VIJAYAWADA MUNICIPAL CORPORATION

DESIGN, CONSTRUCTION, OPERATION AND MAINTENANCE OF 40 MLD SEWAGE TREATMENT PLANT AT SINGH NAGAR IN VIJAYAWADA WITH UASBR TECHNOLOGY.

VOLUME-I

(TO BE SUBMITTED IN SEALED COVER 'A')

NAME OF WORK **Design, construction, operation and maintenance of the 40 MLD Sewage treatment plant at Singh Nagar in Vijayawada with UASBR Technology.**

Name of the Agency to whom issued: _____

_____

Cost of Schedule Paid Rs. _____ vide _____

Bearing No. _____ Date _____ of _____ Bank.

CHIEF ENGINEER,
MUNICIPAL CORPORATION,
VIJAYAWADA

VIJAYAWADA MUNICIPAL CORPORATION

Name of the Work: Design, construction, operation and maintenance of the 40 MLD Sewage treatment plant at Singh Nagar in Vijayawada with UASBR Technology.

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CHAPTER - I : INVITATION FOR OPEN BID TENDER

Name of the Work: Design, construction, operation and maintenance of the 40 MLD Sewage treatment plant at Singh Nagar in Vijayawada with UASBR Technology.

LOCAL COMPETITIVE TENDERING

1. The VMC intends to take up the work of "**construction of 40 MLD Sewage treatment plant at Singh Nagar in Vijayawada with UASBR Technology.**" on turnkey basis. including maintenance of the plant for five years.
2. Commissioner, Municipal Corporation, Vijayawada for and on behalf of the VMC hereby invites sealed tenders for the above work from firms registered under companies act, eligible registered contractors of Class-I (Civil) as per G.O Ms. No.521, Dt: 10-12-1984 I&CAD Deptt. And or registered in any other State in similar or better capacity and are to be executed for the VMC on the basis of Schedule of lump-sum tender.**.** The Tenderers will have to state clearly their willingness to execute the works at the gross lump sum Contract Value indicated at price Schedule. A higher-class contractor is allowed to tender for works falling in lower class without getting himself registered in the lower category.
3. The above work is being taken up under Jawaharlal Nehru National Urban Renewal Mission (JNNURM) to augment the treatment capacity of sewerage in the city. Therefore the bidder should take up the work of **construction of 40 MLD Sewage treatment plant at Singh Nagar in Vijayawada with UASBR Technology.**" On turnkey basis and to be executed for the VMC on the basis of Schedule of lump sum rate Tender.
4. The works to be carried out include the following:
    1. Preparation of the process designs, drawings, plans as per manuals and the codes
    2. Site investigation, sub soil exploration including, ground water table identification
    3. Preparation of structural designs, drawings, plans based on the relevant IS codes including bar bending schedules.
    4. Preparation of mix designs for the various units in accordance with the relevant IS codes.

5. Preparation of the bill of quantities.
6. Preparation of the electrical installations designs and the drawings with specifications and brand names of the materials.
7. Preparation of the mechanical unit designs ands the drawings including pumps, chlorinators etc with specifications and makes.
8. Construction of the plant as per the approved designs and the drawings duly procuring the best quality of the materials and skilled laborers.
9. Construction of the plant including supply delivery and fixing of the electro-mechanical units
10. Trail run of the plant with suitable start up methods for the plant with the sewage supplied by the VMC.
11. Commissioning of the plant as per the norms.
12. Operation and maintenance of the plant for a period of five years.
13. Preparation of the work schedule, Bar charts etc to the work including milestones of the works.
14. Operation &maintenance schedule with chemicals and consumables usage chart
15. Routine maintenance program for the plant. With staff proposed for the O&M operations.

5. The total **period for completion of above work is twelve (12) months** from the date of site handing over to the successful bidder inclusive of monsoons
6. Interested eligible contractors may peruse the documents in the office of the Superintending Engineer, Municipal Corporation, Vijayawada, at the address below. Prospective tenderers shall take note of any conditions in the Tender documents.
7. Set of Tender Documents will be issued to each on payment of **Rs.5000 /- (Rupees five thousand only)** and **Rs.650/- (Rupees six hundred Fifty only)** for sales tax for this work (non-refundable), towards cost of Tender Documents in the shape of Demand Draft drawn in favour of **Commissioner, Municipal Corporation, Vijayawada and CTO, Vijayawada** respectively**.** Tender Documents will not be sent by post under any circumstance. The Tender Documents can be had from the

office of The superintending Engineer,
Municipal Corporation,
VIJAYAWADA – 520 001.
Phone No. : 0866-2424338; Fax No: 0866-2423022

on any working day from 11.00 am to 5.00 p.m. (IST) from Monday to Saturday (except on AP Government Public Holidays) as per the schedule given below

	As per Original Schedule	**As per Revised Schedule**
Issue of Tender Schedules	4-12-2006 to 19-12-2006.	7-5-2007 to 2-06-2007.
Receipt of Bids	28-12-2006 up to 3.00 P.M.	4-06-2007 up to 3.00 P.M.
Opening of Bids	28-12-2006 @ 4.00 P.M.	4-06-2007@ 4.00 P.M.
Pre bid meeting		23-5-2007 at 4.00 PM

Venue of the bids Opening& pre Bid meeting - Chamber of The Superintending Engineer, Municipal Corporation, Jawaharlal Nehru Buildings, Vijayawada.

8. **An EMD of Rs.500000/- (Rupees five lakhs only)** shall be submitted along with the Tender. This can be submitted in the form of Crossed Demand Draft or a Bank Guarantee from a Nationalized Bank / Schedule Bank in India acceptable to VMC, in favour of. **Commissioner, Municipal Corporation, Vijayawada.** The EMD shall be valid for a period of 180 days after opening of the tenders. In the case of Bids from a Joint Venture the BG should be in the name of all Joint Venture partners
9. The tenders will be received by the Chief Engineer, Municipal Corporation, Vijayawada or authorized officer. If the due date mentioned is a Government Holiday, tenders will be received and opened on the next working day at the same time.
10. The commissioner Municipal Corporation Vijayawada, reserves the right to reject, cancels, postpone, and advance any tender or all the tenders without assigning any reason there for. Any Tenderer shall have no cause of action or claim against the VMC or its officers, employees, successors or assignee for rejection of his tender.

Commissioner
Municipal Corporation,
VIJAYAWADA.
Phone No. : 0866-2424338; Fax No: 0866-2423022
Chief Engineer
Municipal Corporation
VIJAYAWADA.

TENDERER

CHAPTER - II : INSTRUCTIONS TO TENDERERS

A. GENERAL

IT 1. DESCRIPTION OF THE WORK

1.1 The works under this Contract constitute a part of the project "**construction of 40 MLD Sewage treatment plant at Singh Nagar in Vijayawada with UASBR Technology.**" The works to be carried out include the following:

preparation of the process designs ,drawings, plans as per manuals and the codes

Site investigation, sub soil exploration including, ground water table identification

Preparation of structural designs, drawings, plans based on the relevant IS codes including bar bending schedules.

Preparation of mix designs for the various units in accordance with the relevant IS codes.

Preparation of the bill of quantities.

Preparation of the electrical installations designs and the drawings with specifications and brand names of the materials.

Preparation of the mechanical unit designs ands the drawings including pumps, chlorinators etc with specifications and makes.

Construction of the plant as per the approved designs and the drawings duly procuring the best quality of the materials and skilled laborers.

Construction of the plant including supply delivery and fixing of the electro-mechanical units

Trail run of the plant with suitable start up methods for the plant with the sewage supplied by the VMC.

Commissioning of the plant

Operation and maintenance of the plant for a period of five years.

Preparation of the work schedule, Bar charts etc to the work including milestones of the works.

Operation & maintenance schedule with chemicals and consumables usage chart

Routine maintenance program for the plant. With staff proposed for the O&M operations.

IT 2. SOURCE OF FUNDS

2.1 The VMC intends to take up the above work with J.N.N.U.R.M financial assistance VMC funds. It is intended that a portion of the proceeds of these deposits will be applied to eligible payments for the above work.

IT 3. ELIGIBILITY AND QUALIFICATION REQUIREMENTS

3.1 Commissioner, Municipal Corporation, Vijayawada for and on behalf of the VMC hereby invites sealed tenders for the above work from firms registered under companies act, eligible registered contractors of Class-I (Civil) as per G.O Ms. No.521, Dt: 10-12-1984 I&CAD Dept., and or registered in any other State in similar or better capacity and are to be executed for the VMC on the basis of Schedule of lump-sum tender**..** The Tenderers will have to state clearly their willingness to execute the works at the gross lump-sum Contract Value indicated at price Schedule. A higher-class contractor is allowed to tender for works falling in lower class without getting himself registered in the lower category.

3.2 Tenders submitted by a Joint Venture of two or more firms, as partners shall comply with the following requirements:

(a) the tender and in case of successful tender the Form of Agreement, shall be signed by all the Joint Venture Partners/Firms so as to be legally binding on all partners/firms of the Joint Venture;

(b) One of the partners shall be nominated as being in-charge; and his authorization shall be evidenced by submitting a power of attorney signed by legally authorized signatories of all the partners;

(c) The partner in charge shall be authorized to incur liabilities and receive instructions for and on behalf of any and all partners of the joint venture and the entire execution of the Contract including payment shall be done exclusively with the partner in charge;

(d) All the parties should be jointly and severally responsible for executing the works, if any awarded to them in accordance with the tender conditions. They should be jointly responsible for payment of any and all monies becoming payable to the VMC consequent on non-fulfillment of the terms of contract, if any awarded by the VMC to the Joint Venture;

(e) A copy of the agreement entered into by the joint venture partners shall be submitted with the tender. The Joint Venture agreement should categorically state that all the members are jointly and severally responsible to execute such work as may be awarded to the Joint Venture in strict compliance with all the terms and conditions of the contract.

(f) The parties should assign a specific name for the Joint Venture separate and distinct from the names of the constituents and the tender filed in such name and the tender signed by all parties.

3.3 Each Tenderer must enclose Sales Tax Clearance Certificate from the appropriate authorities in the form prescribed therefor for the year 2005-06.

3.4 The Tenderer must produce the latest Income Tax Clearance Certificate.

The Sub-contractors / GPA holders experience shall not be taken into account in determining the bidder's compliance with the qualifying criteria.

The bidder should furnish EMD of Rs.5,00,000/- either in the shape of Bank Guarantee or Demand Draft drawn in favour of Commissioner, Municipal Corporation, Vijayawada payable at any nationalized Bank in Vijayawada.

Qualification Criteria (Documents and schedules to be completed and certified as required and enclosed in Sealed Cover 'A' of the Tender)

3.8 *a) Past Experience:*

The Tenderer shall have executed the minimum quantities of work as stated below.

Experience relating to the works executed in any State / Central Government Departments, or State/Central Undertakings / Boards / Corporations, Municipalities and Municipal Corporations, Urban Development Authorities will only be considered.

The past performance of the tenderer is established from record of successful execution and completion of similar type of works in time and in workman like manner. For this purpose testimonials etc., from clients for whom the applicant had executed similar type of works during the past five years and having present worth equal to or higher than minimum amount indicated below will have to be submitted by the tenderer and where necessary reference will be made to previous clients. Tenderers are expected to furnish past performance data for the works referred by them and indicated in Schedule-F (enclosed in Volume-I). Said similar works executed during the past five years

i) It is necessary that the tenderer/ in the case of Joint Venture, the prime partner or any one or more of the partners of the joint ventures should have designed executed, completed, tested and commissioned successfully 20 MLD sewage treatment plant in any one year of the last five years from March 2007

b) Equipment:

Each Tenderer should further demonstrate the availability of his own Plant, Machinery and equipment required to execute this work.

c) Financial standing:

i. The Tenderer shall furnish audited financial statements for the last five years i.e. audited by a Chartered Accountant, which include Profit and Loss Account, Balance Sheet and certificates regarding contingent liabilities. In case of any nil statements, the same shall be certified accordingly by a Chartered Accountant. The tenderer shall furnish the financial statement for the previous financial year including liabilities, Contingent liabilities and projects in progress (in case audited statements are not available). **If the Tenderer is a Company, audited annual reports of the financial years** for the last five years along with the audit reports under the Companies Act shall be furnished. In case of Tenderers other than companies, if the turnover in any of the above financial years exceeds Rs.350 lakh per annum, the audited accounts along with the auditor's certificates under section 44 AB of the Income tax Act shall be furnished. If audited reports under Section 44AB of Income Tax Act is not furnished for any year, it will be deemed that the turn

over for that year was less than Rs.350 lakh. In the case of Tenderers other than companies, if the turnover in any of the above financial years does not exceed Rs.350.00 lakh per annum, the following certificate shall be given by a Chartered Accountant for each year for the Profit and Loss Account and the Balance Sheet. "We have audited the above Profit and Loss Account / Balance Sheet of ---------- ---------- as on ---------- ---------- for the financial year ending -------- ------ and in our opinion the said accounts give a true and fair view. The said Balance Sheet and Profit and Loss Account are in agreement with the books of accounts and returns produced and that we have obtained all the information and explanations which to the best of our knowledge and belief were necessary for the purpose of the audit".

ii. Bidder should have turn over of at least Rs 10 crores per annum in any year of the last five years..

In any one financial year during the five financial years immediately preceding the financial year in which tenders are invited, the Tenderer shall have, in his own name, in case of joint venture the prime partner, satisfactorily completed works similar to the proposed works valued not less than **Rs. 350.00 lakhs**

v. Original Certificates:

Originals of the certificates shall be produced at the time of opening of tenders to verify the copies of statements and other information furnished in cover 'A'.

d). History of litigation and criminal record:

If any criminal cases are pending against him/her/partners at the time of submitting the tender, the tender will be summarily rejected. In this respect the Tenderer shall submit an affidavit to the effect that the history of litigation, criminal cases pending against him/her/partners furnished by him/her is true.

In case it is detected at any stage that the affidavit is false, he will abide by the action taken by the VMC / A .P. Government without approaching any court whatsoever for redress. He will, however, be given suitable opportunity to offer his explanation before action is taken against him.

e) Contractor shall not be eligible to tender for works in VMC in which any of his near

relatives are working in the cadre of A.E.s and above in the Engineering section or in other wings of VMC officers near relatives include:

1. Sons, step-sons, daughters, step-daughters.
2. Sons-in-law and daughters-in-law.
3. Brothers-in-law and sisters-in-law.
4. Brothers and sisters.
5. Father and mother.
6. Wife/husband.
7. Father-in-law and mother-in-law.
8. Nephews, nieces, uncles, aunts.
9. Cousins. And, in addition,
10. Any person residing with the Contractor, whether related or not.

f) *Other requirements*:

Even if the Tenderer meets all the eligibility and qualification criteria, his tender shall be summarily rejected if he is found to have misled or made false representation in the form of any of the statements submitted in proof of the eligibility and qualification requirements or if he has a record of poor performance such as absconding from work, works not properly completed as per contract, inordinate delays in completion, financial failure and/or has participated in previous tendering for the same works and had quoted unreasonably high tender price/premium. In addition to the above, even while executing the work, if it is found that he produced false/fake certificates in his Tender, he will be blacklisted and the work will be taken over invoking Clause no. 60 (a) of the Preliminary Specification to AP Standard Specification, i.e. General Conditions of Contract, and Conditions of Particular Application.

IT 4. COST OF TENDERING

The Tenderer shall bear all expenses associated with the preparation and submission of his tender and the VMC shall in no case be responsible or liable for reimbursement of such expenses, regardless of the conduct or outcome of the tendering process.

Each bidder shall submit only one bid. A bidder who submits or participates more than one bid will cause all the bids with the bidders participation to be disqualified.

IT 5. SITE VISIT

5.1 The Tenderer is advised to visit and examine the site of the works and its

surroundings and obtain for himself on his own responsibility all information that may be necessary for preparing the tender and entering into a contract. The costs of any such visits shall be entirely at the Tenderer's own expense.

5.2 The Tenderer and any of his personnel or agents will be granted permission by the department to enter upon their premises and lands for the purpose of such inspections, but only upon the express condition that the Tenderer, his personnel or agents, will release and indemnify the VMC and their personnel and agents from and against all liability in respect thereof and will be responsible for personal injury (whether fatal or otherwise), loss of/or damage to property and any other loss, damage, costs and expenses that may arise however caused, which, but for the exercise of such permission would not have arisen.

B. TENDERING DOCUMENTS

IT 6. CONTENTS OF TENDERING DOCUMENTS

6.1 Each of the two sets of Tender Documents issued for the purpose of tendering include the following, together with any addenda thereto which may be issued in accordance with IT 8.

VOLUME – I (To be enclosed in Sealed Cover 'A')

Schedules of Supplementary Information

Schedule C	-	Income Tax Clearance Certificate (Form – I)
Schedule D	-	Sales Tax Clearance Certificate
Schedule E	-	Identification and Financial Data sheet
Schedule F	-	Project Experience Record (Parts A, B, C & D)
Schedule G	-	Construction Equipment
Schedule H	-	Personnel
Schedule J	-	Bio-data of Technical Personnel of Tenderer
Schedule K	-	Record of Arbitration and Litigation
Schedule L	-	History of Criminal Cases
Schedule M	-	Form of General Power of Attorney
Schedule N	-	Deleted
Schedule P	-	Copy of the Contractor's Registration in the required Class.
Schedule Q	-	Affidavit
Section I	:	Invitation to Tender
Section II	:	Instructions to Tenderers
Section III	:	Preface, General Conditions of Contract and Conditions of Particular Application.
Section-IV	:	Form of Tender, Tender Appendix, Bill of Quantities, Form of Letter of Acceptance, Form of Agreement, Form of Bank Guarantee for Security Deposit, List of Specification Drawings, Programme of Work including schedule of contractor's proposal for maintaining works during defect liability period.
Section-V	:	Schedules: Fair Wages Clause, Quarterly Report of Labour Employed on Construction Work.
Section VI	:	Addenda issued by the Superintending Engineer, VMC.
Section VII	:	Technical Specifications

6.2 The Tenderer is expected to examine carefully all instructions, conditions, forms, appendix to tender, terms, specifications, addenda, schedules, schedules of supplementary information and specification drawings in the Tender Documents. Failure to comply with the requirements of tender submission will be at the Tenderer's own risk. Pursuant to IT 25, tenders, which are not responsive, and not meeting the qualification requirements of the Tender documents will be rejected.

6.3 **Pre bid meeting:** The bidder or his official representatives is invited to attend a pre bid meeting, which will take place at the address indicated in the letter of invitation. The purpose of the meeting will clarify issues and to answer the questions on any matter that raised at that stage. The bidder is requested to submit the any questions in writing or by cable to reach VMC on or before the pre bid meeting. Minutes of the meeting and the test of the questions raised by the participants and the answers given by the VMC will be transmitted to all the bidders who purchased the bidding documents. Non attendance of the pre bid meeting will not be cause for disqualification of bidder.

IT 7. CLARIFICATION OF TENDER DOCUMENTS.

Tenderers shall carefully examine the Tender Documents and fully inform themselves as to all the conditions and matters, which may in any way affect the work or the cost thereof. Should a Tenderer find any discrepancy in or omission from the Specification or any other of the Tender Documents or should he be in doubt as to their meaning, he should immediately address a query in writing or by fax to the authority given in IT 18.3.

The VMC will entertain and offer clarifications to any such queries only if they are received prior to or on the date fixed for the pre-tender meeting (see IT 16). Written copies of the response of the VMC, including a description of inquiry, but without identifying its source, will be sent as an addendum to all prospective Tenderers, i.e. the persons to whom tenders have been issued. Any verbal information and/or clarification given by any representative of the VMC shall not be binding on the Superintending Engineer, VMC.

IT 8. AMENDMENT OF TENDER DOCUMENTS

8.1 At any time prior to the dead line for submission of Tenders, the VMC may for any reason, whether at its own initiative or in response to the clarifications requested by the prospective Tenderers, modify the Tender Documents by issuing an Addendum. Each Addendum will be issued to all the bidders by fax/e-mail/post.

Such addenda will be sent in writing or by fax/e-mail/post to all prospective Tenderers who have purchased the Tender Documents and will be binding upon them. Prospective tenderers shall acknowledge receipt of each addendum by cable and confirm in writing. The Tenderers shall duly sign and return one copy of each Addendum, along with their Tenders, which shall form part of their Tenders. Tenderer shall give a certificate in the affidavit as described in schedule Q.

In order to afford prospective Tenderers reasonable time to take such addenda into account in preparing their tenders, the VMC at its discretion, will extend the dead line for the submission of tenders in accordance with IT 19.

C. PREPARATION OF TENDERS

IT 9. LANGUAGE OF THE DOCUMENTS

9.1. All documents relating to the tender shall be in the English language.

IT 10. DOCUMENTS COMPRISING THE TENDER

10.1 The Tender to be prepared by the Tenderer shall comprise the following:

a) All documents and Specification Drawings (indicated in IT 6.1 Vols.I & II) Issued to the tenderer by the Chief Engineer, VMC.

b) Addenda issued by the Chief Engineer, VMC.

IT 11. TENDER PRICES

11.1 Unless stated otherwise in the Tender Documents, the Contract shall be for the whole of the works and the Tenderer shall indicate his willingness to execute the works at the lump sum price.

Not used

11.3 All duties, taxes, seigniorage charges and other levies payable by the Contractor under the Contract, or for any other cause shall be included in the tender submitted by the Tenderer and the evaluation and comparison of the tenders by the VMC will be made accordingly. For Sales Tax / Tax on Works Contract, the contractors are given the option to opt for the composing schemes under section 5 (g) of the APGST Act. The contractors opting for such a scheme are subject to a tax deduction at source such rate as applicable from time-to-time under APGST Act on the gross value of each bill. If not, Sales Tax will be deducted from all bills, according to the rules in force at the time. 0.25% of the gross value of each bill will be deducted for the development and functioning of the National Academy of Construction, Hyderabad, and forwarded to the Academy as per G.O.Ms.No:39, dt:3.2.1999 of MA&UD Department (K1).

11.4 Not used

11.5 The premium/discount quoted by the Tenderer shall be firm.

IT 12. Not used

IT 13. TENDER VALIDITY

13.1 Tenders shall remain valid and open for acceptance for a period of **180** days after the date of tender opening prescribed in IT-22.

13.2 In exceptional circumstances, prior to expiry of the original tender validity, the VMC may request the Tenderer for a specified extension in the period of validity. The request for any extension and the responses thereto, shall be in writing or cable. A Tenderer may refuse the request without forfeiting his EMD. A Tenderer agreeing to the request will not be required or permitted to modify his tender, but will be required to extend the validity of his EMD.

