his negligence shall be made good by the Contractor to the satisfaction of the Engineer.

The Contractor shall carry out the works in such manner that there is minimum interruption in the supply through the existing water mains and services. The Contractor shall comply with the requirements of the Water/Sewerage and other Authorities. Where such interruption is unavoidable, it shall only be carried out with the written permission of Engineer.

If it should become necessary for the proper execution of the work, to remove or divert temporarily any existing pipe, sewer, field-drain or other service, the Contractor shall obtain permission from the Competent Authority or Owner and shall carry out the work at his own cost in a manner and at times to be approved by such Authority or Owner and shall subsequently reinstate the work to the satisfaction of such Authority or Owner.

1.4.4 Levels and Dimensions

The levels of the ground and the levels and dimensions of existing features are believed but are not guaranteed to be correct. Wherever dimensions or levels are marked on the drawings, such dimensions or levels shall take precedence over dimensions scaled from the drawings and scaled dimensions shall be used only in the absence of other more precise information. Large scale drawings shall be used only in the absence of other more precise information. Large scale drawings shall be taken in preference to drawings of a smaller scale.

The drawings give dimensions and levels relating to the works, but these dimensions may be modified by the Engineer if so required.

1.4.5 Offices, Yards, Store

The Contractor shall provide and maintain on the site an office for his site staff where written instructions from the Engineer may be delivered and in such case, such instructions will be deemed to have been delivered to the Contractor. The Contractor shall make his own arrangement for all yards, stores and the like and for all services in connection therewith.

The Contractor shall provide and maintain on the site an office for use by the Engineer only. This office should be provided with lights, washing basin, drinking water, wall sockets and telephone facilities. The office should contain a meeting table suitable for seating six persons and six chairs.

The Contractor shall make his own arrangements for the supply of electricity, water and telephone services, pay all constructional and connection costs, fees and expenses incurred for both offices. The water shall be of a quality fit for human consumption in accordance with the World Health Organisation Guidelines.

1.4.6 Sanitary Conveniences

Sanitary conveniences for the use of persons employed on the works shall be provided and maintained by the Contractor to the extent and in such manner and at such places as shall be approved by the Engineer and the Authority concerned, and all persons connected with the works shall be obliged to use them.

Sanitary conveniences for the use of the Engineer only shall be provided and maintained by the Contractor to the extent and in such manner and at such places as shall be approved by the Engineer and the Authority concerned.

The Contractor shall make all temporary arrangements for the proper discharge of sewage and drainage from or in connection with the works and shall maintain the same to the satisfaction of the Engineer and the Authority concerned as long as they may be required.

1.4.7 Medical Facilities

During the progress of the works, the Contractor shall provide and maintain in easily accessible positions on the Site adequate First Aid outfits to the approval of the Medical Officer and of the Engineer and such outfits to be in charge of an experienced dresser who shall be on duty on Site during all hours when work is being carried out.

1.4.8 Abatement of Nuisance

The Contractor shall adopt such measures as the Engineer may consider reasonable and necessary to minimise nuisance to others from noise, dust and other causes.

1.4.9 Notice Boards

Notice Boards in English are to be displayed in suitable positions on the Sites on the day work commences. This is to show the Employer's name together with the name of the Project and the names of the Consulting Engineer and the Contractor. The exact sign dimensions and layout and the exact positions of the signs on the Site are to be agreed with the Engineer.

1.4.10 Traffic Safety and Control

The Contractor shall provide, erect and maintain on the Sites at such positions and for such duration as may be required by the Engineer all protective barriers, traffic signs and traffic control signals necessary for the direction and control of all traffic and clear away when the work involved in the diversions has been completed.

The signs and barriers shall be adequately illuminated at night and kept clean and legible at all times. The Contractor shall reposition the barriers, signs and signals as necessary as the work progresses.

Where single file traffic is necessary, the Contractor shall, where directed by the Engineer, provide and maintain temporary lighting, barriers and traffic direction signs required.

1.4.11 Local Regulations

The Contractor shall at all times conform to the provisions of any ordinance and of any order, proclamation, rule or notice made under any ordinance relating to the works, employment of labour, etc. and to any water or electricity company within whose area and jurisdiction the works are to be executed.

1.4.12 General costs

Any cost involved in the performance of works required under General Data shall be deemed to be included in the contract cost if not specifically provided for in the Bill of Quantities.

1.5 Documents

At the as built phase the following drawings and documents shall be submitted in 12 sets:

a) Specification sheets of all (each) equipment and instruments delivered and installed.

b) Vendor data sheets of all (each) equipment and instruments delivered and installed.

c) Installation, testing, calibration and commissioning of all equipment and instruments delivered and installed as well as coherent operation and maintenance manuals for the CETP.

d) Mechanical

As built drawings.

After installation of the electrical machines and accessories, the contractor should prepare as built drawings together with specification and data covering performance and materials of construction.

e) Single lines of distribution system; installation schemes, separate for each panel

- Loop wiring drawings and hook up drawings
- Instrument location details with installation particulars
- Instrument and instrument cable layout
- As built drawing of instrument panel cum control desk

f) Civil

With typical Layout, GA and technical specification, the contractor should prepare the design and detailed engineering along with Structural Drawing should be submitted.

As Built Drawing shall be submitted during handing over of the project.

2 STANDARDS

The works shall be executed in accordance with all standards mentioned in this tender as well as the following Indian Standards (I.S.). If no I.S. is mentioned the applicable British Standard will apply.

Indian Standards Cited for the work

The standards listed herein shall not be deemed as all inclusive. The Bidder shall furnish a comprehensive list of standards he would be following in the works. These shall be furnished along with the tender. In case of discrepancy between the specifications and the standards, the specifications shall govern.

2.1 Materials

IS : 226 - Specification for structural steel (Standard Quality)
IS : 269 - Specification for ordinary and low-heat portland cement.
IS : 299 - Specifications for Sulphate of Alumina
IS : 383 - Specification for coarse and fine aggregates from natural sources for concrete.
IS : 428 - Specification for distemper, oil emulsion, colour as required
IS : 455 - Specification for portland slag cement
IS : 458 - Specification for concrete pipes.
IS : 459 - Specification for unreinforced corrugated & semi corrugated asbestos cement sheets.
IS : 650 - Specification for standard sand used for testing of cement.
IS : 651 - Specification for salt glazed stoneware pipes and fittings.
IS : 777 - Specification for glazed earthenware tiles.
IS : 808 - Specification for dimensions for hot rolled steel sections. [Parts I to VI]
IS : 814 - Specification for covered electrodes (Part I metal arc welding of struct. Steel I & II
IS : 961 - Specification for structural steel (High Tensile)
IS : 1003 - Specification for timber paneled and glazed shutters. (Parts I & II)
IS : 1038 - Specification for steel doors, windows and ventilators.
IS : 1077 - Specification for common burnt clay building bricks.
IS: 1148 - Specification for hot rolled steel rivet bars (upto40mm) for structural purpose
IS : 1149 - Specification for high tensile steel rivet bars for structural purposes.
IS : 1230 - Specification for cast iron rainwater pipes and fittings.
IS : 1363 - Specification for black hexagonal bolts, screws, nuts and black hexagonal screws
IS : 1364 - Specification for hexagon bolts, screws nd nuts
IS : 1367 - Technical steel supply conditions for (Parts I threaded fasteners To x VIII)
IS : 1398 - Specification for packing paper water proof bitumen laminated.
IS :1489 - Specification for portland pozzolana cement.
IS : 1540 - Specifications for Quicklime
IS : 1566 - Specification for hard drawn steel wire fabric for concrete reinforcement.
IS : 1580 - Specification for bituminous compounds for water proofing & caulking purposes.
IS : 1786 - Specification for high strength deformed bars & wires for concrete reinforcement.
IS : 1852 - Specification for rolling and cutting tolerances for hot ventilators.
IS : 1948 - Specification for aluminium doors, windows and ventilators.
IS : 1977 - Specification for structured steel (ordinary quality)
IS : 2016 - Specification for plain washers.
IS : 2062 - Specification for weldable structural steel
IS : 2074 - Specification for ready mixed paint, air drying, red oxide zinc chrome & priming.
IS : 2116 - Sand for masonry works
IS : 2185 - (Part I)Specification for concrete masonry units, hollow and solid concrete blocks.

IS : 2202 - Specification for wooden flush door shutters (Parts I & II]
IS : 2645 - Specification for integral cement water proofing compounds.
IS : 2750 - Specification for steel scaffoldings.
IS : 2835 - Specification for flat transparent sheet glass.
IS : 3102 - Classification of burnt clay solid bricks
IS : 3384 - Specification for bitumen primer for use in waterproofing and damp proofing.
IS : 3502 - Specification for steel checkered plates.
IS : 3757- Specification for high strength structured bolts.
IS : 4021 - Specification for concrete porous and ventilator frames.
IS : 4351 - Specification for steel door frames
IS : 4984 – High Density Polyethylene pipes
IS : 4990 - Specification for plywood for concrete shuttering work.
IS : 5369- General requirements for plain washers and lock washers.
IS : 5372- Specification for taper washers for channels.
IS : 5374 - Specification for taper washers for I beams.
IS : 7215 - Specification for tolerances for fabrication of steel structures.
IS : 7280 - Specification for bar wire electrodes for submerged arc welding of struct. steel.
IS : 7634 - Laying and jointing of Polyethylene pipes
IS : 8008 – Specifications for HDPE fittings
IS : 8360 – Fabricated HDPE fittings
IS: 8217 – HDPE runouts and undercuts
IS: 10262 - Recommended guidelines for concrete mix design
IS: 14333 – High Density Polyethylene pipes for sewerage

Tests

IS : 516 - Methods of test for strength of concrete.
IS : 1182 - Recommended practice for radiographic examination of fusion-welded butt joints
IS : 1199 - Methods of sampling and analysis of concrete.
IS : 1542 - Sand for Plastering
IS : 2386 - [I to VIII] Methods of test for aggregates for concrete
IS : 2720 - (Parts I to XLI) Methods of test for soils.
IS : 3025 - Methods for sampling and test (physical and chemical) for water and wastewater.
IS : 3495 - Methods of tests of burnt clay building bricks.
IS : 3613 - Acceptance tests for wire flux combinations for submerged arc welding
IS : 4020 - Methods of tests for wooden flush doors: Type tests.
IS : 4031 - Methods of physical tests for hydraulic cement.
IS : 5807 - Method of test for clear finishes for wooden [Parts Ito VI] furniture
IS : 7318- Approval tests for welders when welding procedure approval is not required.

Codes of Practice

IS :456 - Code of practice for plain and reinforced concrete.
IS : 783- Code of practice for laying of concrete pipes.
IS : 800 - Code of practice for general construction in steel.
IS : 806 - Code of practice for use of steel tubes in general building construction.
IS : 816 - Code of practice for use of metal arc welding for general construction in mild steel.
IS : 817 - Code of practice for training and testing of metal arc welders.
IS : 875 - (Parts 1 to V) Code of practice for design loads/other than earthquake safety
IS : 919 - Recommendations for limits and fits for engineering.
IS : 1081 - Code of practice for fixing & glazing of metal doors, windows and ventilators.
IS : 1172 - Code of basic requirements for water supply, drainage and sanitation.
IS : 1477 - (Parts I &II) Code of practice for painting of ferrous metals in buildings.
IS : 1597 - (Parts I & II) Code of practice for construction of stone masonry.

IS : 1742 - Code of practice for building drainage
IS : 1893 - Criteria for earthquake resistant design of structures.
IS : 2065 - Code of practice for water supply in buildings.
IS : 2212 - Code of practice for brickwork.
IS : 2338 - (Parts I & II) Code of practice for finishing of wood and wood based materials.
IS : 2394 - Code of practice for application of lime plaster finish.
IS : 2395 - (Parts I & II) Code of practice for painting Concrete, masonry & plaster surfaces.
IS : 2470 - (Part I) Code of practice for installation of septic tanks - Design & construction.
IS : 2470 - (Part II) Code of practice for installation & disposal of septic tanks
IS : 2502 - Code of practice for bending and fixing of bars for concrete reinforcement.
IS : 2571 - Code of practice for laying insitu cement concrete flooring.
IS : 2595 - Code of practice for radiographic testing.
IS : 2751 - Code of practice for welding of mild steel plain and deformed bars used for RCC
IS: 2974 - (Parts II to V) Code of practice for design and construction of machine foundations.
IS : 3007 - (Parts I & II) Code of practice for laying of asbestos cement sheets.
IS : 3114 - Code of practice for laying of Cast Iron pipes.
IS : 3370 - (Parts I & IV) Code of practice for concrete structures for the storage of liquids
IS : 3414 - Code of practice for design and installation of joints in buildings.
IS : 3558 - Code of practice for use of immersion vibrators for consolidating concrete.
IS : 3658 - Code of practice for liquid penetrant flow detection.
IS : 3935 - Code of practice for composite construction.
IS : 4000 - Code of practice for assembly of struct. joints using high tensile friction fasteners.
IS : 4014 - (Parts I & II) Code of practice for steel tubular scaffolding.
IS : 4111 - Code of practice for ancillary structures in sewerage system
IS : 4127 - Code of practice for laying of glazed stoneware pipes.
IS : 4353 - Recommendations for submerged arc welding of mild steel and low alloy steels.
IS : 5329 - Code of practice for sanitary pipe work above ground for buildings.
IS : 5334 - Code of practice for magnetic particle flaw detection of wells.
IS : 5822 - Code of practice for laying of welded steel pipes for water supply.
IS : 7215 - Tolerances for fabrication of steel structures.
IS : 9595 - Recommendations for metal arc welding of carbon & carbon manganese steels.
IS:10005 - SI units and recommendations for the use of their multiples & certain other units.

2.2 Construction Safety

IS : 3696 - (Parts I & II) Safety code for scaffolds and ladders.
IS : 3764 -Safety code for excavation work.
IS : 7205 -Safety code for erection of structural steel work.
I.S. 456 -Code of Practice for Plain and reinforced concrete.
I.S. 875 -Code of Practice for design load (other than earthquake) for building structures.
I.S. 3370 - (Part I to IV) Code of practice for concrete structures for the storage of liquids.
I.S. 1893 - Criteria for earthquake resistant design of structures
I.S. 2974 - (Parts I to V) Code of practice for design & construction of machine foundations.
IRC : 6 - Standard specs. & Code of Practice for road bridges - loads & stresses
I.S. 800 - Code of Practice for general construction in steel.
I.S. 806 - Code of Practice for use of steel tubes in general building construction.

2.3 Electrical

Standard Specifications

Except where otherwise specified, all electrical machines and accessories shall comply with

current national standards provided that these standards are not less stringent than the equivalent of the International Organisation for Standardisation (ISO) or the International Electrotechnical Commission (IEC). For the purpose of inspection or testing, the Contractor shall make available to the Engineer or his representative copies of relevant standards if requested.

2.4 Instrumentation

Except where otherwise specified, all instrumentation and accessories shall comply with current national standards provided that these standards are not less stringent than the equivalent of the International Organisation for Standardisation (ISO) or the International Electrotechnical Commission (IEC). For the purpose of inspection or testing, the Contractor shall make available to the Engineer or his representative copies of relevant standards if requested.

2.5 Mechanical

Except where otherwise specified, all equipment and accessories shall comply with current national standards provided that these standards are not less stringent than the equivalent of the International Organisation for Standardisation (ISO) or the International Electrotechnical Commission (IEC). For the purpose of inspection or testing, the Contractor shall make available to the Engineer or his representative copies of relevant standards if requested.

3 GENERAL SPECIFICATION OF METAL WORKS

3.1.1 Material Standard & Workman-ship

The standard of materials for metal work and workmanship shall conform to relevant British Standard specifications or equivalent Indian Standard.

3.1.2 Workshop Drawing

The Contractor shall prepare workshop drawing taking into consideration the following:
All proposed connection and joints which are not detailed in the contract document shall be approved by the Engineer;

The requirements of fabrication technology, transportation and erection of steel structure; and
Uniformity of elements and parts of structures shall be maintained through out.

3.1.3 Erection Process

The Contractor shall align, plumb and level all steel work accurately and in accordance with the approved installation Drawings. No permanent bolting or welding may be done until correct alignment, plumbing and levelling has been achieved. During erection, steel work should be securely bolted and if necessary, temporarily braced. Where considered necessary by the Engineer, the Contractor shall provide, prior to erection, all calculations relating to strength and anticipated deflections of the structure to be caused by the proposed method of erection which shall be to the satisfaction of the Engineer. Approval by the Engineer shall in no way relieve the Contractor from full liability for the security of the structure and plant.

Bedding shall not be carried out until steel work has been finally levelled, plumbed and connected, the stanchions meanwhile being supported on steel packings.

Immediately before grouting, the space underneath the steel should be thoroughly cleaned and freed from water. Bedding should be done using cement grouts, mortar or fine concrete, depending on the space to be filled.

3.1.4 Welding

Before fabrication, all steel shall be thoroughly wire brushed, cleaned of all scale, rust, grease and thoroughly straightened by approved methods that will not injure the materials being worked on. Welding shall be continuous along the entire line of contact except where tack or intermittent welding is permitted. Where exposed, welds shall be cleaned of flux and ground smooth. Welding shall be performed by experienced tradesmen, and made with electrodes conforming to BS 639.

All structural welds shall be continuous and shall be properly sized to develop the full strength of the smaller of the two members being joined. The Engineer shall have to write the limit the thickness of each weld bead and pass.

3.1.5 Making Holes

Holes shall be punched where thickness of the material is not greater than the diameter of bolt +3mm. Where the thickness of the material is greater, the holes shall either be drilled or sub-punched and then reamed to size. Holes for bolts should not be formed by burning. Holes must be accurately drilled or punched and reamed out to full diameter required.

3.1.6 Cutting Metal Plate

As far as possible, cutting must be done by shearing. Oxygen cutting shall be done where shear cutting in not possible and shall perfectly be done by machine. All edges shall be free from gauges, notches and burrs. If necessary the same shall be removed by grinding.

3.1.7 Chainlink Fencing

Galvanised steel chainlink fence fabric shall conform to ASTM A-392, 9 gauge wire, 50 mm mesh. Top salvage shall be twisted and barbed and the bottom salvage shall be knuckled. The bottom of the fabric shall be maximum of 50 mm above grade.

3.1.8 Barbed Wire

Fabricate of galvanised steel, ASTM A-121.

3.1.9 Bolts & Nuts

Only bolts of correct lengths are to be used. The threaded portion of each bolt should project through the nut at least one thread after tightening. Where required, tapered washers are to be used to give true bearing. Standard commercial quality galvanised nuts and bolts shall be used.

3.1.10 Stainless Steel

Stainless steel shall conform to ASTM A-276 or equivalent.

3.1.11 Aluminium

All aluminium plate, pipe and structural shapes shall conform to ASTM B-209, B-221 and/or B-308 for 6061 - T6 alloy or equivalent, unless otherwise noted. All aluminium bearing on or embedded in concrete shall have one coat of zinc chromatic primer.

3.1.12 Galvanising

Iron and steel galvanising shall be done in accordance with ASTM A-123 or equivalent with an average coating weight of 600 gm per sq.m and not less than 560 gm per sq.m. Repair to galvanised coating damaged during erection or fabrication shall be done using specified touching material.

3.1.13 Shop Painting

Before leaving the shop all steel not shown or specified to be galvanised shall be given one coat of primer and final painting shall be as specified under the painting section of these specifications. That portion of steel to be embedded in concrete or masonry shall not be painted.

3.1.14Steel Gratings and Racks

Fabricate and weld rectangular opening type, MS or galvanised bar gratings with seat angles, anchors and supports. All grating up to and including 1 m shall be furnished in pieces approximately 1 m in width and all gratings for spans greater than 1 m shall be furnished in pieces approximately 0.8 m in width. Installed units shall be true to plane and free of warpage and irregularities.

3.1.15 Steel Ladders

Fabricate as detailed and galvanise/paint all ladders and rungs after fabrication. Completed work shall be plumb, secure and accurately positioned.

3.1.16 Pipe Rails and Railings

The railing shall be mounted so as to produce a finished appearance that is plumb, straight and true to dimension, free from kinks, twists, and abrasions. Curves, where indicated or necessary, shall be bent to a radius of not less than 150 mm. Where required, provide removable sections and toe plates. Welds shall be ground flush and of smooth finish.

3.1.17 Gates

Fabricate true to size and details using materials specified. Securely and accurately install on walls in position with specified hinges.

3.1.18 Measurement

Metalwork and all work in connection therewith shall be valued by the measurement of only such items as are included in the Bill of Quantities. The cost of metal work not itemised in Bill of Quantities shall be deemed to be included in the contract rates to cover all the Contractor's obligations under the contract.

3.1.19 Application of Protective Coatings

Shop Coating

Fabricated metalwork and equipment that requires coating may be shop primed with specified primer. Any such work delivered to the site with any other shop coat shall have this coating removed and the specified coating applied in the field. Manufactured equipment with approved corrosion-resistant factory finishes and galvanised finishes shall be exempt from this requirement.

Application of Field-Applied Coatings

Except where in conflict with the manufacturer's printed instructions, or where otherwise specified herein, the Contractor may use brush, roller, air spray; however, any spray painting shall first have the approval of the Engineer. Rollers for applying enamel shall have a short nap. Areas inaccessible to spray coating or rolling shall be coated by brushing or other suitable means.

The Contractor shall give special attention to the work to ensure that edges, corners, crevices, welds, bolts, and other areas, as determined by the Engineer receive a film thickness at least equivalent to that of adjacent coated surfaces.

All protective coating materials shall be applied in strict accordance with the manufacturer's printed instructions.

The prime coat shall be applied within a four hour period of cleaning, before deterioration or oxidation of the surface, and in accordance with the manufacturer's recommendations. Drift from sand blasting procedures shall not be allowed to settle on freshly painted surfaces.

All coatings shall be applied in a dry and dust-free environment, and unless otherwise approved by the Engineer shall not be applied when the air temperature or the temperature of the surface to be painted is above 32 C. All surfaces to be coated shall be clean and dry at the time of application.

Each coat shall be applied evenly, at the proper consistency, and free of brush marks, sags, runs, drops, ridges, waves, laps, variations in colour, texture and finish and other evidence of poor workmanship. Care shall be exercised to avoid lapping paint on glass or hardware. Coatings shall be sharply cut to lines. Finished coated surfaces shall be free from defects or blemishes. Protection coverings shall be used to protect floors, fixtures, and equipment. Care shall be exercised to prevent paint from being spattered onto surfaces from which such paint cannot be removed satisfactorily. Drop cloths or other approved protective measures shall be used. Surfaces from which paint cannot be removed satisfactorily shall be painted or repainted as required to produce a finish satisfactory to the Engineer.

Interior surfaces of roof plates, roof rafters and supports, and all contact surfaces inaccessible after assembly shall be coated before erection; however, no structural friction connections or high tensile bolts and nuts shall be painted before erection. Areas damaged during erection shall be hand or power tool cleaned and recoated with prime coat.

Touch-up of all surfaces shall be performed after installation.

Time of Coating

Sufficient time shall be allowed to elapse between successive coats to permit satisfactory recoating, but once started, the entire coating operation shall be completed without delay. No additional coating of any structure, equipment, or other item designated to be painted shall be undertaken without specific permission of the Engineer until the previous coating has been completed for the entire structure, piece of equipment, or other items.

Piping shall not be finish coated until it has been pressure tested and approved.

Clean-up

Upon completion of the work, staging scaffolding, and containers shall be removed from the site. Paint, spots, oil, or stains upon adjacent surfaces shall be removed.

Measurement

Painting and protective coating and all work in connection therewith shall be valued by the measurement of only such items as are included in the Bill of Quantities. The cost of painting and protective coating not itemised in the Bill of Quantities shall be deemed to be included elsewhere in the contract rates to cover all the Contractor's obligations under the contract.

4 CIVIL WORKS - GENERAL SPECIFICATIONS

4.1 Geo-technical survey

A detailed geo-technical survey of the CETP site has to be carried out before finalising the structural design for construction.

4.2 General Guidelines and design criteria.

- All RCC designs of the foundations and constructions shall be conform to IS 456, IS 800 and IS 3370.
- Minimum concrete grade used in foundation is of M25 grade and for water retaining structure is of design mix M30.
- Minimum cement content for foundation should be of 300 kg/m^3 and for other RCC works should be provided with 320 kg/m^3 of cement.
- Reinforcement used in RCC structure should have minimum characteristic strength of 500N/mm^2. The TMT bar should be coated with fusion bonded epoxy . Preferred powder band: Valspar, Jotun, 3M. The density of steel should be as standards.
- Nominal Clear Cover all RCC structure are provided with a clear cover of 75-mm.
- Levelling concrete for foundations of load bearing brick masonry walls shall be of 150 mm thick PCC M20 1:1.5:3 with 40 mm down size graded stone aggregate.
- All tanks resting on ground shall be provided with 100 mm thick PCC 1:1.5:3 with 40 mm size aggregates levelling concrete below the base slab.
- Levelling concrete below RCC footings shall be of PCC 1:1.5:3 using 40 mm down size aggregates.
- Load bearing brick masonry walls shall be provided with damp proof course and Admixture of CM 1:4, 25 mm thick.
- Water retaining structures are added with water proofing admixtures while concreting.
- Cube sampling has to done at site as per IS 456.
- Test report for all construction materials have to submitted to AEDOL .
- All water retaining structures should pass leak test.
- Whereever necessary construction joints are to be provided.
- Preferred MoC of all Shuttering works shall be Plywood.
- For concrete more than 10 m^3, ready mix concrete has to be adopted.

Preferred Make:

For Cement	Ultratech,/ /Coromandel/Ramco
TMT bar	Tata tiscon/ /SAIL/JSW

Tolerances

Tolerance is a specified permissible variation from lines, grade or dimensions given in approved drawings. No tolerance specified for horizontal or vertical building lines or footings shall be constructed to permit encroachment beyond the legal boundaries. Unless otherwise specified, the following tolerances will be permitted:

Tolerances for R.C.C. Buildings

(i) Variation from the plump -

In the lines and surfaces of columns, piers, walls and in arises: 5mm per 2.5m or 25mm whichever is less.

For exposed corner columns and other conspicuous lines -

In any bay or 5m maximum: 5 mm
In 10m or more: 10 mm

(ii) Variation from the level or from the grades indicated on approved drawings -

In slab soffits, ceilings, bean soffit, and in arises -

In 2.5m 5 mm
In any bay or 5m maximum: 10 mm
In 10m or more 15 mm

For exposed lintels, sills, parapets, horizontal grooves and other conspicuous lines -

In any bay or 5m maximum: 5 mm
In 10 m or more: 10 mm

(iii) Variation of the linear building lines from established position in plan and related position of columns, wall and partitions -

In any bay or 5m maximum: 10 mm
In 10m or more: 20 mm

(iv) Variation in the sizes and location of sleeves, openings in walls and floors - 5mm except in the case of and for anchor bolts.

(v) Variation in cross-sectional dimensions of columns and beams and in the thickness of slabs and walls -

Minus 5 mm
Plus 10 mm

(vi) Footings -

Variation in dimension in plan:

Minus 5 mm
Plus 50 mm

Misplacement or eccentricity - 2% of footing width in the direction of misplacement but not more than 50mm.

Reduction in thickness - minus (-) 5% of specified thickness subject to a maximum of 50mm

(v) Variation in steps -

In a flight of stairs -

Rise 3 mm
Tread 5 mm

In consecutive steps -

Rise 1.5 mm
Tread 3.0 mm

Tolerances in other Concrete Structures

(i) All Structures –

Variation of the Constructed linear outline from established position in plan –

In 5m 10 mm
In 10m or more1 5 mm

Variations of dimensions to individual structural features from established positions-
In 20m more 25 mm
In buried construction 50 mm

Variation from plumb, from specified batter or from curved surfaces of all structures
In 2.5 m 10 mm
In 5m 15 mm
In 10m or more 25 mm
In buried construction - twice the above values

Variation from level or grade indicated on approved drawings in slab, beams, soffits, horizontal grooves and visible arises -
In 2.5 m 5 mm
In 7.5 m or more 10 mm
In buried construction - twice the above values

Variation in cross-sectional dimensions of columns, beams, buttresses, piers and similar members -
Minus 5 mm
Plus 10 mm

Variation in the thickness of slabs, walls and sections and similar members -
Minus 5 mm
Plus 10 mm

(ii) Footings for columns, piers, walls buttresses and similar members -

Variation of dimensions in plan -
Minus 10 mm
Plus 50 mm

Misplacement or eccentricity - 2% of footing width in the direction of misplacement but not more than 50 mm.

Reduction in thickness - 5% of specified thickness subject to a maximum of 50 mm

(iii) Tolerances in other types of structures shall generally conform to those given in Clause 3.3 of Recommended Practice for concrete Form wok (American Concrete Institute - ACI 347).

(iv) Tolerances in fixing anchor bolts shall be as follows -

- Anchor bolts without sleeves - + 5 mm
- Anchor bolts with sleeves - + 5mm up to 28mm dia. bolts, + 3.mm for 32mm dia. bolts.
- Embedded parts- + 5mm in all directions.

4.3 Excavation

4.3.1 Setting Out and Levelling

Prior to starting of earth works the Contractor shall setout the necessary alignment and grade boards for proper control of the works. All earth works shall have to be made to the required grades and sizes as per the drawings, specifications and directions of the Engineer. The line and level of excavations shall be as shown in the Drawings or as may be directed by the Engineer. The Contractor shall maintain the setting-out undisturbed during the course of earth work and subsequent construction, and arrangements shall be provided for reference bench marks / reduced levels so that the levels can be checked and measured as and when necessary. The Contractor shall take and record the levels in a manner agreed by or specified by the Engineer. Two working days' notice is to be given to the Engineer so that he can be present during taking and recording of the levels.

4.3.2 Excavation General

Excavations shall be done in all kind of materials and shall be taken to the required depths and sizes as per drawing and/or direction of the Engineer. While excavating, at least 150 mm of the depth shall initially be left unexcavated which shall be dug out carefully in the final dressing after checking of the levels. If any portion of the trench or pit is excavated to a greater depth than specified, the excess depth shall be filled up with compacted khoa and sand in the ratio of 2:1, at the Contractor's own cost. If foundation bed is wet due to rains or due to slow seepage of water, care shall be taken to dry it up before the foundation is laid. Dry sand is to be laid to the required thickness for this purpose at Contractor's cost. The excavated earth shall be kept sufficiently away from the sidewalls to avoid collapse of the excavations due to the pressure of the surcharged earth and also in such a manner that it does not interfere with traffic or approach to private or public properties.

When excavation is made on metalled, tarred, concrete or brick paved areas, the Contractor shall remove the salvageable cut materials, stack them away from the excavation and preserve them separately from excavated earth. Any excess excavated earth shall be removed from site within 24 hours of excavation.

The sides of any excavation shall be vertical unless the Engineer permits otherwise. The Contractor shall support the sides of the excavation to prevent any fall or run from any portion of the ground outside the excavation and to prevent settlement of or damage to structures adjacent to the excavation. The Contractor shall be deemed to have made his own allowance for any excess excavation necessary to provide space for such support and for any other working space. If any portion of excavation shall give way, the Contractor shall at no extra cost to the Employer, take all necessary remedial measures including the excavation and removal of all the ground thereby disturbed.