IT 14. EARNEST MONEY DEPOSIT, ITS FORFEITURE AND PENAL ACTION

14.1 Along with tender documents, the tenderers shall deposit an amount of **Rs.500000/- (Rupees five Lakhs only) as Earnest Money deposit**. As an alternative the tenderer may furnish a Bank Demand Draft or an unconditional Bank Guarantee from a Scheduled Bank / Nationalized bank issued on behalf of the tenderer. In case of a tender by a Joint Venture the Bank Guarantee should be on behalf of all the constituents of the Joint Venture. The Bank Guarantee should be valid for a minimum period of 45 days beyond the period of validity of the tender stipulated in IT 13.1 above. In case the tenderer extends the period of the validity of this tender extended, he shall take steps to extend the Bank Guarantee for a further period equal to the period of extension of the validity of the tender. Where a cash deposits is made towards Earnest Money it should be accompanied by a letter signed by the tender (and in case of a Joint Venture by all the constituents of Joint Venture) agreeing that the money should be retained as Earnest Money and be liable to forfeiture in terms of IT 14.5 and IT 14.2.

14.2 Deleted

14.3 The EMD of an unsuccessful Tenderer will be discharged / returned after an agreement is entered into with the Tenderer whose tender has been accepted.

14.4 The EMD of any successful Tenderer who has furnished the EMD in the form of a Bank Guarantee will be discharged when the Tenderer has signed the Form of Agreement and furnished the required Security Deposit.

14.5 The EMD shall be forfeited:

a) If a Tenderer modifies or withdraws his Tender during the period of tender validity; or, as described in IT 21.4.

b) In the case of a successful tender, if, within the specified time limit, the Tenderer fails to;

i) sign the agreement ;

or

ii) furnish the required Security Deposit;

or

c) If, pursuant to Clause IT 26, the Tenderer does not accept the correction of his tender premium / discount.

A Tenderer who withdraws his tender without a valid reason (to be decided by the authority competent to accept the tender) shall be disqualified for tendering further works in the VMC.

IT 15. VARIATIONS IN TENDERING CONDITIONS

15.1 Each Tenderer shall submit an offer, which complies with the requirements of the Tender Documents, including the basic technical design as indicated in the Specification Drawing and Specifications.

The Tenderer is requested to submit any queries in writing or fax addressed to the VMC to reach his office not later than ten working days before the submission of tender.

Proceedings of the Pre-tender Meeting including copies of the queries raised and responses given will be furnished expeditiously to all those attending the meeting, and subsequently to all purchasers of the Tender Documents. Any modification to any of the Tender Documents listed in Sub-clause IT 10.1, which may be necessary as a result, the Pe-tender Meeting will be made by the VMC and issued as an addendum or addenda pursuant to Cluase IT 8, and not in the shape of the minutes of the Pre-tender Meeting.

IT 17. FORMAT AND SIGNING OF TENDERS

17.1 The Tenderer shall prepare one copy of the documents comprising the tender.

17.2 The copy of the tender shall be typed or written in indelible ink and shall be signed by a person or persons duly authorised to bind the Tenderer to the

Contract. Proof of authorisation shall be furnished in the form of a certified copy of Power of Attorney, which shall accompany the tender. All pages of the tender where entries or amendment have been made shall be initialled by the person or persons signing the tender.

17.3 The completed tender shall be without alterations, inter-lineation or erasures except those which accord with instructions given by the VMC, or as necessary to correct errors made by the Tenderer, in which case such corrections shall be initialled by the person or persons signing the tender.

Each Tenderer shall submit only one tender. No Tenderer shall participate in the tender of another for the same contract in any capacity whatsoever.

ATTACHMENTS TO THE TECHNICAL BIDS

The bidder should submit brief details about his profiles of the firm, his past experience, financial turnover, O&M capabilities, Contact details etc.

The bidder should furnish the layout diagram with flow diagram for sewage treatment plants the technical details of the bid should contain the following but not limited to the items indicated as under.

a) Flow diagrams
b) Layout and general alignment diagram
c) Designs criteria adopted
d) Effluent quality and characteristics
e) Plant equipment along with rated capacities
f) Details of electrical, mechanical, instrumentation items with manufacturer names
g) Details of piping
h) Details of disposal of treated effluent and sludge
i) Details of chemicals and consumables at each and every unit for regular operation and maintenance
j) Power consumption at each and every unit
k) Detailed program schedule for work execution
l) Annual operation and maintenance plan with proposed manpower, chemicals, power consumption
m) Safety precautions proposed and fire fighting equipment proposed etc.

FORMAT AND SIGNING OF BIDS

The bidder shall prepare the bid documents in typed or computerized formats signed by the authorized representative of the bidder on each and every page with their office seal. Any interlineations, erasures, overwriting shall only be valid if they are initialed by the person or the persons signing the bid.

SUBMISSION OF TENDERS

IT 18. SEALING AND MARKING OF TENDERS

18.1 The signed documents shall be submitted in sealed covers, as follows:

i) Sealed Cover 'A' shall contain the entire qualification data and information required as per the Bid Documents, Record of Litigation, History of criminal cases, Affidavit, Power of Attorney, Joint Venture Agreement (in case of the tender submitted from JV of two or more firms / contractors as partners), Income Tax Clearance Certificate, Sales Tax Clearance Certificate, addenda issued duly signed Technical Specifications and Specification Drawings and any other relevant information required as per Bid Documents and as per Schedules B to R contained in Volume-I of the Bid Documents, except financial offer. In addition to the above the bidder should submit the details of the technical proposal detailed process diagram with sizes, levels. Brief description of the process, disposal process effluent standards etc. the bear the superscription as "COVER-`A' - TECHNICAL BID".

The data and information need to be furnished as per the Schedule of Supplementary information in the proformas given in Volume-I of Bid Document. The said information and data shall be either filled in the proformas given in the Volume-I of the Bid Document or enclosed separately as per the said proformas along with Volume-I duly signed by the tenderer (in case of bid from a JV, signed by all partners of the JV). The Volume-I of Tender Document as well as the information and data furnished by the tenderer as required shall be duly signed and enclosed in Sealed Cover-A.

ii) Sealed Cover 'B' i.e. Price Bid, shall contain Vol-II of the Bid Documents along with the price offer offered and signed by the bidder in Schedule-A of Volume-II of Bid Document (signed by all the JV partners, in case of the tender submitted from JV of two or more firms / contractors as partners), and bear the superscription "COVER-B 'PRICE BID'".

iii) Both the covers 'A' and 'B' shall be submitted in Sealed Cover 'C' which will be provided by the VMC as part of the Tender Documents, while issuing tender schedule.

The Tenderer shall also ensure that Sealed Covers A and B both bear his name and address in case either cover has to be returned to him unopened.

18.2 Sealed Cover 'C' shall bear the following identification marks (to be completed by the Issuing Officer at the time of issue of the Tender Documents):

i) Tender Notice No. :_____

ii) Name of Work :_____

iii) Contract No. :_____

iv) DO NOT OPEN BEFORE_____ (the time and date specified in Sub-clause IT 19.1)

v) The name and address of the Tenderer.

vi) The name and address of the officer to whom the Tender is to be submitted, as detailed in Sub-clause IT 18.3.

The completed Tender shall be sent to the following address to arrive before the time and date specified for receiving the tenders (see Sub-clause IT 19.1). The above sealed tenders are to be submitted in the tender box placed at

1. O/o Superintending Engineer, Municipal Corporation, Vijayawada.

18.4 If the cover 'C' is unsealed, or is damaged in any way such that Cover A or B may be lost or exchanged without damaging the seal or the cover further, the VMC will assume no responsibility for the misplacement or premature opening of the tender. Such tenders will be summarily rejected. Any tender opened prematurely for either because of damage to it or because of inadequate identification, as specified in Sub-clause IT 18.2, will also be rejected.

Tenders not submitted in the proper form or in due time, will be rejected. No alterations which have been made by the Tenderer in the Form of Contract, the Conditions of the Contract, the Specification Drawings, Specifications or quantities accompanying the same, will be recognized, and if any such alterations have been made, the tender will be void.

IT 19. DEADLINE FOR SUBMISSION OF TENDERS

19.1 Tenders shall be received in the office of the officer designated in Sub-clause IT 18.3 up to 3.00 p.m. on **30-05-2007**. They may be deposited in the tender box expressly provided for the purpose. In the case of submission by post, including registered post and/or courier, the risk and responsibility for loss, delay, damage

to the seal or tampering with the cover shall be at the risk of the Contractor. If for any reason the date for submission of tenders is declared a holiday the next working day will be treated as the last date for submission of tenders.

19.2 The tender should be in the prescribed form as described in IT 10.

19.3 The VMC may, at its discretion, extend the dead line for submission of the tenders by issuing an amendment in accordance with Clause IT 8, in which case all rights and obligations of the VMC and of the Tenderers which were previously subject to the original dead line shall thereafter be subject to the new dead line as extended.

IT 20. LATE TENDERS

20.1 Any tender received after the deadline for submission of tender as stated in Clause IT 19, or, as subsequently extended by the VMC, will be returned to the Tenderer unopened.

IT 21. WITHDRAWAL OF TENDERS

21.1 The Tenderer may withdraw his tender after tender submission, provided that the notice of withdrawal is received in writing by the VMC prior to the prescribed dead line for submission of tenders.

21.2 The Tenderer's notice of withdrawal shall be prepared, sealed, marked and delivered in accordance with provision of IT 18.3 for submission of tender, with the envelope marked "Withdrawals".

21.3 No tender may be withdrawn after the deadline for submission of tenders.

21.4 Withdrawal of a tender by a Tenderer during the interval between the deadline for submission of tenders and the expiration of the period of tender validity specified in the Form of Tender shall result in the forfeiture of the EMD pursuant to Clause IT14.

E. TENDER OPENING AND EVALUATION

IT 22. TENDER OPENING

22.1 The Chief Engineer, VMC or authorised officer designated by the Chief Engineer, VMC will open the Technical Bids (Cover-A's) and any submissions made pursuant to Clause IT 21, in his office, **at 3.30 p.m**. on **29-05-2006** in the presence of any of the Tenderers' or their representatives who choose to attend, all of whom sign a register as evidence of their attendance.

22.2 Tenders for which an acceptable notice of withdrawal has been submitted pursuant to IT 21, shall not be opened and shall be returned to the Tenderer on completion of the Tender acceptance process.

22.3 Cover 'C' of the remaining tenders shall be examined and their condition minuted. Any Tenders in which the Cover 'C' is found unsealed or is damaged such that Covers 'A' or 'B' can be exchanged without damaging the cover further or damaging the seal shall be rejected, and minuted.

22.4 Cover 'C' of the remaining tenders shall then be opened and the condition of covers 'A' and 'B' examined to ensure that they are properly sealed and their condition minuted. Any tenders in which either of the covers A or B are found to be unsealed, shall not be opened and shall be rejected. Any such action shall also be minuted.

22.5 Then sealed covers 'A' will then be opened. The tender will be rejected and the cover 'B' will not be opened if:

i) If there are any criminal cases pending.

ii) If the eligibility and qualification criteria are not in accordance with various Clauses of IT-3 and Clause-84, Part-II – Conditions of Particular Application.

iii) If the Income Tax Certificate is not enclosed.

iv) If the Sales Tax Certificate is not enclosed.

v) If the registration certificate of the contractor is not enclosed.

vi) If the Affidavit is not enclosed.

vii) If the Power of Attorney is not enclosed.

viii) Details of the process and technical specification of the proposed technology.

ix) If the history of criminal cases is not enclosed.

x) If the record of litigation and arbitration is not enclosed.

xi) Identification and financial data sheet is not enclosed.

xii) If the Joint Venture agreement is not enclosed in case of bids received from Joint venture of two or more firms / contractors.

xiii) Addenda issued by the superintending engineer, VMC are not enclosed.

xiv) If the Manufacturers Authorization Form (Schedule-U) is not enclosed. In case if the tenderer is not a manufacturer of D.I. pipes as per IS 8329-1994 Class K-9 the Manufacturers Authorization Form (Schedule-U) required to be obtained from reputed D.I. pipe manufacturers who successfully manufactured D.I. pipes of various diameters during past five years with an established pipe manufacturers factory in India.

Any such conditions shall be minuted and the cover 'B' shall not be opened. It shall then be kept in the safe custody of the VMC, until the tender process is finished. Thereafter the tender shall be returned to the Tenderer.

22.6 At the time of opening of the Cover-A's (i.e. Technical Bids), the CHIEF ENGINEER, VMC would announce any written notification of tender withdrawals, the presence of the requisite EMD or not, and such other details as the Tender opening authority may consider appropriate to be announced.

22.7 At the time of opening the Cover-B's (i.e. Price Bids), the CHIEF ENGINEER, VMC would announce the lump sum rate quoted by the tenderer whose Cover-B's (i.e. Price Bids) are opened.

The VMC shall prepare, for his own record, minutes of the tender opening, including the information disclosed to those present in accordance with Sub-clause IT 22.6 & IT 22.7.

IT 23. PROCESS TO BE CONFIDENTIAL

23.1 After the opening of tenders as per Clause IT 22, information relating to examination, clarification, evaluation and comparison of tenders and recommendations, concerning the award of contract shall not be disclosed to the Tenderers or any other persons not officially concerned with the process until the award of the Contract to the successful Tenderer has been announced.

23.2 Any effort by any Tenderer to influence the officials of VMC in the examination, clarification, evaluation and comparison of tenders, and in any decisions

concerning award of a contract, may result in the rejection of the Tenderer's tender.

IT 24. CLARIFICATION OF TENDERS

24.1 To assist in the examination, evaluation and comparison of the tenders, the Chief Engineer, VMC may ask Tenderers individually for clarification of their tenders. The request for clarification and response shall be in writing or by cable. However, no change in the tender premium / discount or substance will be sought, offered or permitted by the VMC, during the evaluation of the tenders except as provided in IT 26.

IT 25. DETERMINATION OF RESPONSIVENESS

25.1 Prior to the detailed evaluation of tenders, the VMC would determine whether each tender has been submitted in the proper form and whether it is substantially responsive to the requirements of the Tender Documents. Tenders, which have not been submitted in the proper form, will be rejected.

For the purpose of the above Sub-clause, a substantially responsive tender is one in which conforms to all the terms, conditions and specifications of the Tender Documents without material deviation or reservation. A material deviation or reservation is one which effects in any substantial way the scope, quality or performance of the works, or which limits in any substantial way inconsistent with the Tender Documents the rights of the VMC or restricts the Tenderer's obligations under the contract and one in which the rectification of any such deviations or reservations would affect unfairly the competitive position of any of the other Tenderer's who have presented substantially responsive tenders.

25.3 Any tender which is not substantially responsive to the requirements of the Tender Documents would be rejected by the VMC and may not subsequently be made responsive by the Tenderer correcting or withdrawing the non-conforming deviation(s) or reservation(s).

IT 26. CHECKING FOR AND CORRECTION OF ERRORS

26.1 Tenders determined to be substantially responsive will be checked by the CHIEF ENGINEER, VMC for any discrepancy between the quoted value in figures and in words. Should any discrepancy be found the tender quoted rate in words will govern.

26.2 Any tender is found to be incorrect as described in the above Sub-clause will be recorded and attested by the Chief Engineer, VMC or authorised officer designated by the Chief Engineer, VMC at the time of opening the Cover-B (i.e. Price Bid). With the concurrence of the affected Tenderer, the corrected tender quoted rate shall be considered binding. If the Tenderer does not accept the corrected tender value , the tender will be rejected and the EMD will be forfeited.

IT 27. Not used.

IT 28. EVALUATION AND COMPARISON OF TENDERS

28.1 The VMC will evaluate and compare only those tenders, which have been determined to be substantially responsive to the requirements of the Tender Documents in accordance with Clause IT 25.

28.2 Evaluation of the tenders shall comprise an assessment of the impact of any material deviations or reservations that may have been placed on any of the tenders which may affect the execution of the works in the manner and/or the time specified, and their relationship to the tender premium / discount offered. Such deviations or reservations will not be permitted, and such Tender shall be rejected. Record of arbitration/Litigation shall also be taken into account at the time of evaluation of Tenders.

28.4 Not Used.

28.5 The Competent Authority shall initially verify the correctness of the qualification criteria and certificates of the Tenderers submitting the three lowest conforming tenders. Attention shall be paid to the statements of experience, the authenticated agreements of previous works executed, and the histories of arbitration and litigation and the trend in growth of business.

IT 29. Not used

F. EVALUATION PROCEDURE

VMC will examine the technical proposal of the bidder after responsiveness of the bidder in all other aspects such as furnishing of EMD, satisfying the registrations, sales tax certification, Income Tax certification, Annual financial turnover, Technical past experience, financial turnover in one year for similar nature of works as mentioned in the IT 3. Then, the technical proposals of the bidder will compared to the standard specifications laid down by the IS codes, manuals etc. While evaluating technical proposal

VMC will consider all the process parameters, efficiency of the units, effluent standards, chemicals and consumables requirement, power consumption, land utilization, sludge handling and disposal, gas handling and disposal. The sewage processing should be innovative with less power consumption and occupies limited land space.

G. EVALUATION CRITERIA

The bids will be evaluated on the basis of capital and maintenance cost. The capital will alone shall not decide the bid. The Project cost will be calculated duly considering the O&M period of 5 years. The annual maintenance for each and every bid will be calculated based on the power consumption, chemical & consumables, routine maintenance, oils, greases, spares etc., the bidder whose price is lowest when considering both i.e. maintenance cost and capital cost after discounting the maintenance cost will be the successful bidder.

H. NEGOTIATIONS

Prior to the expiration period of the proposal validity, VMC will notify the successful tenderer who submitted the lowest quoted value by registered letter, cable, telex or facsimile and invite to negotiate a contract.

Negotiations normally take from two to five days. The aim is to reach agreement on all points and to instate a draft contract as per the conclusion of negotiations.

Negotiations will commence with a discussion of your financial proposal, the proposed methodology (work plan), staffing and suggestions you may have made to improve the system. Agreement must then be reached on the final document the staffing, bar charts, which will indicate activities, staff, and periods in the field, logistics and reporting. Special attention will be paid to optimize the required outputs form the service provider within the available budget and to define clearly the inputs required from the VMC to ensure satisfactory implementation of the Assignment.

Changes agreed upon will then be reflected in the financial proposal, using proposed lump sum rates.

The negotiations will be concluded with a review of the draft form of Contract. The VMC and the BIDDER will finalize the contract to conclude negotiations after finalizing the financial at the bottom line.

I. AWARD OF CONTRACT

IT 30. AWARD CRITERIA

30.1 Subject to Clause IT 31, the Commissioner / CE / Tender Committee / Council will award the contract to the Tenderer whose tender has been determined to be qualified and substantially responsive to the Tender Documents and who has submitted the best tender according to the comparison and evaluation process described in Clause IT 28. Normally this shall be the substantially responsive Tenderer offering the lowest tender sum for Part I of Schedule A, based on the tender premium / discount offered.

IT 31. DEPARTMENT'S / VMC'S RIGHT TO ACCEPT ANY TENDER AND TO REJECT ANY OR ALL TENDERS

31.1 Not withstanding Clause IT 30, the Commissioner or C.E. reserves the right to accept or reject any tender, and to annul the tendering process and reject all tenders at any time prior to the award of Contract without thereby incurring any liability to the affected Tenderer or Tenderers on the grounds of its action.

IT 32. NOTIFICATION OF AWARD

32.1 Prior to the expiration of the tender validity period prescribed in Clause IT 13 the Chief Engineer, Municipal Corporation, Vijayawada of VMC will notify the successful Tenderer by fax, letter, or in some other written form, that his tender has been accepted. This letter hereinafter and conditions of contract called "Letter of Acceptance", will conform the tender premium / discount which will apply to the works and a request to submit a security deposit to the VMC as specified in Clause IT 34.

32.2 The Letter of Acceptance will constitute notification of the intention to enter into a contract with the Tenderer for the execution of the works.

32.3 As soon as the successful Tenderer submits the security deposit in accordance with the provisions of Clause IT 34, and has signed the agreement the Chief Engineer, VMC will promptly return/discharge the EMD of the unsuccessful Tenderers.

IT 33. SIGNING OF AGREEMENT

33.1 At the same time as the Chief Engineer, Municipal Corporation, Vijayawada notifies the successful Tenderer that his tender has been accepted, the VMC will send the Tenderer the Form of Agreement, incorporating all the agreements between the parties provided in the Tendering Document, and the Conditions of Contract, Schedules, Technical Specification and the Specified Drawings.

33.2 Within 7 days of receipt of Form of Agreement, the successful Tenderer shall sign the Form and return it to VMC.

IT 34. **SECURITY DEPOSIT AND WITHHELD AMOUNTS**

34.1 Within 7 days of receipt of the Letter of Acceptance from the Chief Engineer, Municipal Corporation, Vijayawada, VMC the successful Tenderer shall furnish the VMC Security Deposit in the form of crossed Demand Draft or a Bank Guarantee which shall be to the value of two and half percent (2 ½ of the contract price)

34.2 The Bank Guarantee shall be issued by any Scheduled Bank / Nationalized Bank located in India, as chosen by the Tenderer.

34.4 The Security Deposit for the works shall be returned to the Contractor at the end of defects liability period, subject to the satisfactory performance of the contract in all respects, less any dues owing from the contract.

34.5 Failure of the successful Tenderer to comply with the requirements of Clauses IT 33 or IT 34 shall constitute sufficient grounds for the annulment of the award and forfeiture of the EMD.

33.0 CORRUPT OR FRAUDULENT PRACTICES:

33.1 The VMC reserves the right to declare a firm ineligible, either indefinitely or for a stated period of time, to be awarded the said contract if it at any time determines that the firm has engaged in corrupt or fraudulent practices in competing for, or in executing, any other Contract financed by a Competent Authority. In pursuance of this policy, the VMC defines, for the purpose of this provision, the terms set forth below as follows:

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

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

PURVIEW OF THE CONTRACT:

All the transactions pertains to this assignment will falls under the purview of APDSS, departmental codes, Municipal ACT, Government orders, manuals, IS codes, and all relevant guide lines.

SECTION - III : CONDITIONS OF CONTRACT

PREFACE

The Conditions of Contract comprises two parts, namely:

Part I : General Conditions of Contract (Preliminary Specifications)

Part II : Conditions of Particular Application.

CHAPTER - III

GENERAL CONDITIONS OF CONTRACT

RESPONSIBILITIES AND LIABILITIES OF THE CONTRACTOR

Explanation: This section sets forth some responsibilities which the contractor shall assume in addition to those mentioned in other sections of this "Preliminary Specification" – under every contract which he enters into, with the Andhra Pradesh Public Works Department and he should therefore calculate his unit prices for schedule items of work accordingly.

Observance of laws – Local regulations and notices – Attachments: The Contractor shall conform to the regulations and bye-laws of any local authority and/or of any water or lighting companies with whose systems the structure is proposed to be connected and shall, before making any variations from the drawings or specification that may be necessitated by so conforming, give to the Executive Engineer, VMC written notice, specifying the variations proposed to be made and the reasons for making them, and apply for instructions thereon. In case, the contractor shall not receive such instructions within seven days, he shall proceed with the work, conforming to the provision; regulation or bylaw in question; and any variations in the drawings or specifications so necessitated shall be dealt with under clause 63. The contractor shall give all notices required by the said Acts, regulations or bye-laws and pay all fees in connection therewith, unless otherwise arranged and decided on in writing with the Executive Engineer, VMC. He shall also ensure that no attachments are made against materials or work forming part of or for the use of the contract. In every case referred to in this clause, the contractor shall protect and indemnify Government against any claim or liability arising from or based on the violation of any such law, ordinance, regulation, order, decree, or attachment, whether by himself or by his employees.

Accidents-Hoarding, Lighting Observations – Watchmen:

When excavations have been made or obstacles have been put in public thorough fares or in places where there is any likelihood of accidents, the contractors shall comply with any

requirement of law on the subject, and shall provide suitable hoarding, lighting and watchmen as necessary.

It shall be the contractor's sole responsibility to protect the public and his employees against accident from any cause and he shall indemnify Government against any claims for damages for injury to person or property, resulting, from any such accidents; and shall where the provisions of the Workmen's Compensation Act apply, take steps to properly insure against any claims thereunder.

On the occurrence of an accident which results in the death of any of the workmen employed by the contractor or which is so serious as to be likely to result in the death of any such workmen, the contractor shall, within 24 hours of the happening of such accident, intimate in writing to the concerned Section Officer of the Public Works Department, the fact of such accident. The contractor shall indemnify Government against all loss or damage sustained by Government resulting directly or indirectly from his failure to give intimation in the manner aforesaid including the penalties or fines if any payable by Government as a consequence of Government's failure to give notice under the Workmen's Compensation Act or otherwise confirm to the provisions of the said Act in regard to such accident.

In the event of an accident in respect of which compensation may become payable under the Workmen's Compensation Act VIII of 1923 whether by the contractor or by the Government as principal it shall be lawful for the Executive Engineer, VMC to retain out of monies due and payable to the contractor such sum or sums of money as may in the opinion of the said Executive Engineer, VMC be sufficient to meet such liability. The opinion of the Executive Engineer, VMC shall be final in regard to all matters arising under this clause.

Blasting: Blasting executed by contractors in connection with Government works shall be carried out in the manner described under "Blasting operation – Instructions to contractors" of the A.P.S.S.

Protections of adjoining and existing premises: The contractor is to protect the whole of the adjoining and, where necessary, the existing premises, and all works and all fittings to all buildings on and adjoining the site against structural and decorative damage caused by the execution of these works and make good in all respects all such damage done or occurring to the same, and leave such reinstatement in perfect order. He is also to make good any damage done in the execution of the work to existing public or private footways or roadways.

Permit other Workmen-Co-operation-Afford facilities: The Executive Engineer, VMC shall have full power to send workmen upon the premises to execute fittings and other works not included in the contract, for whose operations the contractor is to afford every reasonable facility during ordinary working hours, provided that such operations shall be carried on in such a manner as not to impede the progress of the work included in the contract, but the contractor is not to be responsible for any damage which may happen to or be occasioned by any such fittings or other works, provided he complies with the Executive Engineer, VMC 's instructions in connection therewith, and provided that the damage is not caused by himself or his workmen.

The contractor shall, to all times, co-operate, assist, attend on, and afford facilities for such specialist as may be employed by the Executive Engineer, VMC on other works in connection with the building, allowing them, free of charge, the use of all plant, light and water installed in the works. The contractor shall also cause such special work or protect it as instructed to avoid injury during progress of the works. For failure so to protect, the contractor must make good any damage caused.

Holes for water service, gas, electrical, and Sanitary fittings: The contractor shall leave all holes in masonry and floors for the insertion of water services, gas, and electrical connections and sanitary fittings in the exact positions indicated by the Executive Engineer, VMC during the progress of the work. These holes must be properly built up, in a workman like manner, at the contractor's cost, as soon as the fittings have been installed, in cases where the installations are made during the construction of the building

and where, in the opinion of the Executive Engineer, VMC delays in settlement of accounts will not thereby occur.

Contractor's risk and insurance: The work executed by the contractor under the contract shall be maintained at the contractor's risk until the work is taken over by the Executive Engineer, VMC . The contractor shall accordingly arrange his own insurance against fire and other usual risks during such period unless otherwise specified:

Provided however that the contractor shall not be liable for all or any loss or damage occasioned by or arising out of acts of God, and in particular unprecedented flood volcanic eruption, earthquake or other convulsion of nature, invasion, the act of foreign enemies' hostilities or warlike operations (before or after declaration of war) rebellion, military or usurped power.

CONDITIONS OF PARTICULAR APPLICATION

Contractors Risk and Insurance:

Employer's and Contractor's Risks: The employer carries the risks which this Contract states are Employer's risks, and the Contractor carries the risks which this Contract states are Contractor's risks.

Employer's Risks: The Employer is responsible for the expected risks which are (a) in so far as they directly affect the execution of the works in the Employer's country, the risks of war, hostilities, invasion, act of foreign enemies, rebellion, revolution, insurrection or military or usurped power, civil war, riot commotion or disorder (unless restricted to the Contractor's employees), and contamination from any nuclear fuel or nuclear waste or radioactive toxic explosive, or (b) a cause due solely to the design of the works, other than the Contractor's design.

Contractor's Risks: All risks of loss of or damage to physical property and of personal injury and death which arise during and in consequence of the performance of the Contract other than the expected risks are the responsibility of the Contractor.

Insurance: The Contractor shall provide, in the joint names of the Contractor, insurance cover from the Start Date to the end of the Defects Liability Period, in the amounts and deductibles for the following events which are due to the Contractor's risks:

- loss or damage to the Works, Plant and Materials;
- loss or damage to Equipment;
- loss of or damage of property (except the Works, Plant, Materials and Equipment) in connection with work.
- Surrounding structures, assets etc.
- Personal injury or death of workers, contractor, employees etc.
- Damage injury of death to the 3rd Party, general public etc.

Policies and certificates for insurance shall be delivered by the Contractor to the Engineer for the Engineer's approval before the Start Date. All such insurance shall provide for compensation to be payable in the types and proportions of currencies required to rectify the loss or damage incurred, injury and death of workers and public.

If the Contractor does not provide any of the policies and certificates required, the Employer may effect the insurance which the Contractor should have provided and recover the premiums the Employee has paid from payments otherwise due to the Contractor or, if no payment is due, the payment of the premiums shall be a debt due.
Alterations to the terms of an insurance shall not be made without the approval of the Engineer.
Both parties shall comply with any conditions of the insurance policies.

Cancellation of Contract

The Contractor shall indicate the names of the persons who are working with him in any capacity and are subsequently employed in the VMC. He shall also furnish a list of Non-gazetted employees of the VMC, related to him. Failure to furnish such information renders him liable to be removed from the list of Contractors and his Contract liable for cancellation. Near relatives include:

1. Sons, step sons, Daughters, step-daughters
2. Son-in-law and Daughter-in-law

3. Brother-in-law and Sister-in-law
4. Brothers and Sisters
5. Father and Mother
6. Wife/Husband
7. Father-in-law and Mother-in-law
8. Nephews, Nieces, Uncles, Aunties
9. Cousins
10. Any person residing with the Contractor.

OPERATION AND MAINTENANCE OF EQUIPMENT

Statement giving brief particulars of equipment that will be put at the disposal of the work, should accompany the tender in Schedule-`G'.

Equipment (Transport for materials viz., lorries and carts, piles and pile driving equipment etc.).

PAYMENT TO LABOUR UNDER EMERGENCY

The Contractor should note that in the event of emergency he shall pay the labour every day and if this is not done, the department shall make requisite payment and recover the cost from the Contractor.

Water & Power Charges

The supply of water and electric power is the responsibility of the contractor at his own expense. However, if either electric power or water is made available by VMC, then the costs of such electric power or water will be recovered by VMC from the contractor at the rates prevailing at the time.

The amount quoted by the contractor shall be deemed to be inclusive of taxes and duties on all the materials that the contractor has to purchase for the performance of this contract. The contractor shall also be liable to pay turnover tax under works contract at the prevailing rates under A.P. General Sales Tax Act. The recoveries will be made as per the rates in force under the Act at the time of payment.

Break-up for Excise Duty & Sales Tax

The amount quoted by the contractor shall be deemed to be inclusive of taxes and duties on all the materials that the contractor has to purchase for the performance of this contract.

The contractor should ensure the safety of the water supply lines, sewer lines, telephone cables, power cables, storm water drains etc., at the site of work and, if any damage occurs during execution it should be attended immediately at the contractors cost. Failing to attend immediately, the same will be got done by the Department at the cost risk of the contractor.

OTHER CONDITIONS OF CONTRACT

1. Definitions

Terms which are defined in the Contract Data are not also defined in the Conditions of Contract but keep their defined meanings. Capital initials are used to identify defined terms.

The **Adjudicator** is the person appointed jointly by the Employer and the Contractor to resolve disputes in the first instance, as provided for in Clauses 24 and 25. The name of the Adjudicator is defined in the Contract Data.

Compensation Events are those defined in Clause hereunder.

The **Completion Date** is the date of completion of the O&M Contract as certified by the Engineer in accordance with Sub Clause.

The **Contract** is the contract between the Employer and the Contractor to execute, complete and maintain the Works. It consists of the documents listed in Clause below.

The **Contract Data** defines the documents and other information which comprise the Contract.

The **Contractor** is a person or corporate body whose Bid to carry out the Works has been accepted by the Employer.

The **Contractor's Bid** is the completed Bidding document submitted by the Contractor to the Employer.

The **Contract Price** is the price stated in the Letter of Acceptance and thereafter as adjusted in accordance with the provisions of the Contract.

Days are calendar days; **months** are calendar months.

A **Defect** is any part of the Works not completed in accordance with the Contract.

The **Employer** is the party who will employ the Contractor to carry out the O&M operations.

The **Engineer** is the person named in the Contract Data (or any other competent person appointed and notified to the contractor to act in replacement of the Engineer) who is responsible for supervising the operation and maintenance activities and administering the Contract.

Equipment is the Contractor's machinery and vehicles brought to the Site to carryout the O&M operations.

The **Initial Contract Price** is the Contract Price listed in the Employer's Letter of Acceptance.

The **Intended Completion Date** is the date on which it is intended that the Contractor shall complete the Works. The Intended Completion Date is specified in the Contract Data. The Intended Completion Date may be revised only by the Engineer by issuing an extension of time.

Materials are all supplies, including consumables, used by the contractor for incorporation in the O&M operations.

Plant is any integral part of the Works which is to have a mechanical, electrical, electronic or chemical or biological function.

The **Site** is the area defined as such in the Contract Data.

Site Investigation Reports are those which were included in the Bidding documents and are factual interpretative reports about the surface and sub-surface conditions at the site.

Specification means the Specification of the Works included in the Contract and any modification or addition made or approved by the Engineer.

The **Start Date** is given in the Contract Data. It is the date when the Contractor shall commence execution of the works. It does not necessarily coincide with any of the Site Possession Dates.

A **Subcontractor** is a person or corporate body who has a Contract with the Contractor to carry out a part of the work in the Contract which includes work on the Site.

Temporary Works are works designed, constructed, installed, and removed by the Contractor which are needed for construction or installation of the Works.

A **Variation** is an instruction given by the Engineer which varies the Works.

The **Works** are what the Contract requires the Contractor to construct, install, and turn over to the Employer, as defined in the Contract Data.

2. Interpretation

In interpreting these Conditions of Contract, singular also means plural, male also means female or neuter, and the other way around. Headings have no significance. Words have their normal meaning under the language of the Contract unless specifically defined. The Engineer will provide instructions clarifying queries about the Conditions of Contract.

If sectional completion is specified in the Contract Data, references in the Conditions of Contract to the Works, the Completion Date, and the Intended Completion Date apply to any Section of the Works (other than references to the Completion Date and Intended Completion date for the whole of the Works).

The documents forming the Contract shall be interpreted in the following order of priority:

(1) Agreement

(2) Letter of Acceptance, notice to proceed with the works

(3) Contractor's Bid

(4) Contract Data

Conditions of Contract including Special Conditions of Contract.

3. Languages and Law

3.1 The language of the Contract and the law governing the Contract are stated in the Contract Data.

4. Engineer's Decisions

4.1 Except where otherwise specifically stated, the Engineer will decide contractual matters between the Employer and the Contractor in the role representing the Employer.

5. Delegation

5.1 The Engineer may delegate any of his duties and responsibilities to other people except to the Adjudicator after notifying the Contractor and may cancel any delegation after notifying the Contractor.

6. Communications

6.1 Communications between parties which are referred to in the conditions are effective only when in writing. A notice shall be effective only when it is delivered (in terms of Indian Contract Act).

7. Subcontracting

7.1 The Contractor may subcontract with the approval of the Engineer but may not assign the Contract without the approval of the Employer in writing. Subcontracting does not alter the Contractor's obligations.

Other Contractors

8.1 The Contractor shall cooperate and share the Site with other contractors, public authorities, utilities, and the Employer between the dates given in the Schedule of Other Contractors. The Contractor shall as referred to in the Contract Data, also provide facilities and services for them as described in the Schedule. The employer may modify the schedule of other contractors and shall notify the contractor of any such modification.

9. Personnel

9.1 The Contractor shall employ the key personnel named in the Schedule of Key Personnel as referred to in the Contract Data to carry out the functions stated in the Schedule or other personnel approved by the Engineer. The Engineer will approve any proposed replacement of key personnel only if their qualifications, abilities, and relevant experience are substantially equal to or better than those of the personnel listed in the Schedule.

9.2 If the Engineer asks the Contractor to remove a person who is a member of the Contractor’s staff or his work force stating the reasons the Contractor shall ensure that the person leaves the Site within seven days and has no further connection with the work in the Contract.

10. Employer’s and Contractor's Risks

10.1 The Employer carries the risks which this Contract states are Employer's risks, and the Contractor carries the risks which this Contract states are Contractor's risks.

Employer's Risks:

The Employer is responsible for the excepted risks which are (a) in so far as they directly affect the execution of the Works in the Employer's country, the risks of war, hostilities, invasion, act of foreign enemies, rebellion, revolution, insurrection or military or usurped power, civil war, riot commotion or disorder (unless restricted to the Contractor's employees), and contamination from any nuclear fuel or nuclear waste or radioactive toxic explosive, or (b) a cause due solely to the design of the Works, other than the Contractor's design.

12. Contractor's Risks

12.1 All risks of loss of or damage to physical property and of personal injury and death which arise during and in consequence of the performance of the Contract other than the excepted risks are the responsibility of the Contractor.

13. Insurance

13.1 The Contractor shall provide, in the joint names of the Employer and the Contractor, insurance cover from the Start Date to the end of the Defects Liability Period, in the amounts and deductibles stated in the Contract Data for the following events which are due to the Contractor's risks:

(a) loss of or damage to the Works, Plant and Materials;

(b) loss of or damage to Equipment;

loss of or damage of property (except the Works, Plant, Materials and Equipment) in connection with the Contract;

Surrounding structures, assets, infrastructure such as water, road, communication, sewer lines.

Personal injury or death of workers, employees.

Damage, Injury or death to the 3rd Party, general public etc.

13.2 Policies and certificates for insurance shall be delivered by the Contractor to the Engineer for the Engineer's approval before the Start Date. All such

insurance shall provide for compensation to be payable in the types and proportions of currencies required to rectify the loss or damage incurred.

13.3 If the Contractor does not provide any of the policies and certificates required, the Employer may affect the insurance which the Contractor should have provided and recover the premiums the Employer has paid from payments otherwise due to the Contractor or, if no payment is due, the payment of the premiums shall be a debt due.

13.4 Alterations to the terms of insurance shall not be made without the approval of the Engineer.

13.5 Both parties shall comply with any conditions of the insurance policies.

14. Site Investigation Reports

14.1 The Contractor, in preparing the Bid, shall rely on any site Investigation Reports referred to in the Contract Data, supplemented by any information available to the Bidder.

15. Queries about the Contract Data

15.1 The Engineer will clarify queries on the Contract Data.

16. The Works to Be Completed by the Intended Completion Date

16.1 The Contractor may commence O&M operations on the Start Date and shall carry out the Works in accordance with the program submitted by the Contractor, as updated with the approval of the Engineer.

17. Approval by the Engineer

17.1 The Contractor shall submit Specifications and Drawings showing the proposed Temporary Works to the Engineer, who is to approve them if they comply with the Specifications and Drawings.

17.2 The Contractor shall be responsible for design of Temporary Works.

17.3 The Engineer's approval shall not alter the Contractor's responsibility for design of the Temporary Works.

17.4 The Contractor shall obtain approval of third parties to the design of the Temporary Works wherever required.

17.5 All Drawings prepared by the Contractor for the execution of the temporary or permanent Works, are subject to prior approval by the Engineer before their use.

18. Safety

18.1 The Contractor shall be responsible for the safety of all activities on the Site.

19. Discoveries

19.1 Anything of historical or other interest or of significant value unexpectedly discovered on the Site is the property of the Employer. The Contractor is to notify the Engineer of such discoveries and carry out the Engineer's instructions for dealing with them.

20. Possession of the Site

20.1 The Employer shall give possession of all parts of the Site to the Contractor. If possession of a part is not given by the date stated in the Contract Data the Employer is deemed to have delayed the start of the relevant activities and this will be Compensation Event.

21. Access to the Site

21.1 The Contractor shall allow the Engineer and any person authorized by the Engineer access to the Site, to any place where work in connection with the Contract is being carried out or is intended to be carried out and to any place where materials or plant are being manufactured / fabricated / assembled for the works.

22. Instructions

22.1 The Contractor shall carry out all instructions of the Engineer which comply with the applicable laws where the Site is located.

22.2 The Contractor shall permit the bank to inspect the Contractor's accounts and records relating to the performance of the Contractor and to have them audited by auditors appointed by the Bank, if so required by the Bank.

23. Disputes

23.1 If the Contractor believes that a decision taken by the Engineer was either outside the authority given to the Engineer by the Contract or that the decision was wrongly taken, the decision shall be referred to the Adjudicator within 14 days of the notification of the Engineer's decision.

24. Procedure for Disputes

24.1 The Adjudicator shall give a decision in writing within 28 days of receipt of a notification of a dispute.

24.2 The Adjudicator shall be paid daily at the rate specified in the Contract Data together with reimbursable expenses of the types specified in the Contract Data and the cost shall be divided equally between the Employer and the Contractor, whatever decision is reached by the Adjudicator. Either party may refer a decision of the Adjudicator to an Arbitrator within 28 days of the Adjudicator's written decision. If neither party refers the dispute to arbitration within the above 28 days, the Adjudicator's decision will be final and binding.

24.3 The arbitration shall be conducted in accordance with the arbitration procedure stated in the Special Conditions of Contract.

25. Replacement of Adjudicator

Should the Adjudicator resign or die, or should the Employer and the Contractor agree that the Adjudicator is not fulfilling his functions in accordance with the provisions of the Contract, a new Adjudicator will be jointly appointed by the Employer and the Contractor. In case of disagreement between the Employer and the Contractor, within 30 days, the Adjudicator shall be designated by the Appointing Authority designated in the Contract Data at the request of either party, within 14 days of receipt of such request.

B. Time Control

26. Program

26.1 Within the time stated in the Contract Data the Contractor shall submit to the Engineer for approval a Program including Environmental Management Plan showing the general methods, arrangements, order, and timing for all the activities in the Works along with monthly cash flow forecast.

26.2 An update of the Program shall be a program showing the actual progress achieved on each activity and the effect of the progress achieved on the timing of the remaining work including any changes to the sequence of the activities.

26.3 The Engineer's approval of the Program shall not alter the Contractor's obligations. The Contractor may revise the Program and submit it to the Engineer again at any time. A revised Program is to show the effect of Variations and Compensation Events.

27. Delays Ordered by the Engineer

27.1 The Engineer may instruct the Contractor to delay the start or progress of any activity within the Works.

28. Management Meetings

28.1 Either the Engineer or the Contractor may require the other to attend a management meeting. The business of a management meeting shall be to review the plans for remaining work and to deal with matters raised in accordance with the early warning procedure.

28.2 The Engineer shall record the business of management meetings and is to provide copies of his record to those attending the meeting and to the Employer. The responsibility of the parties for actions to be taken is to be decided by the Engineer either at the management meeting or after the management meeting and stated in writing to all who attended the meeting.

29. Early Warning

29.1 The Contractor is to warn the Engineer at the earliest opportunity of specific likely future events or circumstances that may adversely affect the quality of the work, increase the Contract Price or delay the execution of works. The Engineer may require the Contractor to provide an estimate of the expected effect of the future event or circumstance on the Contract Price and Completion Date. The estimate is to be provided by the Contractor as soon as reasonably possible.

The Contractor shall cooperate with the Engineer in making and considering proposals for how the effect of such an event or circumstance can be avoided or reduced by anyone involved in the work and in carrying out any resulting instruction of the Engineer.

C. Quality Control for Petty works

30. Identifying Defects

30.1 The Engineer shall check the Contractor's work and notify the Contractor of any Defects that are found. Such checking shall not affect the Contractor's responsibilities. The Engineer may instruct the Contractor to search for a Defect and to uncover and test any work that the Engineer considers may have a Defect.

30.2 The contractor shall permit the Employer's Technical auditor to check the contractor's work and notify the Engineer and Contractor of any defects that are found. Such a check shall not affect the Contractor's or the Engineer's responsibility as defined in the Contract Agreement.

31. Tests

31.1 If the Engineer instructs the Contractor to carry out a test not specified in the Specification to check whether any work has a Defect and the test shows that it does, the Contractor shall pay for the test and any samples. If there is no Defect the test shall be a Compensation Event.