Where the Contractor elects, and is permitted by the Engineer, to execute excavations with battered sides instead of providing support as aforesaid they shall be excavated to stable slopes and heights and the resulting extra excavation shall be held to be excess excavation.

Where excavation or other work is carried out close to or across existing drains, pipes, cables, or other services etc. the Contractor shall from the relevant parties obtain all necessary consents and execute the work in agreement with regulations etc. in force. The Contractor shall take due care of the existing installation, structure, construction in order to avoid damaged to the said objects. Any damage caused in this connection shall be the responsibility of the Contractor and he shall bear all expenses to remedy the damage caused.

Where, in the opinion of the Engineer, excavation can not be carried out unless the existing drains, pipes, cables, or other services are permanently diverted, or permanently supported by concrete, he shall order the Contractor to undertake such work.

Notwithstanding any relevant information furnished by the Employer or Engineer, the Contractor shall be responsible for ascertaining from his own inspection of the Site and from the respective supply authorities and other public bodies the position of all mains, pipes and cables, whether underground or overhead, within or near the site.

4.3.2.1 Trench Excavation

Before starting trench excavation, the route of the trench shall be pegged out accurately and the natural ground levels and chainages shall be measured and agreed with the Engineer. Strong sight rails shall then be fixed and maintained at each change of gradient, and at as many intermediate points as may be necessary. On these rails shall be marked the centre line and the level at which the excavation is to be carried out, such rails being not more than 50 m apart. In the case of trenches for pipelines, which are set out with reference to stations indicated in the Drawings, the station of each sight rail shall be marked upon it.

No length of pipe trench excavation shall be started until the pipes to be laid in that length are available on site.

Where land drains, culverts or field drains are severed by pipe trench excavation, they shall be kept in effective temporary operation during construction of the pipeline. At the appropriate stage of refilling the trench excavation, the drains shall be permanently restored to their original capacity to the satisfaction of the Engineer

Where the trench excavation crosses barriers such as fences and walls, the Contractor, as a temporary measure during construction, shall provide temporary fencing for any part of such barriers that had to be removed. After trench excavation has been reinstated, the Contractor shall carry out the permanent restoration of such barriers.

Trial holes shall be excavated well ahead of the trench excavation to such depths as are necessary to determine the alignment for the trench. Trial holes may also be required by the Contractor to determine the position of underground services, subsoil drains or for any other reason. Trial holes shall be excavated and reinstated, the cost of which shall be deemed to be included in the contract rates for pipe installation.

The Contractor shall arrange for the refilling and reinstatement of trial holes to be carried out immediately the required information is obtained. The reinstatement of the surfaces of trial holes shall be carried out to the satisfaction of the Engineer.

4.3.3 Borrow Excavation

When the quantities of suitable surplus materials obtained from the excavations are insufficient to construct the specified fills, additional materials shall be obtained from approved borrow areas. Borrow pits shall be excavated and finally dressed in a manner eliminating steep or unstable side slopes or other hazardous or unsightly conditions. The extent and depth of borrow pits within the limits of the designated areas shall be approved by the Engineer. The Contractor is responsible for the arrangements and payment for all borrow material and material selected shall meet the approval of the Engineer.

4.3.4 Shoring and Boxing

Shoring and boxing work should be done in cases where loose soil is encountered, masonry structures are close to the excavations, depth of cutting exceeds 1.5 metres, and/or utilities require safeguarding, etc., to avoid side collapse, and should be done simultaneously with the earthwork excavation.

Design of the shoring or boxing shall be determined by the site conditions and shall be subject to the approval of the Engineer. The process of boxing and shoring shall be continued until the excavation reaches the required depth of cutting. All boxing and shoring materials such as planks, runners and struts shall be withdrawn from the excavations prior to completion of backfilling.

4.3.5 Dewatering of Excavations

All excavations shall have sufficient clearance for the purpose of making sumps for dewatering and boxing arrangement. Arrangement for sumps shall be made in such a way that the water level remains below the bed level, and bailing out of water from the sumps should be continuous. Where necessary in trenches, sumps may be made away from the trenches and connected by laying pipes.

During construction of the works existing watercourses or flows of drains may have to be diverted through pipes or open channels so that no water can seep into the excavations and interfere with the works, or cause collapse of the walls. The diversion channels should be large enough to take the load of rains, and should be leak proof. The diversion arrangement should be continuous from section to section and the slope should be such that it maintains a gravity flow.

In case the soil on which the diversion pipes are to be laid is not suitable for the purpose the diversion pipes should be laid on proper staging. All diversion lines shall be maintained till completion of the works as a whole. The Contractor will, in no case, be allowed to put up bunds that may cause stagnation of water anywhere within the excavation.

Where gravity drainage is not possible or practical, the Contractor shall provide adequate pumping facilities to maintain the excavation in a safe and workmanlike condition so that water does not interfere with the progress and quality of the works. Unless specifically provided for by a separate item in the contract, any costs of pumping shall be deemed to be included in the contract rates, and no extra payment will be made on this account.

4.3.6 Trench Excavation in Roads

All trench excavation and other work carried out within the limits of any existing road or highway shall be completed as rapidly as possible and, in the case of roads capable of carrying two or more lanes of traffic, not more than one half of the width of the carriageway shall be obstructed at any time. In single lane roads, the Contractor shall programme his work in such a manner that the minimum inconvenience is caused to those persons who have reasonable grounds for using the road and, in the case of private or, restricted roads, which have authority to use them. Road drains and channels shall be kept free from obstructions at all times.

The Engineer shall normally direct that trench excavation along roads be located in footpaths or verges adjacent to the road rather than in the carriageway itself. Trench excavation shall wherever practicable be carried out in such a way that every part of the excavation is at least 0.9 m clear of existing edges of the carriageway. In any event the Contractor shall take special precautions, which shall include the continuous support of the sides of the excavation, from the time that excavation begins until the refilling of the trench, to ensure protection of the adjacent road and its foundation.

Where trench excavation or any other part of the Works obstructs any footpath or right-of-way, the Contractor shall provide, at his own cost, a temporary footpath around the obstruction to the satisfaction of the Engineer. Where applicable, this temporary footpath shall include stout bridges of wooden planks or other approved construction across any open trenches.

Where excavated material has temporarily been deposited on a grass margin or verge, the margin shall on completion of refill be restored entirely to its original condition and left free from loose stones.

4.3.7 Trench Excavation in Surfaces Other than Roads

Trench excavation in surfaces other than roads shall include all surfaces except those asphalt surfaces that require road reinstatement. These surfaces include but are not limited to fields, paddy fields, pastureland and the like, footpaths, verges, non-asphalted roads, lanes, alleys, and all private lands. Trench excavation shall, if the Engineer so requires, have temporary fencing erected around that length. Temporary fencing shall not be removed without the Engineer's permission, which will not normally be given until the trench excavation has been refilled and reinstated. The Contractor shall have particular regard to the safety of livestock, and shall ensure that all open excavation, access routes and steep or loose slopes arising from the Contractor's operations are adequately fenced and protected. After the erection of temporary fencing where required, the Contractor shall remove topsoil to such depth and over such area as may be necessary to provide sufficient material to ensure adequate surface reinstatement of the working areas occupied by the Contractor for construction of the pipeline.

4.3.8 Inspection by Engineer

When the specified levels of excavation are reached the Engineer will inspect the ground exposed and if he considers that any part of the ground is by its nature unsuitable he may direct the Contractor to excavate further and to refill the further excavation with such material as he may direct and such further excavation shall be held to be excess excavation.

Should the bottom of any excavation while acceptable to the Engineer at the time of his inspection subsequently become unacceptable due to exposure to weather conditions or due to flooding or have become puddled, soft or loose during the progress of the works the Contractor shall remove such damaged, softened or loosened material and excavate further by hand. Such further excavation shall not be held to be excess excavation.

4.3.9 Disposal of Materials from Excavation

Subject to any specified requirements of the Contract, the Contractor shall make his own arrangements for the temporary storage of any excavated material which is required for use in refilling excavations, including any necessary double handling. In this connection the Contractor shall have regard to the working areas available to him for the construction work particularly where this is located in roads or in other places to which the public has free access. Any temporary tips alongside the excavation shall be to stable slopes and heights. Where the nature of the excavated material is suitable, the Contractor’s temporary storage as aforesaid shall include for separate storage as the Engineer may direct of any of the various grades of material hereinafter specified for the refilling and surface reinstatement of excavation, namely, selected fill, coarse backfill, and topsoil. Any excavated material required for or not suitable for use as refilling as aforesaid or use elsewhere in the works shall remain the property of the Employer. The Contractor

shall be responsible for its removal from the site and for disposal as directed by the Engineer.

The cost of removal of excess excavated earth shall be deemed to be included in contract rates. The Contractor, when working along carriageways where it is not possible to stack excavated materials along the trench, shall be required to remove such materials required for backfill to temporary sites to be provided by the Employer and to return these materials to the worksite for backfilling afterwards.

All requirements herein for the disposal by the Contractor of materials arising from ground surface preparation or from excavations shall be in accordance with the provisions of Clause 4.23 of the Conditions of Contract.

4.3.10 Trenches Not to be Left Open

Trench excavation shall be carried out expeditiously and subject to any specific requirements of the Contract, the refilling and surface reinstatement of trench excavations shall be started and completed as soon as reasonably practicable after the pipes have been laid and jointed. Pipe laying shall follow closely upon the progress of trench excavation, and the Contractor shall not excavate unreasonably excessive lengths of trench to remain open while awaiting testing of the pipeline. The Contractor shall take precautions to prevent flotation of pipes in locations where open trench excavations may become flooded, and these precautions may include the partial filling of the trench leaving pipe joints exposed for tests of the joints. If the Engineer considers that the Contractor is not complying with any of the foregoing requirements he may prohibit further trench excavation until he is satisfied with the progress of laying and testing of pipes and refilling of trench excavation. The Contractor will not be permitted to excavate trenches in more than one location in any one road at a given time without the Engineer's permission.

4.3.11 Backfilling

Filling and backfilling must not be started before obtaining directive of the Engineer.

4.3.11.1 Foundation

Backfilling of excavations for foundation purposes shall be carried out by excavated material or sand or local fill sand as directed by the Engineer in 150 mm layers, each layer being thoroughly rammed and consolidated until desired density is achieved before the succeeding layer is placed. Any defect caused by subsidence of the backfilling as a result of improper workmanship shall be made good at the Contractor's expense.

4.3.11.2 Partial Back-filling of Pipeline Trench for Testing

After laying and jointing of pipes partial backfilling of the trench shall be done leaving the joints exposed. Testing of pipes shall be carried out expeditiously and after successful testing the trench shall be backfilled and road surface reinstated. The Contractor shall strictly comply with Clause 6.1.20 to avoid any accident to road users due to exposed trench. Where the pipes are laid across the road complete backfilling shall be done immediately after laying and jointing of pipes pending the pressure test.

4.3.11.3 Backfilling Pipeline Trench Excavation

Backfilling of pipe trench shall consist of bedding, backfill in the pipe zone and backfill over the pipe zone as specified and shown in the drawings. Pipe bedding shall be prepared with sand layer compacted to a thickness of 100 mm. After laying and testing of the pipes, the trench shall be backfilled and compacted to 150mm over the top of the pipe with sand. (FM 0.8) For backfilling over the pipe zone in open areas and untrafficked pathways, excavated materials from the trench shall be placed in layers and compacted to at least 95% maximum dry density as specified in IS in accordance with standards given elsewhere in this document. For backfilling over the pipe zone in trafficked and paved surfaces, backfilling shall be done using local fill sand (FM 0.7) compacted to 95% maximum dry density and surface pavement shall be restored to its original condition. Backfilling in the road crossing shall be immediately executed for restoration of movement of vehicular traffic in easy manner. Until the pavement is restored, the Contractor shall be responsible to maintain the road in a manner that will allow easy traffic movement.

Compaction of sand, local fill sand and excavated trench materials shall be done by watering and compacting with pneumatic or petrol driven tamper not exceeding 150 mm layers. Prior to acceptance of the work, the Contractor shall regrade the area up to the level of the surrounding ground.

Volumes of backfill which fail to meet the specified compaction, as tested by the Engineer, shall be reworked and recompacted until they conform to the specified compaction.

Should the materials being placed as refilling, while acceptable at the time when approved, become unacceptable to the Engineer due to exposure to weather conditions or due to flooding or have become puddled, soft or segregated during the progress of work, the Contractor shall, at no extra cost to the Employer, remove such damaged, softened or segregated materials and replace it with fresh approved material. To permit the proper consolidation of backfill into the voids behind trench sheeting and supports, trench sheeting shall be withdrawn gradually as backfill progresses in depth and along the trench. On no account shall any excavated materials be dozed back when refilling trenches in roads and no backfilling shall be carried out unless, in the opinion of the Engineer, sufficient mechanical rammers are in operation on that portion of the work.

Where directed by the Engineer, trench excavation shall be refilled with granular materials or concrete in accordance with the Drawings and/or direction of the Engineer.

4.4 Concrete works

4.4.1 Portland Cement Concrete

General

This work shall consist of the construction of all portions of structures using Portland cement concrete of the required class or classes, with or without reinforcement, and with or without admixture, constructed in accordance with these specifications and to the lines, levels, grades, and dimensions shown on the drawings, and as required by the Engineer. Portland cement concrete shall consist of a mixture of Portland cement, water, coarse and fine aggregate with or without admixture.

Quality of Concrete

The concrete shall conform to the requirements for the particular class as set out in *Table 1* below. The proportion by dry weight of coarse to fine aggregate, which will normally be approximately 2

to 1 may be varied between 1.5 to 1 and 3 to 1, with the agreement of the Engineer provided the quality of the concrete is thereby improved.

The minimum quantity of cement permitted will be as set out in *Table 1* even though the strength of mixes containing these quantities may exceed the minimum required for the particular classes. The Contractor will design the concrete mixes and submit his proposals along with a certified test report from an approved testing laboratory for the approval of the Engineer at least 30 days before beginning his concrete casting operations.

Table 1 Constituents of Concrete for use in Structures

Class	Min. Cement Content kg/m^3		Range of Coarse Aggregate Size	Minimum Compressive Strength				Proportionate Mix
				7 - Days		28 – Days		
	Max.	Min.		kg/cm 2	Psi	kg/cm 2	Psi	
I	540	390	19 mm - No 4	200	2860	300	4285	1:1:2
II	540	330	19 mm - No 4	153	2185	250	3575	1:1½:3
III	540	280	19 mm - No 4	133	1900	200	2860	1:2:4
IV	540	220	19 mm - No 4	100	1430	150	2140	1:3:6
V	540	200	25 mm - No 4	67	960	100	1430	1:4:8

Note: Compressive strength determined from 150-mm diameter x 300-mm cylinders.

Class I and II concrete shall be limited in use as shown on the drawings or as otherwise ordered by the Engineer. Class III concrete shall normally be used for reinforced structures or elements of structures. Class IV and V concrete shall be used for unreinforced concrete and for blinding layers where shown on the drawings or ordered by the Engineer.

Use of either crushed stone or broken brick chips as coarse aggregate for Class IV or V concrete shall be in accordance with the drawings or otherwise ordered by the Engineer except that only crushed stone aggregate will be permitted for use in roof slabs of buildings. Only crushed stone may be used as coarse aggregate for any Class I, II and III concrete.

4.4.2 Trial Mixes

The Contractor shall prepare trial mixes having workability, strength, and surface finish as criteria, to satisfy the Engineer regarding these qualities. The trial mixes shall be made and compacted in the presence of the Engineer using the same type of plant and equipment as will be used for the works. From each trial mix, cylinders shall be made and tested in accordance with Clause 3.3.

From the same mix as that from which the test cylinders are made, the workability of the concrete shall be determined by the Slump Test in accordance the AASHTO Test Method T 119 or other method approved by the Engineer.

A trial mix for particular class of concrete shall be acceptable when the test cylinders (from sets of three cylinders made from the test batches) are cured and tested after 7 and 28 days in a laboratory approved by the Engineer and are not below the specified compressive strength.

In addition, the consistency shall be to the satisfaction of the Engineer.

When a proposed mix has been approved, no variations shall be made in the mix proportions, or in the type, size, grading zone or source of any of the constituents without the consent of the

Engineer, who may require further trial mixes to be made before any such variation is approved.

Until the results of trial mixes for a particular class have been approved by the Engineer, no concrete of the relevant class shall be placed in the works.

4.4.3 Sampling and Testing

A slump test of fresh concrete shall be taken for every batch or whenever directed by the Engineer to test the workability of the mix. Concrete mixes that exceed the maximum permissible slump shall be rejected outright and shall not be used in the works. Under no circumstances shall the Contractor be allowed to rework defective mixes to attempt to achieve the specified slump.

Sampling of concrete for test purposes shall be carried out in accordance with the requirements of IS in accordance with standards given elsewhere in this document.

Concrete specimens shall be manufactured and cured in accordance with the requirements of IS in accordance with standards given elsewhere in this document

Concrete of a particular class shall have a compressive strength at 28 days not less than that given in *Table 1*. If the compressive strength at 7 days is less than what is indicated on *Table 1*, the Engineer shall order all future concrete work on the effected elements to be suspended until the results of the 28 days test are available. Concrete not attaining the 28 days compressive strength shall be rejected. The Contractor shall remove and rectify all affected elements to the satisfaction of the Engineer at his own expense.

4.4.4 Materials

Portland Cement

Cement shall conform to the requirements of IS in accordance with standards given elsewhere in this document. Ordinary Portland and Rapid Hardening Portland Cement.

The Contractor shall provide adequate covered buildings for storing and protecting the cement against dampness. All cement shall be stored on pallets at least 150 mm off the floor. Cement which has become partially set or which contains lumps of caked cement shall be rejected. The use of cement reclaimed from discarded or used bags will not be permitted.

All cement shall have the written approval of the Engineer prior to being used in the works. The Contractor is to produce samples of cement from his stock at site for physical and chemical tests as required under the contract or as on demand of the Engineer. The cement to be used in work is to conform to the following parameters as shown in *Table 2*. The Contractor shall undertake at his own cost necessary tests for cement as and when asked by the Engineer.

Table 2 Quality of Cement

Parameters	Standards / Remarks

1.	Specific Surface (Turbidiment Method)	1500 - 1750 sq.cm / gm
2.	Setting time (Vicat needle m/d)	
	a) initial setting	not less than 30 minutes
	b) final setting	not more than 10 hours
3.	Tensile Strength (Briquette Test)	
	a) 3 days	not less than 20 kg / sq.cm
	b) 7 days	not less than 25 kg / sq.cm
4.	Compressive Strength (Standard Cube)	
	a) 3 days	not less than 115 kg / sq.cm
	b) 7 days	not less than 180 kg / sq.cm

Water

The water used for the preparation of concrete or mortar shall be clean, potable, free from objectionable quantities of silt, organic matter, alkali, sulphates and other salts and other impurities, and will be subject to approval of the Engineer.

Admixtures

Admixtures shall not be used without the written approval of the Engineer. The Contractor shall submit samples of any admixtures he proposes to use to the Engineer at least 28 days prior to the date of commencement of construction of the particular structure or portion of structure on which he intends to use such admixtures.

Reinforcement

All reinforcement shall comply with the requirements of Clause 3.8.

Coarse Aggregate

Coarse aggregate for concrete shall consist of either (i) stone chips or (ii) brick chips. The brick chips shall be made from 1st class picked jhama bricks having a minimum compressive strength of 175 kg/cm^2 for individual bricks and an average of 210 kg/cm^2, as may be specified on the drawings and in the Schedule of Items/Works. Chips shall be graded from 5 mm to 20 mm with 33% passing 10 mm sieve unless otherwise determined from the laboratory Trial Mixes or as directed by the Engineer.

All coarse aggregates shall be cleaned and made free from dust and other impurities by screening and washing in clean water immediately before use.

Fine Aggregate

Fine aggregates for concrete shall consist of a blend of coarse sand (with a FM of minimum 2.5) and medium sand (minimum FM of 1.5) having a minimum FM of 1.80 in accordance with the following gradation:

BS Sieve No.	Sieve Size mm	Percentage passing
7 14 25 52 100	2.36 1.18 0.60 0.30 0.15	90 - 100 75 - 90 45 - 75 30 - 50 0 - 5

Fine aggregates shall be free from clay particles and other deleterious materials. Organic

materials content shall not exceed 5% and silt and other fine materials content shall not exceed 6%. All fine aggregates shall be screened and washed in clean water immediately before use.

At the direction of the Engineer, the Contractor shall be responsible to assist in periodic sampling and providing in gradation test for each 15 m^3 (500 cft) of coarse and fine aggregate at his own cost.

4.4.5 Joints in Concrete

Joints in concrete shall be either construction joints or movement joints. Construction joints are joints required for the purposes of limiting the amount of concrete placed continuously. Movement joints are joints required in the permanent works and include expansion points.

Construction Joints

Where not shown on the drawings, the details and positions of construction joints shall be submitted to the Engineer for approval before any concreting takes place.

A period of not less than three days and not more than 14 (fourteen) days, shall elapse between the casting of successive lifts of concrete. In the case of water retaining part of the structures, a maximum period of 7 (seven) days only will be permitted to elapse between castings.

Water Stops

The Contractor shall supply fix and join water stops in all construction and expansion joints in members which are to be water retaining and where shown on the drawings.

Flexible water stops unless otherwise specified, shall be of approved manufacture and formed from high-grade polyvinyl chloride.

The water stop shall be carefully maintained in the position shown on the drawings and properly protected from harmful effects of light and heat during all stages of construction and storage.

Joint Fillers

The Contractor shall supply and fix approved joint fillers in all expansion joints. Unless otherwise specified, the joint filler shall be of resin or bitumen. The joint filler shall be fixed as specified by the manufacturer to fill the whole space between the concrete faces if not otherwise filled by water stop or joint sealer.

Joint Sealers

The Contractor shall prepare tapered recesses at expansion and construction joints on both faces of the concrete work except from the under side of floors or ground slabs.

The Contractor shall prepare the surfaces of the recesses before being completely filled with joint sealing compound. In case of buried concrete structures, the joint sealer shall be a bituminous-based compound. In other structures, the joint sealer shall be of the polysulphide type.

The application of joint sealer shall not be commenced without the prior approval of the Engineer. At the reservoir floor joints, the sealer shall be poured only after the construction of the reservoir roof.

4.4.6 Equipment and tools

General

Equipment and tools necessary for handling materials and performing the work, and satisfactory to the Engineer as to design, capacity, and mechanical condition, shall be at the site of the work before work is started.

Formwork

Formwork shall include all temporary or permanent moulds for forming the concrete. All formwork shall be of wood or metal and shall be built mortar tight and rigid enough to maintain the concrete in position during placing, compaction, setting, and hardening.

Formwork for exposed surfaces shall be made of dressed timber of uniform thickness with or without a form liner of an approved type or shall be of metal sufficiently rigid in itself with no surface blemishes that will impair the quality of the concrete surface finish.

No rusted or bent metal forms shall be used. Formwork shall be chamfered on all sharp edges and shall be given a bevel in the case of all projections.

All timber shall be sound, free from warps and twists, sap, shakes, large or loose knots, wavy edges or other defects affecting the strength or appearance of the finished structure.

The shape, strength, rigidity, water tightness and surface smoothness of reused formwork shall be maintained at all times. Any warped or bulged timber must be resized before being reused. Formwork that is unsatisfactory in any respect shall not be reused.

Internal ties shall be so arranged as to permit their removal to a depth of at least 25-mm from the concrete face without injury to the concrete. No permanently embedded metal shall have less than 25-mm cover to the finished concrete surface.

Formwork shall be so constructed that easy cleaning out of any extraneous material inside the formwork can be achieved without disturbing formwork already checked and approved by the Engineer.

Formwork shall be treated with approved non-staining oil or saturated with water at the discretion of the Engineer before placing the concrete. Form oil will only be used after the approval of the Engineer has been given.

Falsework and Centring

All falsework shall be designed and constructed to provide the necessary rigidity and to support the loads coming upon it without significant settlement or deformation. Falsework shall be founded on solid footings not liable to settlement under load.
Arch centring shall be so constructed as to permit it being lowered gradually and uniformly.

Curing Agent

The burlap used for curing shall be made from jute or hemp and at the time of using shall be in good condition, free from dirt, clay or other substances that interfere with its absorptive quality. It shall not contain any substance that would have a deleterious effect on the concrete. Burlap shall be of such quality that it will absorb water readily when dipped or sprayed.

Sand shall be clean and free from clay balls or any other deleterious matter.

Mould Oil

Mould oil shall be a petroleum distillate free from water, asphalt and other insoluble residues. It shall be non-staining paraffin oil.

Vibrating Equipment

High frequency internal vibrators of either the pneumatic, electric or hydraulic type shall be used for compacting concrete in all structures and in precast units. The vibrators shall be of a type approved by the Engineer, with a minimum frequency of 6000 cycles per minute; and shall be capable of visibly affecting a properly designed concrete with a 20 mm slump over a circular area of 450 mm radius.

Concrete Mixers

All concrete shall be mixed in concrete mixers unless otherwise approved by the Engineer. The Contractor shall supply the rating capacity of each mixer he proposes to use for the Engineer's prior approval.

The mixer shall be arranged so that mixing action can be observed by the Engineer from a location convenient to the mixing plant operator's action. Mixers shall not be loaded in excess of their rated capacity.

Mixers shall be examined daily for changes in their condition due to the wear of their blades or to the accumulation of hard concrete or mortar. Any mixer that at any time produces unsatisfactory results, shall be repaired promptly and effectively or shall be replaced.

4.4.7 Construction Methods

General

The Contractor shall maintain an adequate number of trained and experienced supervisors and foremen at the site to supervise and control the work.

Formwork, Falsework, and Centring

Before concrete is placed the Engineer shall inspect all formwork, falsework and centring. No concrete shall be placed until the Engineer has inspected and approved such formwork, falsework, and centring. Such approval shall not relieve the Contractor of any of his responsibilities under the Contract for the successful completion of the structure.

Reinforcement

The Engineer shall inspect and approve all reinforcement in place in accordance with the requirements of Clause 6.4.8, Reinforcement for Concrete Structures, before concrete is placed. An experienced steel fixer shall be present while all concrete is placed to ensure that no reinforcement becomes displaced during placing. If displacement occurs, repositioning of such reinforcement shall be done before placing continues.

Batching

The Contractor shall provide such means and equipment required to accurately determine and control the amount of each separate ingredient entering the concrete mix. Such means as well as the equipment and its operation shall at all time be subject to approval of the Engineer.

All dry materials shall be measured by calibrated volume boxes.

Batch Mixing

The concrete mixer shall be cleaned before mixing begins. The concrete ingredients shall be mixed in a batch mixer or portable mixer for not less than 1½ minutes after all ingredients (except for the full amount of water) are in the mixer. The mixing time will be increased where the batch mixer exceeds a capacity of 1.5 m^3. The Engineer reserves the right to increase the mixing time when the charging and mixing operations fail to produce a concrete batch throughout which the ingredients are evenly distributed and their consistency uniform.

The concrete shall be uniform in composition and consistency from batch to batch except when changes in composition or consistency are required. Water shall be added prior to, during, and following the mixer charger operations. Excessive over mixing requiring the addition of water to preserve the required concrete consistency will not be permitted.

Placing Concrete

All concrete shall be placed immediately after mixing. Concrete shall be placed in such a manner as to avoid segregation and the displacement of reinforcing bars and shall be spread in horizontal layers where practicable. Concrete shall be placed inside forms using hand shovels where necessary. In no instance shall vibrators be manipulated to transport concrete inside formwork.

Trough, pipes, or short chutes used as aids in placing concrete shall be positioned in such a manner that segregation of the concrete will not occur. All chutes, troughs, and pipes shall be kept clean and free from coating of hardened concrete or mortar. Concrete shall not be dropped freely over a vertical distance of more than 1.5 meters.

Concrete shall be placed continuously throughout each section of the structure or between indicated joints as shown on the drawings or as directed by the Engineer. If, in an emergency, it is necessary to stop placing concrete before a section is completed, bulkheads shall be placed as the Engineer may direct and the resulting joint shall be deemed a construction joint.

The Contractor must not place concrete under condition as stated below:

- after dark
- during rains or storm
- when air temperature is more than 43°C
- when the temperature of the concrete when discharged from mixer is more than 32°C

Vibrating Concrete

All concrete is to be vibrated in place using a mechanical vibrator approved by the Engineer. Mixing or placing of concrete shall not be allowed without a vibrator in top working condition on site. Concrete shall be poured and compacted in the presence of the Engineer or his representative.

The concrete shall be worked under and around the reinforcing bars and into corners of forms with the use of vibrators immediately after placing. Touching the reinforcement bars with the

vibrator shall not be permitted.

The vibrators shall be inserted slowly and vertically at points 450 to 500 mm apart before more concrete is added. The vibrators shall be moved to new position as frequently as necessary to ensure uniform vibration of the whole mass.

Curing

All concrete surfaces shall be kept wet for at least seven days after placing. Deck slabs shall be covered with wet burlap immediately after final finishing of the surface. This material shall remain in place for the full curing period or may be removed and replaced with sand when the concrete has hardened sufficiently to prevent marring. In both cases the materials shall be kept thoroughly wet for the entire curing period. All other surfaces, if not protected by forms, shall be kept thoroughly wet, either by sprinkling or by the use of wet burlap until the end of the curing period. If wood forms are allowed to remain in place during the curing period, they shall be kept moist at all times to prevent openings at joints.

Removal of Formwork and Falsework

Forms and falsework shall not be removed without the approval of the Engineer. The Engineer's approval shall not relieve the Contractor of responsibility for the safety of the work. Blocks and bracing shall be removed at the same time as the forms, and in no case shall any portion of the wood forms be left in the concrete.
As soon as the forms are removed, all wire or metal devices used for securing the formwork which project from or appear on the surface of the finished concrete shall be removed or cut back at least 25 mm from the finished surface of the concrete. All holes and pockets so formed shall be filled with cement mortar mixed in the same proportions as the fine aggregate to cement of the concrete mix used for that particular section of the structure, after the surface to be patched has been thoroughly cleaned and wetted to receive the patch.

Finishing Concrete

All concrete surfaces exposed in the completed work shall comply with the requirements for ordinary finish except were the drawings indicate otherwise.

An ordinary finish is defined as the finish left on a surface after the removal of the forms when all holes left by form ties have been filled, and any minor surface defects have been repaired. The surface shall be true and even, free from depressions or projections.

Loading

No superstructure load shall be placed upon finished bents, piers, or abutments until the Engineer so directs, but in no case shall any load of any kind be placed until curing has been completed as specified above. The Contractor shall not pile any temporary loads on deck slabs. Deck slabs shall be loaded only when so directed by the Engineer and generally no sooner than 28 days after the placing of the concrete has been completed.

Cleaning Up

Upon completion of structure and before final acceptance, the Contractor shall remove all falsework, falsework piling, etc., down to the finished ground line. Excavation, useless materials, rubbish, etc., shall be removed from the site. The site shall be left in a neat and presentable condition acceptable to the Engineer.

Measurement and Payment

The concrete cast-in-situ shall be measured by the number of cubic meters of the several classes complete in place and accepted. In computing quantities, the dimensions used shall be based on actual measurement, but they shall not exceed those shown on the drawings or ordered in writing by the Engineer. The measurement shall not include any concrete used for the construction of temporary works.