32. Correction of Defects

32.1 The Engineer shall give notice to the Contractor of any Defects before the end of the Defects Liability Period, which begins at Completion and is defined in the Contract Data. The Defects Liability Period shall be extended for as long as Defects remain to be corrected.

32.2 Every time notice of a Defect is given, the Contractor shall correct the notified Defect within the length of time specified by the Engineer's notice.

33. Uncorrected Defects

33.1 If the Contractor has not corrected a Defect within the time specified in the Engineer's notice, the Engineer will assess the cost of having the Defect corrected, and the Contractor will pay this amount.

Note: Where in certain cases, the technical specifications provide for acceptance of works within specified tolerance limits at reduced rates, Engineer will certify payments to Contractor accordingly.

34. Cash flow forecasts

34.1 When the Program is updated, the contractor is to provide the Engineer with an updated cash flow forecast.

35. Payments

35.1 Payments shall be adjusted for deductions for advance payments, retention, other recoveries in terms of the contract and taxes, at source, as applicable under the law. The Employer shall pay the Contractor the amounts certified by the Engineer within 28 days of the date of each certificate.

35.2 If an amount certified is increased in a later certificate or as a result of an award by the Adjudicator or an Arbitrator, the Contractor shall be paid interest upon the delayed payment as set out in this clause. Interest shall be calculated from the date upon which the increased amount would have been certified in the absence of dispute.

Items of the Works for which no rate or price has been entered in will not be paid for by the Employer and shall be deemed covered by other rates and prices in the Contract.

36. Tax

36.1 The rates quoted by the Contractor shall be deemed to be inclusive of the sales and other taxes that the Contractor will have to pay for the performance of this Contract. The Employer will perform such duties in regard to the deduction of such taxes at source as per applicable law.

37. Currencies

37.1 All payments shall be made in Indian Rupees.

38. Retention

38.1 The Employer shall retain from each payment due to the Contractor the proportion stated in the Contract Data until Completion of the whole O&M operations.

38.2 On Completion of the whole of the Works half the total amount retained is repaid to the Contractor and half when the Defects Liability Period has passed and the Engineer has certified that all Defects notified by the Engineer to the Contractor before the end of this period have been corrected.

38.3 On completion of the whole O&M operations, the contractor may substitute retention money with an "on demand" Bank guarantee.

39. Liquidated Damages

The Contractor shall pay liquidated damages to the Employer at the rate per day stated in the Contract Data for each day that the Completion Date is later than the Intended Completion Date (for the whole of the works or the milestone as stated in the contract data). The total amount of liquidated damages shall not exceed the amount defined in the Contract Data. The Employer may deduct

liquidated damages from payments due to the Contractor. Payment of liquidated damages does not affect the Contractor's liabilities.

If the Intended Completion Date is extended after liquidated damages have been paid, the Engineer shall correct any overpayment of liquidated damages by the Contractor by adjusting the next payment certificate. The Contractor shall be paid interest on the over payment calculated from the date of payment to the date of repayment at the rates specified in Sub Clause.

40. Securities

40.1 The Performance Security shall be provided to the Employer no later than the date specified in the Letter of Acceptance and shall be issued in an amount and form and by a bank or surety acceptable to the Employer, and denominated in Indian Rupees. The Performance Security shall be valid until a date 28 days from the date of expiry of Defects Liability Period and the additional security for unbalanced bids shall be valid until a date 28 days from the date of issue of the certificate of completion.

FINISHING THE CONTRACT

41.0 Operating and Maintenance Manuals

41.1 If "as built" Drawings and/or operating and maintenance manuals are required, the Contractor shall supply them by the dates stated in the Contract Data.

41.2 If the Contractor does not supply the Drawings and/or manuals by the dates stated in the Contract Data, or they do not receive the Engineer's approval, the Engineer shall withhold the amount stated in the Contract Data from payments due to the Contractor.

42.0 Termination

42.1 The Employer or the Contractor may terminate the Contract if the other party causes a fundamental breach of the Contract.

42.2 Fundamental breaches of Contract include, but shall not be limited to the following:

(a) the Contractor stops work for 28 days when no stoppage of work is shown on the current program and the stoppage has not been authorized by the Engineer;

(b) the Engineer instructs the Contractor to delay the progress of the Works and the instruction is not withdrawn within 28 days;

(c) the Employer or the Contractor is made bankrupt or goes into liquidation other than for a reconstruction or amalgamation;

(d) a payment certified by the Engineer is not paid by the Employer to the Contractor within 56 days of the date of the Engineer's certificate;

(e) the Engineer gives Notice that failure to correct a particular Defect is a fundamental breach of Contract and the Contractor fails to correct it within a reasonable period of time determined by the Engineer;

(f) the Contractor does not maintain a security which is required;

(g) the Contractor has delayed the completion of works by the number of days for which the maximum amount of liquidated damages can be paid as defined in the Contract data; and

(h) if the Contractor, in the judgment of the Purchaser has engaged in fraud and corruption, as defined in GCC Clause, in competing for or in executing the Contract.

42.3 When either party to the Contract gives notice of a breach of contract to the Engineer for a cause other than those listed under Sub Clause above, the Engineer shall decide whether the breach is fundamental or not.

42.4 Notwithstanding the above, the Employer may terminate the Contract for convenience.

42.5 If the Contract is terminated the Contractor shall stop work immediately, make the Site safe and secure and leave the Site as soon as reasonably possible.

43. Payment upon Termination

43.1 If the Contract is terminated because of a fundamental breach of Contract by the Contractor, the Engineer shall issue a certificate for the value of the work done less advance payments received up to the date of the issue of the certificate, less other recoveries due in terms of the contract, less taxes due to be deducted at source as per applicable law and less the percentage to apply to the work not completed as indicated in the Contract Data. Additional Liquidated Damages shall not apply . If the total amount due to the Employer

exceeds any payment due to the Contractor the difference shall be a debt payable to the Employer.

43.2 If the Contract is terminated at the Employer's convenience or because of a fundamental breach of Contract by the Employer, the Engineer shall issue a certificate for the value of the work done, the reasonable cost of removal of Equipment, repatriation of the Contractor's personnel employed solely on the Works, and the Contractor's costs of protecting and securing the Works and less advance payments received up to the date of the certificate, less other recoveries due in terms of the contract and less taxes due to be deducted at source as per applicable law.

44.0 Property

44.1 All materials on the Site, Plant, Equipment, Temporary Works and Works are deemed to be the property of the Employer, if the Contract is terminated because of a Contractor's default.

45.0 Releases from Performance

45.1 If the Contract is frustrated by the outbreak of war or by any other event entirely outside the control of either the Employer or the Contractor the Engineer shall certify that the Contract has been frustrated. The Contractor shall make the Site safe and stop work as quickly as possible after receiving this certificate and shall be paid for all work carried out before receiving it and for any work carried out afterwards to which commitment was made.

46.0 Fraud and Corruption

46.1 The Bank requires that Borrowers (including beneficiaries of Bank loans), as well as Bidders, Suppliers, Contractors, and Consultants under Bank-financed contracts, observe the highest standard of ethics during the procurement and execution of such contracts. In pursuit of this policy, the Bank:

(a) defines, for the purposes of this provision, the terms set forth below as follows:

(i) "corrupt practice" means the offering, giving, receiving, or soliciting, directly or indirectly, of anything of value to influence

the action of a public official in the procurement process or in contract execution;

(ii) "fraudulent practice" means a misrepresentation or omission of facts in order to influence a procurement process or the execution of a contract;

(iii) "collusive practice" means a scheme or arrangement between two or more Bidders, with or without the knowledge of the borrower, designed to establish bid prices at artificial, non competitive levels; and

(iv) "coercive practice" means harming or threatening to harm, directly or indirectly, persons or their property to influence their participation in the procurement process or affect the execution of a contract;

(b) will cancel the portion of the loan allocated to a contract if it determines at any time that representatives of the Borrower or of a beneficiary of the loan engaged in corrupt, fraudulent, collusive or coercive practices during the procurement or the execution of that contract, without the Borrower having taken timely and appropriate action satisfactory to the Bank to remedy the situation;

(d) Will sanction a firm or individual, including declaring them ineligible, either indefinitely or for a stated period of time, to be awarded a Bank-financed contract if it at any time determines that they have, directly or through an agent, engaged, in corrupt, fraudulent, collusive or coercive practices in competing for, or in executing, a Bank-financed contract; and

(e) will have the right to require that Contractors to permit the Bank to inspect their accounts and records and other documents relating to the bid submission and contract performance and to have them audited by auditors appointed by the Bank.

CHAPTER- IV

SPECIAL CONDITIONS OF CONTRACT

1. **LABOUR :**

The Contractor shall, unless otherwise provided in the Contract, make his own arrangements for the engagement of all staff and labour, local or other, and for their payment, housing, feeding and transport.

The Contractor shall, if required by the Engineer, deliver to the Engineer a return in detail, in such form and at such intervals as the Engineer may prescribe, showing the staff and the numbers of the several classes of labour from time to time employed by the Contractor on the Site and such other information as the Engineer may require.

2. **COMPLIANCE WITH LABOUR REGULATIONS** :

During continuance of the contract, the Contractor and his sub contractors shall abide at all times by all existing labour enactments and rules made thereunder, regulations, notifications and bye laws of the State or Central Government or local authority and any other labour law (including rules), regulations, bye laws that may be passed or notification that may be issued under any labour law in future either by the State or the Central Government or the local authority. Salient features of some of the major labour laws that are applicable to construction industry are given below. The Contractor shall keep the Employer indemnified in case any action is taken against the Employer by the competent authority on account of contravention of any of the provisions of any Act or rules made thereunder, regulations or notifications including amendments. If the Employer is caused to pay or reimburse, such amounts as may be necessary to cause or observe, or for non-observance of the provisions stipulated in the notifications/bye laws/Acts/Rules/regulations including amendments, if any, on the part of the Contractor, the Engineer/Employer shall have the right to deduct any money due to the Contractor including his amount of performance security. The Employer/Engineer shall also have right to recover from the Contractor any sum required or estimated to be required for making good the loss or damage suffered by the Employer. The employees of the Contractor and the Sub-Contractor in no case shall be treated as the employees of the Employer at any point of time.

SALIENT FEATURES OF SOME MAJOR LABOUR LAWS APPLICABLE TO ESTABLISHMENTS ENGAGED IN BUILDING AND OTHER CONSTRUCTION WORK.

a) Workmen Compensation Act 1923: The Act provides for compensation in case of injury by accident arising out of and during the course of employment.

b) Payment of Gratuity Act 1972: Gratuity is payable to an employee under the Act on satisfaction of certain conditions on separation if an employee has completed 5 years service or more or on death the rate of 15 days wages for every completed year of service. The Act is applicable to all establishments employing 10 or more employees.

c) Employees P.F. and Miscellaneous Provision Act 1952: The Act Provides for monthly contributions by the employer plus workers @ 10% or 8.33%. The benefits payable under the Act are :

   (i) Pension or family pension on retirement or death, as the case may be.

   (ii) Deposit linked insurance on the death in harness of the worker.

   (iii) payment of P.F. accumulation on retirement/death etc.

d) Maternity Benefit Act 1951: The Act provides for leave and some other benefits to women employees in case of confinement or miscarriage etc.

e) Contract Labour (Regulation & Abolition) Act 1970: The Act provides for certain welfare measures to be provided by the Contractor to contract labour and in case the Contractor fails to provide, the same are required to be provided, by the Principal Employer by Law. The Principal Employer is required to take Certificate of Registration and the Contractor is required to take license from the designated Officer. The Act is applicable to the establishments or Contractor of Principal Employer if they employ 20 or more contract labour.

f) Minimum Wages Act 1948: The Employer is supposed to pay not less than the Minimum Wages fixed by appropriate Government as per provisions of the Act if the employment is a scheduled employment. Construction of Buildings, Roads, Runways are scheduled employments.

g) Payment of Wages Act 1936: It lays down as to by what date the wages are to be paid, when it will be paid and what deductions can be made from the wages of the workers.

h) Equal Remuneration Act 1979: The Act provides for payment of equal wages for work of equal nature to Male and Female workers and for not making discrimination against Female employees in the matters of transfers, training and promotions etc.

i) Payment of Bonus Act 1965: The Act is applicable to all establishments employing 20 or more employees. The Act provides for payments of annual bonus subject to a minimum of 8.33% of wages and maximum of 20% of wages to employees drawing Rs.3500/-per month or less. The bonus to be paid to employees getting Rs.2500/- per month or above upto Rs.3500/- per month shall be worked out by taking wages as Rs.2500/-per month only. The Act does not apply to certain establishments. The newly set-up establishments are exempted for five years in certain circumstances. Some of the State Governments have reduced the employment size from 20 to 10 for the purpose of applicability of this Act.

j) Industrial Disputes Act 1947: The Act lays down the machinery and procedure for resolution of Industrial disputes, in what situations a strike or lock-out becomes illegal and what are the requirements for laying off or retrenching the employees or closing down the establishment.

k) Industrial Employment (Standing Orders) Act 1946: It is applicable to all establishments employing 100 or more workmen (employment size reduced by some of the States and Central Government to 50). The Act provides for laying down rules governing the conditions of employment by the Employer on matters provided in the Act and get the same certified by the designated Authority.

l) Trade Unions Act 1926: The Act lays down the procedure for registration of trade unions of workmen and employers. The Trade Unions registered under the Act have been given certain immunities from civil and criminal liabilities.

m) Child Labour (Prohibition & Regulation) Act 1986: The Act prohibits employment of children below 14 years of age in certain occupations and processes and provides for regulation of employment of children in all other occupations and processes. Employment of Child Labour is prohibited in Building and Construction Industry.

n) Inter-State Migrant workmen's (Regulation of Employment & Conditions of Service) Act 1979: The Act is applicable to an establishment which employs 5 or more inter-state migrant workmen through an intermediary (who has recruited workmen in one state for employment in the establishment situated in another state).

The Inter-State migrant workmen, in an establishment to which this Act becomes applicable, are required to be provided certain facilities such as housing, medical aid, travelling expenses from home upto the establishment and back, etc.

o) The Building and Other Construction workers (Regulation of Employment and Conditions of Service) Act 1996 and the Cess Act of 1996: All the establishments who carry on any building or other construction work and employs 10 or more workers are covered under this Act. All such establishments are required to pay cess at the rate not exceeding 2% of the cost of construction as may be modified by the Government. The Employer of the establishment is required to provide safety measures at the Building or construction work and other welfare measures, such as Canteens, First-Aid facilities, Ambulance, Housing accommodations for workers near the work place etc. The Employer to whom the Act applies has to obtain a registration certificate from the Registering Officer appointed by the Government.

Factories Act 1948: The Act lays down the procedure for approval at plans before setting up a factory, health and safety provisions, welfare provisions, working hours, annual earned leave and rendering information regarding accidents or dangerous occurrences to designated authorities. It is applicable to premises employing 10 persons or more with aid of power or 20 or more persons without the aid of power engaged in manufacturing process.

3. SUB-CONTRACTING:

The contractor shall not be required to obtain any consent from the employer for:

a) the sub-contracting of any part of the Works for which the Sub-contractor is named in the contract;

b) the provision of labour; and

c) the purchase of materials which are in accordance with the standards specified in the Contract.

Beyond this if the contractor proposes sub-contracting any part of the work during execution of works, because of some unforeseen circumstances to enable him to complete the work as per terms of the contract, the Engineer will consider the following before according approval:

- The contractor shall not sub-contract the whole of the Works.

- The contractor shall not sub-contract any part of the Work without prior consent of the Engineer. Any such consent shall not relieve the contractor from any liability or obligations under the contract and he shall be responsible for the acts, defaults and neglects of any sub-contractor, his agents or workmen as fully as if they were the acts, defaults or neglects of the contractor, his agents or workmen.
- The Engineer should satisfy whether (a) the circumstances warrant such sub-contracting; and (b) the sub-contractors so proposed for the Work possess the experience, qualifications and equipment necessary for the job proposed to be entrusted to them in proportion to the quantum of work to be sub-contracted.
- If payments are proposed to be made directly to that sub-contractor, this should be subject to specific authorization by the prime contractor so that this arrangement does not alter the contractor's liability or obligations under the contract.

4. ARBITRATION :

25.3 (a) In case of Dispute or difference arising between the Employer and a domestic contractor relating to any matter arising out of or connected with this agreement, such disputes or difference shall be settled in accordance with the Arbitration and Conciliation Act, 1996. The arbitral tribunal shall consist of 3 arbitrators one each to be appointed by the Employer and the Contractor. The third Arbitrator shall be chosen by the two Arbitrators so appointed by the Parties and shall act as Presiding arbitrator. In case of failure of the two arbitrators appointed by the parties to reach upon a consensus within a period of 30 days from the appointment of the arbitrator appointed subsequently, the Presiding Arbitrator shall be appointed by the * Indian Council of Arbitration/President of the Institution of Engineers (India)/The International Centre for Alternative Dispute Resolution (India).

(Note: 1. All bidders are expected to indicate clearly in the bid, if they proposed sub-contracting elements of the works amounting to more than 20 percent of the Bid Price. For each such proposal the qualification and the experience of the identified sub-contractor in the relevant

field should be furnished alongwith the bid to enable the employer to satisfy himself about their qualifications before agreeing for such sub-contracting and include it in the contract. In view of the above, normally no additional sub-contracting should arise during execution of the contract.

2. However, [a] sub contracting for certain specialized elements of the work is not unusual and acceptable for carrying out the works more effectively; but vertical splitting of the works for subcontracting is not acceptable. [b] In any case, proposal for sub-contracting in addition to what was specified in bid and stated in contract agreement will not be acceptable if the value of such additional sub-contracting exceeds 25% of value of work which was to be executed by Contractor without sub-contracting.

3. Assignment of the contract may be acceptable only under exceptional circumstances such as insolvencies/liquidation or merger of companies etc.

(b) In the case of dispute with a foreign contractor the dispute shall be settled in accordance with provisions of Arbitration Rules. The Arbitral Tribunal shall consist of three Arbitrators one each to be appointed by the Employer and the Contractor. The third Arbitrator shall be chosen by the two Arbitrators so appointed by the Parties, and shall act a presiding arbitrator. In case of failure of the two arbitrators appointed by the parties to reach upon a consensus within a period of 30 days from the appointment of the arbitrator appointed subsequently, the Presiding arbitrator shall be appointed by the * Indian Council of Arbitration/President of the Institution of Engineers (India)/The International Centre for Alternative Dispute Resolution (India).

(c) If one of the parties fails to appoint its arbitrator in pursuance of sub-clause (a) and (b) above within 30 days after receipt of the notice of the appointment of its arbitrator by the other party, then the * Indian Council of Arbitration/President of the Institution of Engineers (India)/The International Centre for Alternative Dispute Resolution (India), both in cases of the Foreign Contractor as well as Indian Contractor, shall appoint the arbitrator. A certified copy of the order of the *Indian Council of Arbitration /President of the Institution of Engineers (India)/The International Centre for Alternative Disputes Resolution (India), making such an appointment shall be furnished to each of the parties.

(d) Arbitration proceedings shall be held at Vijayawada, India, and the language of the arbitration proceedings and that of all documents and communications between the parties shall be English.

(e) The decision of the majority of arbitrators shall be final and binding upon both parties. The cost and expenses of Arbitration proceedings will be paid as determined by the arbitral tribunal. However, the expenses incurred by each party in connection with the preparation, presentation, etc. of its proceedings as also the fees and expenses paid to the arbitrator appointed by such party or on its behalf shall be borne by each party itself.

(f) Where the value of the contract is Rs.50 millions and below, the disputes or differences arising shall be referred to the Sole Arbitrator. The Sole Arbitrator should be appointed by agreement between the parties; failing such agreement, by the appointing authority, namely the *Indian Council of Arbitration/President of the Institution of Engineers (India)/The International Centre for Alternative Disputes Resolution (India).

(g) Performance under the contract shall continue during the arbitration proceedings and payments due to the contractor by the owners shall not be withheld, unless they are the subject matter of the arbitration proceedings.

5. PROTECTION OF ENVIRONMENT:

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

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

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

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

The Air (Prevention and Control of Pollution) Act, 1981, This provides for prevention, control and abatement of air pollution. 'Air Pollution' means the presence in the atmosphere of any 'air pollutant', which means any solid, liquid or gaseous substance (including noise) present in the atmosphere in such concentration as may be or tend to be injurious to human beings or other living creatures or plants or property or environment.

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

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

LIQUIDATED DAMAGES:

Please substitute the last sentence with the following:

“Time is the essence of the contract and payment or deduction of liquidated damages shall not relieve the contractor from his obligation to complete the work as per

agreed construction program and milestones or from any other of the contractor's obligations and liabilities under the contract."

CHAPTER - V
SCOPE OF WORK

General

Construction, erection, testing and commissioning of 40 mld capacity Sewage Treatment Plant with UASB process at Ajitsinghnagar, Vijayawada including cost of all associated civil, mechanical, electrical and instrumentation items etc., complete including miscellaneous works associated with plant, with warranty period of five years from the date of commissioning of the plant **on turnkey basis** including Manning, Operation and Maintenance of the plant and assets for a period of 5 Years

Construction of civil engineering works for all the units and all the ancillary structures
Supply, erection, testing & commissioning of all the mechanical equipment
Supply, erection, testing & commissioning of all the electrical & instrumentation equipment
Supply, erection, testing & commissioning of all the piping, valves and specials etc.
Hydraulic testing of all the water retaining structures.
Operation & Maintenance of Sewage Treatment Plant during trial run/ start-up/ stabilization for a period of Three (3) months or complete stabilization of the plant indicating satisfactory performance.
Manning, Operation & Maintenance of the plant along with electrical and mechanical equipment for a period of Five (5) Years after stabilization of the plant process.
During the stabilization period & trial run period electricity charges will be borne by the department. Contractor will provide all other consumable materials such as chemicals, chlorine etc.
During the Operation and Maintenance Period after successful stabilization and Trial run period, electricity charges will be borne by the department
Supply of equipment drawings, Technical specification/ Catalogue.
Supply of as built drawings after completion.
Supply of Operation & Maintenance manual including manufacturer manual of the equipment supplied.

Site Information

Sewage Treatment Plant (STP), based on the UASB technology, are proposed to be constructed at Ajitsinghnagar, Vijayawada.