Precast concrete elements (wall panels, drain cover slabs, etc.) or thin shell concrete elements laid-up in place shall be measured by the number of cubic meters, as specified in the Bill of Quantities, and shall include all costs of fabrication, curing, reinforcement and erection. The total payment to the Contractor under this item shall not exceed the tendered value of the installed works.

4.4.8 Reinforcement for Concrete Structures

Description

This work shall consist of transporting, storing and placing reinforcement bars of the types and sizes in accordance with these specifications, and as shown on the drawings.

Materials

Bar reinforcement shall conform to the general requirements of IS in accordance with standards given elsewhere in this document for plain round mild steel bars (Grade 250) or IS in accordance with standards given elsewhere in this document for deformed high yield steel bars (Grade 460).

Reinforcement binding wire shall be as per IS in accordance with standards given elsewhere in this document.

The Engineer reserves the right to inspect the place where the steel for reinforcement or binding wire is manufactured and select samples for load testing. The cost of such testing shall be borne by the Contractor.

The Contractor shall submit samples of the various sizes of reinforcement steel and binding wire as well as their respective certificates of testing that he proposes to use for the Engineer's approval prior to commencing any concrete work. Materials rejected either by visual inspection, lack of certification, or after load tests have been conducted shall be immediately removed from the Site.

Construction Methods

Reinforcement for structures shall be handled and stored in a manner that will prevent the unnecessary accumulation of dirt, oil, grease, paint, millscale and loose or thick rust. Bars shall be cut and bent cold to the dimensions indicated and with equipment and methods approved by the Engineer in accordance with the drawings,

Stirrups and tie bars shall be bent around a pin having a diameter not less than two times the minimum thickness of the bar. Bends for other bars shall be made around a pin having a diameter not less than six times the minimum thickness except for bars larger than 30 mm in which case the bends shall be made around a pin of eight bar diameters.

All bar reinforcement shall be placed, supported, and secured before the beginning of concreting operations. The relation between the minimum spacing of bars and the maximum size of

aggregate shall be as follows unless otherwise stated by the Engineer. The minimum clear distance between two bars in a beam or column shall not be less than the diameter of the bar or 25 mm or the largest size of aggregates plus 10 mm whichever is the greatest. Laying or driving bars into the concrete after placement will not be permitted.

All horizontal reinforcement shall be supported on metal supports or mortar blocks of approved shape with tie wires embedded in them. Mortar blocks shall be made out of Portland cement and sand in the ratio of 1:3 by weight. Supports, which are in contact with the external face of the concrete, will all be mortar blocks. The use of small stones, brick chips, or wood blocks will not be permitted.

The reinforcement shall be held securely in place at the exact position and at the exact spacing as indicated on the drawings by the use of wire ties at bar intersections, supports and spacer blocks. Wire ties shall be securely tied and folded so that they do not project beyond the planes formed by the reinforcing bars. The adequacy of the supports and ties to secure the reinforcement properly shall be subject to the approval of the Engineer.

Reinforcement shall be furnished in the lengths indicated on the drawings. Lap splicing, except where shown on the drawings, will not be permitted without written approval of the Engineer. Where lap splices are permitted, the laps shall be staggered such that the end to end distance between laps at any two adjacent reinforcement bars is greater than the lap length of the larger of the two laps.

All splices shall have a lap length of not less than 40 bar diameters for tensile reinforcement and 32 diameters for compressive reinforcement or as shown on the drawings. Lap splices shall generally be located at points of minimum stress. Except where otherwise shown on the drawings, lap splices shall be made with the bars placed in contact and wired securely together.

Substitution of different size bars will be permitted only with specific authorisation by the Engineer. If steel is substituted, it shall have a cross sectional area equivalent to the design area, or larger. The Contractor shall provide, in the case of substitutions, at his own expense and to the approval of the Engineer, working drawings of all reinforcement accompanied by bending schedules and copies of orders placed for bars.

The use of undersized bars will not be permitted without the Contractor submitting an alternative bar bending schedule for the elements in which he proposes to use the undersized bars to the Engineer for his approval. This schedule shall have the distances between reinforcement bars appropriately reduced to the satisfaction of the Engineer.

Measurement

Separate measurement will be made for reinforcement work specified for precast concrete and cast-in-situ concrete as detailed in the Bills of Quantity.

4.5 Brick works

4.5.1 General

This specification section covers the construction of brick masonry in cement mortar.

All brick masonry required to be constructed under the Specifications or as may be required by the Engineer shall consist of the materials specified below. These materials shall be supplied, proportioned, mixed, formed and placed in accordance with these stipulations and requirements

or as ordered by the Engineer. These stipulations and requirements shall apply to all brick masonry works, except when such works are specifically modified by the Engineer.

4.5.2 Bricks

Well burnt first class coal or natural gas fired clay bricks of uniform colour, shape, and size having sharpened square sides and edges as well as parallel faces shall be used. Bricks shall be sound, hard, homogenous in texture, free from cracks, chips, flows etc. Bricks shall emit a clear metallic sound when struck.

The mean compressive strength of twelve halved bricks shall be 175 kg/cm^2. The minimum compressive strength for an individual brick shall be 140 kg/cm^2.

The maximum water absorption of the bricks shall be 14% by weight. Slight efflorescence shall be permitted with the approval of the Engineer.

The standard dimensions of first class bricks shall be 238 mm x 112 mm x 70 mm. The allowable variation shall not be more than 6 mm in length, 3 mm in breadth, and 1 mm in height. Banana shaped bricks shall be rejected and shall not be used in the works.

The minimum unit weight of first class bricks shall be 1100 kg/m^3. The minimum weight of first class picked jhama bricks shall be 1300 kg/m^3.

The Engineer reserves the right to inspect the place where the bricks are manufactured and select bricks for load testing as he may direct. The cost of such testing shall be borne by the Contractor.

4.5.3 Cement Mortar

Brick masonry work shall be laid with the specified mortar of workable consistency as detailed in the drawings. Mortar mix proportions by volume for all type of brick work shall be as specified in the Bill of Quantities or as detailed in the drawings.

Cement for cement mortar shall comply with Clause 4.4.

Sand for cement mortar shall comply with Clause 4.4, with a minimum fineness module of 1.8 unless otherwise specified.

Methods and equipment used for proportioning and mixing mortar shall be such that they will accurately determine and control the amount of each separate ingredient entering in to the mortar and shall be subject to the approval of the Engineer.

Mortar shall be mixed only in quantities sufficient for immediate use. All mortar not used within 30 minutes after adding water to the mix shall be discarded. Retempering of mortar will not be allowed. Mixing troughs and pans shall be thoroughly cleaned and washed at the end of each day's work.

4.5.4 Placing of Brick Masonry

Brick used in masonry shall be properly cleaned and scrubbed before placing and shall be approved by the Engineer. The brick shall be thoroughly soaked in water for at least six hours by immersing it in a water reservoir. Soaking shall be discontinued at least two hours before use. The soaked bricks shall be kept on wooden planks or hessian cloth to avoid earth or other harmful material being smeared on the bricks.

Brick shall not be placed during rains sufficiently heavy or prolonged to wash mortar from the masonry. Mortar already spread, which becomes diluted by rain, shall be removed and replaced before continuing with the work. Loads shall not be allowed on the brick masonry before it is fully set.

Masonry shall be placed on properly prepared and firm foundation accordance with the drawings of the Engineer's instruction. Foundations shall be approved by the Engineer before placing masonry.

Generally bricks shall be laid in English Bond with frogs upward unless otherwise specified. Half or cut bricks shall not be used except where necessary to complete the bond.

Brickwork in honeycomb shall be done exactly the same as general brickwork except that the openings of stated sizes are to be left in the masonry.

A layer of mortar shall be spread to the full width and a suitable length of the lower course. Each brick shall be properly bedded with its frog mark upwards and set by gentle tapping with the handle of a trowel. Its inside faces shall be covered with mortar before the next brick is laid and pressed against it. All joints shall be completely filled with mortar.

The thickness of all mortared joints used in brick masonry shall vary between 10 and 14 mm unless otherwise shown on the Drawings, indicated in the Bill of Quantities, or ordered by the Engineer.

Old brickwork shall be toothed to the full width of the new wall and to the depth of a quarter of a brick in alternate courses. It shall be cleaned of dust, loose mortar and thoroughly wetted with water before starting new brickwork. The thickness of each course of new brickwork shall be made equal to the thickness of the corresponding course of the old brickwork by adjusting the thickness of the horizontal mortar joint.

All anchors, holdfast, frames, subframes, and other hardware fittings required to be built in the masonry shall be positively set without disturbing the pattern as the brickwork progresses. No deviation shall be allowed unless permitted by the Engineer.

4.5.5 Curing and Repair

Fresh masonry work shall be protected from rain or quick drying due to direct heat by a suitable covering of empty cement bags or other acceptable methods approved by the Engineer.

When curing by water the brick masonry shall be kept moist continuously for at least seven days, unless otherwise specified by the Engineer. Water used for curing shall meet the requirements of the Specifications for water used for mortar specified in Clause 6.6.4.

The top of the masonry work shall be left flooded with water at the close of the day following work. Flooding shall be done after the mortar has started to set.

If, after the completion of any masonry, the masonry is out of alignment, not levelled, or does not conform to liners and grades shown in Drawings, it shall be removed and replaced by the Contractor at his expense, unless the Engineer grants permission in writing to patch or replace part of the defective area to his satisfaction.

Measurement

All brickwork of 250-mm thickness and above shall be measured by cubic meter. For brickwork

of less than 250-mm thickness, the measurement shall be made on the basis of square meters.

4.5.6 Brick Soling

General

This work shall consist of the construction of brick soling for the construction of walkways, foundation etc. as shown on the Drawings or ordered by the Engineer.

Brick soling with mortared joints shall be considered to be brick masonry as described in 4.3 to 4.4.

Materials

Brick for brick soling comply with Clause 4.2.

Sand filler shall consist of sound, clean, free draining fine sand having FM of 0.8 as approved by the Engineer.

Construction Methods

All works to be covered by brick soling shall be compacted and trimmed to the lines and levels shown on the Drawings. For roads, the sand sub-base course shall be prepared to the corrected profile, grade, and camber, and compacted to the satisfaction of the Engineers before the bricks are placed.

Bricks shall be hand laid with each brick touching the adjacent brick and laid flat or on edge in a herringbone bond unless otherwise directed. The bonds shall have their joints broken in both longitudinal and transverse directions. Immediately after the bricks are placed, all gaps shall be blinded with sand by spreading and brushing until the gaps are filled. Water shall be poured freely on the entire surface so that the sand enters and completely fills the interstices.

For single layers of flat brick soling, the interstices shall be filled with sand at 0.085 m^3/m^2. For brick on edge pavement in a single layer herringbone bond, the interstices shall be filled with sand at 0.12 m^3/m^2.

When a layer of brick on edge pavement in a herring bone bond is to be placed over the initial layer of flat brick soling, one layer of 12 mm thick sand cushioning shall be placed between the two layers. Local deviations in the finished brick-soling surface shall no be allowed. They shall be rectified to the satisfaction of the Engineer.

Defects present in the finished construction shall be rectified at the Contractor's expenses. The entire defective soling shall be dismantled to the full depth and reconstructed to the satisfaction of the Engineer. In no case shall filling the depressions with filler material be permitted.

Measurement

All measurements will be made according to the lines, levels and thicknesses shown on the Drawings or ordered by the Engineer. Brick soling shall be measured per square meter. Brick edging shall be measured per liner meter.

4.5.7 Cement Plastering

General

This work shall consist of the application of cement plaster to masonry and all other surfaces shown on the Drawings or ordered by the Engineer.

Materials

Cement mortar for plastering shall conform to the general requirements given in Clause 6.5.3. Sand, having a FM of at least 1.5, shall be screened and washed prior to use to remove all deleterious material.

Construction Methods

The surfaces to be plastered shall be cleaned of all dust and mud by brushing and scraping. All loose flakes of brick, mortar, or stone shall be removed with a trowel, or a hammer and chisel. Bricks to be plastered shall be thoroughly wetted and maintained wet for at least 24 hours before any plaster is placed on them.
The average thickness of the final layer of plaster shall be not less than the specified thickness by more than 3 mm. In local depressions were the masonry surface requires more than 20 mm of plaster, an initial levelling layer of plaster shall be applied and allowed to set for 24 hours prior to applying the final surface. The levelling layer shall be left rough and grooved by trowel cuts to ensure a good bond with the final layer.

The mortar for the final layer of plaster shall be applied in a fairly wet condition as a rough layer of approximately the required thickness. The evenness of the layer shall be continuously checked using a wooden straight edge. When the plaster has achieved its initial set and feels firm under the fingertips, the surface shall be smoothed using a wooden float. Where required by the Engineer, the plaster surface shall be finished using a steel float or trowel and a light application of water as required to seal the surface. The masonry surfaces shall then be thoroughly wetted, and kept wet for at least seven days. During this period it shall be suitably protected from all damages.

Mortar stricken off the plastered surface shall not be reused. Such work using reused plaster shall be rejected and redone to the satisfaction of the Engineer at the Contractor's expense.

A full wall or ceiling shall be completed in one day.

All plastered surfaces shall be absolutely plane and free of joint patches or lapse. Corners and edges shall be finished as shown on the Drawings or as otherwise directed by the Engineer. The plaster shall be cured for a minimum of 7 days. A coat of neat cement finish approximately 1.5 mm thick shall be applied where shown on the Drawings or otherwise directed. The cement shall be applied by hand and brushed while the plaster is still fresh. It shall be finished smooth with steel trowels and brought to the desired polish. Marks of any kind shall be removed to the satisfaction of the Engineer.

Any cracks which appear on the surface as well as all portions which sound hollow when tapped, are found to be soft, or are otherwise defective shall be cut out in a rectangular shape and redone as directed by the Engineer.

4.6 Coating and Testing Water Retaining Structures

4.6.1 Water Retaining Structures

The water retaining structure under the section includes all basins and storage reservoirs (overhead or underground). The Contractor shall carry out testing of all water retaining structures for water tightness and disinfect only the potable water storage reservoirs after successful testing.

4.6.2 Water-Proof Coating

Inside surface of all water retaining structures shall be coated with epoxy as follows :

Primer coat:

Araladite GY250 Hardener WY830 and Hardener HY850 in the ratio of 100:45:15. Primer coat shall be allowed to dry sufficiently so that solvent does not evaporate later on. The quantity mixture to be applied for the primer coat is about 25 Kg/100 sq.m. and thickness not less than 100 microns.

Seal Coat:

Three (3) coats of same composition as of the primer coat. Thickness of each coat shall be 100 microns. Coating to be applied for $1^{st}/2^{nd}/3^{rd}$ shall be 20 Kg/100 sq.m., 18 kg/100 sq.m and 16 kg/100 sq.m respectively.

The above resin and hardener codes are from Ciba Geigy. Tenderer can select equivalent of SIP Resins also.

4.6.3 Testing of Structures other than Storage Reservoirs

As soon as the water retaining structure attains full structural strength after the completion of construction including pipe works and after it has received the prescribed waterproof coating, it will be tested for water tightness. Water shall be filled to the maximum level by closing all the outlets and retained for 72 hours to allow for absorption. The structure shall be considered satisfactory if subsequent to this period, there is no fall in level over a period of 24 hours, after making due allowance for absorption and evaporation.

During the test any visible leakage should be marked and drop in water level recorded including evaporation. All leakages shall be located and repaired and test repeated at no extra cost to the Employer until the water tightness is ensured.

4.6.4 Measurement

The cost of testing and waterproofing, including provision of water and all other associated works shall be deemed to be included in the contract rates.

4.7 Architectural works

4.7.1 Painting to Walls & Ceilings

White and Colour Washing

The work to be performed includes the painting with three coats of white or colour wash to all exteriors and interior plastered surfaces designated to receive such painting. Prior to preparation of white wash paints, all ingredients shall be available at site for inspection and approval of the Engineer. White wash shall be prepared in clean drums by mixing and stirring unslaked lime (lime stone) with water in such a proportion as to produce a mixture of thin consistency cream when thoroughly mixed. The lime then shall be strained through clean coarse cloth. Gum in the proportion of 0.11 kg to 27 kg of lime shall be added in the screened lime. In case of white washing robin blue completely dissolved in water and strained through fine cloth shall be added. For colour washing the required amount of colour shall be added to the previously prepared white wash and thoroughly stirred.

Surface to receive white wash or colour wash shall be thoroughly cleaned with clean water and freed from all foreign matters. Defects shall be repaired for a smooth, finished surface. White wash or colour wash shall be applied to surfaces in two coats over a priming coat. It shall be applied vertically and horizontally in alternate applications. The final coat shall be applied vertically. Each coat shall be perfectly dry before the succeeding coat is applied over it. In case of coloured wash, the priming coat shall be white. The final coat shall be perfectly smooth and free from any mark of the brush.

Care shall be taken to protect hardware, doors, windows, floor etc. against spreading of paints. After white washing all unwanted paint marks and drips shall be removed thoroughly at contractor expenses.

Distemper, Plastic Emulsion and Enamel Paint

The paints shall be ODB paint of approved quality and shade. The same type of paint shall be used throughout.

Before painting work is commenced, the finished surface shall be coated with alkali resistant paint and sized with approved primer in accordance with the manufacturer's specifications for the respective kind of paint to be applied. Paint shall be applied quickly and boldly with large flat brushes, rollers or sprayers of approved make. The brush is to be dipped and stroked cross-wise on the walls and then immediately stroked up and down. This process shall be considered to be one coat of paint. Each coat shall be inspected and passed by the Engineer before the next coat is applied. The finished surface shall be carefully stippled to remove any brush marks. The Contractor shall carry out as many coats as are specified in accordance with the above specifications. If finished surface is not up to the specified standard, the Contractor shall provide extra coats to produce the required uniform finish and no payment shall be made for the work so done to produce the desire uniformity.

Weather Proof Paint to Exterior Surfaces

SUPERCEM/SNOCEM or equivelent paint of approved quality and shade shall be provided to exterior surfaces in complete conformity with the manufacturer's specifications and instructions of Engineer.

Cement Washing and Painting

The work includes three coats cement wash of all exterior plastered surfaces designated to receive such painting. Prior to the preparation of the work, all ingredients shall be available at site for inspection and approval the Engineer. Cement wash shall be prepared in clean drums by mixing and stirring cement with water in such a proportion as to produce a mixture of thin creamy consistence when thoroughly mixed. The cement then shall be strained through clean coarse cloth. Gum in the proportion of 0.11 kg. to 27 kg. of cement shall be added in the screened cement.

Surfaces to receive cement wash shall be thoroughly cleaned with clear water and free from all foreign matters. Defects shall be repaired to obtain a smooth, finished surface. Cement wash shall be applied to surfaces in two coats over a priming coat. It shall be applied vertically and horizontally in alternate applications. The final coat shall be applied vertically. Each coat shall be perfectly dry before the succeeding coat is applied. The final coat shall be perfectly smooth and free from any mark of the brush.

Painting of Wood Works

Painting of wood works, window, frames and grills, shall be done when these are absolutely dry. Before applying paint, the wood surface must be thoroughly cleaned and all projections removed. The wood works should be brought to smooth by applying sandpaper of different grades. Synthetic enamel paints shall be used. The paint must be approved by the Engineer before application. Varnishing to be applied is either oil varnish or spirit varnish as directed by the Engineer.

4.7.2 Steel Doors, Windows and Grills

General

All steel materials used shall be the products of reputable manufacturer and shall conform to the British or American Standard specifications. The section, sizes and profile shall be as per requirement for the specific works as shown in the drawings and bill of quantity.

Workmanship

The steel framework anchors shall be true to size and shape and when fixed in position, it shall completely conform to the drawings. Tolerance shall have to be kept, so that the framing can be fixed in without distortion. Joints, unless otherwise specified in the drawings or by the Engineer shall be standard welded joints. Riveted or pin joints if required, shall conform to British or American Standard specifications for steel connections regarding size and quality of rivets, tolerance, spacing, maximum and minimum pitches, driving and finishing of the rivets, etc.

Welding

The welding in steel joints shall be done neatly. The operation shall be done in a continuous run for as much length as reasonable for each run. The deposit of weld metal shall be as uniform as possible. The crust of weld metal shall be chipped off by light hammering and cleaned by steel wire brushes before doing the second run. The surface of the final run of weld metal shall be even and flush with surrounding metal surface. the surface of the weld metal shall be rendered smooth and flush with the surrounding surface by power grinding supplemented by manual grinding where the former is not feasible.

Painting

Painting of steel surface shall be done with one coat of red lead prime followed by two coats of synthetic enamel paint as approved by the Engineer.

4.7.3 Lime Concrete Roofing

Materials

Lime concrete shall be mixed using lime, surki and brick aggregate as herein specified. Lime shall not contain more than 5 percent of foreign impurities. It shall dissolve in soft water when this added in sufficient quantities. Stone lime from Sylhet meeting the above requirements may be used.

Lime shall first be slaked for 48 hours, then strained through a sieve of 64 meshes to the square inch.

Surki shall be made only from well burnt 1st class bricks but not vitrified brickbats of Class One or Two. Surki made from under-burnt bricks shall not be used. Surki shall be perfectly clean, free from admixture of dust, sand or any other particles, and shall be ground to such fineness as would pass a sieve of 64 meshes to the square inch.

Brick aggregate shall be from well-burnt but not vitrified bricks, shall be below 25mm size, and shall be continuously soaked for 2 days before use.

Mixing

The approximate proportion of the mixture shall be 2 parts lime to 2 parts surki to 7 parts brick aggregate. The lime and surki shall be mixed dry and laid on top of stack of brick aggregate. While mixing small quantities of water shall be added as required. Once the materials are mixed the mixture shall be left to temper itself for 24 hours, after which it will be remixed by spading followed by another spading after 24 hours. The procedure shall be repeated for minimum 4 days till the mixture is ready for laying as per instruction of the Engineer.

Installation

The roof deck on which the mixture will be laid shall be thoroughly cleaned and washed accompanied by scrubbing if necessary. The mixture shall be laid 25mm more than the beaten thickness according to the grades and slopes on the drawings. Before beating commences, lime grout shall be sprinkled on the surface and allowed to soak well.

Beating shall be done by two rows of workers sitting in a row that will traverse the length of the roof backwards and forwards beating with wooden mallets. Beating shall continue for 5 to 6 days until the mixture has almost set and the mallets rebound from the surface. Lime water to which molasses are added @¼ kg to 4.5 litres shall be sprinkled at intervals to keep the lime concrete continuously wet while being beaten. The surface shall never be allowed to dry. No plaster shall be given to the surface.

The surface shall be brought to a very fine polish by rubbing with a fine small trowel and to assist in this fine lime putty may be used sparingly. The work shall be cured for 2 weeks by covering with a 50mm layer of moist earth mixed with 3% straw or hay. This layer shall be moistened from time to time as required. At completion of the curing period the layer of earth shall be removed and the entire roof area swept clean.
Where lime concrete roofing cannot all be placed in one day, each day's work shall be terminated on a straight line with a 1:2 slope. Joining of new work to previous day's work shall be accomplished by applying a bonding paste of lime and surki mortar (1:1) to the slope before placing the new lime concrete. Turn-ups along parapets shall be provided as shown in the drawing and finished in a manner similar to decks.

5 MECHANICAL WORKS - GENERAL SPECIFICATIONS

5.1. Standards

All items of equipment forming part and parcel of this contract shall be in accordance with the relevant and latest standards of the Bureau of Indian Standards. For this purpose, a listing of the key standards are furnished in Annex – 1 to these specifications. Neither this listing is by any means comprehensive nor it is the duty of the owner to turn in a compendium of standards as part of these specifications. The contractor shall remain contractually bound to identify the relevant standards and proceed accordingly. Where the said standards offer a discretion, the same shall be exercised by the engineer upon being requested by the contractor in writing for such a decision, provided that the decision shall be communicated by the engineer within three calendar weeks from the date of receipt of the request from the contractor. For the purpose of bidding, the bidder shall choose his choice between such discretionary materials and appropriately record it in the technical bid envelope. Should standards of the Bureau of Indian standards are not available for any item of equipment, the relevant applicable standards of other member countries shall be used. Except that no weightage for either technical superiority shall be given to the items offered under standards of other countries.

5.2. Design life

The allowable lifespan of any stationary and / or intermittently operating mechanical equipment shall be 15 years from the date of manufacture and / or assembly in fabrication. In the case of continuously operated equipments, this shall be 10 years. This shall be the basis of design of mechanical fixtures.

5.3. Selection of metallurgy

The selection of metallurgy shall be in accordance with the specifications laid down henceforth in these specifications. However, unless otherwise laid down explicitly, in general, parts that are fully submerged all the time in the effluent shall be of mild steel duly painted in accordance with the painting specifications specified elsewhere in the bid document and all parts which are in the effluent – air interface shall be designed as spliced with a minimum linear SS 316 L material of 30 cm on both the interface sides. Such of those parts, which are to be in direct contact with chemicals shall be made or carved out of polypropylene. Wherever, dissimilar metals are required to be in contact, the electrolytic series of metals shall be followed in order to establish minimum corrosivity.

5.4. Cast iron

Cast iron wherever used in the equipments shall be of standard grey close-grained quality to I.S 210 Grade FG 200 or better. The presence of non-metallic intrusions and / or extraneous materials trapped in the casting shall lead to disqualification and rejection of the cast iron component. Blowholes shall be notified to the engineer and his decision shall be final in regard to the admissibility of the welding technique as a means of rectification. In no case, such rectifications shall be carried out unless the written approval of the engineer has been obtained. All cast iron parts shall be certified by X ray testing for the trueness of the finish after they have been stress relieved whenever welding has been carried out whether it be for machining the casting or as a means of rectification of blowholes.

5.5. Forgings

Wherever the contractor proposes to use forging as a technique of obtaining stress-bearing parts of an equipment of which he is the exclusive fabricator, the standards to which such forgings are proposed to be made shall be submitted to the engineer in writing and got approved in writing prior to commencing such forgings. Nitriding techniques wherever used shall not result in environmental pollution as a result of disposal of spent nitriding baths. On no account, on-site nitriding shall be permitted at the CETP worksite. All forgings shall be subject to heat-treatment for the release of residual stresses and shall be subjected to non-destructive tests for the detection of flaws. Wherever flaws are detected by the engineer and in his opinion will be detrimental to the use in the contract, the engineer shall reject these on entering at the site of work and his decision shall be final.

5.6. Fasteners

All fasteners as nuts, bolts, washers etc. shall conform to the requirements of the relevant standard. In general, these shall be of the best quality bright steel, machined on the shank and under the head and nut. Bolts shall be of sufficient length that at least two full threads show up through the nut when in the fully tightened position. Where bolts pass through structural members, taper washers shall be fitted where necessary to ensure that no bending stress is transmitted to the bolt. The bolts and nuts shall be designed so that the maximum stress in the bolt and nuts does shall not exceed half the yield stress of the material. All bolts, nuts and screws, which are submerged in water, shall be made of nickel-bearing stainless steel. All other carbon steel fasteners shall be hot dip electro galvanized.

5.7. Non-metals

All non-metals such as and not restricted to fabrics, cork, paper, wood and similar materials shall be treated with fungicide. Wood shall be avoided in the works except if needed in the administrative building if so required for architectural finish. All joints in woodwork shall be dovetailed or tongued & pinned. However, if it shall be used unavoidably in the works, the wood so brought to site shall be thoroughly seasoned Indian Tectona Grandis free from shakes, warp, sap, wane, knots, faults and other blemishes. Synthetic resin cement only shall alone be used for joining and in no case, Pasein cement shall be used. Such wood shall be treated against fire, moisture, fungus, bacterial attack, chemical attack and humidity. In general, as there are a variety of such treatments available, it is impossible to lay down all these in the present specification and hence, it is left to be decided between the contractor and engineer. Even otherwise, the consumption of these non-metals for the present contract are extremely minimal. Metal fittings shall be brass or SS 304 as approved by the engineer.

3.1. Lubrication

In general, the contractor shall attempt to keep the list and inventory of the various listings to the minimum. The idea is to render the store as least complicated as feasible and more importantly, mis matched charging of lubricants while dispensing to the equipments. Grease lubricated bearings shall be of the pressure injection type not requiring frequent adjustment or recharging. All grease nipples of particular equipment or a location of contiguous equipments shall be bunched conveniently to a common place and mounted in a physically convenient and accident free position. Button head type nipples shall be used. Where grease lubricated roller type bearings for electric motors are used, these shall be of lithium base grease. Individual grease guns shall be shall be appropriately colour coded and the receiving nipples shall be suitably colour banded with

fluorescent matching colour and permanently labelled. Where oil lubricated bearings are to be used as part of original equipment manufacturer's specifications, these shall be provided to permit charging the lubricant while the prime mover is in running condition and with an oil reservoir capable of automatically maintaining the correct oil level within the bearings. The drain system for nipples shall be laid out to prevent lubricant spills from contacting electrical glanding, heated surfaces and / or other potential sources of hazard.

5.8. Spare parts

The spare parts to be supplied by the contractor under the classification of Essential Spares relate to such spares that are needed to be considered necessary to support the three month mandatory O&M of the CETP after completion of the successful Performance Guarantee tests. The classification under "Optional spares" relate to such spares that are needed to support the CETP in the 5 year optional O&M contract which may be given to the contractor at the discretion of the owner. In either case, the spare parts shall be suitably labelled indicating the name of the manufacturer, the equipment for which it is meant, the identity number of the spare part and the special instructions for fitting them on to the equipment. The identity numbers shall dovetail with operating instructions of the equipment.

5.9. Erection / De-erection tools and tackle

The contractor shall supply a comprehensive set of tools and tackle for the erection / dererection of the equipment supplied by him. These shall include such major tools as chain pulley blocks, tripods with winch, wirerope etc. in original packed / delivered condition with due paintings all intact.

5.10. Packing and forwarding

In general, the packing and forwarding shall meet the appropriate requirements of the transit undertakers and shall meet the requirements of identification over and above the requirements of the transiting undertakers. On no account, shall flammable materials be transited and / or delivered without appropriate warning colour codes and descriptions.

5.11. Gate valves

These shall conform to IS 780 / IS 2906 and its latest revisions. Where, manually operated and gear controlled valves are supplied, these shall utilize non-rising spindle. Pneumatically operated valves shall however have rising spindles. In either case, the bushing arrangement shall permit gland packing without leakage. The manual control valves shall not require more than 7-kg torque on the hand wheel. The materials of construction shall be (1) Body CI IS 210 Gr FG 200, (2) Wedge CI IS 210 Gr FG 200, (3) Spindle SS AISI 431, (4) Seat rings SS 304. The mandatory tests shall be (a) Seat leakage test at rated pressure, (b) Back seat leakage test at rated pressure and (c) Body hydrostatic test at 1.5 times rated pressure. These shall be factory demonstrated to the engineer before dispatch.

5.12. Non return valves

These shall be of the non-slam characteristics suitable for mounting on both vertical as well as horizontal pipeline. The non-slam properties shall be derived in the valve design by recourse to dashpot arrangement but not the spring loaded and / or the external counterweight variety. The

valves shall be supplied with either a supporting foot or multi doors. The Materials of Construction shall be (1) Body CI IS 210 Gr Fg 200, (2) Door CI IS 210 Gr FG 200, (3) Body ring SS 304, (4) Door rings SS and (5) Hinge pin AISI 410/431. The mandatory tests shall be (a) Seat leakage test at rated pressure and (b) Body hydrostatic test at 1.5 times rated pressure. These shall be factory demonstrated to the engineer before dispatch.

5.13. Sluice gates

These shall be of the rising spindle type. The frame of the gates shall be of the flange back type. They shall be mounted on cast iron wall thimbles having cross section shape of the letter 'F'. The gates shall be provided with lifting lugs. The materials of construction shall be (1) Wall thimble Cast iron to ID 210 GR FG 200, (2) Frameguide and slide Cast iron to IS 210 GR Fg 200, (2) Seating faces Bronze, (3) Wedge blocks Bronze, (4) Stem Stainless steel AISI410/431, (5) Thrust nut Bronze and (6) Stem splice Stainless steel AISI410/431. The Shop testing – withstanding shall be for (a) clearance test that shall check the clearance between seating faces to not even less than 0.1 mm tolerance, (b) free dry movement and (c) full-load test for leak less than 11 litres per minute per m of seating perimeter.

5.14. Structural steel

All structural steel used in the work shall be of manufacture within six months from the date of proposed procurement and shall be free of defects, rust, loose scale, slag, pitting corrosion, blisters, dents, structural defects, lamination, flakiness, etc. and of full weight or thickness specified and first got approved by the contractor in regard to its sourcing by supplying the necessary test certificates from the rolling mills to the engineer who shall verify the same and send his recommendations to the owner who shall accord or reject the approval. The engineer shall mandatorily inspect at least a 50 % test check of the steel even though test certificates are in order and is free to draw the samples at his discretion and get them tested separately in independent GOJ&K laboratories and where such test results are in variance, these results would be binding on the contractor. For this purpose, the engineer is free to appropriately mark the rest of the stock after sampling with indelible paint. Wherever, even though steel has been authorized in writing but still the contractor for some genuine reason in the opinion of the engineer proposes to use alternative materials, these shall be got approved in writing from the owner in writing based on the written recommendations of the engineer who shall follow the procedure specified earlier in this clause.

5.15. Fabrication

All fabrication shall conform to standard engineering practice and to the relevant standards. The following specific sub-clauses shall apply notwithstanding the specifications in the stated standards. Wherever, fatal differences arise between the stated standards and the sub-clauses, the sub-clauses shall prevail.

5.16. Workmanship – General

All workmanship shall be so finished as to result in trueness and straightness and shall be machined to fineness with no burrs. The tolerance on the finished dimensions shall be as mutually agreed between the contractor and the engineer in writing before commencement of fabrication of the particular item.

a) Connections

Connections between structural members wherever required to be worked with bolts and nuts shall be in accordance with I.S. 1363. The making up of the required length of a member shall not be arising out of more than one connection. Wherever rain water may stagnate due to the flatness and / or location of the connection, suitable drain holes shall be provided to drain the rainwater without allowing it to stagnate at the said location. Where washers are required to be used, these shall be either tapered washers or felt washers or spring washers as demanded for the stated location depending on the opinion of the engineer, which shall be binding on the contractor. The finished position of the bolt and nut shall exhibit at least two full threads beyond the nuts, which shall have hexagonal head and bevelled on its top corners to avoid injury to workmen and walkers by. The quantity of bolts and nuts brought to site and held in stock by the contractor shall at all times be in excess of the requirement by at least 50 % to take care of losses arising from non-conformity of sizes, shearing of the head, loss of hexagonal shape etc.

b) Straightening

Straightening of materials after being brought to site shall not be allowed if the angle requiring straightening exceeds 5 % in the opinion of the engineer and consequently, such members shall be rejected by the engineer except that the reinforcement rods shall be permitted to be straightened by 180 degrees. The straightening in so far as long plates are concerned shall be by passing through mangle or levelling rolls and straightening of structural shapes shall be done by mechanical or hydraulic bar / section straightening machines. Heating or forging shall not be resorted to without the prior approval of the engineer in writing.

c) Cutting, Rolling and Forming

Where cutting or rolling or forming a steel member becomes required, such cutting shall be carried out only after obtaining the approval of the engineer in writing for each such work. The request for the same as preferred by the contractor shall clearly state his proposed method as to whether it is by shearing, sawing or machine flame cutting. In all cases, the cut edges shall be cropped to a neat finish and shall be free from distortion and burrs and all flame hardened material shall be removed by machining / edge planning. Hand flame cutting where opted for shall be later ground to smoothness. The contiguous sections shall be match-marked to facilitate accurate assembly, welding and erection on site.

d) Punching and drilling

In general holes requiring to be drilled of the same nominal diameter through more than one structural member shall be got done by assembling these sections as far as practicable to render the work in one attempt for better accuracy and prevent errors caused by human fatigue. Sub-punching may be permitted before assembly, provided the holes are punched 3mm smaller in diameter than the required size and reamed subsequently. The diameter of the holes for turned and fitted bolts shall be drilled to a diameter equal to the nominal diameter of the shank or barrel subject to H8 tolerance specified in I.S. 919. On noaccount shall burring / deburring with gas flames be allowed.

e) Riveting

In general, all rivet steel used shall conform to I.S. 1148 or I.S. 1149, as may be applicable. The parts of riveted members shall be well pinned and firmly drawn together with bolts before riveting is commenced. Contact surfaces inaccessible after riveting shall be painted before assembly prior to riveting. Rivets shall be heated uniformly to a light cherry red (108.5 ^{0} C) and driven when hot by using machines of the steady pressure type or the pneumatic riveting hammer type. In either case, this shall be carried out with adequate precautionary back up to avoid

distortion of the primary member. Where it becomes necessary to remove the rivet already in place, the engineer's decision shall be binding on the contractor to either permit the same or to direct a total replacement of the stated member / members.

f) High strength friction grip bolting

In general, high strength friction grip bolts and nuts shall conform to I.S. 3757. And the installation of high strength friction grip bolts in joints shall comply with I.S. 4000. The diameter of the bolthole associated with the boltheads, nuts and washers, shall be free of scale, burrs, dirt and other foreign matter tending to inhibit uniform ceiling of the joint components. However, tight mill scale and the light residual oil coating on bolts, nuts and washers need not be removed. All fasteners in a joint shall be tightened to a tension equal to or greater than the specified proof load shown in the following table, either by the calibrated - wrench method or the turn-of-nut method.

Proofload [kg]

Bolt Size	Bolts to I.S. 3757-BG	Bolts to I.S. 3757-10K
M16	9120	10790
M 20	14700	17150
M22	18180	21210
M24	21180	23710
M27	27450	32130
M33	41640	48580

Tightening shall be permitted by either pneumatic powered impact wrenches, long-handled manual torque wrenches [with or without torque multipliers] or electric wrench provided that a hardened washers shall be placed under the element being turned. Bolts shall be tightened at the most rigid portion of the joint, proceeding towards the free edges.

g) Welding

In general, electrodes for shielded - arc manual welds shall comply with the requirements of I.S. 814 for welding steel conforming to I.S. 226 and I.S. 2062 and I.S. 1442 for steel conforming I.S. 961. The joints in the materials above 20mm thick and all-important connections shall be made with low hydrogen electrodes. The wire and flux combination for submerged arc welding shall conform to the requirements for the desired application as laid down in I.S. 3613. The weld metal deposited by the submerged arc process shall have mechanical properties not less than that specified by the relevant standard and with reference to provisions of I.S. 9595 and I.S. 4353. In joints connected by fillet welds, the minimum sizes of single fillet welds or first runs and minimum full sizes of fillet welds shall conform to the requirements of I.S. 816 and I.S. 9595. No welding shall be done on base metal at a temperature below 5 C. Base metal shall be preheated to the temperature given in the table below prior to tack welding or welding. When base metal not otherwise required to be preheated, is a temperature below 0 C, it shall be preheated to at least 20 C prior to tack welding or welding. Preheating shall bring the surface of the base metal within 75mm of the point of welding to the specified preheat temperature, and this temperature shall be the minimum interpass temperature.

Table of welding

Thickness of the thickest part of welding	Minimum Preheat and Interpass Temperature

	Other than low – Hydrogen Welding Electrodes		Low Hydrogen Welding Electrodes	
	I S 226 or I S 2062 Steel	I S 961 Steel	I S 226 or I S 2062 Steel	I S 961 Steel
Upto 20 mm inclusive	None	Welding with this process not allowed	None	10 deg c
Above 20 mm and including 40 mm	65 deg c		10 deg c	65 deg c
Above 40 mm and including 63 mm	110 deg c		95 deg c	110 deg c
Above 63 mm	150 deg c		110 deg c	150 deg c

h) Test on welds

i. Magnetic particle test

In general, where the root and intermediate passes of a weld are examined by magnetic particle testing, such testing shall be carried out throughout its entire length in accordance with IS:5334 or ASTM specification E-109. In the case of completed welds, such tests shall be carried out in accordance with IS:5334 or ASTM Specification E-109 or E-138 as decided by the Engineer. If heat treatment is performed, the completed weld shall be examined after the heat treatment. All defects shall be repaired and retested. Magnetic particle tests shall be carried out using alternating current. Direct current may be used with the permission of the Engineer.

ii. Liquid penetrant inspection

In general, in the case of welds examined by Liquid Penetrant Inspection, such tests shall be carried out in accordance with ASTM E-165 or I.S, 3658. All defects shown shall be repaired and rechecked.

iii. Radiographic inspection

In general, all full strength butt wells shall be radiographer in accordance with the recommended practice for radiographic testing as per IS:2595.

iv. Dimensions, Workmanship & Cleanliness

In general, members shall be inspected at all stages of fabrication and assembly to verify that dimensions, tolerances, alignment, surface finish and painting are in accordance with the requirements indicated in the specification and approved drawings.

v. Inspection or Test Failure

In general, in the event of any failure of members to meet an inspection or test requirement, the contractor shall notify the Engineer or his authorized representative. The contractor must obtain permission from the Engineer before repair is undertaken. The quality control procedures to be followed to ensure satisfactory repair shall be subject to approval by the Engineer. The Engineer has the right to specify additional inspection or testing as he deems necessary, and the additional cost of such testing will be borne by the Contractor. The contractor shall maintain records of all inspection and testing which shall be made available to the Engineer or his authorized representative.

5.17. Painting

In general, steel parts shall be thoroughly cleaned by sand blasting and / or wire brushing as approved in writing by the engineer. The cleaning shall be to St3 in case of powered cleaning methods and Sa 2 ½ in the case of sand blast cleaning in conformity with primary Swedish standards SIS 055900 – 1967 and its latest modifications. The primer coat shall be epoxy zinc chromate in 1successive coat applied after the first coat has dried and of each 35 micron thickness as the minimum. The finish coat shall be epoxy high build chlorinated rubber zinc phosphate in 1 successive coat applied after the first coat has dried and of each 35-micron thickness as the minimum. Stainless Steel components shall be pickled and passiviated both on the inside and outside. Mechanized and bearing surfaces shall be protected with varnish or thick coat of grease or as directed by the equipment manufacturer. Non-ferrous materials and / or plastic, HDPE, UPVC, pre-painted items shall not be repainted unless directed in writing by the engineer. As a matter of convenience, the colour coding of pipelines, equipment etc. shall be as mutually agreed between the engineer and contractor in writing prior to any painting work being commenced by the contractor. In general, the steel surfaces shall be rendered dry and clean in accordance with the following requirements and all grease, oils and contaminants shall be removed fully by non-chemical means. Similarly, all weld splatter and grind burrs on cut edges and rough welds shall be rendered smooth. All surfaces after fabrication shall be blasted in accordance with SSPC SP10 with profile depth of 1.5-2.0 mils and the first primer applied before any rust bloom forms. All exterior non-seal welding joints shall be filled with rubber caulking painting and sufficient time allowed for caulking to dry before applying the finish coat. For all exterior surfaces, the first clat shall be one coat of average dry film thickness of two mils minimum, of a high-build catalysed epoxy. Applied to all steel surfaces except the areas within 5 cm adjacent to field welds and surfaces specified to be hot-dip galvanized. The shop finish coat shall be the application of one coat average dry film thickness of 1.0 mils minimum, of a polyurethane paint. The second coat shall be the field touch-up of damaged and unpainted areas and shall be the same as specified for the first coat at the same film thickness. The total dry film thickness shall be an average of 3 mils. The interior surfaces shall have an application of one coat of average dry film thickness of four mils, of an immersion grade high-build catalysed epoxy and applied to all steel surfaces except the areas within 5 cm adjacent to field welds and surfaces specified to be hot-dip galvanized. The paint shall be of approved make. The shop finish coat shall be the application of one coat average, dry film thickness of 3 mils, of an immersion grade high-build catalysed epoxy. The second coat shall be the field touch-up of damaged and unpainted areas and shall be by the same manner as specified for the first coat at the same film thickness. The dry film thickness shall be an average of 4 mils.

5.18. Erection

In general, all structural steel be erected as shown on the specification drawings as per an erection scheme approved by the Engineer. Proper size steel cable slings etc. shall be used for hoisting. Guys shall not be anchored to existing structures, foundations, etc. unless so permitted by the Engineer in writing. The contractor shall furnish the necessary non-inflammable staging and hoisting materials or equipment required for the erection work and shall remove and take them away after completion of the job. Structural steel frames shall be erected plumb and true. All steel columns and beams shall be checked for plumb and level individually before and after connections are made. Temporary branching shall be introduced wherever necessary to take care of all loads to which the structure may be subjected. Such bracing shall be left in place as long as may required for safety and stability. As erection progresses, the work shall be securely bolted to take care of all dead load, wind, seismic and erection stresses. No riveting or welding or final bolting shall be done until the structure has been properly aligned and approved by the Engineer. No cutting,

heating and enlarging of the holes shall be carried out without the prior approval of the Engineer. After steel has been erected, all bare and abraded spots, rivet heads, field welds, bolt heads and nuts shall be spot painted with primer specified. Before paint is applied, the surface shall be dry and free from dust, dirt, scale and grease. All surfaces inaccessible after erection shall receive two coats of the approved paint before erection. The Engineer shall have free access to all parts of the job during erection and all erection shall be subject to his approval. In case of faulty erection all such dismantling and re-erection required will be at the contractor's cost. No paint shall be applied to rivet heads of field welds or bolts until these have been approved by the engineer.

5.19. Installation of pumping equipment

Pumping Equipment

Scope of Work

This clause describes the general standards of materials, workmanship for installation testing and commissioning of all pumping equipment including those furnished by the Employer and as shown in Drawings, Bill of Quantities and directed by the Engineer.

Installation Drawing

The Contractor shall submit detailed installation drawing for Engineer's approval. Where required, information related to proposed foundation including installation details, supports, etc. are to be provided.

Installation Procedure

The Contractor shall comply with the manufacturer's installation instruction and furnish all tools and equipment required for complete installation, testing and commissioning. The Contractor shall provide skilled supervisor for installation of pumping equipment and testing.

Field Testing

The Contractor shall demonstrate to the Engineer's satisfaction that the installations are fully operated complying with the specifications in all respect. The alignment and levelling of pumping equipment will be checked. Each pumping unit when operated and tested over the entire specified range shall be free from vibration, notice or cavitation. The recorded vibration at full speed shall be equal to or less than the amplitude limits recommended in the Hydraulic Institute Standards.

Pump performance shall be documented by recording readings of motor voltage and current readings, discharge and corresponding head. The pump when operated at full load shall not overload the motor.

In the event any pumping equipment (to be supplied by Employer) fails to meet the test requirements, corrective measures shall be adopted by the Contractor if the fault arises due to installation defects.

Clearance of Site

On completion of installation work, the Contractor shall at his own expense remove from the site all surplus materials supplied by him including rubbish and shall ensure that the site is left tidy to the satisfaction of the Engineer.

As-built Drawing

As-built drawings showing on the original approved drawing, any modification made to the installation shall be submitted by the Contractor in full details.

Measurement

Pumping equipment installation and all work in connection therewith shall be valued by the measurement of only such items as are included in the Bill of Quantities. The cost of equipment not itemised in the Bill of Quantities shall be deemed to be included elsewhere in the contract rates to cover all the Contractor's obligations under the contract.

6 GENERAL ELECTRICAL SPECIFICATIONS

6.1 Preamble

The specifications herein are general in nature and any particular specifications indicated elsewhere supersedes these stipulations. Tenderer has to work out his costing based on the particular specifications wherever mentioned. Where no specifications are indicated, these standards, subject to interpretation and approval of the Engineer, shall prevail as the minimum requirements.

6.2 General description and requirements

This Chapter of the specification describes the general standards of materials, workmanship and design of all electrical works as shown on the drawings, in the Bill of Quantities and/or as directed by the Engineer. Requirement specified in other sections of the specification shall apply to this section when applicable.

Further standards of materials, workmanship and performance of machinery and equipment for the plant are to be as specified and of the best make. Machinery, accessories and other equipment shall be of sound workmanship, robust in design and of a grade and quality suitable for the purpose and the climatic conditions at the location.

Before installation and purchasing of any machinery, accessories and equipment, catalogues related to type and model no. and warranty certificate (s) from the manufacturer (s) shall be presented to the Engineer. As per decision of the Engineer, the Contractor shall take necessary steps for the execution of the testing and inspection of the above mentioned materials, prior to purchase and installation.

6.2.1 Quality Assurance

A. Manufacturer's Qualifications

Electrical equipment to be furnished by the Contractor shall be of makes and sizes proved to be successfully operating under the prevailing conditions if not otherwise specified by manufacturer and catalogues submitted prior to ordering of equipment; accessories and the like.

B. Factory Tests

Factory tests are required for all electrical equipment and assemblies to be supplied by the Contractor. The Contractor shall perform factory tests in accordance with the relevant British Standards or other such standards approved by the Engineer.

Test at the manufacturer's works shall be accompanied with test certificates showing all the relevant information and details relating to the test. Three (3) copies of test certificates signed by the manufacturer's representative shall be submitted to the Engineer.

C. Factory Inspection

The Engineer or his representative may inspect fabricated electrical equipment at the

factory. The Contractor shall notify the engineer in sufficient time so that factory inspection can be arranged. Factory inspection may be made after the manufacture has performed satisfactory checks, adjustments, tests, and operations. Approval of equipment at the factory only allows the manufacturer to ship the equipment to the site, and does not constitute a final acceptance.

D. Product Protection and Handling

Box, crate and equipment are to be protected during shipment, handling and storage. Equipment is to be kept dry and covered from exposure to weather. Pumps, motors, electrical equipment and equipment having anti-friction or sleeve bearings are to be stored in weather-tight storage facilities. Large equipment items are to be lifted only at the point designated by manufacturer.
Protection against impact, abrasion discoloration and other damage are to be ensured. Damages are to be repaired as directed and approved by the manufacturer.

E. Factory Painting

On mechanical and electrical equipment, drives, starters, control panels and similar self-contained or enclosed components, a factory primer and high quality oil-resistant backed industrial enamel finish are to be applied. Surfaces that are inaccessible after assembly are to be painted otherwise protected by a method, which provide protection for the life of the equipment.

F. Guarantee and Warrantee

The Contractor shall guarantee all equipment in accordance with the condition of contract. In addition to the guarantee requirements, equipment guarantee shall cover (i) faulty or inadequate design; (ii) improper assembly or erection; (iii) defective workmanship or materials; and (iv) leakage, breakage, or other failure. For equipment bearing a manufacturer's warranty certificate in excess of one year (WEF the date of commissioning) furnish a copy of the warranty to the Employer is to be furnished.

G. Operation and Maintenance Instructions

Before purchasing and installation of any machinery, accessories and equipment, the Contractor shall provide three complete sets of catalogues related to type and model number, drawings and instructions required for operation and maintenance of all items of equipment and instrumentation furnished. These shall include instructions for lubrication, repair and servicing, parts lists and all other pertinent information available from the equipment manufacturers.

6.2.2 Brand Names

Brand names are used herein merely to describe the nature of the described equipment and not used to endorse or indicate a preference for a particular product or manufacturer. Goods that have similar characteristics and provide performance in quality at least equal to those specified are acceptable.

In case of HT connection the following components should be provided and fitted as per prior consultation and approval of the relevant local authority.

<u>Lightning Arrester</u>

Lightning arrester should be of rated voltage, 11 kV, 50 Hz, maximum permissible voltage rm.'s. nominal discharge current 5 kA, minimum prospective symmetrical fault current 20 kA suitable for use at ambient temperature 50^0C (maximum) at 1000 metre (Maximum) above sea level.

6.3 General requirements concerning cubicles and enclosures

6.3.1 Cubicles and enclosures

General

Cubicles and enclosures for all electrical control equipment including switch gear and motor controls shall be constructed as described hereinafter.

The enclosures shall be constructed in accordance with BS 5486 and be flush fronted with all projection kept to a minimum. Where two or more new enclosures are joined together, they shall be uniform height.

Unless specified otherwise enclosures shall be floor standing with lockable hinged front door and bolted removable rear panels where access to live equipment such as busbars and terminals is required. Suitable warning levels and instruction for earthing and isolating shall be fitted where necessary. Each front access door shall be fitted with non-ferrous hinges and a numbered lock of the car type barrel panthra operating on a sufficient number of points to ensure firm pressure of the door seal around the whole periphery. The door shall be protected by an interlock preventing its release before the isolation of the live contact parts.

The enclosure shall be constructed with a degree of protection at least equal to IP 54.

The enclosure shall be earthen and where a number are used, earthing shall be via a continuous copper bar of the whole panel.

Terminals shall be provided for the connection to the metal cladding or armouring of all incoming and outgoing cable. Movable element such as hinged door shall be securely earthen by means of bared copper earthing connections.

All relays, timers, contactors, etc. shall be mounted on sub-panel readily removable and arranged with terminal blocks placed vertically at one side to allow in/out going cables and interconnection to be kept away from the main panel.

All indicator lamps, push button, switches fuses and instrument shall be mounted in the access door and wired back to the panel terminals by flexible loops arranged vertically on the hinged side and shall be long length to minimise strain.

6.3.2 Panel board/Switch board

Control Component

The switch board control component shall be as described in this clause.
The panel board shall be fabricated from of 2 mm thick (min) sheet steel pressed or rolled to shape and neatly finished and free from any joints or sharp edges. The structural and design criteria shall be as described for fabricated switchboards. The panel board shall be metal clad, totally enclosed,

dust and vermin-proof and self-supporting suitable for floor mounting. Each panel board shall contain the number of motor control units of similar type as required at each location. Spare motor control units where indicated or specified shall be supplied and installed in the panel board.

Indicating Instruments and Meters

All instrument and meters shall be flush mounted and generally of the same pattern and appearance. Items that perform similar duties shall be of uniform type and manufacture.

Indicating instruments shall be fitted with an externally accessible zero adjuster and shall be positioned not more than 1.8 meter and not less than 0.75 meter above floor level. They shall have no parallax error and their normal maximum reading shall be approximately 60% full-scale deflection.

Ammeters in motor starter circuits shall be capable of withstanding the starting current and shall have compressed over load scale. The scale shall be clearly marked with area line indicating normal full load current.

Indicating instruments shall comply with IEC-51 and shall be of industrial grade accuracy.

Kilo watt-hour meters shall comply fully with IEC 51 and shall have industrial grade accuracy (+2.5%) except where otherwise specified.

Indicator Lights

Indicator Lights shall be not less than 20-mm diameter and shall be of the projecting type so that they can be seen from the front and the side of the switchboard. They shall be visible under bright sun light conditions. The Lights shall be under-run to give long life or higher voltage lamps shall be used. Alternatively the lights shall be transformer operated.

Colours of indicator lights shall generally comply with IEC 78.

Labels

All designating labels shall be finished white with engraved letters and numbers filled with black and fixed by non-rusting screws. Text is to be written in English and Bengali.

Pushbuttons:

Red - stop, off or emergency buttons.
Green- start or on buttons.

Terminal blocks

Terminal blocks shall be screw or stud type barrier pattern with transparent insulated covers. Punch screw type block shall not be used.

Blocks at different voltages shall be grouped separately and labelled accordingly.

Test Terminal Blocks

When specified test terminal blocks shall be provided for secondary injection and testing of relays.

A metering block shall be provided where specified for the connection of portable instruments for

plant testing.

Test terminal blocks shall be provided with short licks or alternatively be of a type suitable for use with portable testing plug-in-equipment.

Switch Board / Panel Board Earthing

A continuous copper earth bar shall run the length of each board or panel and shall be provided with terminals for connections to the metal cladding or armouring of all incoming and outgoing cables. The cross section of the earth bar shall be not less than the recommendations of BS 162 Appendix-D.

A brass main earth terminal point shall be provided in the incoming section to which the earth bar shall be bonded. No earth terminals shall be less than 8-mm diameter.

Within each enclosure, all metal components which are not forming part of the electrical conducting circuits, shall be solidly bonded to the main structure and sheet metal of the enclosure for earthing purposes. Movable elements such as hinged doors shall be securely bonded to the main structure of the enclosure by means of braided copper earthing tapes bolted to bare metal contacts at each end.

Cubicle Safety Arrangement

All terminals, connectors, relays and other components that may remain or become energised when front access doors are open shall be adequately screened. It shall not be possible to obtain access to adjacent cubicles when any door is opened.

Components within the cubicles shall be adequately labelled to facilitate testing.

Isolators, clearly labelled, shall be provided in such positions and so connected that main entrance can be carried out with maximum safety. This particularly applies to control circuits fed from a remote position. Where it is necessary to maintain certain components in cubicles in an energised condition when the isolator is in the "Off" position, such apparatus shall be screened and labelled to eliminate the possibility of accidents. Additionally, a system of removable insulated links or isolating type terminal blocks shall be provided to enable particular components to be isolated for maintenance purposes whilst retaining other essential circuits in an energised condition.

Where more than one outgoing circuit occupies a common distribution section all cable terminations, cable lugs and such like shall be fully insulated or screened to allow work to be carried out on any one circuit with other circuits remaining live.

Cubicle Small Wiring

Wiring within the switchboard shall be distinctly coloured throughout and marked with ferrules at each end for identification. The letters and numbers used shall correspond with the switchboard-wiring diagram.

The wiring colour code if not specified further on, shall be as follows:

Phase- red, yellow, blue
Neutral - black
Control - grey
Earth - green with yellow stripe

The wiring shall be neatly placed and cleated to the switchboard structure and arranged so that access to equipment is not impeded. Where wiring passes through metalwork the access hole shall be fitted with a suitable grommet or bush. Wiring between cubicles or panel sections shall be terminated in terminal blocks at each end. Terminations for screw or stud type terminals shall be crimped ring type or claw and washer type. Small wiring associated with remote control and indication circuits shall be segregated from power wiring circuits and shall be suitably screened by the use of either screened cable, conduit or trucking.

All wiring within the switchboard shall be run continuously from terminal to terminal without intervening joints. Each conductor shall have an identifying number adjacent to each termination. All terminals shall be placed in easily accessible enclosures. Terminals for all outgoing cables other than power supplies shall be located at the top of the panel unless otherwise specified.

Bus-bars and Primary Connections

All bus bars and primary connections shall be liberally rated for continuous operation. The mechanical and dielectric strengths of bus bars and connection supports shall be able to withstand the worst conditions of electrical surge that can occur on the installation.

Bus bars and primary connections shall be housed in air insulated enclosures which shall be so arranged that no direct access to or contact with live bars is possible via slots or apertures. This shall also apply to trunk type circuit breakers when trunk has been removed. Suitable warning labels shall be provided. Baffles shall be provided to prevent the accidental entry of tools etc. while maintenance work is being carried out in the vicinity of the chambers. Bus bar systems shall have a short time rating not less than that of the associated switchgear.

The conductors shall be separated and supported with the appropriate clearances in air or shall be otherwise adequately insulated or encapsulated.

Panel Board/Switch Board: Cable Terminals

All incoming and outgoing cables shall be provided with cable dividing and sealing boxes or cable glands suitable to the type of cable specified.

All Panel board or switchboards shall, unless other wise specified, be provided with bottom cable entry. Removable gland plates shall be mounted at not less than 300 mm above the base of the switchboard.

Each cubicle shall be suitable for cable access for all incoming and outgoing cables as stipulated in the particular specification. This access shall be so arranged that cables can be installed directly to their respective terminations without being threaded through another compartment.

Ancillary Equipment

The following ancillary articles shall be supplied with each switchboard.

- One black fluted rubber safety mat running the length of the SwitchBoard / Panel Board.
- 2 pair rubber gloves according to rated voltage of switchboard.
- One "treatment for electric shock" metal enamel instruction plate suitable for screen attachment, written in English and Bengali.
- Operating handles, tools, spares and lubricants as specified elsewhere.

Protective Relays: General

Protective relays shall be mounted on the front of the switchgear or relay panel in such a position that operation and maintenance can be conveniently carried out. Auxiliary relays may be earthen inside a cubicle provided that they are readily assessable.

Each relay shall have contained in a dust proof case and be vibration proof. All metal bases and frames shall be earthen except where that are special technical reasons for being impracticable. Each relay shall have a glass observation window and means of resetting the relay. All relay contacts shall be capable of making the maximum current that can occur in the circuit without causing damage to the contacts.

Relays connected to current transformers shall incorporate a shorting bar to ensure that the current transformer has its secondary windings automatically stated when the relay is removed.

Where solid state relays are specified, these shall be of the module type comprising a number of plug-in elements allowing inter-change of functions. Each of the protection elements shall have adjustable controls for current and time settings as required.

A built in test facility shall be provided for individual testing of the settings of each of the protection elements. The test shall be carried out by means of test sockets so that elements do not have to be removed from he panel.

All solid state relays of a particular type shall have interchangeable protective elements with other similar relays supplied under this contract.

Protection relays shall comply with IEC specified standard where appropriate.

6.4 Motor Control Units

The motor control unit may use one or the combination of the following procedure for starting of the motors as required and as specified in BOQ:-

- Direct on line
- Star-delta
- Auto transformers

In all cases, each motor control unit shall have an individual circuit breaker or isolator, protection fuses for the motors as well as the control wiring, ammeters in three phases volt meter with selected switch, thermal overload relays, single phasing protector, under/over voltage release, on/off and/or manual/automatic selector switch, start-stop buttons, run and failure indication lights and supply main lights etc. all complete as specified in BOQ. An interlocking switch shall be provided for protection of simultaneous running of standby pump.

Contents in details for major components of star-delta starter are as follows:

- Contactors: The contactors for the Star-Delta starter shall be three pole with silver alloy contacts with capacity at least for two times the rating of the steady current through the individual star line and delta contactors in the circuit. Coils shall be suitable for continuous rating without overheating or damage or noise and shall operate on 240 volts AC, 50 HZ capable of remote control by a switch that may be one way, two way or intermediate. Contactors shall be capable of being serviced or replaced from the front of the switch board or distribution boards. Same instruction will applicable for contactor of PFI plant and other

equipment.

- Overload relay: Bi-metal hand-auto set rest positioned external of delta 100p and rated for full load starting of motor.

- Phase failure control relay: Control of rotational direction of phases and total phase failure control relay.

- Timer: Bi-metal or synchronous type 0-20sec. adjustable. The manufacturer or supplier shall submit the final proposed control wiring to the Engineer for approval before proceeding to manufacture or take delivery of the motor control centres. Control centres equipped with wrong or inadequate facilities to suit requirements at site will be rejected at no additional cost to the Employer.