Location

The Vijayawada city is situated Coastal Andhra Pradesh in the country and is the third largest city in A.P. Two National Highways i.e. NH5 and NH9 pass through the city .

Plant Capacity

40 mld capacity sewage treatment plant based on UASB Technology followed by aerobic process and post chlorination system shall be constructed at Ajitsinghnagar.

Treated Sewage Quality

The treated sewage quality of final effluent for which sewage treatment plant is designed and to be guaranteed by the contractor during operation and maintenance period is as under:

BOD_5 days at 20^0C	:	less than 30 mg/l
Suspended Solids	:	less than 30 mg/l
Sulphides	:	less than 2 mg/l
Fecal Coliform Count after chlorination	:	less than 10,000 MPN/ 100 ml

OTHER CONDITIONS

1. Bidder should inspect the site before submitting the tender.
2. Bidder should carry out relevant tests, subsoil explorations to assess the soil conditions, ground water table, safe bearing capacity etc., on his own for preparation of designs. Any data furnished by the VMC is only for information
3. Bidder should collect the data regarding floods, rains etc., to estimate the minimum plinth levels and to finalize other design parameters
4. Sewage characteristics furnished by the VMC is indicative and successful bidder should carry out detailed analysis while preparing process designs
5. Process designs should be prepared in confirmation with CPHEEO Manuals, IS Codes etc.
6. The bidder should prepare designs duly adopting upflow anaerobic sludge blanker reactor (UASBER) technology
7. Bidder should provide invariable. The inlet chamber / stilling chamber fine screen chamber, grit chamber and UASBR's to treat 40 MLD of sewage generated from the Central and Northern parts of the city. Sewage collected at different zones through collection network will be pumped to the sewage treatment plant inlet chamber. Since the sewage is being lifted through pumps to the Treatment facility. Bidder has liberty to propose the units as per the field conditions.
8. Bidder has liberty to propose secondary treatment units of the UASBR as per the field condition duly confirming the effluent standards as prescribed by the A.P. Pollution Control Board (APPCB)
9. Bidder should design the units in such a way that the proposal should optimize the power consumption, land utilization and minimum O&M cost.
10. Bidder should invariable incorporate chlorine contact tank and effluent channel up to VMC drain.
11. Bidder should provide MWL of all the units above the MFL
12. Bidder should prepare the structural designs as per the IS 456-2000 and relevant IS codes. Minimum of 8mm Dia should be adopted

13. Bidder should utilize best quality of structuring materials and shoring malaise during construction. Wooden shoring structuring is not permitted in the construction.
14. Power and water required for the construction should be made by the bidder on his own and VMC has no responsibility in this regard.
15. Bidder should use only is approved materials units in the plant. The construction materials proposed by the bidder will be approved by the VMC before utilization.
16. Bidder should establish field laboratory and following minimum equipment should be erected.
    - Measuring tape, steel scales, tapes
    - Screw gauge for measurement of steel bars
    - Coarse aggregate SIEVES
    - Slump cone apparatus.
    - Leveling instruments
    - Fine aggregate SIEVES
    - Weight measuring balance
    - Concrete testing cubes – 15 Nos
    - Density measuring JAR
    - Flakness index measuring plate
    - Compressive strength testing machine (CTM), calibrated by the reputed agency and certification
    - Test registers
    - Any essential equipments
17. Bidder should use potable water approved by quality assurance agency of VMC for construction and curing.
18. Bidder should use following equipment in the field during construction.
    - Hopper concrete mixer
    - Weigh batcher / ready mixer
    - Pin vibrator
    - Pan vibrator

- Gunny bags for curing

19. Bidder should carry out quality control test on his own and prepare samples as per the codes and record as per the codes and record the same in the registers.
20. Bidder should use approved brands of cement having 1st and it should be tested before use.
21. Bidder should use TMT steel of VSP plant or any reputed manufacturer.
22. Bidder should prepared designs for worst conditions confirming to IS code
23. Bidder should remove the honeycomb, bulged portions of the concrete and recast it the same with necessary precautions.
24. Bidder should carry out water tightness test for all the water retaining structures. If any leakage is observed during the test it should be rectified by proper groating process.
25. Bidder should adopt minimum M-30 grade of concrete for all the water retaining structures and minimum M-20 grade of concrete for all other concrete units.
26. Bidder should adopt design mix of concrete designed as per the IS codes and it should be approved by the VMC before adoption.
27. Bidder should plaster the surfaces of concrete units wherever it is necessary. While plastering the water retaining structures bidder should use sulphate resistant cement. Plastering mix should be C.M(1:3) and minimum 20mm thick plastering should be provided for liquid retaining structures.
28. Bidder need not take up the following works.
    - Internal roads
    - Internal open drainage
    - Land scaping and greenery
    - Staff quarters, watchman quarters
    - Compound wall
    - Administrative office
29. Bidder should take up the following ancillary works

    Lab with lab equipment

    Yard lighting

    Transformer yard, toilets

30. Bidder should obtain necessary licenses, approvals from the competitive authorities for carrying out the work.
31. Bidder should make his own arrangements for payment of Banker's Charges, Insurance, E.S.I. etc.
32. Bidder should engage the following minimum skilled staff at site for supervision of works and to carry out the quality control tests.
    - Graduate Engineer Civil - 1 No
    - Diploma Engineer Civil - 2 Nos
    - Graduate Engineer in Electrical- 1 No
33. Bidder should provide temporary structures to accommodate the following.
    - Field laboratory
    - Stores for Cement
    - Stores for Steel
    - Stores for Valves, Pipes, Gauges, Electrical equipment etc.
    - Office room with furniture
    - Toilets etc.
34. Bidder should provide Gas handling units including gas-flaring units at suitable locations.
35. Bidder should provide sludge handling units confirming to Pollution Control Board norms and bidder should propose sludge disposal facilities such as sludge drying beds / centrifuge / decanter etc., according to the process parameters. But sludge should be completely decomposed and should be treated properly before disposing off from the plant site.
36. Bidder should provide stand by arrangements wherever it is necessary.
37. VMC has right to modify the process, structural Designs, layouts plans units proposed by the bidders.
38. Design can be modified within the ranges of design parameters indicated in the IS codes manuals.
39. The Effluents of the sewage treatment plant will be let out into the VMC drain parallel to the Railway track and near to the Treatment plant compound. The drain water will joins with Budameru (Rivulet) after traveling to a distance of

2.5KM and Budameru will culminates at Kolluru lake which a popular Bird Sanctuary:

40. The Dried Sludge should be utilized as manure in horticulture.

41. Bio gas generated in the UASBR will be captured properly VMC will make arrangements to divert the processed gas (to be done by bidder) to the existing Biomethenization, located just adjustment to the proposed STP plant site. The Gas will be converted into power after processing.

42. Bidder should provide gas-flaring unit in the STP Plant site for flaring.

43. Bidder is responsible for the plant efficiency. Effluent characteristic and process parameters.

44. Bidder is responsible for the quality of works progress of work and durability of work.

45. Bidder should furnish 5% of the of Agreement value of the plant as performance security either in the form of Bank Guarantee or Demand Draft or Cash to VMC.

46. Bidder should operate the plant for 5 years after successful commissioning.

47. Bidder can propose and provide any proprietary item in the system to improve the efficiency of the system. However bidder is responsible for the efficiency of the system and bidder is responsible for the process parameters and effluent standards.

48. Bidder should indicate the proprietary items in the bids and their advantages in adoption in the facility.

49. Bidder should propose the process in such a way that the flow should be in gravity and no pumping arrangements should be proposed with in the plant unless otherwise it is inevitable.

50. Bidder should use pipes, valves of ISI Mark confirming with the IS Codes.

51. Bidder should propose minimum two Screen chambers. Out of two chambers one should be flitted with mechanical screens with lifting equipment.

52. Screens proposed should be fine screens made up of with stainless steel. In the Mechanical Screen Unit Belt conveyor should be supplied from the reputed firms.

53. Bidder should provide necessary arrangements for the changing of Screens in the Chamber and Maintenances of the Screen Chamber.

54. Bidder should provide sluice gates in inlet chamber / stilling chamber, screen chambers, grit chamber, common manifold chamber, UASBR, Chlorine contact tank and where ever it is necessary. All the sluice gates should be designed properly confirmed to IS Code specifications. The gates should be made up of with case Iron (CI) and spindle rods should be stainless steel only.

55. Bidder should provide reduction gearbox Central driven / motor driven wheel unit and be should also provide access walk ways to operate the units

56. All the access walkways can be made up of with mild steel painted with bitumen epoxy coats.

57. Bidder should propose and construct mechanical grit chamber. Grit should be removed mechanically by providing electrical driven screw type de-gritting equipment.

58. Bidder should made necessary arrangements for collection of separated screens and grit.

59. Bidder should provide by pass arrangements to all the units with necessary arrangements for maintenance of the units.

60. Bidder should use only cast Iron pipes with double flanges with in the plant to transport sewage sludge, etc.

61. Bidder should use cast Iron bend, Ductile Iron bends having flange and suitable for mechanical bolt nut fittings.

62. Bidder should provide Fiber reinforced plastics (FRP) lining on mild steel (MS) works wherever surfaces are explosions to the sewage.

63. Bidder should provide bridge baffle walls, ports, scrappers, rakes, floating removal unit with epoxy bitumen coated using MS material.

64. Bidder should carry out all miscellaneous items of works such as site clearance leveling of site, dismantling of bill work, CC etc.

65. Bidder should design the entire piping unit for its flow, velocity and fluid Transient phenomenon; sluice valves, air valves, scour valves should be provided as per the field requirements.

66. Bidders can also use HDPE pipelines of suitable class in the plant wherever it is feasible.

67. Chlorinator should be procuring from reputed manufacturer and bidder should procure 10 nos of chlorine toners for further operation and maintenance activities.

68. Bidder can propose centrifuge / decanter of reputed manufacturer having “ISI”.

69. Bidder should provide flow-measuring gauge at the in let and effluent outlet. The flow-measuring gauge should be magnetic type with Digital readings.

70. Bidder should also provide venturi flume in civil construction for measurement of flow in the inlet.

71. The efficiency of plant units and effluent characteristics should comply with APPCB norms and IS codes during peak hour flows

72. Bidder should provide entire lab equipment required to carry out all the tests for sewage, treated effluent, sludge etc. Bidder should procure B.O.D incubator for measuring B.O.D besides all the required apparatus.

B.O.D incubator

Muffle furnace

Ovens

Water battles

Refrigerators

Micro Scope

PH meter

73. (a) Bidder should supply, delivery and erect gas measuring gauges

74. Bidder should provide main panel board and individual panel boards for each and every unit with on site remote monitoring operations should be provided in the plant.

75. Panel board should be made up of with 14 gauge thick powder coated smooth finished to accommodate the following

- Starters
- MCCB / ACB's

- Volt meters
- Ammeters
- Bus Bars
- Hour Meters
- Relays
- Capacitors

76. Bidder should provide necessary capacity of capacitor to maintain the power factor

77. Bidder is responsible for the power connection, inspection of the APDISCOM officers to the plant site.

78. Bidder should supply deliver and erect the transformer of suitable capacity with aluminum wounds and transformer should be provided with the following:

- Incoming cables
- Fuses
- Dipole structures with guy wires
- Porcelain discs with jumpers
- Lightening Arresters ((LAS)
- Plinth for Transformer
- Earthing arrangements as per IE vales with copper plates

79. The electrical inspectorate should approve transformer and all electrical installation. Bidder should prepare drawings, plans and proforma prescribed by them and arrange for site inspection bidder should pay additional charges towards transformer relating to approvals.

80. All the motors and pumps should be designed as per efficiency curves and 100% stand by arrangements are to the considered in the designs.

81. All the pumps and motors should be fitted with valves and pumps should be kept in enclosed conditions.

82. Bidder should provide cables, earthing as per IE rules and copper cables should be provided, if required.

83. Bidder should provide all electrical arrangements in the plant. He should provide at least the following

- 10MV lamps
- 10SV lamps
- Tube lights
- Fans 3 Nos
- Lighting Points - 20 Nos
- 3 Pin Plug Points – 10Nos
- 60W Bulbs – 20Nos

84. Entire wiring should be done with PVC pipes with durable specials.

85. Bidder should take all precautions for safety and fire fighting. He should provide necessary units and equipment in the plant; Following are the minimum apparatus to be provided in the plant.

- Fire extinguish buckets
- Separate treated effluent line for fire fighting
- Solid carbon dioxide (CO_2) of 10 Kgs Capacity – 4 Nos
- Railing for all the units for a height of 1.55 mts.
- Rubber mats at Panel Boards

- Hand gloves, helmets
- Danger indication boards
- Safety measure indicating boards

86. All the Units should be finished smoothly on exterior side and bidder should apply two coats of white wash and two coats of emulsion

87. All the M.S. work should be coated with enamel paints of two coats after application of red oxide two coats.

88. Bidder should use NP_3 class RCC pipes, ductile Iron pipes with cement motor lining.

89. Bidder can provide SCADA arrangements in the plant for monitoring the process parameters. While proposing SCADA, bidder should propose a centralizing monitoring unit

90. Bidder should indicate the process parameters that can be monitored through SCADA, various reports that can be generated through this system and its impact on efficiency of the system. The SCADA should link to all the Units.

91. Bidder should Design the structural elements duly considering earthquakes, cyclones etc.

92. If bidder failed to provide field laboratory to monitor the quality tests during execution. VMC will establish filed laboratory and recovers double the cost from the bidder.

93. If bidder failed to engage the Technical agents in the field, VMC will recover Rs.10,000 per month per person from the running bills of the successful bidder.

94. If the bidder failed to achieve the progress as per the mile stones VMC will levy fines appropriately but not less than Rs.10,000/-

95. If the bidder failed to maintain the quality of work, necessary fines will be imposed on the firm not less than Rs.10,000/- and the bad quality of work should be removed and re-casted by the bidder on his own cost incase of civil structures, and bidder should replace all the mechanical, electrical, piping, instrumentation units if VMC or the 3rd party finds any interior quality and he should be fined Rs.10,000/- Minimum.

96. If the bidder failed to comply with the directions of the VMC in maintaining the Quality and durability VMC will initiate action against firm including black listing of the firm.

97. If the bidder failed to provide construction equipment and stores etc., bidder will be fined appropriately.

98. If the bidder completes the work well with in the due date VMC will give incentives depending up on the efficiency.

99. VMC will scrutinize the process designs, structural designs etc., and it can be referred to 3rd party consultant for proof checking if necessary.

100. VMC had appointed 3 rd party Quality Assurance team to monitor the quality. The successful bidder should obey the direction of 3rd party to ensure quality.

101. VMC is in process of appointing Project Management Consultant (PMC) to assist the successful bidder to complete the job within the given time frame. Therefore, the successful bidder should take the advise of Project Management Consultant (PMC) and make use of his professional skills for completion of the project within the stipulated time.

102. Bidder should consider uplift under empty conditions and out side surrounding soil submerged up to zero ground level for all the under ground structures.

103. Weather proof coarse should be provided on the roof slabs with minimum thickness of 20mm.

104. Foundations are to be refilled with sand only.

105. Whenever walkways are proposed bidder should propose 1.25M width of walkway.

106. All the windows should be wooden Frame with glass panels only.

107. All the Doors must be wooden doors of 1st quality made up of teak wood.

108. If any vibration actions are proposed in the system, structural stability against Aerodynamic effect should be checked.

109. All Flooring should be tiled flooring, building should have minimum of 40 Sqms of plinth area.

110. Chain pulley block and gravity gantry girders are to be provided wherever necessary to lift the pump sets.

111. No escalation of rates is allowed either in the construction stage or in the Operation & Maintenance stage.

112. VMC has right to modify the process designs, structural designs, lay out plan etc., submitted by the bidder.

OPERATION & MAINTENANCE CONTRACT

Scope of Work, Special Instructions / Responsibilities OF CONTRACTOR / Bidder

1.1 Scope Of Work

The contractor is to manning, operate, maintain and monitor the performance of 40 mld Sewage Treatment Plant (STP) at Ajitsinghnagar, Vijayawada. The scope of work is given below but not limited to the following. This may include other incidental items of work connected with the regular operation of plant as decided by Engineer in Charge (EIC) from time to time. Operation and maintenance for a period of 5 Years after commissioning/stabilization period.

1.1.1) The contractor shall ensure proper running of the plant to give the desired effluent standards i.e. BOD less than 30 mg/l, TSS less than 30 mg/l, Faecal coliform less than 10000 MPN/ 100ml & Sulphides less than 2 mg/l. The contractor shall also be responsible for overall maintenance of the plant i.e. civil, electrical, mechanical including gas utilization and gas flaring system. The contractor shall also be responsible for all repairs of equipment/machinery.

1.1.2) The contractor shall monitor the quality of influent and effluent. The contractor shall intimate and take adequate action to ensure smooth and satisfactory performance/running of the plant.

1.1.3) The contractor shall prepare and implement an effective plant maintenance programme in consultation with Engineer-in-Charge. It shall be absolutely contractor's responsibility to look after all sorts of maintenance whether preventive or break down. The contractor shall maintain the operational activity record as prescribed in this volume.

1.1.4) The contractor shall be responsible for keeping updated record of documents including History-Card for equipment and maintaining every day logbook relating to running of machinery, consumption of energy, fuel, biogas, and other consumables etc. and various analysis performed. The contractor shall record and maintain the operation and maintenance data of at least following units of STP on performance to be decided by Engineer-in-charge, in consultation with the contractor.

i. Daily status record of STP
ii. Daily flow record
iii. Daily sampling record
iv. Operation record of mechanical screens
v. Operation records of Pumps
vi. Operation record of Mechanical Degritting unit/grit channel
vii. Operation record of Sludge Pumps
viii. Operation record of Fixed Type Surface Aerators
ix. Operation record of sub station including power cut records etc
x. Operation record of Gas Scrubber & Gas Compressor.
xi. Operation record of chlorination system
xii. Performance/evaluation sheet of the UASB STP
xiii. Performance data of UASB reactor
xiv. Sludge profile data of UASB reactor
xv. Record of sludge discharge
xvi. Record of Bio-gas production
xvii. Record of Bio-gas composition
xviii. Record of power generation and its usage for operation of equipments and drives
xix. Performance data of Chlorination system
xx. Record of all repairs and replacements of parts/equipments
xxi. Any other allied works required by EIC during O&M.

The contractor shall prepare proper equipment wise log books and submit a daily report of plant regarding functioning of all units of plant.

The contractor shall be responsible to carry out day to day as well as periodic maintenance necessary to ensure smooth and efficient performance/running of all equipment/instruments installed at the Sewage Treatment Plant. The contractor shall hand over the machinery & site to the department after expiry of the contract period in good running condition.

The contractor shall also be responsible for proper upkeep of Administrative block of the Sewage Treatment Plant.

He shall be responsible for proper maintenance of all the pumps and allied items including Bar Screens, Sewage pumps, Gates, Mechanical Degritter, Aerators, Sludge Pumps, Gas scrubber, DFE and gas Flaring System, etc.

He shall be responsible for maintenance of streetlight, poles & fixtures also.

The sewerage system, roads and pathways provided at the sewage treatment plant shall be maintained properly.

Round the Clock watch and ward of the entire premises including plants/machinery etc. will also be the responsibility of the contractor.

The contractor shall also be responsible for proper gas collection and shall put it to proper use for running duel fuel engines for conversion of gas to electricity. This electricity generated shall be utilized for lighting the streetlights, all the buildings at the STP & MPS, including staff quarters & running of machinery at STP/MPS.

The entire STP premises including Administration building will be kept neat and clean.

The records maintained by the contractors shall be produced periodically to the Engineer-in-charge for proper monitoring as desired by him.

Replenishment/Replacement (in case of clogging) of filter media in Sludge Drying Beds as and when necessary will be done by the Contractor, to the satisfaction of EIC.

1.2 General Terms And Conditions

The contractor is to keep their staff engaged continuously without any break for Operation, Maintenance and Monitoring of STP

The contractor will also supply all consumables including chemicals and reagents. The contractor will employ its own staff for testing purpose. However the department will be at liberty to get random sampling & testing done on its own or from any other agency, to the entire satisfaction of Engineer-in-charge. In case of testing from other agency, charges will be borne by VMC.

Plant and equipment covered under this contract shall be totally attended to by the contractor including any "Trouble Shooting" to ensure smooth and trouble free operation.

For effective maintenance of STP, the contractor shall employ sufficient staff with proper qualification. For his guidance the pattern and no. of minimum staff to be engaged is described in this chapter.

The contractor shall take operational measures that there shall be no flooding of STP area.

The contractor shall abide by all central/state govt./Semi govt./Local Bodies rules regulations, pertaining to this contract, without any extra cost.

In the event of any damage/loss of life/theft of property, due to negligence on the part of contractor, the contractor shall be solely responsible and liable for compensation and damages, regarding negligence and the decision of Engineer-in-charge shall be final.

Flaring of gas will only be done when it is not possible/feasible to generate electricity from gas and this shall be allowed on getting approval from the Engineer-in-charge or his authorized representative.

The site will be open for inspection by the designated officers/official of the VMC at all times during the contract period.

The staff employed will be provided with all the required safety equipments. It shall be ensured that full safety measures are taken by the staff on duty. Staff employed shall be experienced and trained to handle the respective job/equipment.

1.3 Financial Terms And Conditions

During the operation and maintenance for stabilization and monitoring period Electricity charges will be borne by the department. The electricity charges will be paid directly to the APTRANSCO by the VMC on actual basis as per electricity bill raised by the APTRANSCO. Bidder will provide all other consumable materials and required staff for Operation & Maintenance.

The contractor shall not use the spares required as the machinery is within the guarantee period.

The contractor at his own cost shall arrange all sorts of Tool & Plant, required for proper operation & Maintenance of the plant.

General Operation & Maintenance Procedures

Collection Of Data

Data collection is carried out under the supervision of qualified staff and as per instructions of the Engineer-in-Charge. The responsible employee of the contractor will indicate the details of sample locations timings on the sample template.

During routine monitoring, samples of influent, effluent, sludge and biogas are analysed based on the Analysis Schedule given in the following Table for the given parameters.