Level Control Switch

The level control system regarding centrifugal pump shall be automatic to signal, by audible alarm bell as well as automatic starting of high water level and automatic cut-off (stop) of the high lift pump at low water level in the CWR. The system shall consist of the necessary float switches, probes and a metal clad control cubicle to house the necessary equipment such as electronic circuitry, relays, power cap, bell, buzzer and all other necessary appurtenance. The float switch shall completely sealed, inside a moulded plastic float with mercury type switch, supported by a neoprene rubber cable. The buzzer and visual alarms shall be mounted within the control panel. The bell shall be mounted externally of the cubicle or on the wall directly above the control cubicle.

The sensing equipment such as float switches and or probes shall be furnished as required for installation in the CWR. All terminals for external wiring shall be brought to suitable connectors. The bells rated at 20 to 30 volt DC shall be 150-mm diameter with armature driven hammer and adjustment for audible alarm level. The system shall allow for muting of the audible alarm of either the bell or buzzer while maintaining the visual light. The system shall be reset manually following clearance of an alarm.

Capacitor for power factor improvement

Capacitor bank should be dry type, self-healing compact with register. For more than 10KVAR the capacitor bank shall be operated through magnetic contact switch so that the capacitor bank will in off position during idle position of the motor. An automatic power factor improvement plant shall be provided with digital power factor meter, power factor regulator for minimum 4 step operation, protective fuse, indication lights etc. all complete as mentioned in BOQ as well as per direction of the Engineer.

Test Certificates for Motor Control Centres

Each control centre shall carry separate test certificates from the manufacturers. These certificates shall be submitted to the electricity authorities at the time of application for power connection or testing of the installation.

6.5 Power and motor control centre

The manufacture and supply of Power and Motor Control Centre shall conform to the following additional requirements.

a) Construction Features

1) Sheet steel used for fabrication of power and motor control centre shall be2 mm thick cold rolled / 3 mm thick hot rolled.
2) All doors, panels, removable covers, gland plates etc., shall be gasketed using Neoprene gaskets all round the perimeter.
3) All doors shall be provided with concealed type of hinges and captive screws.
4) The PMCC shall be provided with min 50 mm high channel base frame. Total height shall be 2250 mm (max) . The minimum operating height shall be 300 mm and maximum operating height shall be 1800 mm. The PMCC shall be extendable on both sides.
5) Colour finish shade shall be as per IS 5. The colour of the interior shall be glossy white and the exterior shall be as suggested by the client.
6) Instruments, relays, and control devices shall be mounted flush on hinged door of the metering compartment located in the front portion of the module. Each module shall be fitted with a lable on the front and rear. Each module shall also be fitted with a lable indicating the rating and duty. Module shall be complete with interpanel wiring.
7) The PMCC shall comprise separate, segregated modules for each circuit.
8) Busways, cableways and wireways shall be run in separate segregated compartments.

b) Incomer Feeder and Bus Coupler Detail

1) Two incomers (one for EB supply and other one for DG set supply) and one bus coupler shall be considered in the PMCC. Both incomers and bus coupler shall be interlocked to achieve at a time the following condition:
   a) EB incomer ON, Bus coupler ON and DG set incomer OFF.
   b) Bus coupler ON, DG set incomer ON and EB incomer OFF.
   c) Bus coupler OFF, EB incomer ON, DG set incomer ON.

2) The interlock shall be achieved mechanically as well as electrically.

3) The incomer feeder (EB and DG set) module shall have the following features:
   - Motorised operated spring charged ACB unit (4P, 415 VAC 1000A).
   - Voltmeter with voltmeter sel switch.
   - Ammeter with CTs and sel switch.
   - KWhr, KW, pf, maximum demand, frequency indicating meter
   - On/Off indication lamps
   - R, Y, B indication lamps
   - Bus bars (RYB) extended down from the incomers for connection of incoming cables without any problem
   - Bus coupler unit shall have motorised operated spring charged ACB of 1000 amps rating

c) Outgoing Feeder Modules Details

1) The outgoing feeder modules shall be either DOL contactor type motor starter or automatic star/delta contactor type motor starter or automatic autotransformer motor starter as per the requirement.

2) The DOL contactor starter module shall be considered for control of motors rated upto and including 10 HP and shall be equipped with:

   - Main Load Break Switch (TPN)
   - HRC Fuses for power circuit and DPMCB for control circuit

- Power and auxiliary Contactors as required
- Overload relay
- Start, stop and reset PB
- On, off and trip indication
- Ammeter with set switch
- Power and control circuit wiring and termination accessories
- Local/remote sel switch
- Auto / off / manual sel switch as per requirement

3) The Automatic star delta contactor starter module shall be considered for control of motors of rated from 12.5 HP to 50 HP and shall be equipped with:

- Main Load Break Switch (TPN)
- HRC Fuses for power circuit and DP MCB for control circuit
- Power and auxiliary contactors as required
- Overload Relay
- Start, stop and reset PB
- On, off and trip indication
- Ammeter with CTS and Sel Switch
- Power and control circuit wiring and termination accessories
- Electronic timer with relays
- Local/Remote Sel Switch
- Auto / off / manual sel switch as per requirement

4) The Automatic auto transformer starter module shall be considered for control of motors of rated from 60 HP & above and shall be equipped with:

- Main Load Break Switch (TPN)
- HRC Fuses for power circuit and DP MCB for control circuit
- Power and auxiliary contactors as required
- Overload Relay
- Start, stop and reset PB
- On, off and trip indication
- Ammeter with CTS and Sel Switch
- Power and control circuit wiring and termination accessories
- Electronic timer with adjustable definite time transfer relay, auto-transfer relay and other relays / contactors for smooth transition from auto transformer starting to dol starting.
- Auto-transformer with over-temperature protection
- Local / Remote sel switch
- Auto / off / manual sel switch as per requirement

5) Module Size (Min Requirement) - 240 mm - For SFU
300 mm - For DOL starter
400 mm - For Star Delta starter
Full vertical panel - for autotransformer starter

6) The rating of the electrical items / components in the DOL/Star Delta/Autotransformer starter motor feeder modules shall conform to recommendation of the panel manufacture with due regard given to derating condition and operation factors.

7) Incomers, bus coupler and auto transformer starter modules shall be fully draw out and

outgoing DOL as well as automatic star delta motor starter feeder modules shall be fixed design

d) Bus bars

1) PMCC shall be provided with three phase and neutral bus-bars.(Both vertical and horizontal)

2) Bus-Bars shall be of Aluminium with sleeving and rated for 1000 amps.

3) Bus-Bars joints shall be of the bolted type and shall be insulated. Spring washers shall be provided to ensure good contact at the joints.

4) Bus-Bars shall be located in air insulated enclosures. Direct access to or accidental contact with bus bars and primary connections shall not be possible. All apertures and slots shall be protected by baffles to prevent accidental shorting of bus bars by the entry of maintenance tools. Tight seals with shrouds between cubicles, bushings or insulating panels shall be provided for bus bars crossing from one cubicle to another.

5) The bus bars and primary connections shall have a short time rating. The mechanical strength of the bus bars and supports shall be able to withstand the electromagnetic forces arising under the most onerous short circuit condition.

e) Contactor Type Motor Starter

1) Motor starter contactors shall be of the full voltages, star/delta or direct-on-line or automatic auto transformer as the case may be and also all break single throw, electromagnetic type suitable for motor. Three pole contactors shall be furnished for 3 phase motors and two pole contactors shall be furnished for single-phase motors. Reversing contactors shall be provided with electrical interlocks between forward and reverse contactors.

2) Contactors shall be suitable for uninterrupted duty as defined in IS:2959. Contactors for reversing motors shall be rated for Class AC 4 duty in accordance with IS 2959. All other contactors shall be rated for class AC 3 duty.

3) Main contacts of the contactors shall be silver faced.

4) Insulation class of coils shall be class B.

5) One number spare auxiliary contactor in addition to the required auxiliary contactor shall be considered. All power and auxiliary contactors shall be provided with at least two pairs of NO and NC auxiliary contacts as spare in addition to the required number of contacts.

6) Contactors shall not drop out at voltages down upto 70% of rates coil voltage.

7) Contactors shall be provided with a three element, positive acting, ambient temperature compensated, time lagged, hand reset type of thermal overload relay with adjustable settings. The hand reset button shall be flush with the front door of the control module, and shall be suitable for resetting the overload relay with the module door closed. Relays shall be either direct connected or CT operated. Overload relay and the reset buttons. The setting range shall be properly selected in accordance with the rating of motor selected.

8) Test facility shall be provided in each motor starter for the purpose of testing the starter modules.

6.6 Air circuit breakers (for incomers & bus coupler)

1) Air circuit breakers shall be 4 poleair break type and shall be of the vertical isolating pattern with horizontal drawout facilities. These shall be power operated by a motor operator spring charging type of mechanism. The tripping spring shall be charged by the closing actin, to enable quick tripping. Closing of the circuits breaker shall automatically initiate recharging of the springs to enable the mechanism to be ready for the next closing stroke. Charging time for the springs shall not exceed 30 seconds. It shall be possible to manually charge the springs in an emergency. Transfer from motor to manual charging shall automatically disconnect the charging motor. The charging mechanism shall be provided with mechanical indicators to show charged and discharged conditions of the spring. Failure of any spring, vibration or mechanical shock shall not cause tripping or closing of the circuit breaker.

2) Means shall be provided to manually open and close the breakers slowly when the operating power is not available, for maintenance and adjustments.

3) All operating mechanisms shall be provided with ON-OFF mechanical indicators in addition to ON, OFF electrical indications.

4) A local manual trip device shall be provided on the operating mechanism.

5) Closing coils and other auxiliary devices shall operate satisfactorily at all voltages between 80 - 110% of the rated control voltage. Trip coils and associated trip relays shall operate satisfactorily between 50 - 110% of the rated control voltage.

6) The rated breaking capacity of the ACB shall not be less than 35 MVA and the short circuit withstand current for one second duration shall not be less than 40 KA.

6.7 Switch and fuse

1) Low voltage air-break switches shall be of the load break, fault make, group operated type. For use on three phase system, the switches shall be of the triple pole type with a link for neutral wire. For use on single phase system and d-c systems, the switches shall be of the two pole type.

2) Switches shall be of the heavy duty, quick make and quick break type. Switch contacts shall be silver plated, and contact springs shall be of stainless steel. Switch handles shall have provision for locking in both fully open and fully closed positions. Mechanical ON-OFF indication shall be provided on the switches.

3) Switches for controlling motor circuits shall be of the load break, fault make type and shall be capable of breaking locked rotor current of the associated motor.

4) Low voltage switches and composite units of switches and fuses shall comply with the requirements of IS 4064.

5) Low voltage composite units of switches and fuses shall be provided with the following interlocks so that:
   - The fuses are not accessible unless the switch is in fully open condition.
   - It is not possible to close the switch when the fuse cover is open, but an authorised person may override the interlock and operate the switch. After such an operation the cover shall

be prevented from closing if the switch is left in the ON position.

6) Fuses and links shall be provided to enable any circuit to be isolated as necessary for maintenance and test purposes without isolating the whole panel.

7) All fuses shall be of the HRC cartridge type mounted on plug in type of fuse bases. Fuses shall be provided with visible indicators to show that they have operated. Current Vs time characteristics of all types of fuses shall be furnished for the approval of the Consultant/Engineer. Fuses shall comply with the requirements of IS 2208.

8) Fuse carriers and solid link carriers and bases shall be made of plastic moulded insulating material of an approved make. Ceramic materials will not be accepted. All accessible live connections shall be efficiently shrouded. Wherever fuses with high current ratings are directly plugged in to the circuit terminals, without their having to be mounted in fuse carriers, enshrouded terminals may be provided. However, in such cases an insulated fuse removal handle shall be furnished for each possible to change fuses with the circuit live without danger of contact with live metal. The fuses shall be rated to give maximum protection to the apparatus in circuit and the rating shall be inscribed on the fuse label.

9) Earthing and neutral links in main supply circuits shall be of solid silver plated copper and be of the bolted pattern.

10) Fuses and links functionally associated with the same circuit shall be mounted side by side.

11) An adequate number of spare fuse cartridges for each rating shall be supplied and fitted in clips inside the panel.

6.8 Cabling system for complete plant

The cabling system covers the design as per relevant national/international standards. It shall be the responsibility of the contractor to work out a detailed layout for the complete plant cable system. The layout drawing shall be furnished for the approval before commencement of installation including cable trays, cable racks, accessories, tray supports, conduit etc.

6.8.1 Cable layout

The following points shall be noted while planning cabling system for the plant:

1) Inside the building cable tray in built in RCC cable trench shall be planed as per cabling requirement.

2) Outside the building also the cable from the MCC to the drives and other electrical equipments shall be laid in GI cable trays.

6.8.2 Cable trays, accessories and tray supports

1) Cable racks/trays shall either be run in concrete trenches inside the building and on overhead supports, supported from building steel, floor slab etc., on outside the buildings.

2) Cables shall be clamped to the cable trays at regular intervals.

3) Lines and grade for trays may be measured from building steel and finished floor elevations. Change in line or grade, or the addition of offsets by means of cutting standard tray sections and inserting additional tray fittings to match with the exiting arrangement shall be considered as a normal part of the work.

4) All cable trays and vertical raceways shall be hot dip galvanised (min Galvanishing thickness shall be 100 microns).

5) Installation work shall comprise installation of trays as per approved layout drawings prepared by successful Bidder. All steel sections such as angles, channels, brackets etc., required for supporting the trays shall be hot dip galvanised (100 micron thickness) and supplied by the contractor.

6) GI Cable Trays shall be of perforated mild steel (2.5 mm thick) with formed flanges and duly hot dip (100 micron Thk). Any damage caused by the Contractor to surfaces of buildings / structures etc., during installation of trays shall be made good by the Contractor to the satisfaction of the Client / Consultant.

7) The scope of cable tray installation shall include the installation of accessories like GI coupler plate. GI elbows, GI dropouts, GI tees, GI bends as required. The Contractor shall also include earthling of cable trays at distances not exceeding 10 m length by means of 25 x 3 mm GI flat. Nuts, both & washers are also of GI (100 micron Thk) Flat. Contractor shall also provide identification mark for cable trays. Only hot drip galvainising of cable trays and hardwares as well as accessories are permitted. No other method of galvanising is allowed.

6.9 Conduits, pipes and ducts

1) The Contractor shall supply and install conduits, pipes and ducts as per requirement. All accessories/fittings required for making the installation complete, including but not limited to, ordinary and inspection tees or galvanised steel bushings, male and female reducers and enlarges, wooden plugs, caps, square headed male plugs, nipples, gland sealing fittings, junction boxes, pull boxes, conduits, outlet boxes, splice boxes, terminal boxes, glands, gaskets and box covers, saddles and all steel supporting work shall be supplied by the contractor. Conduit fittings shall be of the same material as the conduits.

2) Flexible metallic conduits shall be used for termination of connections to equipment such as motors or other electrical equipment to be disconnected at periodic intervals.

3) GI conduits or pipes shall run along walls, floors, and ceilings, on steel supports, embedded in soil, floor, wall or foundation, in accordance with approved layout drawings.

4) Exposed GI conduit shall be adequately supported by racks and clamps or straps or by other approved means. Conduit supports shall be erected square, and true to line and grade with an average spacing of one support for every 2 meters of conduit length.

5) Each conduit run shall be marked with its designation.

6) All installed conduits shall have their ends temporarily closed by caps, wooden plugs, or other approved means until cable is pulled. Closures shall be made in such a way that they do not get dislodged easily.

7) When one or more cables are trained through a conduit, conduit size shall be such that the total cross sectional area of the cable does not exceed 60% of the internal cross sectional

area of th conduit.

8) The contractor shall be responsible for bonding of metal pipes or conduits in which cables have been installed to the main earthing systems. Joints, metal sheath and armour of cables shall be bonded to the earth system in an approved manner. The entire system in an approved manner. The entire system of conduit after installation shall be tested for mechanical and electrical continuity throughout and permanently connected to earth by means of a special approved type earthing clamp efficiently fastened to the conduit. Gas or water pipes shall not be used as an earth medium.

9) All conduits shall be hot dip galvanised. Conduits shall be run on the surface or embedded and shall be neatly arranged. When one or more cables are laid through a conduit, conduit size shall be such that the total cross sectional area of the cables does not exceed 40% of the internal cross-sectional area of the conduit.

10) The conduits shall be screwed into spout outlets of conduit boxes or where fixed to boxes drilled with properly sized clearance holes they shall be secured by means of sockets and hexagon bushes. All threads shall be cut clean and all burrs removed with a reamer.

11) All bends and sets shall be formed in the conduit itself, factory made bends are not to be installed. The radius of bends shall not be less than that given in Indian Electricity Regulations / relevant Indian Standards.

12) Particular care must be taken to ensure that no water is allowed to enter the conduit at any time. Inaccessible junction boxes will not be allowed.

13) Only continuous lengths of buried conduit shall be installed between boxes, no joint boxes being allowed in the floors creeds. The ends of conduits laid or set in framework prior to concreting shall be temporarily sealed off with a coupler and a solid brass plug.

14) Fixing to surfaces of walls shall be by means of spacers and saddles securely fixed by screws. Where conduits are concealed or laid in constructional floors, they shall be held in position with substantial fixings.

15) Adaptor boxes shall be constructed of minimum 2 mm thick sheet steel and sized to prevent the undue packing of cables in them.

16) Weather proof boxes and accessories shall be used outdoors, where agreed on Site by the Client / Consultant.

17) Conduit shall be installed such as to permit complete rewiring without the need to remove false ceilings or carryout builders work

6.9.1 Installation of cables

1) The contractor shall install, test and commission the cables specified in the technical specification in accordance with approved drawings and instructions issued by the client. Cables shall be laid directly on cable racks and on cable trays and supports, in conduits and ducts or bare on walls, ceiling etc., as per approved drawing. Contractor's scope of work includes shifting from client's store to site, unloading, laying, fixing, jointing, bending, and terminating of the cables. The Contractor shall also supply the necessary materials and equipment required for jointing and terminating of the cables.

2) All apparatus, connections and cable work shall be designed and arranged to minimise the risk of fire and any damage which might be caused in the event of fire. Wherever cables pass through floor or wall openings or other partitions, suitable bushes of an approved type shall be supplied and put into position by the Contractor.

3) Inspection on receipt, unloading, storage and handling of cables shall be in accordance with IS: 1255 and other Indian Standard Codes of Practice.

4) After pulling the cable, the Contractor shall record cable identification and date pulled neatly with waterproof ink and lines tags and shall securely attach such identification tags. Identification tags shall be attached to each end of each cable with non-corrosive wire. The said wire must be non-ferrous material on single conductor power cable. Tags may further be required at intervals on long runs of cables on cable trays and in pull boxes. Cable and joint markers and RCC warning covers shall be provided wherever required.

5) Sharp bending and kinking of cables shall be avoided. The bending radii for various types of cables shall not be less than those specified below:
650 / 1100 V PVC insulated cables : 10 times the overall dia of the cable.

6) Power and control cables shall be laid in separate cable racks / trays.

7) Where groups of LV and control cables are to be laid along the same route, suitable barriers to segregate them physically shall be employed.

8) When power cables are laid in the proximity of communication cables, minimum horizontal and vertical separation between power and communication cables shall be normally 600 mm, but in any case not less than 460 mm for single core cables and 300 mm for multicore cables. Power and communication cables shall be far as possible, cross at right angles to each other.

9) Where cables cross roads and water, oil, gas or sewage pipes, the cables shall be laid in reinforced spun concrete or steel pipes. For road crossings the pipe for the cable shall be buried at not less than one metre depth.

10) In each cable run some extra length shall be kept at a suitable point to enable one or two straight through joints to be made should the cable develop a fault at a later date.

11) At cable terminal points where the conductor and cable insulation will be terminated, terminations shall be made in a neat, workman like and approved manner by men specialised in this class of work. Terminations shall be made by the Contractor for each type of wire or cable in accordance with instructions issued by cable manufacturer's and the Client / Consultant.

12) Control cable terminations shall be made in accordance with wiring diagrams, using colour codes established by the Client / Consultant for the various control circuits, by code marked wiring diagrams.

13) When control cables are to be fanned out and cabled together with cord, the Contractor shall make connections to terminal blocks, and test the equipment for proper operation before cables are corded together.

14) After installation and alignment of motors, the Contractor shall complete the conduit installation, including a section of flexible conduit between the motor terminal box and cable

tray. The Contractor shall install and connect the power, control and heater supply cables as per equipment manufacturer's drawings if any. The Contractor shall be responsible for correct phasing of the motor power connections and shall interchange connections at the motor terminal box if necessary, after each motor is test run.

15) Metal sheath and armour of the cable shall be bonded to the earthing system of the station. The size of conductor for bonding shall be appropriate with the system fault current.

16) All new cables shall be megger tested before laying and termination. After laying and termination are completed all L.V. Cables shall be megger tested. 1100 / 650 Volt grade cables shall be tested by 1000 volt megger.

17) Cable cores shall be tested for

- Continuity;
- Absence of cross phasing;
- Insulation resistance to earth;
- Insulation resistance between conductors.

18) Contractor shall furnish all testing kit and instruments required for field testing.

19) Where cables are not buried directly in the ground, but laid in floor trenches or drawn into ducts, they shall, unless otherwise agreed by the Engineer be supported on hangers or by cleats, secured on tray or enclosed in conduit or similar. Areas in which the type of installation requires particular attention are indicated on the drawings.

Every cable whether in or out of sight shall neatly be run vertically, horizontally or parallel to adjacent walls, beam or other structural members. Spacing of climbs, saddles and cleats shall be such as to prevent sagging of the cables at all times during their installed life. The method of fixing clip etc. shall be by means of non-corrosive screws installed into an approved wall fixing.

All cable hangers, cleats, saddles, brackets and similar supporting devices shall be of an approved type and of adequate strength for the cables they are supporting, so treated as to withstand site conditions without corroding.

Where a number of cables are terminated at any particular item of equipment, special care shall be taken to ensure the cables finally approach the equipment from a common direction and are individually terminated in an orderly and symmetrical fashion.

Where the building structure incorporates built-in covered trench systems, distribution cables may be laid on the floor of the trench, but control and instrumentation cable shall be segregated and installed on supporting steel work or cable tray secured to the walls of the trench.

Where the building structure incorporates general service trenches containing pipework, chemical lines and other services, all cabling shall be segregated from other services and run on the trench walls. Crossovers shall be kept to a minimum and where possible cabling shall be taken above wet service pipework.

The cables shall be spaced as necessary to maintain current ratings and to restrict interference between power and signal circuits.

Cables shall be run at least 150 mm clear of plumbing (and below) and hot water pipework.

Where cables are laid direct, the bottom of the trench shall be free of sharp stones and such like and 75 mm of sieved soil or sand laid below the cable. After cable laying 75 mm of sieved soil or sand shall be laid above the cable. Unless otherwise agreed by the Engineer, cables at voltages up to and including 1000 V shall have a minimum cover of 500 mm. Cables at voltages in excess of 1000 V and all cables passing under roadways shall have a minimum cover of 1.00 m. These depths may be varied in certain circumstances due to the proximity of other cables or services.

Where cables of different voltages are laid together at the same depth, vertical cable tiles shall be used to segregate the cables. Control and communication cables shall not be laid closer than 1000 mm to high voltage cables. Armoured cables laid direct shall have a layer of protective inter locking earthenware or concrete cable tiles laid 150 mm above the buried cable or alternatively an approved marker tape may be used where specified. Cable tiles and marker tape shall read "Danger-Electric Cable".

Concrete cable route markers shall be installed at changes of direction and at 50-m intervals on straight runs, each fitted with a suitably inscribed metal plate indicating the voltage of the cable being marked. Marker posts shall also be installed to identify any joint locations on cable runs. Where cables pass in or out of any duct entries into or within buildings such entries, together with any spare ducts, shall be sealed against the ingress of moisture by means of duct stoppers and bituminous compounds, or by other method approved by the Engineer. The stopper shall have a fire resistance of at least 30 minutes.

n) Power and control cable terminations

1) Cable boxes shall be of approved design with adequate clearances between phases and between phases and earth, in accordance with relevant standards.

2) Cable boxes shall be complete with combined armour and earthling clamps.

3) Suitable double compression type cable glands shall be provided for power and control cables.

4) Provision shall be made for earthling the body of each cable box.

5) Equipment terminal blocks for power connections shall be complete with adequate phase segregating insulating barriers and suitable crimping type of lugs for connecting the insulated cable tails.

6) Where more than one core is terminated on each phase, unnecessary bending of cable cores shall be avoided, without decreasing the length of the insulated cable tail and the electrical clearances which would normally be obtained when using one core per phase.

7) All switchboards shall, unless otherwise specified, facilitate bottom cable entry. Removable gland plates shall be mounted at least 300 mm above the base of the panel. If the gland plates are provided inside the MCC cubicles, entries in the base of cubicle must be adequately vermin proofed.

8) The individual cores of power and control cables shall be neatly dressed and supported at regular intervals inside the PMCC, before connecting them to the relevant terminals.

o) Installation Methods

1) Electrical installation work shall comply with all currently applicable statutes, regulations and safety codes in the locality where installation is carried out.

2) Installation of cable shall include unloading, storing, laying, fixing, jointing, termination & all other work and material necessary to make job complete.

3) All cables where required to be run on walls, ceiling or other building structures shall unless otherwise agreed by the Client / Consultant be secured on tray or enclosed in conduit or trucking.

4) Where the building structure incorporates purpose built covered cable duct/trench systems for main cables, power cables, control and protection cables shall be segregated and installed on tray-work.

5) Where the structure incorporates general service ducts / trays containing pipe work, chemical lines and other services all cabling shall be segregated from other services and run on the trench walls.

6) Throughout the installation contractor shall ensure minimum spacing of cables to maintain current ratings, to prevent interference between power and signal cables and to avoid unnecessary crossovers.

7) All cabling throughout the installation shall be fixed with purpose designed clamps, cleats or saddles.

8) All floor openings for vertical cable tray / raceways shall be sealed by fire proof compound. Scope of work shall also include supply, preparation and laying of compound.
9) Cable installation shall be tested as per relevant standards.

6.9.2 Cable trays, accessories and tray supports

- Cable trays shall either be run in concrete trenches or overhead supported from building steel, floor slab, etc. All cable trays shall be GI cables shall be clamped to the cable trays in both horizontal runs and vertical runs by suitable site fabricated clamps.
- Cable tray supporting system shall be adequately designed so as to keep maximum deflection with permissible limits.
- All cables shall have route identification markers tags. Samples of tags shall be approved by the Engineer.

6.9.3 LT Motors

Manufacture and supply of LT motors shall conform to the following requirements:

a) Design requirements

The motors shall conform to IS : 325, BS 296, BS 170, BS 3979, BS 4999 and BS 5000 were applicable. Additionally, the specific requirements mentioned in the following clauses shall also be met with.

b) Performance and characteristics

Motors shall be capable of giving rated output without reduction in the expected life span when operated continuously under the following supply conditions:

- Variation in supply voltage +/- 10%
- Variation in supply frequency +/- 5%
- Combined voltage and frequency variation +/- 10%
- Ambient Temperature 45°C

c) Insulation

1) Any joints in the motor insulation such as at coil connections or between slot and end winding sections, shall have strength equivalent to that of slot sections of the coil.

2) The insulation shall be given tropical and fungicidal treatment for successful operation of the motor in hot, humid and tropical climate.

3) The motors shall be provided with Class F insulation with temperature rise limited to that of class B insulation.

d) Enclosure

Enclosures for indoor use shall afford a degree of mechanical protection not less than IP 55 to IS 2147 and self ventilating. For outdoor use, totally enclosed fan cooled motors shall be used having mechanical protection not less than IP55 and cooling standards shall be IC.41 in each case. For outdoor use the motors shall be provided with rain hood to prevent direct rain water from falling on them. Totally enclosed motors shall be provided with suitable means of breathing and drainage to prevent accumulation of condensate.

e) Constructional features

1) The motor construction shall be suitable for easy disassembly and reassembly. The enclosure shall be sturdy and shall permit easy removal of any part of the motor for inspection and repairs.

2) Motors weighing more than 25 KG shall be provided with eye bolts, lugs or other means to facilitate safe lifting.

3) The motor bars shall not be insulated in the slot portion between the iron core lamination.

f) Terminal box

1) Terminal boxes shall be of weather proof construction designed for outdoor service. To eliminate entry of dust and water, gaskets of neoprene or approved equivalent shall be provided at cover joints and between box and motor frame.

2) The terminal box shall be suitable for bottom entry of cables.

3) The terminal box shall be capable of being turned through 360 degrees in steps of 90 degrees.

4) The terminals shall be of the stud type with necessary plain washers, spring washers and check-nuts. They shall be designed for the current carrying capacity and shall ensure ample phase to phase and phase to ground clearances.

5) Suitable cable glands and cable lugs shall be supplied to match specified cables.

6) Separate terminal boxes shall be provided for each of the following:
   - Stator leads
   - Space heaters

g) Accessories

Two independent earthing points shall be provided on opposite sides of the motor, foir bolted connections. These earthing points shall be in addition to earthing stud provided in the terminal box.

h) Other requirements

1) Motors shall be suitable for starting and accelerating the load with the applicable method of starting, without exceeding acceptable winding temperatures, when the supply voltage is 80% of rated motor voltage.

2) The locked rotor current of the motor shall not exceed 600% of full load current (subject to tolerance as per the applicable standard).

3) Motors shall be designed to withstand 120% of rated speed for two minutes without any mechanical damage, in either direction of rotation.

4) Stator leads shall be brought to the terminal box as insulated cable through a suitable barrier and terminated in clamps type terminals.

5) Minimum power factor and efficiency of the motor shall not be less than 0.85 and 95% respectively.

Parameters

- Type of motor : TEFC, SQ Cage, Induction
- Rated Voltage : 415 v AC ± 10% , 3 Phase
- Rated Freg : 50 Hz ± 5%
- Supply system fault level : 16 MVA
- Supply neutral : Solidly earthed
- Type of duty : S1 (continuous)
- Type of cooling : Air (fan cooled)

j) Shop testing

1) Motors shall be tested at manufacturer's works as per IS 4029 and IS 325.
2) One motor in each categories of rating 40HP & above shall be type tested.

3) All motors shall be routine tested.

k) Drive list

Drive list of motors shall be submitted in consultation with mechanical discipline for approval.

6.9.4 Local on / off push button stations

Manufacture and supply of local ON / OFF push button stations shall conform to the following.

1) General

In order to make on and off operations of electrical drives, these stations are located near each drive. These push button stations are in die-cast aluminium enclosure confirming to IP 65. These stations will have on and off PBs with elements. These stations are mounted in channels which are erected near each drives.

6.9.5 Construction features

a. Metal enclosed, weather-proof, suitable for mounting on wall or steel structures. The enclosure shall be die cast aluminium (3 mm thickness) with two coatings of anti corrosive paint.
b. Dust and vermin proof.
c. Provided with a degree of protection of not less than IP:65.
d. Metal parts shall be given tropicalising treatment as per standards and painted with two coat of epoxy primer and two coats of final epoxy paint.
e. Provided with inscription plates of rear engraved perspex with white letters on black background. The letter size shall be 6 mm.
f. Provided with two earthling terminals suitable for 12 SWG G.I. Wire.
g. Provided with removable undrilled gland plate and cable glands for two Nos. 5C x 2.5 Sq.mm copper conductor. PVC insulated armored cable. The cable entry shall be from the bottom.

6.9.6 Push buttons

a. The Start/Stop push buttons shall be of the momentary contact push to actuate type.
b. The stop push buttons shall be stay put type with mushroom knob.
c. All push buttons shall be:
   i. Fitted with two normally open and two normally closed contacts rated to carry and break 6 Amps at 415 Volts.
   ii. Provided with integral escutcheon plates marked with its function.
d. Start push buttons shall be green in colour. Stop push button shall be red in colour.

6.9.7 Wiring

The contacts of the push buttons shall be wired to a terminal board, No. of terminals shall be min 7 and rated 6 Amps 415 VAC.

7 INSTRUMENTATION

Technical requirement of instruments and instrumentation items

7.1 Pressure gauges:

The pressure gauges are to be considered at the delivery lines of waste water pumps, chemical dosing pumps, primary sludge pumps, secondary sludge pumps (for recirculation), secondary sludge pumps for pumping into sludge stabilization system, sludge pumps for pumping primary and stabilised sludge for the dewatering plant as well as sludge drying beds and other locations as shown in P & I.

7.1.1 Specification

Type

Bourdon tube actuated pressure gage.
Functional/Performance
Accuracy - plus or minus 1.0 percent of span or better.

Physical

a. Case - Phenolic shock resistant or 316 stainless steel for surface / stem mounting with a pressure reliving back. The case shall be vented for temperature / atmospheric compensation. Gage shall be capable of being liquid in the field or at the factory.
b. Window - shatter proof glass
c. Bourdon Tube - 316 stainless steel.
d. Connection - flanged bottom entry
e. Gauge size - 150 mm minimum
f. Pointer travel - not less than 200 degrees nor more than 270 degree are.
g. Range - As required for application.

Physical

1. Metering Tube : Stainless steel.
2. Flanges: 316 stainless steel.
3. Liner - Polyurthane
4. Electrodes - 316 stainless steel, bullet nosed or elliptical self cleaning type.
5. Housing - IP68.
6. Painting : All external surface shall be painted with a chemical and corrosion resistant epoxy finish.

Accessories Required:

1. Factory calibration : All meters shall be factory calibrated. A copy of the report shall be in the O & M manual.
2. Grounding - Meter shall be grounded per the manufacturers recommendation. Provide ground ring, ground wires, gaskets, etc., as required. All materials shall be suitable for liquid being measured.

7.2 Flow Transmitter

Type:

(1) Match to flow element

7.2.1 Functional/Performance:

(1) Power requirements - 230 VAC, 50 Hz plus or minus 10 percent.
(2) Accuracy - As defined for flow element.
(3) Temperature - upto 50 degrees C

Accessories Required

Shutoff valve - Each gauge shall have a process shutoff valve which can also be used as an adjustable pressure snubber.

7.2.2 Flow measurement and indication / recording system

(a) This system shall comprise of flowmeter (electro magnetic flow sensor), transmitter (located in the field) and flow indicating recorder (panel) to measure the flow of liquid / sludge / treated water as well as indicate and record the values of flow. The location of this system is shown in the indicative P & I drawing.

(b) Magnetic Flowmeter - Specification

Flow Element

Type

1. Pulsed DC electromagnetic induction type and shall provide a signal which is liner to the liquid flow rate.

Functional/Performance

1 Power requirements - Match to converter / transmitter.
2 Accuracy - plus or minus 1 percent of rate (including converter/transmitter)
3 Temperature rating - suitable for process liquid temperature upto 70 degrees C and an ambient of 50 degrees C.
4 RFI protection - shall be provided.
5 Pressure rating - PN 16.
6 Additional - Meter shall be capable of running empty indefinitely without damage to any component.
7 Output - Isolated 4-20 mA into 0 to 1000 ohms.

Physical:

(1) Housing - IP65 wall mounting

Accessories Required:

(2) Cable - Signal cable shall be provided between magmemter and signal converter.
(3) Indicator - Local indicator shall be provided with scale engraved 0 to 100 percent which indicates actual converter output signal.
(4) Totalizer - A seven digit, non reset totalizer on the face of the enclosure shall be provided and a scalable pulse output to drive the totalizer. The totalizer multiplier shall be a power of 10.
(5) Zero Return Unit - A zero return unit shall be provided. The unit shall be powered from the converter / transmitter and may be mounted in a separate IP65 enclosure, the device shall drive the magmeter output to 4 mA DC on no flow conditions.

7.3 Pressure Switch

Type

(a) Diaphragm actuated.

Functional / Performance

b) Repeatability - Better than 1.0 percent of pressure.
c) Set point - Field adjustable and set between 30 and 70 percent of the adjustable range.
d) Deadband - shall be adjustable.
e) Reset - Unit shall be of the automatic reset type unless noted otherwise.
f) Overrange protection - to be provided.
g) Switch Rating - 230 V AC at 10 amps; and 30 V DC at 5 amps.

Physical

a. Housing - IP65.
b. Switching Arrangements - single pole double throw (SPDT).
c. Wetted parts - Teflon coated diaphragm, viton seals, stainless steel connection port.

Accessories Required

Shutoff value - process shutoff valve which can be used as an adjustable pressure snubber shall be provided.

7.4 Level Sensing and Alarm/Annunciation System

(a) This system shall comprise of level sensor and transmitter located in the field and alarm / annunciation for low and high levels (located in the panel) for sensing and indicating of liquid levels (high and low) in the sumps and chemical solution preparation tanks. The location of the level sensor and transmitter are shown in indicative P & I drawing.

(b) Level Sensor / Transmitter / Controller - Specification

Type

a. Housing- Heavy duty cast aluminium
b. Contact output
c. IP65 enclosure

Operation:

a. Purpose - to detect liquid or loss of liquid at a predetermined level and actuate an alarm.
b. Operating principal - to produce a change in admittance when the liquid, at a predetermined level, reaches the probe which causes the control relay to be actuated.

Functional:

a. Electronic Unit - Remote; with 15m coaxial cable to sensor.
b. Output - DPDt contacts, 7 Amps, 230 VAC or 4 VDC (number of contacts as required by the application) and 4-20 MA DC output also shall be provided.
c. Power requirements - 230 VAC 50 Hz.

7.5 Level gauges

- Reflex / Transparent / Tubular level gauges shall be considered on the process requirement. The reflex level gauges shall be assembled with flat glasses with inner surfaces or reflecting prisons. Reflex type pressure gauges shall be word for colorless liquid and also when observation is required at a distance.

- Transparent level gauges shall be provided for process liquids with highly viscosity, high rate of bubbling and vopouring liquids. These type of pressure gauges shall be assembled with transparent tempered glasses on both the sides of a section of give a thorough visions of liquid levels. Tubular type level gauges shall be used for process liquids of low pressure and low temperature only.

- The material construction of liquid chamber shall be CS / Forged Steel / AISI 304/ 316 / PVC / Rubber / Lined / Lead lined depending upon the process requirements and suitability. The coverplate shall be forged steel. The glasses shall be tempered borosilicate bolts and nuts shall be of high tensile steel. The valve body shall be the same as the liquid chamber and the thin shall be AIS / 316. The operating pressure shall be 0.3000** and the operating temperature shall be 0-100^{o}C. The process connection shall be flanged. Illuminator shall be provided. The should shall be mica or plastic. The valve shall be with bolted bonnet and the chamber and valve shall be with steam jacket.

7.6 Panel mounted instruments

(a) Electronic Indicator

Type

a. Vertical bar graph type.
b. Microprocessor based

Functional / Performance

a. Accuracy - plus or minus 0.5 percent.
b. Display - Dual or single display as required, multi segmented gas discharge tube.
c. Display Life - 10 Years
d. Input - 4-20 mA

e. Ambient Temperature Range 0-55 degrees C.

Physical

a.Mounting - Flush panel mounting, suitable for high density, slide tray rack mounting.
b. Dimensions - approximately 75 mm by 150 mm.
c.Scales - shall be in engineering units.

Accessories required:

a.Nameplates - provide individual nameplates below each process input.
b. Scales - scales shall be in engineering units.

(b) Digital Panel Meter

Type

a. Digital Process meter

Functional/Performance

a. Accuracy - 99.9 percent
b. Power requirement - 230 VAC, 50 HZ.
c. Operating temperature 0-6- degrees C.
d. Display - LED display, 4 digit minimum resolution. The indicator shall indicate the value of the analog input single in engineering units with scale range as noted. Decimal point shall be field selectable. Unit shall provide over range indication.

Physical

a.Housing - High impact plastic with splash proof lens cover and gasketing to meet IP65 requirements.
b. Legend - provide a permanent service legend to display the engineering units of the process variable.

(c) Flow Totalizing Indicator

Type

a. Electronic
b. 8 Digit, Electro - Mechanical
c. IP65 Case

Operation

Purpose - To accept standard electronic input signal and provide a digital display of the electronically integrated value.

Functional

a. Solid State Circuitry
b. Input - 4.20 mA DC.
c. Totalizer 8-Digit, electro-mechanical, non-reset type unless otherwise noted.

d. Dropout - 0 to 10 per cent adjustable.

Physical

a. Case size - Nominal 75mm by 150mm by 500 mm
b. General purpose enclosure, with slide tray
c. Mounting - flush paneled suitable for high density mounting arrangements.

Performance

Accuracy - plus or minus 0.5 percent of span.

(d) Industrial Relays and Time Delays

Type

a. Industrial heavy duty relays

Functional / Performance

a. Contact arrangement/function shall be required to meet the specified control function specified.
b. Contacts shall be rated 10 amps continuous at 600 volts.
c. Relays shall be provided with convertible contact blocks.

Accessories Required

a. Provide all mounting rails, etc.that are required.

(e) Digital indicating microprocessor based controller

The power requirement of the controller shall be 110V AC/230V AC. The frequency shall be 50 Hz. The accuracy shall be ± pulse for batch. 2 relay outputs with 5A 230 VAC SPDT contacts shall be provided. The input to the controller shall be 4.20 MA DC from the fluid transmitter. The output from the controller shall be relay output and also 4-20 MA DC output PID control function shall be desired accordingly. Alarm functions / contacts shall also be provided in the controller. The number of internal set points shall be 4 for each controller. The display shall be 8 digits and the range shall be for the function the controller is meant for.

7.7 Alarm and Annunciator System

The specification of alarm / Annunciator shall conform to the following.

a. Micro processor based logic
b. Optically isolated inputs
c. Integral/split architecture
d. 3 U Standard size card with DIN 41612 two part Euro Connectors.
e. Make / Break to alarm selectable by DIP switch
f. On Board input status indication
g. Power supply shall be 230 V AC
h. One enclosure
i. The no.of channels per card shall be 4
j. 2 (two) lamps per window with each 30 V 2W rating.
k. Photo type set legends. Black letter against milky white background.
i. Test, Accept, next push buttons provided on the front and facia and also wired upto

terminals on the rear side.

m. Dual tone solid states 10W hooter with selectable tones and volume control.
n. The window size shall be 60 height / 71 mm or 29 height / 55 mm or 24 height / 48 mm as per the client's requirement.
o. The operating range shall be 10 to 50 deg C and humidity shall be RH 95% nm condensing.
p. Field terminations shall be on plug in connectors or screwed type as per the clients equirements.
q. Sixteen most popular sequences shall be built in which shall include first out, ring back, auto and manual next type segments.
r. Auto reset of alarm condition before accept shall be provided.
s. Fully integrated unit with integral plug in power supply unit rear terminals singings door display with front accessibility of module power supply unit and lamps.
t. 18 Gauge pressed steel with removable rear cover for chasis, 18 gauge pressed steel with punched windows, finished maH black for hinged front assembly and 20 gauge hinged assembly finished glossy stove enamelled white for lamp assembly shall be provided.
u. 20% spare windows shall be provided in addition to the requirement.

7.8 Instrument Panel cum control desk

(a) This panel shall house the following instruments

- Alarm / Annunciation Windows for high and low levels of liquids in sumps.
. Pressure indicating recorders
- Alarm / Annunciation windows for high & low value of temperature
- Flow indicating recorders.
- pH Indicating controller and recorder.
- Local / Remote Selector Switches for selection of Local (Field) and Remote (Instrument Panel cum control desk) Start / Stop operations of all electrical driven equipments.
- Auto / Manual Selector Switches for selection of Auto / Manual mode operations of pumps controlled by level switches.
- On / Off PBs for Start / Stop functional operations of all electrical driven equipments from the instrumental cum control desk.
- Run / Trip indication of all electrical driven equipments.
- Mimic panel indicating the flow diagram of the CETP.

(b) Specification

- Fabrication shall be of minimum 3 mm thick, CRCA sheet steel, suitably braced internally for structural rigidity and strength. Front panels or sections containing instruments shall be not less than 3 mm CRCA thick stretcher leveled sheet steel, reinforced to prevent warping or distortion. All sections shall be descaled, decreased, filled, ground and finished. The enclosure when fabricated of steel shall be finished with two rust-resistant phosphate prime coats and two air dry silicone alkyd finish coats of enamel which shall be applied by either the hot air spray or conventional cold spray methods. The final finish shall be smooth, free of runs, and uniform in tone and thickness.

- All panel equipment shall be mounted and wired on or within the cabinet. Wiring shall comply with latest local Code. All wiring within the panel shall be grouped together with harnesses or ducts and secured to the structure. All wiring shall be numbered in accordance with the numbering system used on the wiring/connection diagrams. Wiring and connection diagrams shall conform to ISA S5.A Instrument Loop Diagrams and shall be submitted as part of the shop drawings for approval. Power and low voltage DC signal wiring shall be routed in separate wire ways. Crossing of the two system wires shall be at right angles. Parallel troughs of different systems shall be separated by a minimum of 300

mm.

- All wiring shall terminate in a master terminal board, rigid type and numbered. The master terminal board shall have a minimum of 25 percent spares. Terminal blocks shall be arranged in vertical rows and separated into groups. (Power, AC control, DC signal, alarm and graphic). Terminal blocks shall be barrier type with the appropriate voltage rating (600 volts minimum). They shall be the raised channel mounted type for DIN rail mounting (marshalling). Wiring trough for supporting internal wiring shall be pastil type with snap on covers. Wiring connections to the terminal strips shall be with snap on covers. Double-centering beads shall position conductors in the connection space and shall allow both solid and standard conductors to be inserted without the need for crimping or tinning the conductors. Wire and tube makers shall be the sleeve type with heat impressed letters and numbers. DIN rail mounted terminal strips shall be provided for the purpose of connecting all control and signal wiring. Direct interlock wiring between equipment will not be allowed. Only one side of a terminal block row shall be used for terminal wiring. The field wiring side of the terminal shall within 150mm of the side panel or adjacent terminal. Wiring troughs shall not be filled to more than 60 percent visible fill. Wiring trough covers shall be match marked to identify placement. If component identification is shown on covers for visibility, the ID shall also appear on the mounting sub-panel. A plug-in header with socket outlets and flexible plut-in leads shall be supplied for instrument power supplies. A spare switched socket outlet shall be provided. An overhead internal light shall be provided. Front layout shall be submitted for approval.

- Print storage pockets shall be provided on the inside of each panel. Its size shall be of sufficient size to hold all of the prints required to service the equipment. Reduced drawings shall be provided to be stored in these pockets.

- The instrument panels shall include:
  a) A strip heater
  b) Ventilating fan
  c) Intake louvers
  d) Gasketed door

- The heater voltage shall be 230 volts a.c. The heater shall have an on/off switch mounted inside the enclosure. The ventilating fan shall be thermostatistically controlled. The intake louvers shall be fully baffled with filters and insect screens.

- All components shall be mounted in a manner that will permit servicing, adjustment, testing and removal without disconnecting, moving or removing any other component. Components shall be mounted on plates on the inside of panels in such a manner that allows for removal of the components without removal of the plate. Components shall not be mounted directly to the enclosure. Mounting shall be rigid and stable unless shock mounting is required otherwise by the manufacture to protect equipment from vibration.

- Components mounting shall be oriented in accordance with industries' standard practices. All internal components shall be identified with suitable plastic or metal engraved tags attached with drive pins adjacent to (not on) each component identifying the component in accordance with the drawing, specifications, and supplier's data.

- The instrument panel shall be factor-tested prior to shipment. Inspection at the plant by the Engineer is required.

7.9 Signal and Control Cables

- Signal cables are to be considered for transmitting the analog signal from respective transmitter to respective indicators in the control panel. These shall be screened cables with copper conductors.

- The control cable are to be considered for (i) transmitting the digital signal from level switches to the instrument panel cum control desk (ii) for field powering (110V or 230 V AC) to field instruments. This cable shall be armoured, PVC insulated, PVC sheathed and copper conductor.

- All conduits and cables entering control panels shall be gland sealed to prevent the intrusion of gas and moisture.

- All signal cables for carring 4 to 20m A, 1-5V, low level transducer outputs, etc., shall be copper PVC insulated twisted pairs, individually screened with tinned copper drain wire, overall screened, steel wire armored and overall PVC sheath.

- The twisted pairs shall be constructed with 24-30 twist per metre.

- The rated working voltage shall be 100V rms and the maximum working voltage shall be 600 V rms. The continuous current rating shall be at least 5A.

- Screening shall provide a minimum of 95% coverage of copper braid or mylar blacked aluminium foil. Individual shields in multi-core cable shall be insulated from each other and from the overall shield and armoring.

- Insulation between conductors and earth shall not be less than 10 mega ohms at 500 V.

- The different types of signals shall be segregated from each others and shall be contained in separate cables.

- Multi-stranded cable of a minimum conductor size of 24/0.20 mm plain copper to BS 6360 shall be used.

- Strict segregation shall be followed with not more than one type of signal run in any multi-core cable.

7.9.1.1 Instrumentation Circuit Routes

- Signal cables shall not be run in the same conduit, duct, or cable tray as power cables. Installation in GI cable tray, GI rigid steel conduit or GI steel trunking is to be carried out.

- Wherever signal and power cables cross they shall do so at right angles.

- All cables running from the field instruments to the control panel shall be a single, continuous length, without joints, except at marshalling boxes. The boxes shall have terminal blocks with 20 percent spares in addition to terminals for all wires including spare wires. Special care shall be exercised to carry earthling lines through marshalling boxes with the least possible resistance. Multi-core cables shall be used between marshalling boxes and control panels.

7.9.1.2 Instrumentation Earthing

- Earthing shall comply with the Regulations and conform to the relevant to Indian Standards.

- The earthing arrangements shall, unless otherwise specified, comprise;

i. Earth electrodes to provide adequate conductive capacity for the system.
ii. 200mm x 200mm inspection pits to allow ready access to the electrodes connections.
iii. An earth continuity conductor of adequate capacity between each control panel earth bar and the earth electrodes.
iv. A bolted removal tinned copper link mounted in a suitably located link base.

- The earth electrodes shall be in the form of copper rods suitably grouped and connected.

- All metal works, other than current carrying parts of the instrumentation system, shall be properly bonded to earth.

7.10 Execution

- Instrumentation and accessory equipment shall be installed in accordance with the manufacturer's instructions. Contractor shall obtain in the field all information relevant to the placing of process control work and in case of any interference with other work, he shall proceed as directed by the Engineer and furnish all labour and materials necessary to complete the work in an approved manner.

- The work shall be executed in full accordance with codes and local rulings.

- All piping to and from field instrumentation shall be provided with necessary unions, test tees, couplings, adapters and shut-off valves.

- Brackets and hangers required for mounting of equipment shall be provided. They shall be installed in a workmanlike manner and not interfere with any other equipment.

- The screen on each process instrumentation cable shall be continuous from source to destination and be earthen as directed by the manufacturer of the instrumentation equipment but in no case shall more than one earth point by employed for each screen.

- All signed and control cabling between any two building shall be through buried 100 mm dia. UPVC conduit encased in reinforced concrete. An additional 100mm dia conduit shall be provided as a spare.

7.11 Test

- Test plan shall be submitted for approval as part of the project plan.

- Furnish the services of the servicemen, all special tools, calibration equipment and labour to perform the tests. Certified copies of the tests shall be furnished in duplicate to the Engineer.

- Following installation, check-out and final adjustment of all panels, instruments, meters, monitoring and control devices, a performance check shall be made on each. Meters shall be tested at 0 percent, 25 percent, 50 percent 75 percent and 100 percent of scale, as required. All status and alarm switches as well as all monitoring and control functions shall also be checked. Each device on the Process and Instrumentation diagrams must be signed-off by the Engineer as being acceptable. Testing shall be done from the signal source to the final element or device including all field wiring.

- If, during running of the tests, one or more points appear to be out by more than specified amount, adjustments or alterations shall be made as necessary to bring equipment up to specification performance. Following such adjustment, the tests shall be repeated for all specified points to insure compliance.

7.12 General requirements of instrumentation system

- All the panel instruments like indicating recorders and controllers are microprocessor based instruments shall be operating on 110 VAC power supply. These instruments shall accept 4-20 mA DC Signal from field instruments. These instruments shall have the facility for feeding power supply (24 VDC) to field instruments.

- All the field instruments (sensor and transmitter) for measurement of pH and Flow are True smart microprocessor based electronic instruments.

- The equipment to be supplied for mattering, recording and control shall be of robust design, inherently free of faults and requiring as little maintenance and adjustment as possible for effective operation.

- Instruments, electrodes, supports etc., are all be of materials resistant to or protected from the temperature and humidity to be encountered in the atmosphere present in the tropical climate.

- The unit of the flow meter shall be in litres/sec. and the integration reading shall be in cubic metres. Ranges shall be selected to show normal plant operation between 50% and 75% of full scale deflection.

- Instruments and records are to be of a type which will maintain reasonable accuracy without adjustment. Normally accuracy shall be within plus or minus 1% of the full scale deflection throughout the full range of measurement, unless otherwise specified.

- Electronic equipment shall be of the solid-state type and of the manufacture's latest design. The equipment shall use one of the following standards d.c. (direct current) signals. Unless otherwise specified.

    1. 1 to 5 Volts
    2. 4 to 20 milliamperes.

- An exception would include outputs of sensing devices specified hereafter, however output signals shall be immediately raised and/or converted to compatible high level signals for remote transmission.

- Instruments shall be provided with mounting hardware and floor stands, wall brackets, or instrument racks.

- All work shall be in strict accordance with codes and local ruling.

- Indicators and recorder readouts shall be linear in metric process units, unless otherwise noted.

- Transmitters shall be provided with either integral indicators or conduit mounted indicators in metric process units, accurate to one percent.

- Electronic equipment utilizing printed circuitry shall be suitably coated to prevent contamination by dust, moisture and fungus. Solid state components shall be conservatively rated for their purpose, to assure optimum long term performance and dependability over ambient atmosphere fluctuations and 0 and 100 percent relative humidity. The field mounted equipment and system components shall be designed for installation in dusty, humid and

highly corrosive service conditions.

- Equipment shall be heavy-duty type, designed for continuous industrial service. Equipment shall be of the latest equipment models which are currently in production. All equipment shall be a modular construction and shall be capable of field expansion. All identical components shall be by the same manufacturer.

- The equipment shall nevertheless be designed to operate satisfactorily upto 50°C ambient temperature and 90 percent humidity assuming air conditioning may not be available.

- The field mounted digital system equipment and system components shall be designed for installation in dusty, humid and corrosive service conditions. Outdoor field cabinets and enclosures shall be IP55 gasketed with multi-point latching doors and shall be provided with thermostatically controlled strip heaters to prevent condensation.

Accuracy and Range of Measurement

- The process instrument system supplied hereunder shall have the following ranges and / or accuracies depending on type and application:

Instrument Type	Accuracy
Pressure Gauge 100 k N/sqM or over	0.5%
Pressure Gauge Under 100 k N/sqm	1%

- Unless otherwise specified, the accuracy of the primary plus and secondary instruments shall be with ±2% of the full scale deflection. If the accuracy of the equipment is not within his specified range at low flows the tender shall state the accuracy he can guarantee. Where the accuracy of the equipment is not with 2% of the full scale deflection calibration curves shall be provided in graphical form together with the test certificates.

Electrical Requirements

- Equipment shall be designed to operate on 230 volts, 50 Hertz alternating current power source except where specifically noted. All regulators and power supplies required for compliance with the above shall be provided between power supply and interconnected instrument loop. Where equipment requires voltage regulation, constant voltage transformers shall be supplied.

- Analog transmitter and controller outputs shall be 4.20 milliamps into a load of 0 - 750 ohms, unless specifically noted otherwise.

- All switches shall have double pole double - throw contacts rated at a minimum of 600 VA, unless specifically noted otherwise.

- Equipment shall be designed and constructed so that in the event of a power interruption, the equipment shall resume normal operation without manual resetting when power is restored.

TENDER DOCUMENT
(National Competitive Bidding)
For

Upgradation of Common Effluent Treatment Plant (CETP) at Amburtec - Thuthipet sector, Ambur

TENDER – 8/2024

DESIGN, DETAILED ENGINEERING, SUPPLY, INSTALLATION, COMMISSIONING AND TRAIL RUN INCLUDING CIVIL WORKS ON TURNKEY BASIS OF 500 KG/HR. HOLLOW PADDLE SLUDGE DRYER BASED ON THERMIC FLUID HEATING SYSTEM

Volume-III, Section 2

Technical Specification

AMBUR ECONOMIC DEVELOPMENT ORGANISATION (AEDOL)

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Scope of work

1.1. SYSTEM DESCRIPTION

- The sludge dyer system consists of sludge dryer, Thermic fluid heater, Cyclone separator with rotatory valve, ID Fan, forced draft fan, Hydraulic mixer and venturi scrubber system.
- The Entire unit is housed in shed with RCC platform and foundations and RCC sludge pit
- The paddle dryer to handle feed sludge with moisture content of 70%-85%(w/w) at controlled feed rate at 10T/day and the outlet moisture content of the dried sludge should be less than15% (w/w)
- Forced Draft fan with air heater is to be provided for the supply of scavenging air to the dryer system. Water vapour is carried out to the exhaust with the help of scavenging air. The scavenging air – water vapour will be vented to the atmosphere through a cyclone separator and venturi scrubber for removal of dust particles.
- The fines separated in the cyclone will be separated at the bottom of cyclone. The remaining fines carried out along with the exhaust air will be scrubbed in a venturi scrubber with the help of water. Saturated exhaust air from scrubber will be vented to atmosphere. Balanced / negative pressure is maintained with help of induced draft fan.
- Detailed specification are given below. This shall be treated as turnkey contract and accordingly technical and commercial bids may be offered. Tenders without satisfying prequalification requirement or technical requirement will be rejected.

1.2. Scope of work

- Scope of work includes supply, Installation & testing and commissioning of one number of Paddle Dryer to handle a capacity of 10TPD sludge with thermic fluid heater for sludge dewatering system including supply installation and commissioning of sludge handling system like belt conveyer, silo, cyclone separator, scrubbers, chimney etc., complete. Electrical items related to paddle dryer also to be supplied and installed. Foundation works, platforms etc., are also to be considered and quoted for. Civil works involves the construction of the paddle dryer shed of area 200m2 for accommodating all the components related to paddle dryer including RCC sludge pit of capacity 64 m3, RCC Feed area platform 100 m2 foundations for mechanical equipment's and all allied works complete. Civil works involving housing for Paddle dryer and its associated units, RCC sludge pit including necessary platform and foundation etc., are to be considered, tentative size of the civil works is shown in the volume 5.
- This tender may be treated as turnkey contract. Any item or items required for successful commissioning of paddle dryer but not mentioned in the tender document is to be specifically mentioned in the technical bid and same should be quoted in the price bid.
- Note: Process and instrumentation diagram, design calculations, General arrangement drawings, Process description, technical datasheets, brochures of all the components of the sludge drying system to be provided along with the technical bid.

This tender may be treated as **turnkey contract (Civil, Mechanical, Electrical, Instruments, Plumbing and insulation works).** Any item or items required for successful commissioning of paddle dryer to achieve the output sludge moisture content less 15% for the output rate of but not mentioned in the tender document is to be specifically mentioned in the technical bid and same should be quoted in the price bid.