Table 2.1 Analysis Schedule

Sl. No	Description of sample	Frequency	Location of sampling	Type of sample	Tests to be done.
A	**Waste water sample**				
1	Influent waste water.	Three times a week	Before screening	Composite	On Every Sample Temp, pH, BOD TOT, BOD.FIL, COD TOT, COD FIL, TSS,VSS, On One sample per week Alkalinity, Sulphate, Sulphide, VFA, Feacal Coliform
2	Influent waste water.	Three times a week	Before screening	Grab	Temp, pH,BOD TOT, BOD.FIL, COD TOT, COD FIL, TSS,VSS,
3	Effluent waste water	Three times a week	After Chlorine contact tank.	Composite	On Every Sample Temp, pH, BOD TOT,

Sl. No	Description of sample	Frequency	Location of sampling	Type of sample	Tests to be done.
					BOD.FIL, COD TOT, COD FIL, TSS,VSS, <u>On One sample per week</u> Alkalinity, Sulphate, Sulphide, VFA, Feacal Coliform
4	Effluent waste water	Three times a week	After Chlorine contact tank.	Grab	Temp, pH, BOD TOT, BOD.FIL, COD TOT, COD FIL, TSS,VSS,
6	Effluent from reactor.	Once in a week for each reactor.	Effluent gutter	Grab	Temp, pH, BOD TOT, BOD.FIL, COD TOT, COD FIL, TSS,VSS, Alkalinity, Sulphate, Sulphide, VFA, Feacal Coliform
7	Influent to Chlorine Contact Tank	Once in a week	Inlet	Grab	Temp, pH, BOD, TSS, Feacal Coliform
8	Effluent to Chlorine Contact Tank	Once in a week	Outlet	Grab	Temp, pH, BOD, TSS, Feacal Coliform
		Every day	Outlet	hourly	Residual chlorine
	Sludge Sample				
1	From reactor for complete sludge profile at different heights	Once in a week from each reactor.	Sludge pit	Samples shall be tested for each sludge withdrawal	TSS, VSS, Ash contents.

Sl. No	Description of sample	Frequency	Location of sampling	Type of sample	Tests to be done.
				port level separately by mixing sample of all pits of reactor port-level-wise.	
2	From sludge sump.	Once in a week from each Sludge sump.	Sludge sump	Grab	TSS, VSS
3	Dried sludge.	Fortnightly	Sludge Drying Beds	Grab	Moisture content, NPK value.

The composite sample, wherever specified, mean a sample prepared by taking sample every two hours and mixing them in proportion of the flow.

Timings for grab samples are to be decided by Engineer-In-charge.

2.2 Monitoring

Monitoring for the performance and functioning of all components of plants shall be done based on data collected. The monthly consolidated report of assessment prepared after monitoring shall be submitted to Engineer-in-Charge. On completion of Operation & Maintenance period the consolidated report of the whole period i.e. of eighteen months shall be submitted before winding up of the contract.

2.3 General Operation And Maintenance Of Various Units Of The STP

Complete Operation & Maintenance of the plant and allied utilities, as per scope of work defined in Chapter-1 of this volume is the responsibility of the contractor. General operation of some of the units is discussed below to keep the plant intact and keep the units functional without any trouble. For remaining units/equipments, if any, procedures as directed by Engineer-in-Charge shall be followed.

Operation and maintenance activities common to all the units.

The concrete Works/brick works/other civil works shall be checked regularly and repaired as and when required.

All metal works e.g. railing, staircase, chequered plates, valves, rungs etc shall be painted as and when required.

Overflowing of various units shall be checked regularly.

It shall be checked daily that all the units / equipment are operational.

Disposal of screened waste, scum, grit removed and any other waste shall be done to the earmarked dumping site in the STP area.

It shall be checked regularly that all Sluice valve and gates are functioning properly.

All pipes and bends shall be checked regularly for chockage and cleaned if required.

Lubrication of all the moving parts of equipment / gates / valves regularly as per instructions of manufacturer or earlier if required shall be done.

Greasing and glanding of equipment/ gates/valves regularly as per instructions of manufacture or earlier if required shall be done.

All equipments/unit shall be cleaned and repaired regularly.

Weir plates shall be cleaned regularly and their levels shall be kept proper.

Electric connections to all the machinery/equipment shall be checked/repaired regularly.

Level float switches shall be checked/repaired regularly for their proper functioning.

Inlet Chamber

In case of emergencies or when reactors are not operational, by-pass the flow from the Main Pumping station to the by-pass system (if provided).

Screen Chamber

The Operator should check the correct functioning of the screen and smooth movement of the rake mechanism at a suitable time interval.

Check that the lifting mechanism of the mechanical screen properly lifts and dumps the screenings into the hopper and then onto the belt conveyor.

To estimate the quantity of screened waste daily.

Check operation of mechanical screen at no load condition.

Check the operation of rakers and conveyer belt.

The Screens and Mesh Screens are to be painted with approved makes of epoxy paint every six months. During painting the Screens and Mesh Screens shall be checked for necessary repairs.

2.3.4 Grit Chamber

Grit chamber is divided into numbers of channels out of these, some of the channels will act as stand-by. After 2 days or as per the quality of the incoming wastewater, the flow of sewage is diverted to the stand-by grit channels. The gate to the respective channel is lowered in order to stop the flow.

The used grit channel is first allowed to drain the excess quantity of water into the drain pit through vertical grit removal pipe. After the channel is drained, the sewer-men will remove grit from the channels with the help of shovels and drag the grit into the vertical grit removal pipe and finally the grit is dumped in the wheelbarrows.

The quantity of grit disposed daily is estimated.

The flow through proportionate weirs shall be noted and recorded.

The sluice valve of the vertical grit removal pipe of the closed grit channel, will be operated slowly in order to avoid washing out of grit and overflow of drain channel.

2.3.5 Mechanical Degritting Unit

The correct functioning of the degritting unit shall be checked and smooth movement of the scrappers, classifier mechanism and organic return pump shall be ensured.

It shall be checked that the lifting arrangement of the classifier properly lifts and dumps the grit into the grit removal system provided for this purpose.

The quantity of grit disposed daily shall be estimated.

2.3.6 Distribution box & Division box

A. Operation of Distribution boxes and Division boxes

The distribution boxes shall be cleaned regularly.

Check for leakage/blockage of feed inlet pipes especially where they are connected to the feeding boxes/distribution boxes or at their joints.

2.3.7 UASB Reactors

Open and remove floating layer inside the FRP gas domes at regular intervals.

Check FRP Gutters, V-notch weir plates, baffle plates, feeding boxes, gas domes and repair when ever necessary.

The floating scum/material at the top water surface of the reactor shall be removed once a day.

Check that all the feed inlet pipes in the feeding boxes are carrying the sewage to the bottom without overflow / choking.

In case down-take pipes are choked and feeding boxes are overflowing, record the numbers of overflowing feeding boxes and choked feed inlet pipes.

When the down take pipes are choked, the obstruction shall be removed manually by "scrubbing" the pipe with help of a flexible rod/bamboo stick attached with a cleaning device at the far end or with the help of high pressure flow water system.

The weir level of V-notches shall be checked and if needed the level shall be adjusted by adjusting screws to distribute the sewage equally in the reactors.

The obstructions accumulated near the opening of V-notches of the weir plate shall be removed regularly.

The levels of the weir plate fixed to the gutters are important for the correct functioning of the plant. Each weir plate shall be horizontally aligned and all gutters in one reactor shall be fixed at the same level.

The workers shall not step on the gutters.

2.3.8 Sludge Discharge System

Sludge shall be discharged from each reactor on daily basis or as per the instructions of Engineer-in-charge based on sludge profile.

After getting the sludge profile, the quantity of sludge to be discharged from the reactor shall be determined.

Check the operation of valves at sludge sampling ports. Replace the non-functional valve.

The sludge withdrawal pit shall be cleaned regularly. The sludge conveying pipes from reactor to sump shall be washed daily after withdrawal of sludge.

2.3.9 Gas Collection System

Record the rise/fall level of the MS Gas dome.

If biogas production is excessive and it is not possible/feasible to use it for production of electricity then, divert the gas to the gas flare system with the approval of EIC or his authorized representative.

Check that the pulley of the MS Gas dome of the gasholder is freely moving over the rails.

Record the quantity of the biogas production in the Data collection sheet daily.

Record the temperature of the gas at the time of recording the quantity of gas production.

Record the moisture content in the Gas (before and after the scrubber) at the time of recording the gas production.

Check the operation of Gas Scrubbing System regularly. Cleaning of scrubber and replace of media shall be done as and when required.

Check FRP Gas hoods and gas pipes for leakage regularly. Repair the damaged portions of the gas collection system wherever necessary.

Check the water level in the gas holder daily and add water when required.

Check the pressure in the gas holder daily.

Around gas collection system following precautionary measures shall be strictly followed:

Avoid open fires or sparks near the Reactor, Gas holder, Gas flaring system, DG set room, Gas flow meters and other Gas collection system.

Take extreme care against fire hazard while replacing/repairing the accessories provided in the Gas collection system.

Declare and display the gas collection system area as "NO SMOKING" zone.

Display and follow the fire preventive instructions displayed at different places in the plant.

Chlorination System

Check the operation of chlorinator unit including empty toner replacement. Regular inspection of toners, piping, valves etc. to identify & rectify the leakage if any

OTHER CONDITIONS:

Deployment of necessary manpower to perform the assignment

The bidder has to procure chemicals, consumables etc that are required for the maintenance of the plant.

Bidder should attend for the major maintenances and annual maintenances

Major maintenance includes the repairs of all the units, pumps, mechanical units, and electrical installations. Bidder should attend for the replacements of the wear and tear parts

of the pumps and the mechanical units. Restoration of the breakage pipelines, arresting of leaks etc

Routine maintenance is the routine maintenance of the units that includes cleaning, paintings, adding lubricants to the moveable parts, changing of the necessary oils, de-silting of the grit, removal of the screens from the screen chamber etc, removal dust, up-keeping the transformers by pouring oils, etc

Bidder should attend to the emergency maintenances during monsoon rains, floods, breaking of pipelines, cyclones etc.

Carry out day to tests for the influent and effluent characteristics at all STPs

The bidder has to arrange necessary work force to perform the maintenance. This includes technically skilled persons. Persons with good knowledge in environmental sciences. Necessary electrician, helper, operators, Drainage mastries, drainage fitters, security men at all pumping stations, gardeners, computer operators, Non-technical staff, sweepers, drivers, pipe line fitters and chemists etc.

The service contractor has to carry out regular maintenance such as maintenance of sewage treatment plants pumps.

Painting should be done every year for Pump Sets, Pipes lines, Valves, treatment plants, Ventilating Shafts etc. This work should be completed at the end of the every year i.e. by 31st December

The bidder should handover the systems and the installations, in working conditions after expiry of the O & M period.

Bidder is allowed to dispose the sludge generated in the treatment plants and permitted to sell the same .The revenue generated from the sale will be given to the bidder.

Maintenance period is 5 Years and no escalation of rates is allowed and operator is not entitled to claim any escalation of rates on any item of works.

VMC shall hold sole rights over accessing Carbon Credits under the Clean Development Mechanism (CDM) of the Kyoto Protocol.

The bidder should maintain greenery at all the installations and also take all other steps required to ensure that the area is free from any foul smell or odor.

If bidder fails to comply with the timing for restoration of the units VMC will impose suitable penalties as indicated in the schedule.

The bidder has to provide all the safety equipment's in the facilities and bidder is responsible for any damages, collapse, etc of the connected units and the surrounding structures.

VMC has no responsibility in case any untoward incidents are occurred in the course of his assignment and bidder has to take the responsibility in arranging the compensations and restorations etc.

All the valves are to be maintained properly. Bidder has to take up preventive maintenance for valves and valve pits.

The bidder has to bear all the expenses relating to the chemicals, consumables, laboratory tests, licenses, approvals, permissions etc.

The service provider has to take the responsibility in maintaining the vehicles, fuels, spare parts, drivers, servicing arrangements, licenses, octrai, insurance, road tax and all other tax and duties. He should bear all the costs for this purpose.

VMC will supervise the activities of the service operator. At any point of time if the VMC dissatisfied over the performance of the services necessary fines will be imposed on the bidder besides operating the penalty clauses as mentioned below.

The service provider has to show professional skills in planning, designing and in discharging this assignment. In this connection VMC is intended evaluate the performance of the O&M operations of the operator.

The service provider should carry out all the required tests of the effluent discharged as per PCB norms and submit reports to the VMC.

The payment for the operator will be released on monthly basis. The payment will be released at the end of every month after satisfactory performance of the system.

Sewage treatment plants should be maintained properly and the effluent standards should confirm with the pollution control board norms.

Bidder should operate plant and the systems in accordance with the sewage manual of CPHEEO, New Delhi and relevant codes.

Bidder should operate the electrical equipments as per the requirement only and any excess usage and dry runs will not be considered for payment.

VMC will pay necessary electrical bills that include pumping stations, sewage treatment plants etc., to the AP DISCOM, Vijayawada as per the Demand raised by them.

VMC will pay necessary electrical inspection charges to any of the sites to the concern authorities as demanded by them.

VMC will recover the penality imposed by the electrical authorities for misuse of the systems and the improper maintenance of the power factor from the bidder's maintenance fees.

If the power consumption is more than the committed power consumption indicated in the technical bid then the bidder has to bear the addition cost of power and VMC will recover the additional cost from the successful bidders monthly O&M bills.

Bidder can utilize the treated effluent of sewage treatment plants in safe manner for and revenue generated through this source will be transferred to VMC @ 30 % of the profits.

PERFORMANCE INCENTIVES AND PENALTIES

The O&M operator will be awarded suitable incentives or penalties based on his performance. The incentives will be by way of accumulating credits and then encashing them.

1) In case of any minor repairs, which require suspension of the STP the bidder has to restore the same with in 24 hours. For failure he will be fined Rs.10, 000/-

2) Regarding painting and up keeping of STP.

If the bidder failed to provide the paintings for the STP, M.S. works, RCC, Brick works and all other paintable surfaces at the end December every year, 4% of the contracted value will be reduced from the payment for the next year.

3) If service provider does not maintain the plantation lawns and greenery to the satisfaction of VMC, 2% of the contract price will be reduced from the payment for next year. The activity will be evaluated at the end of July every year (after summer).

4) The service provider should maintain the entire STP site in good clean and hygienic conditions and the compound should be free from bad odors, foul smell and should be Eco-friendly. If bidder complies with the above hygienic norms, O&M operator will be rewarded by paying an amount of Rs.10, 000/- one time, for which he has to get at last 30 credits out of 36 scoring credits. This parameter will be observed at the end of January every year.

If he carries out the entire relevant tests specified by the Pollution Control Board (PCB) for the effluent from STP and shows 100% satisfactory results, it scores one credit point per month for satisfactory results. (12 Credits per year)

b) If the service provider gets at an average of 80% of score from the Eco-matrix proforma furnished below, he will get single credit per month. (12 credits per year)

ECO-MATRIX PROFORMA

Performance Parameter	Odours	Maintenance of Plant	Cleaning of Silt & Screens	Overall appearance of the compound
Good	20%	40%	20%	20%
Acceptable	15%	30%	15%	15%
Poor	5%	5%	5%	5%

This should be filled by the officials of the VMC not below the cadre of the Executive Engineer in any one day of the month at each and every pumping station.

One credit will be given for scoring 80% in this 4 x 3 Matrix.

5) If the service provider furnishes the satisfactory certificate from the Residential Welfare Association (RWA) within the vicinity of the STP, the service provider will score one credit point per month. Wherever RWAs are not there they have to get the certificate from a resident. However they should not get the certificate from different residents leaving in different houses every month. (12 credits per year)

6) If the bidder failed to score 15 credits, 2% of the contracted value will be reduced from the payment for next month.

7) If VMC observes any deficiency/absentees in the staff proposed by the bidder an amount of Rs 5,000 per person will be deducted from the bills of the bidder

8) Operator should maintain the effluent standards as per the Pollution Control Board norms other wise fine will be imposed on the firm as follows:

Sl. No	**Name of the test**	**Standards**	**Frequency of tests**		**Fine**
1	BOD	<30 PPM	DAILY	If continuously failed for three days	Rs. 5000 per day
2	TSS	<30 PPM	DAILY	If continuously failed for three days	Rs. 2000 per day

CHAPTER - VI

FINANCIAL CONDITIONS

1 Earnest Money Deposit (E.M.D)

Every bidder has to pay earnest money deposit of Rs.5.0 Lakhs (Five Lakhs) either through demand draft drawn in favour of Commissioner, Municipal Corporation, Vijayawada or in the form of unconditional Bank Guarantee from any schedule bank for a period of 180 days in favour of Municipal Corporation, Vijayawada. The bids without EMD will be rejected. The E.M.D will be refunded to the unsuccessful bidder only after finalization of tender.

Forfeiture of E.MD.

If the successful bidder fails to commence the work with in the prescribed time mentioned in the work order / letter of intent the EMD shall be forfeited to the employer. The EMD of Rs.5.0 Lakhs will be refunded to the successful bidder after entering the agreement.

2. Security Deposit

The successful tender shall deposit 2 ½ % on contract value towards security deposit in the form of Bank Guarantee within 15 days from receipt of work order and before signing the contract agreement. On submission of security deposit the E.M.D. will be refunded and the security deposit will be released only after completion of successful trail run and commissioning.

3. Retention Money

In addition to the above security deposit 5% on gross amount of value of work done shall be deducted as with-held amount in every running account bill and the same will be released after successful completion of trail run and commissions i.e. at the time of final bill.

The successful bidder can pay the retention money of 5% on contract value in the form of Bank Guarantee and it will be refunded at the time of final bill.

4. Performance guarantee

The tender has to furnish performance security of 5% on the contract value before refund of security deposit through Bank Guarantee from the date of commissioning of plant, this performance security will be released only after completion of O&M period of 5 Years.

5. Mobilization Advance

The successful bidder is permitted to avail the facility of mobilization advance up to 10% of contract value of work against an unconditional and irrevocable bank guarantee for a period as desired by the bidder, but it should not be more than construction contract period. The advance will attract a suitable rate of interest (as per Government borrowings) and deducted in suitable installments from the running bills of the contractor.

6. Recoveries & Deductions

VMC will recover all the deductions as per prevailing laws

6.1 INCOME TAX: VMC will recover the Income Tax from each and every running account bills for the gross value of work done @ 2.24%

6.2 Value Added Tax: VMC will recovery the VAT as per applicability in pursuance to the G.O's. At present about 4% on gross value of work done will be recovered from the every running account bill.

6.3. Seigniorage Fee: VMC will recover the seigniorage fee from the running account bills as per prevailing rates in accordance with the G.O's on materials.

6.4 **N.A.C recovery**: 0.25% on every running account bill will be recovered from the bidder towards contribution on the national academy of construction.

6.5 **Others**: If any other recovery or deductions are proposed as per the G.O's it will be reflected in the running account bills.

6.6 **Service Tax**: VMC will recover Service Tax from the O&M bills at 12.50% on monthly bills.

All the above recovery proposals are as per prevailing G.O's. If any fines, penalities are imposed on the bidder in the event of failure to satisfy the VMC authorities in quality

and desired progress of work, for which VMC has right, will be recovered from the contractors running bill.

7. No Escalation

No payment to the contractor on account of escalation of rates of equipment, materials, electrical items, taxes & duties, wages and fees is admissible. The contractor is supposed to foreseen all the statutory and other escalation which may be taken into account while quoting the rates in the tender. In any case if any increase in the rates contractor has to absorb the same and VMC is not at all liable.

8. Liquidated Damages

If any for the reason for which VMC is not approved and the work is not completed by the period as agreed in the tender the liquidated damages will be levied at the rate of Rs.500/- per day from the date of agreed completion till the actual date of completion of work. The maximum amount of liquidated damages to be levied under the clause shall not exceed 5% of the contract value.

Particulars of Payment

Payment for the work done by the contractor made on the basis of measurements recorded by the Assistant Engineer / Assistant Executive Engineer and check measurement made by the Deputy Executive Engineer / Executive Engineer. On the measurement book contractor has to sign on the recorded measurements. The bill has been prepared based on the measurements recorded and payment will be released as per the agreement. If any excess payment is made in the running bills it will be recovered in the subsequent running bills. The bill will be raised as when contracts required the VMC authorities for bill.

Procedure of Payment

The bill prepared by the Assistant Engineer / Assistant Executive Engineer will be scrutinized by the Executive engineer and forwarded to audit section for audit through Superintending Engineer & Chief Engineer. Then bill will be passed duly deducting the necessary recoveries. The bill amount will be given in the shape of Cheque to the contractor.

CHAPTER - VII

TIME SCHEDULE

1. Date of Commencement of work

The successful bidder will be intimated the award of contract through work order. The successful bidder has to start his business i.e. construction activities within 15 days from the receipt of the work order the day in which site handed over to the contractor, that day will be treated as commencement date of work.

2. Construction time

The construction time will begin from the commencement date and ends after 12 months. The bidder has to complete the entire construction activity within 12 months. During the 12 months period the bidder has to complete the work successfully as per the specification. If bidder completes the construction earlier to the 12 months then the subsequent activity i.e. trail run period starts.

3. Trail Run & Commissioning

The trail run date starts as and when the construction date elapses. The trail run period is 3 months, but it is flexible since it depends upon the system of treatment facility. Hence the bidder can make use this and can complete his trail run prior to the schedule date.

The final bill will be paid to the bidder only after completion of the successful trail run and commissioning of all the units. The bidder has to carried out the trail run as per the norms prescribed in for trail run and commissioning. All the units especially pump sets, aerators, movables should be kept in operation as per the specifications. During the trail run period firm has to achieve the desired effluent standards in confirmed to the agreement for continuous period round the clock. If any failure, repairs, cracks, damages, faults, occurs during trail run bidder has to rectify it on its own cost and it is the responsibility of the contractor to show the performance of all the units as per the specification and to the satisfaction of the VMC authorities.

During trail run bidder has to bear all the costs for operation &maintenance such as power, chemicals, consumables, establishment, water, repairs, communication etc.

4. Operation & Maintenance

Operation & Maintenance period will be commenced from the date of successful competition of trail run and commissioning and its period will be completed after 5 Years.

During the O&M period the bidder has to carryout the OM to the satisfaction of owner and all the units should work efficiently besides meeting the desired effluent standards.

5. Defects liability period

The defects liability period shall be reckoned from the date of completion of successful trail run and commissioning and it will be ended after 5 Years i.e. after completion of maintenance period.

ANNEXURE – I

FORMS & SCHEDULES

1. LETTER OF ACCEPTANCE

From:

To

Gentlemen,

Sub:- Tender for .....

Ref:- Your Tender for the above work .....

* * * * * * * * *

Kindly refer to your letter No. ..... dated ……..... ……..…….. Forwarding your tender in response to Invitation to Tender No. .....