I. TECHNICAL SPECIFICATION OF PADDLE DRYER

Sl. No.	Component	Specifications and MOC	Qty	Preferable Make
1	Hollow Shaft Paddle Dryer	Feed flow = 10TPD MOC: SS316	1 No	MTS/ Kilburn / Benner
2	Screw conveyor (Elevated) for feeding & collecting product in dryer with closed casing and supporting structure. The screw conveyor and sludge feeding pit shall be covered under the shed.	MOC: SS304 Capacity: 1000 Kg/hr (maximum) Motor efficiency: IE3 Three nos shall be for wet sludge and one for dried sludge	4 Nos	Motors: Bharat Bijli/Crompton Greaves/ ABB
3	Silo with minimum 1mtr Height from the floor level tobottom of the hopper supporting structure.	13.6 m^3 storage capacity. MOC: SS 304	1 No	
4	Thermic Fluid Heater with variable load	Cyclotherm (Solid fuel vertical thermal oil heater with cyclonic combuster) Model :To be specified by the vendor Capacity : 400000-600000 kcal/hr Bidder should submit the design calculation in the technical bid.	1 Set	Thermax
5	Re-circulation tanks, pumps and piping	• Oil Recirculation pump • Make-up pump • Thermic fluid storage tank: SS304 Seamless Sch20 • Oil Pipeline: SS304 Seamless Sch20 • Structural works • Drain Pipeline: SS304 Seamless Sch20	1 Set	Circulation pump: Kirloskar /Johnson
6	Supply of Thermic fluid	Make: Shell Op. Temperature range: to be provided by the bidder. Low viscosity to promote high and optimum heat transfer • TFH heating coil	1Lot	Make: Shell

		• Expansion tank (level = 30%)		
7	Chimney	MOC: Carbon steel, pre-coated with Heat Resistant Aluminium and Zinc both inside and outside for better corrosion resistance properties with all accessories etc, complete (Grade: ASTM A 792 D) • Air Ducting: SS304 • Flue gas ducting: SS304 • By-Pass ducting: SS304 (damper to chimney)	1 No	Make: As per IBR standard
8	Ducting for TFH operation	SS304	1 Lot	Jindal
9	Cabling and Electrical & Instrumentation works : Suitable Power distribution panel, cubical control panel for TFH and Paddle Dryer, supply and laying/ fixing of incoming & outgoing XLPE cables of suitable size and length, remote switches, complete aluminium earthing, emergency stop switch for TFH and Paddle Dryer, lighting distribution board, 15/5A power sockets, flame proof LED lighting for paddle dryer including FRP cable tray, supporting & fasteners in SS 316 etc., as required. The work also includes provision of safety items like floor mate, fire extinguishers,gloves, sand bucket withstand, all relevant instrumentation works etc., complete.	Cables and control panel Outgoing power distribution feeders from our existing panel at Aeration blower room to Paddle dryer control cabinet room. 75kW Feeder (1 nos) for Paddle dryer, 50 kW feeder (2 nos- 1W+1SB) for TFH and consider one 15 kW Feeder for Lighting at paddle dryer power distribution panel along with one spare feeder.	1 Lot	Cables: PolyCab / Finolex / Lapp LED Light : Bajaj/ Crompton
10	Mechanical Dust Collector	Technical details to be provided by bidder.	1 Set	Thermax
11	Environmental	Technical details to be provided by bidder.	1 Set	Thermax

	compliance equipment for flue gas (PCE)			
12	Refractory lining	Refractory cement, refractory brick and the thickness should be with respect to the calculation, the same calculation to be submit by the bidder during technical bid	1 Set	Cement : ACC white
13	Insulation Works	Thickness should be with respect to the calculation, the same calculation to be submit by the bidder during technical bid MOC: Aluminium sheet coil , Rock Wool	1 Set	Aluminium sheet coil : Jindal LRB Rockwool mattress: Rock/mineral Wool India Pvt Ltd
14	Pollution control system: Thermo pack MD, APH and ID Fan etc.,	Technical details to be provided by bidder.	1 Set	Thermax
15	Civil Works	1. Construction of paddle dryer and TFH, auxiliary units, sludge pit, drying area units shed of area shall be as per volume 5 including uPVC gutter provision with rain water harvesting system, Rolling shutter coupled with integrated uPVC door at one end and only uPVC door on the other end, the sizes to be suited at site. **Paddle dryer shed : 20m X 10m X 6m** 2. Construction of RCC sludge pit of capacity 64 m^3 and the pit should be inclined at one side, so as to sludge would easily fed into the feed tank(hopper) RCC Sludge pit : 8m X 4m X 2 m and the hopper top should be matches with finished floor level. **3.** Control cabinet roomfor TFH & Paddle dryer	1 Lot	Cement : Ultratech / Coromandel king / ACC Reinforcement steel : SAIL /TATA / JSW Grade : Fe 550D Admixture : Sika PEB building should be as per structural drawing.

		including uPVC door and uPVC window. Control cabinet room: 5m X 3m X 4m **4.** Construction of RCC Feed area platform 10m X 10m X 1m **5.** RCC Foundation bed for all equipment relating to TFH and paddle dryer system including power distribution panel, control with all allied electrical, mechanical works etc, complete. Grade of Concrete : M30(For Paddle dryer, TFH bed foundation and flooring) Grade of Concrete : M25 (For Remaining RCC work) **6.** Construction of Conventional earthing pit of 6nos 0.6m X 0.6m X 3m and top cover should be RCC or FRP **7.** Construction of RCC Foundation for Lighting pole of 12 nos 0.4m X 0.4m X 2m (0.6m above FFL) Footing size : 1.2m X 1.2m X 0.4m **8.** Construction of Supporting RCC column of 4m X 2.5m X 7m height For Oil Expansion tank and the same expansion tank should be covered with uPVC truss 9. Construction of restroom 2m X 2m X 2.4m including Indian type toilet, wash basin, uPVC door, uPVC Pipe, ventilator,suitable		

		sewage collection tank and 1kL of water storage tank 10. Interior primer & paint : Dulux Velvet Touch Emulsion Paint, one coat of cement primer (Primer -1 coat & Paint – 2 coats) 11. Exterior paint: Dulux DIY Simply Refresh Multi Surface Paint Washable with Soft Sheen Finish, one coat of Dulux Exterior Acrylic Primer (Primer -1 coat & Paint – 2 coats) All the above-mentioned works are under the scope of bidder.		

Detailed Specification

S.No	Description	Unit	Specification
1	**DOUBLE SHAFT PADDLE DRYER**		
	Preferred make		MTS / Kilburn / Benner
	Selected Model		To be specified by bidder
	Feed Quantity	TPD	10
	Quantity	set	1
	Moisture content in the inlet of the sludge	%	70-85
	Moisture content in the outlet of the sludge	%	Less than 15
	MOC for Body		SS316
	MOC for Feed Hopper		SS316
	Hopper Thickness	mm	6mm
	MOC for Shaft		SS316
	Shaft Thickness	mm	12mm as per schedule 80
	MOC for paddle		SS316
	Paddle Thickness	mm	10mm
	MOC for flexible hose		SS316
	Feeding & delivery Type		Integrated with auto system
	Total connected load (kW)	kW	≃40
2	**THERMIC FLUID HEATER (TFH)**		
	Preferred Make		Thermax
	Quantity	set	1
	Model		To be specified by bidder
	Capacity	kcal/hr	400000 -600000
	Efficiency		Should be as per BS845 part-1 NCV basis
	Fuel		Coal/ Wood/ Briquettes
	Fuel firing system		Manual firing (Fixed grate + Sectoral pin hole grates)
	L X W X H		To be specified by bidder
	T.F. inlet Temperature (Std.)	°C	300
	T.F. Outlet Temperature (Std.)	°C	260
	Volume of Thermic fluid	m3	To be specified by bidder
	Viscosity of Thermic fluid		To be specified by bidder
	Heat transfer area	m2	32.8
	T. F. Flow rate	m3/hr	36
	Available Circuit pressure	mlc (barg)	29.0 (3.0)
	Expansion tank: (capacity ≃ 30%)	L	To be specified by bidder
	Piping		As per IBR Standard
	Wood Logs (30% moisture – GCV ≃ 3500)	kg/hr	To be specified by bidder
	Coal (GCV ≃5000)	kg/hr	To be specified by bidder
	Briquettes (GCV ≃3000)	kg/hr	To be specified by bidder
	Configuration of coils		To be specified by bidder

	(Radiant with Convective coils). Inner & outer convective coils are in series with each other		To be specified by bidder
2A	**Heater Construction Features**		
	Inner coil length	m	To be specified by bidder
	Outer coil length	m	To be specified by bidder
	Heat transfer area (Total)	m2	To be specified by bidder
	Coil hold up capacity	L	To be specified by bidder
	DE tank capacity	L	To be specified by bidder
	Pressure drop on Coil side	mlc	To be specified by bidder
2B	**Heat Exchanger (Radiative and Conductive)**		
	Inner Coil PCD	mm	To be specified by bidder
	Outer Coil PCD	mm	To be specified by bidder
	Jacket ID	mm	To be specified by bidder
	Overall assly. Height	mm	To be specified by bidder
	Heat Exchanger Assembly. Weight	g	To be specified by bidder
	Gear Box Drive (≃ 60 HP)	HP (kW)	To be specified by bidder
2C	**Tube specifications - TFH**		
	MOC		To be specified by bidder
	Tubes OD	mm	To be specified by bidder
	Tube thickness	mm	To be specified by bidder
3	**TFH Re-circulation tanks, pumps and piping**		
3A	**Oil Recirculation pump**		To be specified by bidder
	Flow	m3/hr	To be specified by bidder
	Head	mlc (barg)	To be specified by bidder
	Power rating	HP	To be specified by bidder
	Model		To be specified by bidder
3B	**Make-up pump**		To be specified by bidder
	Make		Kirloskar / Johnson
	Capacity	HP	To be specified by bidder
3C	**Thermic fluid storage tank**		
	MOC		SS304
	Volume	m3	1
	Quantity	Nos	1
3D	**Oil Pipeline**		
	Length	m	To be specified by bidder
	Diameter	mm	To be specified by bidder
3E	**Drain Pipeline**		
	Length	m	To be specified by bidder
	Diameter	mm	To be specified by bidder
3F	**TFH Circulation Pump: Centrifugal type**		
	Flow	m3/hr	To be specified by bidder
	Head	Mlc (barg)	To be specified by bidder
	Power rating	HP	To be specified by bidder
	Model		To be specified by bidder

3G	**Heat Recovery Unit (APH)**		
	Heat transfer Area	m2	To be specified by bidder
	Flue gas Temperature IN/OUT	°C	To be specified by bidder
	Hot air Temperature IN/OUT	°C	To be specified by bidder
	Shipping weight	kg	To be specified by bidder
	Length	mm	To be specified by bidder
	Width	mm	To be specified by bidder
	Height	m	To be specified by bidder
	Stack Temperature	°C	To be specified by bidder
3H	**Induced Draft Fan**		
	Flow	m3/hr	To be specified by bidder
S.No	**Description**	**Unit**	**Specification**
	Head (at STP condition)	mmWC	To be specified by bidder
	Power rating	HP (KW)	To be specified by bidder
	MOC		To be specified by bidder
3I	**Force draft Fan**		
	Flow	m3/hr	To be specified by bidder
	Head (at STP condition)	mmWC	To be specified by bidder
	Power	HP (KW)	To be specified by bidder
	MOC		To be specified by bidder
3J	**Chimney**		
	MOC		Carbon steel, pre-coated with Aluminium, and Zinc both insideand outside for better corrosion resistance properties. (Grade: ASTM A 792 D)
	Electrical accessories		Aviation light & Lightning arrestor
	Yield Strength:	Mpa	To be specified by bidder
	Alloying mass:	GSM	To be specified by bidder
	Height (≃ 30m as per TNPCB norms)	m	To be specified by bidder
	Diameter	m	To be specified by bidder
3K	**Venturi Scrubber system**		Detailed Specifications to be given by the bidder
	MOC		To be specified by bidder
3L	**Wet Scrubber**		Detailed Specifications to be given by the bidder
	Type		To be specified by bidder
	Capacity		To be specified by bidder
	Size		To be specified by bidder
3M	**Scrubber system**		
	MOC		To be specified by bidder
	Type		
	Capacity		To be specified by bidder
	Size		To be specified by bidder
3N	**Hydrostautic mixer**		
	MOC		To be specified by bidder

	Type		
	Capacity		To be specified by bidder
	Size		To be specified by bidder
3O	**Ducting for TFH**		
	MoC		SS 304
	Size (dimensions)		To be specified by bidder
	Quantity	Lot	1
3P	**Supply of Thermic fluid**		
	Grade		To be specified by bidder
	Type		To be specified by bidder
	Make		Shell
	Expected life of oil		To be specified by bidder
	Op. temperature range:	°C	To be specified by bidder
	Specific Gravity		To be specified by bidder
	Low viscosity to promote high heat transfer		To be specified by bidder
	Quantity of TF	Kg or lit	To be specified by bidder
4	**AIR PREHEATER**		Detailed Specifications to be given by the bidder
	MOC		To be specified by bidder and it should be as per IBR Standard
	Area	m2	To be specified by bidder
	Capacity	kW	To be specified by bidder
5	**CYCLONE SEPARATOR WITH ROTARY VALVE**		Detailed Specifications to be given by the bidder
	MOC		To be specified by bidder and it should be as per IBR Standard
6	**Screw conveyor (Elevated) for feeding in dryer with casing andsupport**		
	Conveying length (≃15 m)	m	To be specified by bidder
	MOC		SS 304
	Capacity (1000 Kg/Hr Max)	Kg/hr	To be specified by bidder
	Motor specification		To be specified by bidder
	Motor Make		Bharat Bijlee/ CG / ABB
	Power rating	HP	To be specified by bidder
	rpm / speed		To be specified by bidder
9	**Silo for dried sludge collection**		
	Capacity	m^3	13.6
	MoC		SS 304
10	**Insulation for Hot Surface**		
	Type of insulation		To be specified by bidder
	Material used for insulation		Aluminium sheet coil : Jindal make LRB Rockwool mattress: Rock/mineral Wool India Pvt Ltd
	Outer surface temperature (≃50°C)	°C	To be specified by bidder

11	Shed for Paddle dryer		
	Area	m2	200
	Type of roofing sheet		UPVC sheet of 3mm thickness with RCC columns
	MoC of truss		MS with Epoxy coating of 2 Coats (Primer make : Berger - Epilux 78, Paint make : Berger – Epilux 4)
	Shed Lighting		LED with wiring
	Foundation for Paddle dryer & TFH		RCC M30 Grade
	Side Wall		Brick wall of 230mm thick upto 2.1 mtr and remaining shall be in UPVCSheet.
	Flooring		RCC M30 Grade for suitable load.
12	Control cabinet room for TFH & Paddle dryer		
	Area	m2	15
	Type		RCC building with slab, brick wall with vitrified ceramic tiles finishflooring.
	Side Wall		Brick wall of 230mm thick upto 2.1 mtr and remaining shall be in UPVC Sheet.
	Flooring		RCC M30 Grade for suitable load.
	Epoxy Coating above flooring		Berger, 5mm thick
	Cabinet Lighting		LED with wiring
	Cable Tray MoC		FRP
	Supporting and fasteners MoC		SS316
13	**Instrumentation & Control Panel for Paddle dryer and TFH**		
	Control panel with load and starter details to be provided by the bidder.		
	Protection Class - IP66		
	Local & Remote Control ON/OFF to be specified by the bidder		
	Temperature sensors with indicators		
	Temperature and pressure gauges in fluid line		
	Differential pressure gauge		
	Earthing for all equipment/motors in Aluminium flat with 6 Nos of CI earth pit.		
	Details of Incoming cable (minimum 3.5 Core X 95 Sq.mm Aluminium armoured cable X 2 run) for 200m and outgoing power/control cables to be specified & Provided by the bidder.		
	Power distribution panel for connecting of Paddle dryer, Thermic Fluid boiler and other accessories with lighting distribution panel.		
	Cable schedule for power and control cable.		
	FRP Cable tray with supporting in SS316. All Motor canopy in FRP. All Motor should be IE3 ratings		
	PC Make: Dell, Intel Core i7, OS Windows 11, 8GB RAM, 1TB SSD		

	Printer make: HP Colour printer, with standby cartridge with UPS backup of 4hrs	
	Control desk for PC & Printer	
	Air conditioner of 2-ton capacity, preferred make: Panasonic	
	BLDC Fan, Preferred make: Crompton	
	List of connected and installed load details to be provided.	
14	**Anticorrosion Painting & SurfaceTreatment**	HRA Painting for CS parts exposed to high temperature. Epoxy painting for CS parts which are not exposed to high temperature.

S.No	**Preferred makes**	
1	Cable	Polycab / Finolex /Lapp
2	MCCB, LPBS, Push button, LED Indicators	Schneider / Siemens
3	MCB	L & T
4	Light Distribution Box with control MCB's	Havells/ L&T/ Siemens
4	Bearings	SKF / FAG/NTN
5	Gear box	Bonfiglioli /Shanthi
6	Electric motors	ABB/Bharat Bijlee / CG
7	Pumps	Kirloskar/Johnson
8	VFD	Yaskawa GA700
9	Valves	Intervalve poonawalla
10	Pressure and temperature gauges	Gauge bourdon/ Baumer
11	LED light fitting	Crompton/ Bajaj

Note

- All mechanical items (pipes, fittings, flanges and gaskets) to be as per ASME codes or equivalent international standards (Codes to be specified by the vendor).
- All materials as per BSI/ equivalent international Standards (Code to be specified by thevendor)

1.3. Electrical works

- Supply, Erection, commissioning of suitable Power distribution panel, cubical control panel for TFH and Paddle Dryer, supply and laying/ fixing of incoming & outgoing XLPE cables of suitable size and length, remoteswitches, complete GI conventional earthing, emergency stop switch for TFH and Paddle Dryer, lighting distribution board, 15/5 A power sockets, flame proof LED lighting for paddle dryer including FRP cable tray, supporting & fasteners in SS 316 etc., as required. The work also includes provision of safety items like floor mate, fire extinguishers, gloves, sand bucket with stand, all relevant instrumentation works etc., complete.

- Bidders are requested to visit the site and any clarification is required the same may be communicated to ILIFO before the pre-bid meeting.

1.4. Civil works- Technical specifications

1. Civil works shall adhere to the general specifications as per Section 1, conforming to Bureau of Indian standards.
2. The work involves design, detailed engineering, preparation of architectural

(Detailed floor plans, elevations) and working drawings, site development, soil investigation & foundationdesign, structural design. The structural design along with the structural drawings for foundation and super structure has to be proof checked either by IIT or Anna University, CEG campus. The proof checked documents and drawings shall be submitted to ILIFO for approval before execution.

Construction of Paddle dryer Shed, Control cabinet room for TFH &Paddle dryer, Feed area platform and sludge pit:

Design, detailed engineering, procurement, construction of Paddle dryer Shed, sludge storage shed, solid storage shed as per the drawing shown in volume 5, Control cabinet room for TFH & Paddle dryer, RCC sludge pit of capacity 64m^3, foundation & RCC flooring works for all the components of system withall allied works etc ., Complete.

1. Earth work excavation for footing with all classification of soils including blasting,disposal of soil within the radius of 100m, etc., complete.
2. Back filling of excavated soil, watering and compacting in layers of 300mm height, including transportation, loading, unloading and labour charges, etc., complete.
3. Providing and laying of quarry sand filling 100 mm thick for footings, rafts, plinthbeam, flooring, labour chargers etc.,
4. Providing and Laying of M15 grade P.C.C 100 mm thick for Footings, raft, plinth beam,flooring, labour chargers etc.
5. Providing and fabrication of reinforcement Steel (Fe550D) for footings, raft, Columns, plinth beam, slab, and all RCC structures including labour chargers etc.
6. PEB building should be as per structural drawing
7. Providing laying shuttering works for foundation, raft, plinth beam, column, including labour chargers etc.
8. Providing and Laying of R.C.C mix concrete M30 including labour chargers etc. Designmix for the materials to be used for construction shall be submitted for approval of ILIFO.
9. Brick work in C.M. 1:3 well burnt 1st class silver brick with a size of 230mm x 110mmx 75mm including cement, sand, mixing charges, scaffolding, watering, curing and labour chargers, etc., complete.
10. Plastering work for external surfaces in C.M. 1:3 for buildings with 20mm thick including cement, sand, scaffolding, chipping, curing, mixing and labour charges, etc.,complete.
11. Plastering work for internal surfaces in C.M. 1:3 for buildings with 12 mm thick including cement, sand, scaffolding, chipping, curing, mixing and labour charges, etc.,complete.
12. Providing and applying primer & painting in two coats for internal surfaces at all levels with Dulux Velvet Touch Emulsion, to give an even shade including one coat of cement primer, applying full putty preparation of the surfaces, scaffolding complete all as per specifications.
13. Providing and applying primer & painting in two coats for external surfaces at all

levels with Dulux DIY Simply Refresh Multi Surface Paint Washable with Soft Sheen Finish, to give an even shade including one coat of Dulux Exterior Acrylic Primer, applying full putty preparation of the surfaces, scaffolding complete all as per specifications.

14. Providing and fixing UPVC doors with main door of opening 3m x 2.4m. UPVC windows between each building columns to be provided.
15. The thickness of UPVC sheet shall be 3.0 mm, 3 layer, and 750mm Purlin width with full screw in SS304 with PVC cap.
16. All electrical and plumbing required for this building to become functional have to beprovided.
17. Suitable plinth protection with drain arrangements should be provided all around thebuilding.
18. Supply and fixing of electrical conduit, LED light, cable 4sq.mm, wiring, switched, distribution box, incoming supply cable from near existing panel etc.
19. Construction of Control cabinet room for TFH & Paddle dryer as per requirements forinstalling the electrical and instrumentation components.
20. Construction of RCC sludge pit of capacity 64 m^3 as per requirements for installing the electrical and instrumentation components.
21. Foundation works for installation of all the mechanical equipment's as required shall be in the scope of the contractor.

Sl. No	**Material**	**Approved brand**
1.	Cement	Ultratech, Coromandel, Ramco
2.	Steel	SAIL, TATA, JSW

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TENDER DOCUMENT

(National Competitive Bidding)

for

Upgradation of Common Effluent Treatment Plant (CETP) at Amburtec - Thuthipet sector, Ambur

TENDER – 8/2024

DESIGN, DETAILED ENGINEERING, SUPPLY, INSTALLATION, COMMISSIONING AND TRAIL RUN INCLUDING CIVIL WORKS ON TURNKEY BASIS OF 500 KG/HR. HOLLOW PADDLE SLUDGE DRYER BASED ON THERMIC FLUID HEATING SYSTEM

Volume-III, Section 3

Technical Data sheet

AMBUR ECONOMIC DEVELOPMENT ORGANISATION (AEDOL)

43/53, Raja Muthiah Road ,Periamet, Chennai-600 003

Telephone: 044-42041132/35528648

email: aedolchennai@yahoo.co.in, aedolchennai@gmail.com

Technical Data sheet (To be filled and enclosed in the technical bid)

Sl. No.	Component	Specifications and MOC	Qty	Preferable Make
1	Hollow Shaft PaddleDryer	flow = 10TPD MOC: SS316		
2	Screw conveyor (Elevated) for feeding &collecting product in dryer with closed casingand supporting structure. The screw conveyor and sludge feeding pit shall be covered under the shed.	MOC: SS304 Capacity: 1000 Kg/hr (maximum) Motor efficiency: IE3		
3	Silo with minimum 1mtr Height from the floor level to bottomof the hopper supporting structure.	13.6 m^3 storage capacity. MOC: SS 304		
4	Thermic Fluid Heaterwith variable load	Cyclotherm (Solid fuel vertical thermal oil heater with cyclonic combuster) Model :To be specified by the vendor Capacity : 400000-600000 kcal/hr Bidder should submit the design calculation in the technical bid.		
5	Re-circulation tanks,pumps and piping	• Oil Recirculation pump • Make-up pump • Thermic fluid storagetank: SS304 Seamless Sch20 • Oil Pipeline: SS304 Seamless Sch20 • Structural works • Drain Pipeline: SS304 Seamless Sch20		

6	Supply of Thermic fluidThermia B	Make: Shell Op. Temperature range: to beprovided by the bidder. Low viscosity to promotehigh and optimum heat transfer • TFH heating coil • Expansion tank (level = 30%)		
7	Chimney	MOC: Carbon steel, pre- coated with Heat Resistant Aluminium andZinc both inside and outside for better corrosion resistance properties with all accessories etc, complete(Grade: ASTM A 792 D) • Air Ducting: SS304 • Flue gas ducting: SS304 • By-Pass ducting: SS304 (damper to chimney)		
8	Ducting for TFH operation	SS304		
9	Cabling and Electrical & Instrumentation works :Suitable Power distribution panel, cubical control panel for TFH and Paddle Dryer, supply and laying/ fixing of incoming & outgoing XLPE cables of suitable size and length, remote switches, complete aluminium earthing, emergency stop switch for TFH and Paddle Dryer, lighting distribution board, 15/5A power sockets, flame proof LED lighting for paddle	Cables and control panel Outgoing power distribution feeders from our existing panel at Aeration blower room to Paddle dryer control cabinet room. 75kW Feeder (1 nos) for Paddle dryer, 50 kW feeder (2 nos- 1W+1SB) for TFH, 15 kW Feeder for Lighting		

	dryer including FRP cable tray, supporting & fasteners in SS 316 etc., as required. The work also includes provision of safety items like floor mate, fire extinguishers, gloves, sand bucket withstand, all relevant instrumentation works etc., complete.			
10	Mechanical Dust Collector	Technical details to be provided by bidder.		
11	Environmental compliance equipmentfor flue gas (PCE)	Technical details to beprovided by bidder.		
12	Refractory lining	Refractory cement, refractory brick and the thickness should be with respect to the calculation, the same calculation to be submit by the bidder during technical bid		
13	Insulation Works	Thickness should be with respect to the calculation, the same calculation to be submit by the bidder during technical bid MOC: Aluminium sheet coil , Rock Wool		
14	Pollution control system:Thermo pack MD, APH and ID Fan etc.,	Technical details to beprovided by bidder.		

15	Civil Works	1. Construction of paddle dryer and TFH, auxiliary units, sludge pit, drying area units shed of area shall be as per volume 5 including uPVC gutter provision with rain water harvesting system. Paddle dryer shed : 20m X 10m X 6m 2. Construction of RCC sludge pit of capacity64 m^3 and the pit should be inclined at one side, so as to sludge would easily fed into the feed tank RCC Sludge pit : 8m X 4m X 2 m **3.** Control cabinet room for TFH & Paddle dryer including uPVC door and uPVC window. Control cabinet room:5m X 3m X 4m **4.** Construction of RCC Feed area platform 10m X 10m X 1m **5.** RCC Foundation bed for all equipment relating to TFH and paddle dryer system including power distribution panel, control with all allied electrical, mechanical works etc, complete. Grade of Concrete : M30(For Paddle dryer, TFH bed foundation and		

		flooring) Grade of Concrete : M25 (For Remaining RCC work) **6.** Construction of Conventional earthing pit of 6nos 0.6m X 0.6m X 3m and top cover should be RCC or FRP **7.** Construction of RCC Foundation for Lighting pole of 12 nos 0.4m X 0.4m X 2m (0.6m above FFL) Footing size : 1.2m X 1.2m X 0.4m **8.** Construction of Supporting RCC column For Oil Expansion tank and the same expansion tank should be covered with uPVC truss 9. Construction of restroom 2m X 2m X 2.4m including Indian type toilet, wash basin, uPVC door, uPVC Pipe , ventilator and 1kL of water storage tank 10. Interior paint: Dulux Velvet Touch Emulsion Paint (Primer -1 coat & Paint – 2 coats) 11. Exterior paint: Dulux DIY Simply Refresh Multi Surface Paint Washable with Soft		

		Sheen Finish (Primer -1 coat & Paint – 2 coats) 12. The overall plant operation considered as 10 Hrs for the overall guaranteed quantity All the above mentioned works are under the scope of bidder.		

S.No	Description	Unit	Specification
1	**DOUBLE SHAFT PADDLE DRYER**		
	Preferred make		
	Selected Model		
	Feed Quantity	kg/ hr	
	Quantity	set	
	Moisture content in the inlet of the sludge	%	
	Moisture content in the outlet of the sludge	%	
	MOC for Body		
	MOC for Feed Hopper		
	Hopper Thickness	mm	
	MOC for Shaft		
	Shaft Thickness	mm	
	MOC for paddle		
	Paddle Thickness	mm	
	MOC for flexible hose		
	Feeding & delivery Type		
	Total connected load (kW)	kW	
2	**THERMIC FLUID HEATER (TFH)**		
	Preferred Make		
	Quantity	set	
	Model		
	Capacity	kcal/hr (kW)	
	Efficiency		
	Fuel		
	Fuel firing system		
	L X W X H		
	T.F. inlet Temperature (Std.)	°C	
	T.F. Outlet Temperature (Std.)	°C	
	Volume of Thermic fluid	m3	
	Viscosity of Thermic fluid		
	Heat transfer area	m2	

S.No	Description	Unit	Specification
	T. F. Flow rate	m3/hr	
	Available Circuit pressure	mlc (bar g)	
	Expansion tank: (capacity ≃ 30%)	L	
	Piping		
	Wood Logs (30% moisture – GCV ≃ 3500)	kg/hr	
	Coal (GCV ≃ 5000)	kg/hr	
	Briquettes (GCV ≃ 3000)	kg/hr	
	Configuration of coils		
	(Radiant with Convective coils). Inner & outer convective coils arein series with each other		
2A	**Heater Construction Features**		
	Inner coil length	m	
	Outer coil length	m	
	Heat transfer area (Total)	m2	
	Coil hold up capacity	L	
	DE tank capacity	L	
	Pressure drop on Coil side	mlc	
2B	**Heat Exchanger (Radiative and Conductive)**		
	Inner Coil PCD	mm	
	Outer Coil PCD	mm	
	Jacket ID	mm	
	Overall assly. Height	mm	
	Heat Exchanger Assembly. Weight	g	
	Gear Box Drive (≃ 60 HP)	HP (kW)	
2C	**Tube specifications - TFH**		
	MOC		
	Tubes OD	mm	
	Tube thickness	mm	
3	**TFH Re-circulation tanks, pumps andpiping**		

S.No	Description	Unit	Specification
3A	**Oil Recirculation pump**		
	Flow	m3/hr	
	Head	mlc (barg)	
	Power rating	HP	
	Model		
3B	**Make-up pump**		
	Make		
	Capacity	HP	
3C	**Thermic fluid storage tank**		
	MOC		
	Volume	m3	
	Quantity	Nos	
3D	**Oil Pipeline**		
	Length	m	
	Diameter	mm	
3E	**Drain Pipeline**		
	Length	m	
	Diameter	mm	
3F	**TFH Circulation Pump: Centrifugal type**		
	Flow	m3/hr	
	Head	mlc (barg)	
	Power rating	HP	
	Model		
3G	**Heat Recovery Unit (APH)**		
	Heat transfer Area	m2	
	Flue gas Temperature IN/OUT	°C	
	Hot air Temperature IN/OUT	°C	
	Shipping weight	kg	
	Length	mm	
	Width	mm	
	Height	m	
	Stack Temperature	°C	
3H	**Induced Draft Fan**		
	Flow	m3/hr	

S.No	Description	Unit	Specification
	Head (at STP condition)	mmWC	
	Power rating	HP (KW)	
	MOC		
	Force draft Fan		
	Flow	m3/hr	
3I	Head (at STP condition)	mmWC	
	Power	HP (KW)	
	MOC		
3J	**Chimney**		
	MOC		
	Electrical accessories		
	Yield Strength:	Mpa	
	Alloying mass:	GSM	
	Height (≃ 30m as per TNPCB norms)	m	
	Diameter	m	
3K	**Venturi Scrubber system**		
	MOC		
3L	**Wet Scrubber**		
	Type		
	Capacity		
	Size		
3M	Scrubber system		
	MOC		
	Type		
	Capacity		
	Size		
3N	Hydrostautic mixer		
	MOC		
	Type		
	Capacity		
	Size		
3O	**Ducting for TFH**		
	MoC		
	Size (dimensions)		
	Quantity	Lot	
3P	**Supply of Thermic fluid**		

	Grade		
	Type		
	Make		
	Expected life of oil		
	Op. temperature range:	°C	
	Specific Gravity		

S.No	Description	Unit	Specification
	Low viscosity to promote high heat transfer		
	Quantity of TF	Kg or lit	
4	**AIR PREHEATER**		
	MOC		
	Area	m2	
	Capacity	kW	
5	**CYCLONE SEPARATOR WITH ROTARY VALVE**		
	MOC		
6	**Screw conveyor (Elevated) for feeding in dryer with casing andsupport**		
	Conveying length (≃15 m)	m	
	MOC		
	Capacity	Kg/hr	
	Motor specification		
	Motor Make		
	Power rating	HP	
	rpm / speed		
9	**Silo for dried sludge collection**		
	Capacity	m^3	
	MoC		
10	**Insulation for Hot Surface**		
	Type of insulation		
	Material used for insulation		
	Outer surface temperature (≃50°C)	°C	
11	Shed for Paddle dryer		
	Area	m2	
	Type of roofing sheet		
	MoC of truss		
	Shed Lighting		
	Foundation for Paddle dryer & TFH		
	Side Wall		

S.No	Description	Unit	Specification
	Flooring		
12	Control cabinet room for TFH & Paddle dryer		
	Area	m2	
	Type		
	Side Wall		
	Flooring		
	Epoxy Coating above flooring		
	Cabinet Lighting		
	Cable Tray MoC		
	Supporting and fasteners MoC		
13	**Instrumentation & Control Panel for Paddle dryer and TFH**		
	Control panel with load and starter details to be provided by the bidder.		
	Protection Class - IP66		
	Local & Remote Control ON/OFF to be specified by the bidder		
	Temperature sensors with indicators		
	Temperature and pressure gauges in fluid line		
	Differential pressure gauge		
	Earthing for all equipment/motors in Aluminium flat with 6 Nos of CI earth pit.		
	Details of Incoming cable (minimum 3.5 Core X 95 Sq.mm Aluminium armoured cable X 2 run) for 200m and outgoing power/control cables to be specified & Provided by the bidder.		
	Power distribution panel for connecting of Paddle dryer, Thermic Fluid boiler andother accessories with lighting distribution panel.		
	Cable schedule for power and control cable.		
	FRP Cable tray with supporting in SS316. All Motor canopy in FRP. All Motor should be IE4 ratings		
	PC Make: Dell, Intel Core i7, OS Windows 11, 8GB RAM, 1TB SSD Printer make: HP Colour printer, with standby cartridge		
	Control desk for PC & Printer		
	Air conditioner of 2-ton capacity, preferred make: Panasonic		
	BLDC Fan, Preferred make: Crompton		
	List of connected and installed load details to be provided.		
14	**Anticorrosion Painting & SurfaceTreatment**	HRA Painting for CS parts exposed to high temperature. Epoxy painting for CS parts which are not exposed to high temperature.	

UPS Detailed Specification

#	Description	Requirement
1	UPS TYPE	True Online Double Conversion
	Technology	Advance DSP Controlled, SPWM technology with IGBTs
3	Make	APC by Schneider
4	Model No.	SRC2KUXI
5	KVA Rating	2 KVA (1 No.)
6	Output Power Capacity	Min. 80% of KVA Rating
7	Isolation Transformer	Yes
8	Input Voltage	230V AC (Single Phase)
9	Input Voltage Range	100-285V
10	Frequency (Hz)	50/60 Hz (auto-sensing)
11	Power Factor (PF)	0.8 or better
12	Operatng Temperature	0 - 50 Deg Foe UPS, 30 Deg for Battery
13	Output Voltage	230 VAC 1 Ph
14	Output Voltage Regulation	+/-1%
15	Output Wave Form	Pure Sine Wave
16	Crest Factor	3:1
17	Efficiency	>90%
18	Over Load Capability	105% - Infinite, 125%- 1 minute, 150% - 30 Second
19	Harmonic Distortion	≤ 2 % THD (Linear Load) ≤ 5% THD (Non-Linear Load)
20	Noice Level	<55 dB @ 1 meter
21	Indicators on Display	Battery Info, Fault Info, Load Info, Input/Output Voltage Info
22	Servo Voltage Stabilizer	Yes
23	Static bypass Switch	Yes
24	Over load & short circuit protection with Audible	Yes

	Alarm	
25	Back up Time	30 Mins of Working Load
26	Battery Type	SMF (Sealed Lead Acid Manitenance Free)
27	Protection	Built in Spike & surge Protector
28	Battery Voltage	12 V
29	Battery AH	26AH
30	Number of Batteries	6 Nos.
31	Battery Rack & Links	Yes

TENDER DOCUMENT

(National Competitive Bidding)

for

Upgradation of Common Effluent Treatment Plant (CETP) at Amburtec - Thuthipet sector, Ambur

TENDER – 8/2024

DESIGN, DETAILED ENGINEERING, SUPPLY, INSTALLATION, COMMISSIONING AND TRAIL RUN INCLUDING CIVIL WORKS ON TURNKEY BASIS OF 500 KG/HR. HOLLOW PADDLE SLUDGE DRYER BASED ON THERMIC FLUID HEATING SYSTEM

Volume-IV

Price Bid

AMBUR ECONOMIC DEVELOPMENT ORGANISATION (AEDOL)

43/53, Raja Muthiah Road ,Periamet, Chennai-600 003

Telephone: 044-42041132/35528648

email: aedolchennai@yahoo.co.in, aedolchennai@gmail.com

BILL OF QUANTITIES

I. Explanatory Note
II. Summary of costs

Explanatory Note

1. The schedule given herewith forms the basis of price evaluation of the bidder in terms of all works.

2. While the technical information provided may be considered as a reference, the detailed estimations, should be based on rechecking to be done by the bidder. Checking of presently given designs and re-designing of the units etc. are considered as the responsibility of the tenderer. Unless specifically mentioned, it shall be considered that the tenderer assumes the responsibility of all technical calculations and performance requirements of the plant.

3. The quantities estimated by the Employer is given in the attached Schedules. However, these are the minimum requirement and bidder is required to make his own calculations and wherever extra items and units are felt needed, he should to include it arrive is final quantity and specify the same in the Column indicated for the purpose. Following the given quantities does not absolve the Contractor from not meeting any of the Construction or Performance requirements as per this document.

4. The tender is on turnkey lump sum basis. The quantity shown in this BOQ is only indicative. The contractor shall visit the site and assess the requirements before bidding. Any item which is necessary but inadvertently omitted in BOQ shall be included at any stage of work within the total quoted tender cost. Hence, the tendered price shall be deemed to include all items which are mandatorily required for the comprehensive physical and functional completion of the offered items in all respects to meet the scope of work and performance guarantee as mentioned in this tender document issued to the bidder.

5. The filled up BoQ, but without any price entry, shall be submitted along with the Technical Offer. If the bidder decides to change any quantities, it shall be shown in a separate column marked 'Revised Quantities'. AEDOL/CETP/ILIFO reserve the right to seek clarifications from the bidder on the assumed quantities before opening of the Price Bid.

6. The filled up BoQ with prices shall be attached only in the Price Bid.

7. The prices as furnished hereunder shall be deemed as "**all inclusive price**" for the complete, construction,supply, delivery at site, erection, testing of specific materials, erection, remediation/correction, commissioning, taxes, duties, of all electro-mechanical units under this contract, the " electro-mechanical units" being defined as "all such items, which are mandatorily required for the due and comprehensive physical and functional completion of the systems and accessories in all respects to meet the objectives of treatment as covered in and not limited to the specifications as contained in this tender document issued to the tenderer and as further amended, altered and / or deleted by virtue of the minutes of the pre-bid meeting and any written directives and / or clarifications furnished by the owner as a common document to all the purchasers of the tender document, except those which are specifically listed and covered under the civil works schedule" The tenderer shall not be eligible for any upward variance of this price unless such arises from "authorized" extras.

8. The entries of prices shall be made legibly in indelible waterproof using appropriate typing or computer printouts. Manual entries shall not be accepted. All prices shall be entered in figures and words. All entries shall be terminated to the Rupee and there shall be no entries in "Paise". The "commas" shall be used for entries in figures after every third numeral and not in any other location. The entries in words shall avoid such denotions as hundreds, thousands, lakhs, millions, crores etc and shall write each numeral as it appears in figures.

9. All required entries under each page shall be filled in without fail and the seal of the tenderer shall be fully legible and shall not have any defacing or worn out parts defying readability

10. Such of the tenders violating these provisos shall automatically stand disqualified and hence rejected irrespective of the financial status of such tender and no appeal shall lie with any appellate authority on account of this either.

11. The prices are invited herein on a "wholesome" basis. Upon processing of the entire tender, and upon the owner deciding to offer the LOI to a chosen tenderer, such tenderer shall be called for to furnish the breakup prices for each item of work to the best possible extent for a smooth contract administration and processing of stagewise payments and such "breakup" shall be on a mutually acceptable basis. Unless this mandatory requirement is fulfilled by the tenderer and unless the sum total of prices are not exceeding the quoted price for each item of work, the LOI shall not be issued and the owner reserves the right to reject the said tender.

12. The tenderer is required to fill up all detailed price sheets given. However, it should be explicitly understood by the tenderer that these figures are called for reference purpose only to understand the basis of computations by the tenderer and not for fixing contract prices. The contract price shall be on lumpsum basis in accordance with clause 6 above and entries against the 'total price' in the respective sheets only will be considered for evaluation purpose.

2 SUMMARY OF THE COST

Tender No: 8/2024

Upgradation of Common Effluent Treatment Plant (CETP) at Amburtec - Thuthipet sector, Ambur

SL.NO	Description of Work	Amount
1	**Design, detailed engineering, supply, installation, commissioning and trail run including civil works on turnkey basis of 500 kg/hr. Hollow paddle sludge dryer based on thermic fluid heating system inclusive of GST**	
	GRAND TOTAL (A+B)	

Note 1	***This is a lumpsum contract inclusive of Civil, Electrical, Instrumentation and Mechanical. The quantity given in the BoQ is indicative only. The tenderer shall visit the site and assess the quantity as per the site requirements before bidding.***	
Note 2	***Any item which is necessary but inadvertently omitted in BoQ shall be included at any stage of work within the total quoted cost***	
Note 3	***The quoted rates should inclusive of all applicable taxes.***	
Note 4	***In case of any damage of cable during excavation, replacement of new cable is at tenderer's scope.***	
Note 5	***All Steel fabrication work with Anti Corrosive Painting***	
Total Amount in Words	(Rupees…… …… …….. …… …… …… …… ……	Stamp

PADDLE DRYER MEP WORK ESTIMATION		
S.No	**Description**	**Amount**
1	**Design supply installation erection commissioning of 10TPD paddle dryer unit with thermic fluid heating system & its auxiliary units**	
	GST @ 18%	
	Total Costs of MEP (A)	

Note 1	***This is a lumpsum contract inclusive of Civil, Electrical, Instrumentation and Mechanical. The quantity given in the BoQ is indicative only. The tenderer shall visit the site and assess the quantity as per the site requirements before bidding.***	
Note 2	***Any item which is necessary but inadvertently omitted in BoQ shall be included at any stage of work within the total quoted cost***	
Note 3	***The quoted rates should inclusive of all applicable taxes.***	
Note 4	***In case of any damage of cable during excavation, replacement of new cable is at tenderer's scope.***	
Note 5	***All Steel fabrication work with Anti Corrosive Painting***	
Total Amount in Words	(Rupees……. …… …… …… ……	

S.NO	**DESCRIPTION OF WORK**	**UNIT**	**QTY**	**BOQ as per the bidders**	**Rate**	**Amount (Rs)**
	INSTALLATION OF PADDLE DRYER					
1.	**DOUBLE SHAFT PADDLE DRYER – 1 No** • Feed quantity: 10 TPD • Moisture content in the inlet of the sludge : 70-85% • Moisture content in the outlet of the sludge: Less than 15% • MOC: SS 316 • Feeding % delivery type : Integrated with auto system	**Set**	**1**			
2.	**THERMIC FLUID HEATER (TFH) – 1 No** • Capacity : 6,00,000 kcal/hour (min) • T.F. inlet Temperature (Std.) : 300°C • T.F. Outlet Temperature (Std.) : 260 °C • Available Circuit pressure 29.0 mlc (3.0bar g) • Wood Logs (30% moisture – GCV ≃ 3500) **Heat Exchanger (Radiative and Conductive)** • Gear Box Drive (≃ HP with VFD) • **VFD :** IP 66 with 3C3 coating; Duty : Heavy ; Harmonic Filter : Inbuilt ; Make Yaskawa GA700 • **Tube specifications – TFH:** MOC : ERW as per BS 3059 part 1 Gr. 320 **TFH Re-circulation tanks, pumps and piping** • Oil Recirculation pump	**Set**	**1**			

S.NO	**DESCRIPTION OF WORK**	**UNIT**	**QTY**	**BOQ as per the bidders**	**Rate**	**Amount (Rs)**
	• Make-up pump • Thermic fluid storage tank • Oil Pipeline • Drain Pipeline • TFH Circulation Pump: Centrifugal type • Heat Recovery Unit (APH) • Induced Draft Fan • Force draft Fan • Thermic fluid oil • Refractory lining					
3.	**Chimney – 1 No** • Supply, erection and commissioning of chimney MOC : Carbon steel, pre-coated with Aluminium, and Zinc both inside and outside for better corrosion resistance properties. (Grade: ASTM A 792 D) • Height (≃ 30m as per TNPCB norms)	**No**	**1**			
4.	**Venturi Scrubber system – 1 No**	**No**	**1**			
5.	**Wet Scrubber – 1 No**	**No**	**1**			
6.	**Ducting for TFH** • MOC : SS 304	**Lot**	**1**			
7.	**Insulation of heating surface**					
8.	**Air preheater – 1 No**	**No**	**1**			
9.	**Cyclone separator with rotary valve**	**No**	**1**			
10.	**Sludge feeding Conveyor with support** • MOC: SS304 • Capacity: 1000 kg/hr	**No**	**3**			

S.NO	**DESCRIPTION OF WORK**	**UNIT**	**QTY**	**BOQ as per the bidders**	**Rate**	**Amount (Rs)**
11.	**Dried Sludge Conveyor** • MOC: SS304 • Capacity: 1000 kg/hr	**No**	**1**			
12.	**Silo for dried sludge collection :** • Capacity : 13.6 m3 • MOC: SS 304	**No**	**1**			
13.	**Piping and Fitting**	**LS**	**1**			
14.	**Instrumentation & Control Panel for Paddle dryer and TFH** • Control panel with load and starter details to be provided by the bidder. • Protection Class - IP66 • Local & Remote Control ON/OFF to be specified by the bidder • Temperature sensors with indicators • Temperature and pressure gauges in fluid line • Differential pressure gauge	**LS**	**1**			
15.	**Anticorrosion Painting & Surface Treatment** • HRA Painting for CS parts exposed to high temperature. Epoxy painting for CS parts which are not exposed to high temperature.	**LS**	**1**			
16.	**Electrical Works**					
	Supply, Erection, Commissioning of suitable cubical control panel for TFH and Paddle Dryer, supply and laying/ fixing of incoming & outgoing XLPE cables of suitable size and length, remote switches,	**LS**	**1**			

S.NO	**DESCRIPTION OF WORK**	**UNIT**	**QTY**	**BOQ as per the bidders**	**Rate**	**Amount (Rs)**
	complete aluminium earthing, emergency stop switch for TFH and Paddle Dryer, lighting distribution board, 15/5 A power sockets, flame proof LED lighting for paddle dryer including FRP cable tray, supporting & fasteners in SS 316 etc., as required. The work also includes provision of safety items like floor mate, fire extinguishers, gloves, sand bucket with stand, all relevant instrumentation works etc., complete. • Earthing for all equipment/motors in Aluminium flat with 6 Nos of GI earth pit. • Details of Incoming cable(minimum 95 Sq.mm X 3.5 Core X 2 run) for 200m/run and outgoing power/control cables to be specified & Provided by the bidder. • Power distribution panel for connecting of Paddle dryer, Thermic Fluid boiler and other accessories with lighting distribution panel. • Cable schedule for power and control cable. • FRP Cable tray with supporting in SS316.All Motor canopy in FRP. • All motors should be IE3 ratings List of connected and installed load details to be provided.					

PADDLE DRYER CIVIL WORK ESTIMATION - B		
S.No	**Description**	**Amount**
I	**Construction of Paddle dryer truss with foundation 20m X 10m X 6m with Control cabinet room 5m X 3m X 4m, in RCC M25 grade, M30 grade only for bed foundation, floorings including cement, sand, steel in Fe 550D, metal, plastering, painting, rolling shutter, aluminium window and labour charges, etc., complete.**	
II	**Construction of RCC Sludge Pit with truss of 8m X 4m X 2m in RCC M25 grade size, steel in Fe 550D, metal, plastering, painting and labour charges, etc., complete**	
III	**Construction of RCC feed area platform of 10m X 10m X 1m in RCC M25 grade size, steel in Fe 550D, metal, plastering, painting and labour charges, etc., complete**	
	Sub Total	
	GST @ 18%	
	Total Costs of Civil (B)	

Note 1	***This is a lumpsum contract inclusive of Civil, Electrical, Instrumentation and Mechanical. The quantity given in the BoQ is indicative only. The tenderer shall visit the site and assess the quantity as per the site requirements before bidding.***	
Note 2	***Any item which is necessary but inadvertently omitted in BoQ shall be included at any stage of work within the total quoted cost***	
Note 3	***The quoted rates should inclusive of all applicable taxes.***	
Note 4	***In case of any damage of cable during excavation, replacement of new cable is at tenderer's scope.***	
Note 5	***All Steel fabrication work with Anti Corrosive Painting***	
Total Amount in Words	(Rupees……. …… …… …… ……	

I	Cost Estimation for Proposed Paddle dryer shed (20m X 10m X 6m) with control panel room (5m X 3m X 4m)				
S.No	**DESCRIPTION OF WORK**	**Unit**	**Qty**	**Rate**	**Amount, Rs.**
1	Earth work excavation for all classification of soils, including plastering, shifting of soil, levelling, including the cost of transportation, leading charges and labour charges etc., complete	m^3			
2	Back filling of excavated soil including loading, transportation, watering, compaction, etc., complete	m^3			
3	Supply, filling, leveling and compacting of sand at the height of 100mm & 150 mm including the cost of consolidation and labour etc., complete	m^3			
4	Supply and laying M15 grade PCC 1:2:4 for a thickness of 100mm by using 20 mm metal for levelling course, including cost cement, (the minimum cement 260 kg/Cu.m used) sand, metal, mixing chargers, compaction labour charges etc., complete.	m^3			
5	Providing and Laying of R.C.C mix concrete for footing, Raft concrete, column, beam, sidewall concrete, staircase concrete, using M25, M30 grade 230mm wall thickness, including cost of cement, (the minimum cement 340 kg/ m^3 used), labour charges etc.	m^3			
6	Supply and fabrication steel using Fe 550D grade, 18 SWG binding wire, the cost inclusive of cutting, laying, leading, fixing of briquettes etc.., complete.	M.T			
7	Providing laying shuttering works for foundation, raft, columns, beam, sidewall inner and outer, including labour charges etc.,	m^2			
8	Providing brick work internal, external and parapet including materials and labour charges etc., complete.	m^3			
9	Internal & External Plastering by using C.M:1:3, 12mm thick, including cost of cement, sand, scaffolding, preparation of concrete surfaces, mixing chargers, labour charges and curing etc., complete.	m^2			

10	Supply and white washing, painting of wall for inner side and outer side wall including material with labour charges etc., complete	m^2			
11	Provision of epoxy coating for flooring	m^2			
12	Supply and fixing of A' Truss including material with labour charges etc., complete	m^2			
13	Construction of restroom	sq.ft			
14	Supply and fabrication of Rolling shutter at paddle dryer including materials, transportations, labour and complete etc.,	m^2			
	TOTAL				

II	**Cost estimation for Proposed RCC pit for Sludge collection pit of Paddle dryer (8m X 4m X 2m)**				
S.No	**DESCRIPTION OF WORK**	**Unit**	**Qty**	**Rate**	**Amount, Rs.**
1	Earth work excavation for all classification of soils, including plastering, shifting of soil, levelling, including the cost of transportation, leading charges and labour charges etc., complete	m^3			
2	Back filling of excavated soil including loading, transportation, watering, compaction, etc., complete	m^3			
3	Supply, filling, leveling and compacting of sand at the height of 200 mm including the cost of consolidation and labour etc., complete	m^3			
4	Supply and laying of M15 grade PCC 1:2:4 for a thickness of 100mm by using 20 mm metal for levelling course, including cost cement, (the minimum cement 260 kg/Cu.m used) sand, metal, mixing chargers, compaction labour charges etc., complete.	m^3			
5	Providing and Laying of R.C.C mix concrete for footing, Raft concrete, column, beam, sidewall concrete, staircase concrete, using M25, M30 grade 230mm wall thickness, including cost of cement , (the minimum cement 340 kg/ m^3 used) , labour charges etc.	m^3			

6	Supply and fabrication steel using Fe 550D grade, 18 SWG binding wire, the cost inclusive of cutting, laying, leading, fixing of briquettes etc.., complete.	M.T			
7	Providing laying shuttering works for foundation, raft, columns, beam, sidewall inner and outer, including labour charges etc.,	m^2			
8	Internal & External Plastering by using C.M:1:3, 12mm thick, including cost of cement, sand, scaffolding, preparation of concrete surfaces, mixing chargers, labour charges and curing etc., complete.	m^2			
9	Supply and white washing, painting of wall for inner side and outer side wall including material with labour charges etc., complete	m^2			
10	Providing of Epoxy coating	m^2			
11	Supply and fixing of A' Truss including material with labour charges etc., complete	m^2			
	TOTAL				

III	**Cost Estimation for RCC platform for solid feed area of Paddle dryer (10m X 10m X 1m)**				
S.No	**DESCRIPTION OF WORK**	**Unit**	**Qty**	**Rate**	**Amount, Rs.**
1	Earth work excavation for all classification of soils, including plastering, shifting of soil, levelling, including the cost of transportation, leading charges and labour charges etc., complete	m^3			
2	Back filling of excavated soil including loading, transportation, watering, compaction, etc., complete	m^3			
3	Supply, filling, leveling and compacting of sand at the height of 200 mm including the cost of consolidation and labour etc., complete	m^3			
4	Supply and laying M15 grade PCC 1:2:4 by using 20 mm metal for leveling course, including cost cement, (the minimum cement 260 kg/Cu.m used) sand, metal, mixing chargers, compaction labour charges etc., complete.	m^3			

5	Providing and Laying of R.C.C mix concrete for footing, Raft concrete, column, beam, sidewall concrete, staircase concrete, using M25, M30 grade 230mm wall thickness, including cost of cement , (the minimum cement 340 kg/ m^3 used) , labour charges etc.	m^3			
6	Supply and fabrication steel using Fe 550D grade, 18 SWG binding wire, the cost inclusive of cutting, laying, leading, fixing of briquettes etc.., complete.	M.T			
7	Providing laying shuttering works for foundation, raft, columns, beam, sidewall inner and outer, including labour charges etc.,	m^2			
8	Internal & External Plastering by using C.M:1:3, 12mm thick, including cost of cement, sand, scaffolding, preparation of concrete surfaces, mixing chargers, labour charges and curing etc., complete.	m^2			
9	Supply and white washing, painting of wall for inner side and outer side wall including material with labour charges etc., complete	m^2			
10	Provision of Epoxy flooring	m^2			
	TOTAL				

TENDER DOCUMENT

(National Competitive Bidding)

for

Upgradation of Common Effluent Treatment Plant (CETP) at Amburtec - Thuthipet sector, Ambur

TENDER – 8/2024

DESIGN, DETAILED ENGINEERING, SUPPLY, INSTALLATION, COMMISSIONING AND TRAIL RUN INCLUDING CIVIL WORKS ON TURNKEY BASIS OF 500 KG/HR. HOLLOW PADDLE SLUDGE DRYER BASED ON THERMIC FLUID HEATING SYSTEM

Volume-V

Drawings

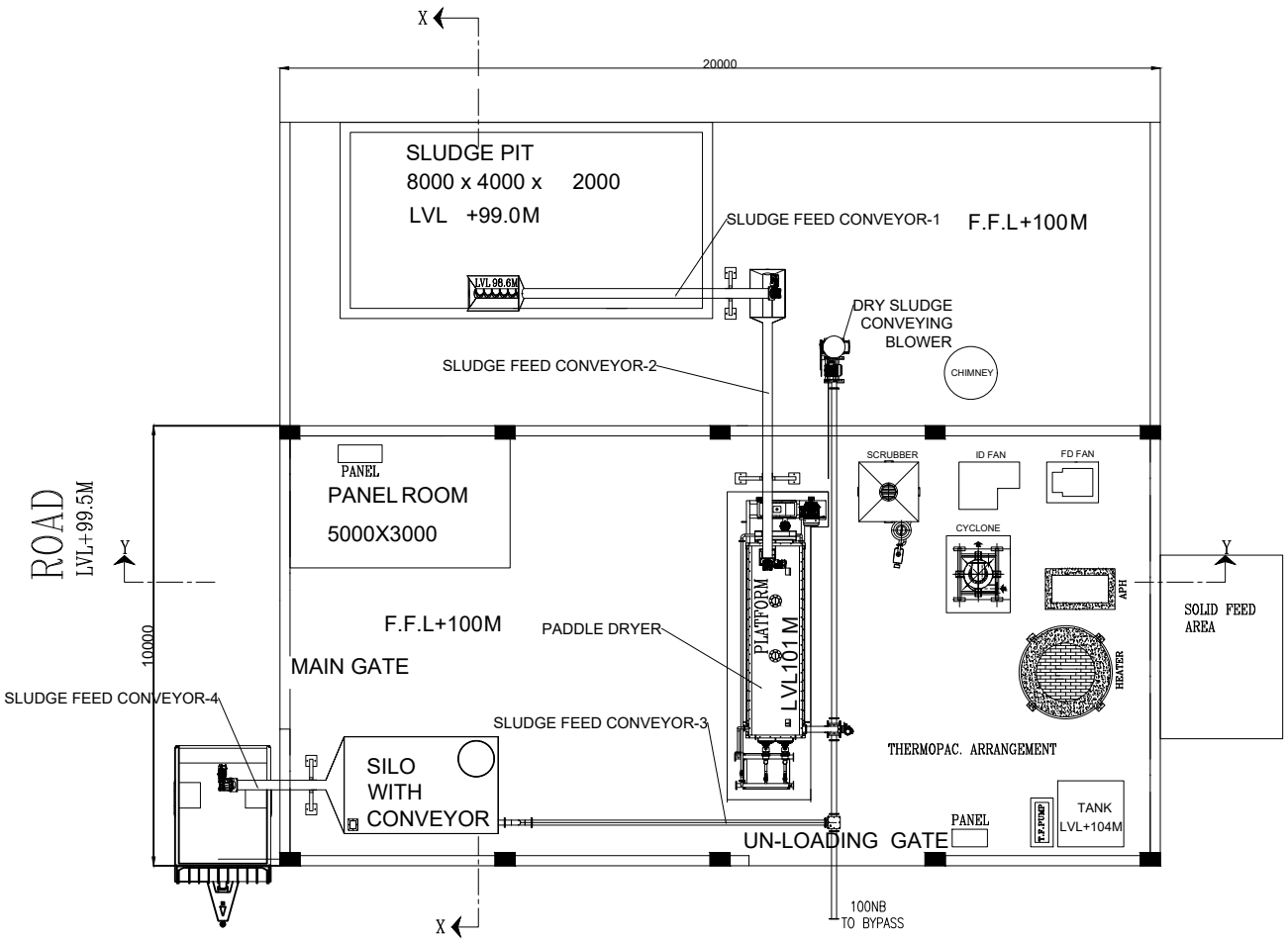
AMBUR ECONOMIC DEVELOPMENT ORGANISATION (AEDOL)

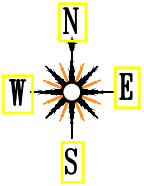
43/53, Raja Muthiah Road ,Periamet, Chennai-600 003

Telephone: 044-42041132/35528648

email: aedolchennai@yahoo.co.in, aedolchennai@gmail.com

ORIENTATION TO BE CONFIRMED





TYPICAL LAYOUT ARRANGEMENT
500 KG/HR - PADDLE DRYER

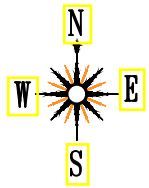
SHEET 1 OF 2

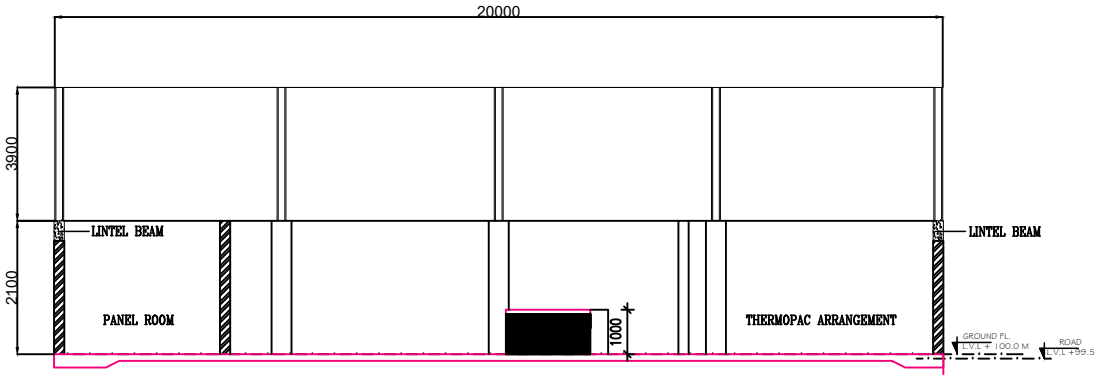
NOTES:-

1. ALL DIMENSIONS ARE IN MM & LEVELS ARE IN METER.

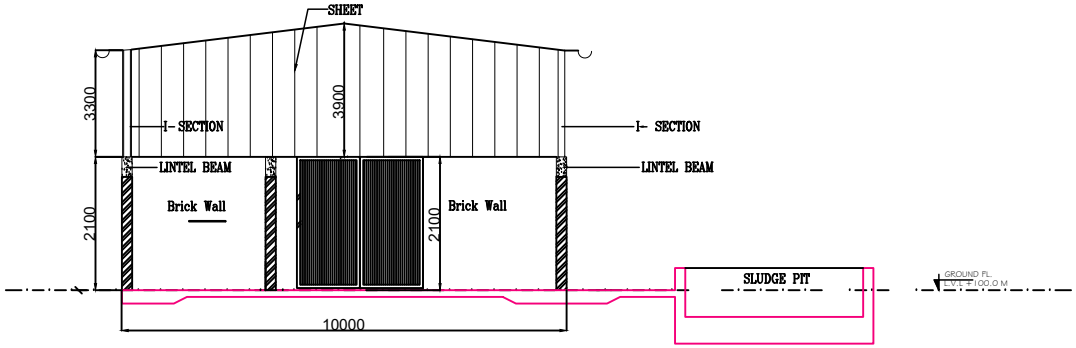
PARTICULARS			REVISED	APPD	DATE
CLIENT	M/S. AMBURTEC-THUTHIPET				
CONSULTANT	M/S. INDIAN LEATHER INDUSTRY FOUNDATION				
PROJECT	UPGRADATION COMMON EFFLUENT TREATMENT PLANT				
TITLE	TYPICAL LAYOUT ARRANGEMENT 500 KG/HR -PADDLE DRYER				
DATE:26.02.24	DESIGN	DRAWN	CHECKED	PROJECT	DRG. NO.: AMBUR-2024-CIVIL-101
NAME	S.A	D.S	K.V.E/K.R	-	SHEET 1 of 2
SIGN					REVISION R3
PROJECTION	UNIT : MM	SCALE : -	SHEET SIZE:- A2		INDIAN LEATHER INDUSTRY FOUNDATION

ORIENTATION TO BE CONFIRMED





SECTION Y–Y



SECTION X–X

TYPICAL LAYOUT ARRANGEMENT
500 KG/HR - PADDLE DRYER

SHEET 2 OF 2

NOTES:-

1. ALL DIMENSIONS ARE IN MM & LEVELS ARE IN METER.

PARTICULARS			REVISED	APPD	DATE
CLIENT	M/S. AMBURTEC–THUTHIPET				
CONSULTANT	M/S. INDIAN LEATHER INDUSTRY FOUNDATION				
PROJECT	UPGRADATION COMMON EFFLUENT TREATMENT PLANT				
TITLE	SECTION TYPICAL LAYOUT ARRANGEMENT 500 KG/HR –PADDLE DRYER				
DATE:26.02.24	DESIGN	DRAWN	CHECKED	PROJECT	DRG. NO.: AMBUR–2024–CIVIL–101
NAME	S.A	D.S	K.V.E/K.R	–	SHEET 2 of 2
SIGN					SHEET SIZE:– A2
PROJECTION	UNIT : MM	SCALE : –			REVISION R3

INDIAN LEATHER INDUSTRY FOUNDATION