You are hereby informed that the referenced tender is accepted.

You are requested to furnish the security deposit in the form specified in clause 79 of the Conditions of Contract within _____ days of the receipt of this letter and are also requested to be present at the Superintending Engineer, VMC Office, _____, for execution of Contract documents within _____ days of the date of receipt of this letter along with non judicial stamp paper as per clause no 77 of conditions of contract.

The Contract will be governed by the Conditions of Contract as set out in the Tender Documents subject to modifications accepted by the _____ VMC.

Please return this copy duly accepted and signed.

Yours sincerely,

(Signature)

Accepted

Signature, Name & Designation

Seal of Firm

2. FORM OF AGREEMENT

THIS AGREEMENT is made on the .....…..... day of ...…….... 200… between (name of Employer) ..... of (mailing address of Employer) ..... hereinafter called "the Employer", of the one part and (name of Contractor) ..... (hereinafter called "the Contractor") of the other part.

WHEREAS the Employer is desirous that certain works should be executed, viz (brief description of Works) ..... and has, by Letter of Acceptance dated (date of Letter of Acceptance) ....., accepted a tender by the Contractor for Operation and maintenance of such Works, NOW THIS AGREEMENT WITNESSETH as follows:

1. In this Agreement words and expressions shall have the same meanings as are respectively assigned to them in the Conditions of Contract hereinafter referred to.
2. The aforesaid documents shall be taken as complementary and mutually explanatory of one another, but in the case of ambiguities or discrepancies shall take precedence in the order set out above.
3. In consideration of the payment to be made by the Employer to the Contractor as hereinafter mentioned, the Contractor hereby covenants with the Employer to execute, complete and maintain the works in conformity in all respects with the provisions of the Contract.
4. The Employer hereby covenants to pay the Contractor in consideration of the execution, completion and maintenance of the Works the Contract Price at the times and in the manner prescribed by the Contract.

IN WITNESS WHEREOF the parties hereto have caused their respective Common Seals to be hereunto affixed (or have hereunto set their respective hands and seals) the day and year first above written.

SIGNED, SEALED AND DELIVERED.

By the said	By the said
Name	Name ...……....
On behalf of the Contractor In the presence of: .....……..	On behalf of the Employer In the presence of: .....……....
Name	Name …..……....
Address	Address .....…..... ……..... ….....

3. FORM OF BANK GUARANTEE FOR SECURITY DEPOSIT / ADDITIONAL SECURITY DEPOSIT

In consideration of the VMC, _____, (hereinafter called "VMC") having agreed to accept from _____ "the said Contractor(s)", a security deposit as may be modified from time to time wherever necessary under the terms and Conditions of the Contract entered into by the said Contractor(s) in respect of work _____, Contract No. _____ under the VMC for the due fulfilment of the terms and conditions of the said Contracts under the said Engineer, on production of a Bank Guarantee for Rs._____ (Rupees _____ _____ only), we _____ Bank _____ branch, hereby undertake the guarantee to pay immediately to the VMC, on demand in writing by the VMC, an amount of Rs. _____ (Rupees _____ _____) without any reservation and recourse against any loss or damage caused to or suffered by the _____ VMC by reason of any breach by the said contractor(s) of any of the terms ad conditions of the said contact under the said VMC

We _____ Bank, _____ further agree that the guarantee hereby contained shall remain in full force and effect during the period that will be taken for the performance of the said Agreement under the said Engineer and that it shall be in enforcement until all the dues of the _____ VMC under or by virtue of the said Contract under the said Engineer have been fully paid and their claims satisfied or discharged or until the said Engineer certifies that the terms and conditions of the said Agreement under the said Engineer have been fully and properly carried out by the said Contractor(s) and accordingly discharges the guarantee subject, however, that the _____ VMC shall have no rights under this guarantee after (date). We _____ _____ Bank Ltd., lastly undertake not to revoke this guarantee during its currency except with the previous consent of the VMC in writing.

Dated _____ day of _____ 2006.

For _____ Bank.

4. SCHEDULES

SCHEDULE – Q

FAIR WAGES CLAUSE AS PER G.O.Ms.No.1763/P.W.D.DATED:22-3-1963

The Contractor shall pay not less than fair wages notified by the Government from time to tome to the labour engaged by him on the work. No claim will be entertained on account of any revision of minimum wages which may be ordered by the Government.

"Fair Wages" means wages whether for time or place work, notified by the Government from time to time in the area in which the work is situated.

The Contractor shall notwithstanding the revisions of any Contract to the contrary cause to be paid to the labour engaged by the Sub-Contractor in connection with the said work as if the labourers had been directly employed by him.

In respect of labour directly or indirectly, employed in the works for the purpose of the Contractor's part of the agreement the Contract or shall comply with the rules and regulations on the maintenance of suitable records prescribed for this purpose from time to time by the Government. He shall maintain his accounts and vouchers on the payment of wages to the labour at the satisfaction of the Executive Engineer, VMC .

The Executive Engineer, VMC shall have the right to call for such records as required to satisfy himself on the payment of fair wages to the labour and shall have the right to deduct from the Contract a suitable amount for making good the loss suffered by the worker or workers by reasons of the "Fair Wages" clause to workers.

The Contractor shall be primarily liable for all payments to be made and for the observance of the regulations framed by the Government from time to time without prejudice to his right to claim indemnity from his Sub-Contractors.

Any violation of the conditions above shall be deemed to be a breach of his Contract.

The Contractor will at all times duly observe the provisions of Employment of children Act XXVI of 1938 and any re-enactment or modification of the same and will not employ or permit any person to do any work for the purpose of under the provision of this agreement in contravention of the provisions of the said Act. The Contractor hereby agrees to indemnify the VMC against all claims, penalties which may be referred by the VMC, or any person employed by the Labour Department, Govt of AP by reason of any default on the part of the contractor in observance of the provisions of Employment of Children Act XXXI of 1938 or any re-enactment or modifications of the same.

5. SCHEDULES

SCHEDULE – R

QUARTERLY REPORT OF THE LABOUR EMPLOYED ON OPERATION AND MAINTENANCE ACTIVITY

Return for the quarter ending :

Name and Location of the Work :

Name of the Contractor(s) :

Employed on Government Works / VMC Works :

Address	Place	District	State

Employment to Earning :

a) Men _____ nos.
b) Women _____ nos.

Total No. of workers employed during the quarter. :

No. of persons employed by the Contractor, on the above work. :

Total No. of man hours worked during the quarter :

Total (Basic) Wages paid (in Rs.) :

Total Net Earnings (in Rs.) :

No. of working hours during the quarter :

a) On Normal Day _____ nos
b) On Saturday _____ nos

12 a) No. of man-hours of over-time worked during the quarter. :

Over-time payment if any (in Rs.) during the quarter :

Total No.of working days during the quarter. :

Length of the Normal Wages periods. :

Accidents :

Number of accidents			Circumstances under which accident occurred
Fatal	Permanent disablement	Temporary disablement	

Total no. of accidents during the quarter :

Compensation paid if any (in Rs.) :

Volume and value of construction done during the quarter. :

a) Total cost of materials (approx.) :

b) Total payment of workers :

c) Overhead Charges (approx.) :

d) Total man hours worked :

e) Maternity benefits

No. of female workers who have been given maternity benefit. :

Amount paid. :

6. SCHEDULES

VOLUME-I

(TO BE SUBMITTED IN SEALED COVER 'A')

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7. SCHEDULE

FORM OF BANK GUARANTEE FOR EARNEST MONEY DEPOSIT

WHEREAS _____ (name of firm hereinafter called 'TENDERER') wish to participate in tender enquiry No: E9-16415/2005 dt 08-05-2006 for (Name of work) '**Providing 600mm Dia D.I. K-9 Pumping Main from Sector-8 Police Colony to S.T.P. at Ramalingeswara Nagar.**".

AND WHEREAS in terms of the tender conditions the Tenderer is required to furnish to the VMC a Bank Guarantee for a sum of Rs. _____ (Rupees _____) as earnest money against the Tenderer's offer aforesaid.

AND WHEREAS We, _____ Bank, _____ branch have at the request of the Tenderer agreed to give to the VMC this guarantee as hereinafter contained.

We, _____ Bank, _____ branch, hereby undertake the guarantee to pay immediately to the VMC, on demand in writing by the VMC, an amount of Rs. _____ (Rupees _____) without any reservation and recourse if the Tenderer shall for any reason withdraw whether expressly or implied their said tender during the period of its validity or any extension thereof or the Tenderer fails to execute the agreement for the work awarded to them by the VMC.

We, The _____ Bank, _____ further agree to that our liability to pay the aforesaid amount is not dependent or conditional on the VMC proceeding against the Tenderer and we shall be liable to pay the amount without any demur, merely on a claim raised by the VMC.

The guarantee herein contained shall not be determined or affected by the liquidation or winding up or dissolution or change of constitution or insolvency of the said

Tenderer but shall in all respects and for all purposes be binding and operative until payment of all money(s) due to the VMC in respect of such liability under the guarantee is restricted to Rs. _____ (Rupees _____). Our guarantee shall remain in force until _____. We shall be relieved and discharged from all our liability thereunder.

We, the _____, undertake not to revoke this guarantee during its pendency/currency except with the previous consent of the VMC in writing.

Station : Name of the Bank :

8. SCHEDULE

INCOME TAX CLEARANCE CERTIFICATE

F O R M – 'I'

1. Name and style (of the Co., Firm, HUF or Individual) in which the applicant is assessed or assessable to Income-Tax and address for the purpose of assessment :

2. Names and addresses of all companies firms, Associations or persons in which the applicant is substantially interested in his individual or fiduciary capacity

   Note: For the purpose of Clause (2) above the words 'substantially interested' would have
   the same meaning as in explanation to section 40A(2).

3. (a) The Income-Tax Circle/Ward/District in which the applicant is assessed and the Permanent Account No.

   (b) In case of partnership firm:

Name of the Partner (1)	Address (2)	Permanent Account No. (3)	Income-tax circle/ ward where assessed (4)

4. The following particulars are to be furnished concerning the Income-Tax Assessments for the preceding five years:

Year (1)	Total income (2)	Tax demanded (3)	Tax paid (4)	Balance due (5)

5. (a) Has any penalty for concealment been imposed under the provisions of the Income-Tax Act, 1961 or Wealth-tax Act, 1957 on or after 1st April 1975?

(i) If answer is affirmative, the date, amount of penalty imposed and the section under which imposed.

(ii) Has any appeal has been filed against the Penalty Order before the Appellate Assistant Commissioner of Income-Tax or before the Income Tax Appellate Tribunal? If so, what was the result thereof along with date of the appellate order?

(b) Has there been any conviction for an offence within the meaning of section 277 of the Income-tax Act, 1961 or under section 36(2) of the Wealth-tax Act, 1957 or under section 199/200 of the Indian Penal Code? If so, the date of conviction orders.

c) Details of total contract amount received by the applicant, whose name is mentioned against (1) above, during the preceding five accounting years.

Date of previous year ending	Assessment Year	Total Contract amount received	The name of the authority or persons from whom amounts are received
(1)	(2)	(3)	(4)

6. In case there has been no I.T. Assessment for any year, whether returns have been submitted under section 139(2) and 133 of the Income-tax Act, 1961 or tax has been paid in advance under section 210(3) of the Income-tax, 1961 and if so, the amount of income returned for each year and tax of each of the five years mentioned above and the I.T Circle/Ward/District concerned where such returns have been filed, give reasons for the same.

Assessment year	Income returned	Tax paid on self-assessment u/s.140A	Tax paid in advance u/s.210	Date of payment
(1)	(2)	(3)	(4)	(5)

7. Whether any attachment certificate or proceedings are pending in respect of the arrears and the name and address of the branch(es) if any.

I declare that the above information is correct and complete to the best of my information and belief.

Signature of the Tenderer / Contractor: _

Date : _____ 20__ P A N : _____

Address : _____

_____

Note: 1) Tax in Column 3 and 4 of para 4 include all items viz., I.T., S.T., Surcharge, etc.

9. CERTIFICATE

I hereby certify that:-

i) Information contained in this application has been verified from the assessment records and found correct.

ii) The assessee has paid all tax demands due other than those, which have been stayed by the competent authority.

iii) The assessee has been co-operating with the Department in facilitating the completion of the pending assessments.

a) The period of three year has expired from the date of the appellate order of the Income-tax Appellate Tribunal confirming or partially confirming the penalty levied on or after 1-4-75 u/s.271(1)(c) of the Income-tax Act, 1961 or u/s. 18(1)(c) of the Wealth-tax Act, 1957.

Or

In cases where no appeal has been filed by the assessee against the penalty imposed on or after 1-4-75 under section 271(1)(c) of the Income-tax Act, 1961 or u/s.18(1)(c) of the Wealth-tax Act, 1957, the period of three years has expired from the date of imposition of the penalty.

b) The period of three years has expired from the date of the order of conviction on or after 1-4-75 u/s.277 of the Income-tax Act or u/s.36(1) of the Wealth-tax At, 1957 or u/s.199/200 of the Indian Penal Code.

Note:- Delete whichever is inapplicable in the above certificate.

Date : Signature of the I.T.O.

Seal : Circle/Ward/District

10. SCHEDULE OF SUPPLEMENTARY INFORMATION - D

SALES TAX CLEARANCE CERTIFICATE

Office of the Commercial Tax Officer,
_____ Circle
_____

Gl.No. Dated :

CERTIFICATE

This is to certify that M/s.
_____ having their Regd.
Office at address _____
_____ are on the rolls of the
Commercial Tax Officer, _____ Circle, _____ with
the following registration number(s):-

APGST No. _____
CST No. _____

They have filed their monthly A-2 returns and have paid tax up to
_____ under the APGST and CST Act and the assessment has been
completed for the Financial Year _____.

Commercial Tax Officer,
_____ Circle
_____
_____

11. SCHEDULE OF SUPPLEMENTARY INFORMATION - E

IDENTIFICATION AND FINANCIAL DATA SHEET

1. Audited Financial Statements (Balance Sheet and Profit and loss account) for the last five years (Preceding last financial year) including Contingent Liabilities and Projects in progress duly certified by the Charted Accountant in the format enclosed.(Illustrative example is also enclosed for guidance).

2. Latest Solvency Certificate from a Scheduled / Nationalized Bank, obtained not earlier than 3 months prior to tender date.

3. Certificate for credit limits from a Scheduled / Nationalized Bank, obtained not earlier than 3 months prior to tender date.

Note:

If the tenderer is a company, Annual reports of the financial years 2001 to 2006, along with the audited reports under the Companies Act shall be furnished.

In case of tenderers other than the companies, if the turnover in any of the above financial years exceeds Rs. 40/- Lakhs per annum, the audited accounts along with the auditor's certificates under section 44 AB of the Income Tax Act shall be furnished. If the audited reports under section 44AB of Income Tax are not furnished for every year, it will be deemed that the turn over for that year was less than Rs.40 lakhs.

In case of tenderers other than the companies, if the turn over in any of the above financial years does not exceed Rs. 40 Lakhs per annum, the following certificate shall be given by the Chartered Accountant for each year for the Profit and Loss Account and the Balance sheet.

" We have audited the above Profit and Loss Account / Balance Sheet of _____ _____ as on _____ for the financial year ending _____ and in our opinion the said accounts give a true and fair view. The said balance sheet and Profit & Loss Account are in agreement with books of accounts and returns produced and that we have obtained all the information and explanations which to the best of our knowledge and belief were necessary for the purpose of the audit.

4. Originals of the certificates shall be produced at the time of opening tenders.

12. SCHEDULE –F PROJECT EXPERIENCE

PROJECT WISE EXPERIENCE							
PART B - ABSTRACT OF PHYSICAL ACHIEVEMENTS OF EXECUTED / COMPLETED WORKS							
S.No.	Description of work item as per Qualification Criteria	Minimum quantity of work required	Quantity of work completed in each of the last five financial years				
			2005-06	2004-05	2003-04	2002-03	2001-2002

Name
Signature

Date
Designation

(Seal)

TENDERER

Chief Engineer
Municipal Corporation
VIJAYAWADA.

PROJECT WISE EXPERIENCE								
PART C - FINANCIAL ACHIEVEMENTS OF EXECUTED / COMPLETED WORKS								
S.No.	Name of project and location	Name and address of client (with telephone and fax)	Value of completed work (lakh Rs.)	Value of work completed each financial year (lakh Rs)				
				2005-06	2004-05	2003-04	2002-03	2001-2002

Note: Certificates signed by a serving Executive Engineer (or equivalent) shall be furnished in proof of the above particulars the certificates shall be counter signed by a serving superintending Engineer or equivalent.

Name Date

Signature Designation

(Seal)

TENDERER

Chief Engineer
Municipal Corporation
VIJAYAWADA.

PROJECT WISE EXPERIENCE				
PART D - FINANCIAL DETAILS OF WORKS AWARDED AND ONGOING WORKS TO BE EXECUTED BY CONTRACTOR DURING THE PERIOD OF THE WORK UNDER CONSIDERATION				
Sl No.	Name of Project and Location	Name and address of client (telephone & fax)	Value of works to be executed during the period of completion of the work under consideration (lakh Rs)	
			Awarded	Balance of ongoing works

Note : Certificates signed by an Executive Engineer (or equivalent) shall be furnished in proof of the above particulars.
The certificates shall be countersigned by a Superintending Engineer or equivalent.

Name
Signature
Date
Designation

(Seal)

TENDERER

Chief Engineer
Municipal Corporation
VIJAYAWADA.

13. SCHEDULE OF SUPPLEMENTARY INFORMATION - H

PERSONNEL

S No	Required		Proposed		Experience		
	Qualification	No.	Qualification	No.	Nature of work	Required experience in years	Experience of the proposed person in years

Name : _____

Signature : _____

Date : _____

Seal of Company Designation :_____

TENDERER

Chief Engineer
Municipal Corporation
VIJAYAWADA.

14. SCHEDULE OF SUPPLEMENTARY INFORMATION - J

BIO-DATA OF TECHNICAL PERSONNEL OF THE TENDERER WHO WILL BE AVAILABLE FOR THE EXECUTION OF THE PROPOSED CONTRACT

(furnish data separately for each of the personnel)

a) S.No. :

b) Name :

c) Designation :

d) Qualifications :

e) Duration of employment with Tenderer :

f) Years of professional experience :

g) Experience on works of similar nature during employment with Tenderer, and previous employment, if any. Details to be furnished in reverse order starting with present project :

Name :

Signature :

Date :

Seal of Company Designation :

15. SCHEDULE OF SUPPLEMENTARY INFORMATION – K

RECORD OF ARBITRATION & LITIGATION

The Tenderer shall record chronologically any disputes he has had with any of his previous Clients during the last 10 years, indicate whether Arbitration or Litigation, the nature, approximate duration and amount of claim involved in respective cases.

S no	Project Identification and Location	Name and Address of Client, tel & fax	Nature of Dispute					
			Description	Arbit'n/ Litigat'n	Period From - To	Amount Claimed (lakh Rs).	Result	In favour of Client/ Contractor
	.							

Name : Date :

Signature : Designation :

Seal of Company

16. SCHEDULE OF SUPPLEMENTARY INFORMATION – L
HISTORY OF CRIMINAL CASES

S No	Name of Police Station	Town or Village and District	FIR No & Date	Details of the Charges	Stage of the case/ Result

Name :

Signature :

Date :

Designation :

Seal of Company

17. SCHEDULE OF SUPPLEMENTARY INFORMATION – M
GENERAL POWER OF ATTORNEY

By this power of Attorney, I/We ....., s/o ..... aged about ..... years, r/o. ...., Partners of . ..... having its registered office at .....……..hereby appoint ....., aged about ..... years s/o. .... as our lawful attorney on behalf of the company, to do and execute all or any of the following acts, deed and things, that is to say:

1) To apply for, obtain and renew all licenses, permits, etc., that are necessary for carrying on the said business.
2) To submit all statements, returns, etc., to proper authorities as required by any law or rule in force and to verify the same by production of documents and papers.
3) To appoint, employ, dismiss or discharge any agent, broker, office, clerk, peon or any other person at such remuneration, commission, or salary, as the said attorney thinks fit.
4) To draw, accept, endorse, negotiate or pay any bill of exchange, hundi, promissory note, cheque, draft, railway receipt, bill of lading or other instrument which may be deemed necessary for carrying on the said business.
5) To open and operate bank accounts in any bank or banks in the name of the firm and/or to authorise any person or persons to operate the above bank account.
6) To borrow or raise loans from time to time, such sums of money, from any individuals, recognised financial institutions such as Banks, Andhra Pradesh State Financial Corporation, Industrial Development Corporation etc., and upon such terms as the said attorney may think fit upon the security of any of the properties of the firm ..... whether movable or immovable and for such purpose to execute such document or documents as may be necessary for securing the repayment of such loan or loans.
7) To negotiate, enter into any bargain, do all acts, things or execute any deeds or documents or other instruments or assurances as may be necessary for selling, mortgaging or purchasing any movable or immovable property, from any individual, recognised financial institutions such as Banks, Andhra Pradesh State Financial Corporation, Industrial Development Corporation etc., and upon such terms as the said attorney may thinks fit.
8) To institute contest, compound, submit to arbitration all suits proceedings, claims, demands etc., arising in course of or in relation to the aforesaid business.
9) To execute and sign in our name individually or collectively and on our behalf any document, letter or deed in respect of ..... to carry on the business effectively.

And I/We hereby agree to ratify and confirm all and whatsoever our said attorney shall lawfully do or cause to be done by virtue of this deed.

In witness whereof, I/We the said partners has hereto signed at ..... on this the .....

WITNESSES:-	Name of Partner	Signatures
1.	1.	1.
	2.	2.
2.	3.	3.
		Date :

18. SHEDULE OF SUPPLEMENTARY INFORMATION - N

JOINT VENTURE AGREEMENT (Format)

The Joint Venture Agreement made at _____ on this day of _____ th _____, 200_____.

M/s. _____ a Registered partnership firm / Construction company / Contractor / Manufacturer etc., having its registered office at _____, represented by its _____ hereinafter called and referred as the party of the **First Part.**

M/s. _____ a Registered partnership firm / Construction company / Contractor / Manufacturer etc., having its registered office at _____-, represented by its _____ hereinafter called and referred as the party of the **Second Part.**

M/s. _____ a Registered partnership firm / Construction company / Contractor / Manufacturer etc., having its registered office at _____-, represented by its _____ hereinafter called and referred as the party of the **Third Part.**

…….

……

WHEREAS the party of the First Part is a Construction Company / Contractor / Partnership Firm / Manufacturer / Undertaking major civil Works / Supply of goods and equipment such as CI / DI / RCC / PSC / MS Pipes / Pumps / Motors / Water Meters etc.

WHEREAS the party of the First Part is a Construction Company / Contractor / Partnership Firm / Manufacturer / Undertaking major civil Works / Supply of goods and equipment such as CI / DI / RCC / PSC / MS Pipes / Pumps / Motors / Water Meters etc.

AND

WHEREAS the party of the First Part is a Construction Company / Contractor / Partnership Firm / Manufacturer / Undertaking major civil Works / Supply of goods and equipment such as CI / DI / RCC / PSC / MS Pipes / Pumps / Motors / Water Meters etc.

WHEREAS the parties, hereto have associated themselves into a Joint Venture / Consortium for the purpose of preparing and submitting Pre-qualification / Post-qualification / Tender for and successfully executing the works of "_____ _____" for which tenders have been invited by the VMC vide Tender Notice No. _____, Dated: _____.

WHEREAS it is mutually decided by the parties hereto that the Joint Venture / Consortium will be known as _____- (Consortium) and that the part of the First Part viz., and submitting of tender on behalf of the Joint Venture / Consortium.

Now therefore, it is hereby agreed and declared by and between the parties hereto as follows.

1. Definitions:

In this Agreement the following expression shall have the following meaning.

JOINT VENTURE / CONSORTIUM – for the purpose of this agreement shall mean acting in collaboration by the parties hereto in a Joint Venture.

JOINT VENTURE – shall mean all the parties to this Agreement acting jointing and / or severally to execute the "Works".

The extent of such acting jointly and/or severally shall be as enumerated below.

THE WORKS – Shall mean, the works as described in the Schedule hereunder written and any sanctioned venation's thereto.

THE CONTRACT – shall mean any contracts entered into by the Joint Venture with the Employer for the execution of the works.THE EMPLOYER – shall means, the Superintending Engineer, VMC for the work as per Contract.

Preparation & Submission of Tender:

The parties of the Joint Venture (JV) shall jointly prepare and submit the pre-qualifications / post-qualification / tender documents in the name of the Joint Venture which shall be in such form and shall contain such items and conditions as the employer shall require. After its preparation and submission as aforesaid, the Joint Venture shall be jointly and severally bound by the provision of the tender or tenders and none of the party of the Joint Venture can vary or seek to vary the same without previous written consent of the other.

Any bond, Guarantees or Indemnities required by or arising out of the terms and conditions of the tender or contract shall be procured by the parties proportionate to their share of participation or as agreed by mutual consent. In connection with submission of

the tenders and the execution of the works, no party of this Join Venture shall in any way act either alone or jointly with, by or through any other party in a manner likely to be detrimental to the tender and/or execution of the work(s).

The Acceptance of Tender:

If the employer accepts the tender it shall be joint binding on the Joint Venture. In that event, the Leader of the Joint Venture shall for an on behalf of the Joint Venture enter into a contract in consultation with the parties herein, with the employer to execute the works and the members of the Joint Venture do hereby jointly and severally bind themselves to fulfill the contract and execute the work faithfully and perform and observe all the terms and conditions thereon of both as to one another and to the employer. If the said Joint Venture is successful in procuring and executing and completing the said works, the parties of the Joint Venture will discharge the responsibilities of each as required for proper execution of work.

Participation:

Each member of the Joint Venture agrees to place at the disposal of the Joint Venture, the benefit of all its experience, technical knowledge and skill and shall in all respects bear its share of responsibility and burden of completing the contract. The parties herein shall be responsible for physical and financial distribution of work as under:

Name of the Company	Physical & Financial Distribution of Work
1.	
2.	
3.	
4.	
5.	

Execution and Control of Works:

The performance of the contracts and execution of the works will be subject to the overall control of a Supervisory Board, which will consist of representatives of all the parties hereto, holding Power of Attorney. Subject to the overriding authority of the supervisory board, execution and carrying out works, co-ordinated, managed and directed by the project manager appointed by the Leader of the Joint Venture.

Working Capital and Banking Accounts:

As soon as necessary after acceptance of the tender, the Leader of the Joint Venture shall open a separate Bank Accounts with the concurrence of the parties with such bankers and at such places. The members of the Joint Venture shall contribute such sums

commensurate to their value of works to the said accounts as required for proper performance of the contract. The said Banking Accounts shall be operated in accordance with the instructions of the Supervisory Board.

Assignment:

No parties to this Agreement shall have the right to assign or its benefits or liabilities under this Agreement to any other, firm or person without obtaining the prior written consent of the other parties.

Law:

All the disputes under this Agreement shall be subject to the jurisdiction of the Vijayawada Courts only.

IN WITNESS WHEREOF the parties hereto have set the subscribed their respective hands hereinto on the day month and year first herein above written.

SIGNED AND DELIVERED BY

1.

2.

3.

4.

5.

Witness:

1.

2.

19. SCHEDULE OF SUPPLEMENTARY INFORMATION – P

Contractor's Registration

1. Copy of Contractor's Registration in the required class and above shall be enclosed

20. SCHEDULE OF SUPPLEMENTARY INFORMATION – Q

AFFIDAVIT

I/We _____ certify that the information furnished by me/us in the Schedules of Supplementary information F, G, H, I, J, K, L and M is true and agree that my / our tender shall be rejected if I/We am/are found to have misled or made false representation in the form of any of the Schedules of Supplementary information and/or statements submitted in proof of the eligibility and qualification requirements or if I/We have a record of poor performance such as absconding from work, works not properly completed as per contract, in ordinate delays in completion, financial failure and/or has/have participated in previous tendering for the same work/s and had quoted unreasonable high tender premium. In addition I/We shall be blacklisted and the work be taken over invoking clause no 60(a) of the General conditions of contract and Conditions of particular application.

I/We _____ agree to be disqualified for tendering further works in the VMC if I/We _____withdraw my/Our tender without a valid reason (to be decided by the Authority competent to accept the tender).

I/We _____ certify that no criminal cases are pending against me/us partners at the time of submitting the tender.

I/We_____ accept that my/our tender shall be rejected if any criminal cases are pending against me/us/partners of the firm at the time of submitting the tender.

I/We _____ agree that if the history of litigation, criminal cases pending against me/us/Partners furnished by me/us is false, I/We _____ will abide by the action taken by the VMC / Andhra Pradesh Government without approaching any court whatsoever for redress. However, I/We shall be given suitable opportunity to offer my/our explanation before action is taken against me / us.

I/We _____ certify that the following addenda issued by the VMC have been received by me/us and incorporated in my /our tender.

1 dated

2 dated

3 dated

(Add if the addenda issued are more than 3)

7. Further I / We _____ certify that no near relatives(as defined in IT 3.3(e)) are working in the VMC.

8. I / We_____ also agree to undertake to keep accurate and system of accounts, records and furnish the same (including that of sub-contractor) and agree to reimburse VMC any excess amount claimed by me / us over and above my / our entitlement as per clause 98 of the General Conditions of contract.

Dated this …… day of ……. 2006

Signature ……. in the capacity of …… duly authorised to sign the

Tender for and on behalf of

……
(Block Capitals)

Signature of Witness :

Name of Witness :

Address of Witness :

Schedule V1-Electrical

1. **LOAD LIST**

Sl. No	Equipment Description	Rating (kW)	Qty		PF Cosφ	Efficiency	Power KVA	Remarks
			W	S				
(a)	Power Load							
(b)	Lighting Load							
	Total Working Load (kVA)							

2 POWER TRANSFORMER

Sl. No	Item	Unit	Description	Remarks/ make
1	General			
a)	Application/Designation			
b)	Manufacturer			
c)	Quantity			
d)	Installation Indoor / Outdoor			
2	Ratings			
a)	Rating	kVA		
b)	No. Load voltage :			
	- HV Winding	kV		
	- LV Winding	kV		
c)	Quantity supplied	nos.		
d)	Rated Frequency	Hz		
e)	Rated Percentage Impedance at 75°C			
3	Winding Connections			
a)	HV			
b)	LV			
c)	Vector Group			
d)	Application/Direction of Power Flow			
e)	Cooling Method			
4	Transformer Protection provided – Buchholz relay, winding & oil temp. indicators, OLTC, surge relay, PRD, MOG			
5	System Data			
a)	System Voltages			
	- HV Nominal/Highest	kV		
	- LV Nominal/Highest	kV		
b)	Fault Levels			
	- HV System	MVA		
	- LV System	MVA		
c)	System neutral earthing			
	- HV system			
	- LV system			
d)	Efficiency at 75°C at unity PF at full load	%		
e)	Full load regulation at 75°C	UNITY P.F.		
		0.8 P.F		
6	Losses			

Sl. No	Item	Unit	Description	Remarks/ make
a)	No load loss on principal tap at 100% rated voltage & frequency subject to +10% tolerance as per IS	KW (MAX)		
b)	Load loss on principal tap & rated current at 75°C winding temp. (guaranteed subject to +10% tolerance as per IS & excluding copper losses)	KW (MAX)		
7	Winding Insulation Whether fully insulated/material of insulation			
8	Guaranteed maximum temperature rise over 40°C			
a)	Ref. Ambient Temperature	°C		
b)	Temperature rise of oil by Thermometer	°C		
c)	Temperature rise of winding by resistance	°C		
9	Tappings			
a)	Tapping on winding			
b)	Whether on load/off Load			
c)	Total Tapping Range			
d)	Step			
e)	Capacity full/reduced			
f)	On HV/LV Winding			
10	If on load taps specify details of OLTC gear			
a)	Manual/Automatic			
b)	Remote/Local Control			
c)	Voltage class of OLTC			
d)	Current rating of OLTC			
11	Terminal Bushings			
a)	Rated Voltage Class	kV		
b)	Minimum clearance in air			
	- Phase to phase	mm		
	- Phase to ground	mm		
c)	Minimum creepage distances (Total)	Mm		
d)	One minute power frequency withstand dry & wet			
e)	1.2/50 impulse withstand			
12	Terminal Connections			

Sl. No	Item	Unit	Description	Remarks/ make
a)	HV winding			
b)	LV winding			
c)	Mounting			
d)	Class of Insulation			
e)	Busbar size in secondary			
f)	LV wdg neutral end			
g)	Disconnecting chamber /cable box			
13	Magnetising current at rated voltage & frequency			
a)	When excited from LV side			
b)	When excited from LV side at 110% rated voltage			
14	Maximum Flux Density	TESLA		
a)	At rated voltage	TESLA		
b)	At 110% rated voltage	TESLA		
15	Current Density			
a)	HV	A/cm2		
b)	LV	A/cm2		
16	Miscellaneous			
a)	Final painting Color shade as per IS:5			
17	Weight (APPRO)			
a)	Core & windings	kg		
b)	Oil	kg		
c)	Tank, coolers & fittings	kg		
d)	Total	kg		
e)	Untanking weight	kg		
18	Dimensions			
a)	Width	mm		
b)	Height	mm		
c)	Depth	mm		
19	Details of Fittings & Accessories			
a)	Inspection Cover			
b)	Rating Plate			
c)	Terminal marking plate			
d)	Two earthing terminals			
e)	Lifting lugs			
f)	Drain valve			
g)	Dehydrating breather			
h)	Oil level prismatic			
i)	Thermometer pocket			

Sl. No	Item	Unit	Description	Remarks/ make
j)	Oil filling hole with cover			
k)	Conservator			
l)	Air release plug			
m)	Jacking pads			
n)	Filter valves			
o)	Weatherproof marshalling box with internal connecting cabling			
p)	Cable box air insulated on HV Side with disconnecting chambers with suitable lugs & glands			
q)	Winding temp. indicator with Mercury switches for alarm and trip			
r)	Oil temperature indicator with mercury switches for alarm and trip			
s)	Magnetic oil level gauge with mercury switch for Alarm Dial Size of magnetic oil level gauge			
t)	Pressure relief valve with alarm contacts			
u)	Buchholz Relay with Alarm and Trip contacts			
v)	Neutral CT – 2 Nos. Mounted on Tank /L.V Bus Box			
w)	Wheels			
	- Flat/flanged			
	- Unidirectional/Bi-directional			
	- Quantity			
	- Gauge			

Note: Use separate sheets for different rating transformers

3 415 POWER CAPACITORS

Sl. No	Item	Unit	Description	Remarks/ make
1				
a)	Name of manufacturer			
b)	Manufacturer's type and designation			
c)	Reference Standards			
d)	Rated VAR capacity of the capacitor bank			
e)	Rated voltage			
f)	Rated frequency			
g)	Output of the capacitor bank at rated voltage	kVAR		
h)	Temperature rise over the specified ambient temperature as mentioned	°C	Detailed Attached	
i)	Hot spot temperature at rated current	°C		
j)	Maximum operating Temperature	°C	Detailed Attached	
k)	Capacity of Bank	μ farads		
l)	Rated line current Maximum permissible overload current	A A		
m)	Capacitor Losses			
	- For complete Bank	Watts		
	- For individual units	Watts		
n)	Electrical clearance in the capacitor bank			
	- Phase to phase min	mm		
	- Phase to earth min	mm		
o)	Permissible Harmonics	%		
2	Unit Capacitors			
a)	Rated Voltage	V		
b)	Rated Output	kVAR		
c)	Number of phases			
d)	Whether single bushing or multibushing type			
e)	Maximum overvoltage the unit capacitor is capable of with standing continuously	%		
f)	Insulation strength to earth			
g)	Number of capacitor elements per capacitor			
h)	Mode of internal connection of the capacitor element			
i)	Type of active element			

Sl. No	Item	Unit	Description	Remarks/ make
	- Watt loss of paper at various dielectric temperature enclosed	Yes / No		
	- Thickness	Mm		
	- Alternating nominal r.m.s. voltage stress on the dielectric paper	Volts / mm		
j)	Impregnant			
	- Type of impregnant used			
	- Pressure at which the impregnant is kept within the unit	kg/mm^2		
3	Capacitor Fuses			
a)	Rating of the fuse element			
	- Current	A		
	- Voltage	V		
b)	Strength of the fuse elements in Amp Sec at which it melts	Amp Sec.		
c)	Type of the fuse			
d)	Discharge device used			
e)	Number of stages			
4	General			
a)	Overall dimensions of bank and units	mm		
b)	Layout and dimension drawings attached	Yes / No		
c)	Type test certificates enclosed	Yes / No		

4 CAPACITOR CONTROL PANEL

Sl. No	Item	Unit	Description	Remarks/ make
1	Manufacturer/Assemble			
2	Quantity			
3	Dimensions of capacitor control panel			
a)	Width	mm		
b)	Depth	Mm		
c)	Height	mm		
4	Enclosure Protection			
5	Auto Power factor relay			

Sl. No	Item	Unit	Description	Remarks/ make
a)	Manufacturer			
b)	Type			
c)	Number of stages			

5 MAINTAINS FREE SEALED LEAD ACID BATTERY

Sl. No	Item	Unit	Description	Remarks/ make
1	General			
a)	Make			
b)	Standards to which battery is manufactured			
2	Capacity			
a)	Capacity at 27^0C	Ah	At 10 hour rate	
	- Initial	Ah		
	- Rated	Ah		
	- End of life	Ah		
b)	Rated capacity at minimum ambient temperature	Ah		
c)	Rated capacity at maximum ambient temperature			
d)	Maximum momentary current 1 minute duration	Amps		
e)	Expected life of battery	Years		
3	Cells			
a)	Number of cells required to give rated D.C. voltage			
b)	Number of spare cells			
c)	Type of cell			
4	Material of separators			
5	Overall dimensions			
a)	Each cell (L x W x H)	Mm x mm x mm		
b)	Complete battery with rack L x W x H	Mm x mm x mm		
6	Weight of complete battery	Kg.		
7	Whether there would any harmful effect on the life of battery if discharged as per load cycle specified above, after being maintained in float charging condition	Yes / No		
8	List of spares / accessories enclosed with tender	Yes / No		

9	Drawing showing battery layout enclosed with tender	Yes / No		

6 BATTERY CHARGER

Sl. No	Item	Unit	Description	Remarks/ make
1	General			
a)	Make			
b)	Applicable Standards			
c)	Rated output voltage (DC)	V		
d)	Rated output	KW		
2	Overload capacity after operation			
a)	For 10 hours at rated load			
b)	For 2 hours	A		
c)	For 1 minute	A		
3	Maximum charging current, battery charger is capable of for			
a)	Float charging the battery	A		
b)	Boost charging the battery	A		
4	Normal continuous DC load the charger is capable of supplying while float charging	A		
5	Boost charging voltage	V		
6	Inherent voltage regulations from no load to rated load	%		
7	Harmonics at rated load			
a)	With battery	%		
b)	Without battery	%		
8	Dimension of battery charger Length x Depth x Height	Mm x mm x mm		

7 LOCAL PUSH BUTTON STATION

Sl. No	Item	Unit	Description	Remarks/ make
1	Manufacturer			
2	Enclosure thickness			
3	Number of contacts			
4	Contact rating at 240V AC			

8 CABLES

Sl. No	Item	Unit	Description	Remarks/ make
1	1kV XLPE Unearthed Power Cable			
a)	Manufacturer			
b)	Permissible voltage, frequency & combined Variation			
c)	Continuous current rating	A		
d)	Derating factors for Variation in ambient temp. in steps of 5deg. Cent. Grouping of cables in covered trenches			
e)	Short circuit capacity			
	- Current & duration	kA/sec		
	- Maximum conductor temperature	℃		
f)	Loss tangent at normal frequency			
g)	Conductor			
	- Composition			
	- Cross section	sq.mm.		
h)	Type of conductor screening			
i)	Insulation			
	- Composition			
	- Thickness	mm		
j)	Type of insulation screening			
k)	Inner sheath			
	- Material			
	- Calculated diameter Over stranded cores	Mm		
l)	Outer sheath			
	- Material			
	- Thickness	mm		
m)	Armour			
	- Type			
	- Nominal diameter of cable over inner sheath	mm		
	- Armour thickness/wire diameter	mm		
n)	Overall diameter of cable	mm		
o)	Recommended minimum bending radius	mm		
p)	Safe pulling force when pulled by pulling eye			
q)	Standard length of cable in drum	m		
2	650/1100V Grade PVC			

Sl. No	Item	Unit	Description	Remarks/ make
	Insulated Power Cables			
a)	Manufacturer & cable type			
b)	Rated Voltage			
c)	Permissible voltage, frequency Variation			
d)	Continuous current rating	A		
e)	Derating factors for Variation in ambient temp. in steps of 5deg. Cent Grouping of cables in covered trenches			
f)	Short circuit capacity			
g)	Current & duration	kA/sec		
h)	Maximum conductor temp	℃		
i)	Conductor			
	- Composition	sq.mm.		
	- Cross section	sq.mm.		
j)	Insulation			
	- Composition			
	- Thickness	mm		
k)	Inner sheath			
	- Material			
	- Calculated diameter Over stranded cores	mm		
l)	Outer sheath			
	- Material			
	- Thickness	mm		
m)	Armour			
	- Type			
	- Nominal diameter of cable over inner sheath	mm		
	- Armour thickness/wire diameter	mm		
n)	Overall diameter of cable	mm		
o)	Recommended minimum bending radius	mm		
p)	Standard length of cable in drum	M		
3	650/1100V Grade PVC Insulated Control Cables			
a)	Manufacturer & cable type			
b)	Rated Voltage			
c)	Conductor			
	- Composition			
	- Cross section	sq.mm.		
d)	Insulation	mm		
	- Composition			
	- Thickness	mm		

Sl. No	Item	Unit	Description	Remarks/ make
e)	Inner sheath			
	- Thickness			
	- Thickness	mm		
f)	Outer sheath			
	- Material			
	- Thickness	mm		
g)	Armour			
	- Type			
	- Nominal diameter of cable over inner sheath	mm		
	- Armour thickness/wire diameter	mm		
h)	Overall diameter of cable	mm		
i)	Standard length of cable in drum	m		
j)	Standard length of cable in drum	m		

9 LIGHTING SYSTEM

Sl .No	Item	Unit	Description	Remarks/ make
1	Lighting Fittings			
a)	Manufacturer			
b)	Nominal working voltage	V		
c)	Maximum permissible supply voltage variation	%		
d)	Power factor at normal working voltage & frequency			
e)	Power loss per ballast at normal working voltage & frequency	W		
2	Emergency Lighting Fittings			
a)	Manufacturer			
b)	Rated voltage	V		
c)	Light output duration			
d)	Lamp rating (AC/DC)	W		
e)	Catalogue containing technical literature enclosed Yes/No			

Sl .No	Item	Unit	Description	Remarks/ make
3	Lighting Installation			
a)	Earthing conductor			
	- Size			
	- Material			
b)	Conduit			
	- Size			
	- Material			
c)	Wire/cables			
	- Conductor			
	- Material			
	- Size			

10 CABLE TERMINATIONS

Sl. No	Item	Unit	Description	Remarks/ make
1	Gland type			
2	Lugs			
3	Application Indoor/Outdoor			

11 CABLE TRAY

Sl. No	Item	Unit	Description	Remarks/ make
1	Manufacturer			
2	Type			
3	Material			
4	Finish			
5	Tray width			
6	Cable tray supports and fixing			
	- Type			
	- Material			
	- Finish			

12 EARTHING

Sl .No	Item	Unit	Description	Remarks/ make
1	Earthing conductor buried in			
a)	Ground			
b)	Material			
c)	Size			
2	Earthing conductor above ground upto equipment terminal			
a)	Material			
b)	Size			
3	Earth Electrode test pits			
a)	Material			
b)	Size			
c)	Type of Electrode			

ANNEXURE - II

CITY PROFILE

Introduction:

Vijayawada is the third largest city in the state of Andhra Pradesh after Hyderabad and Visakhapatnam, located on banks of river Krishna. Vijayawada has considerable historical importance and cultural heritage. It is considered as the agricultural and commercial capital of Andhra Pradesh. It is a major railway junction connecting north and south India. The population of Vijayawada city was around 0.75 million in 1991, which has increased to 0.90 million by 2001. The Vijayawada Urban Agglomeration is identified as one of the 35 metropolitan cities in India with a population of 1.01 million as per 2001 census. The area of the city stood at 58 square kilometres. Vijayawada city has a density of about 12,000 persons per square kilometre. Vijayawada Municipal Corporation was constituted on 1st April, 1888 with an area of 30 Sq.Kms and was upgraded as selection grade in the year 1960. The Municipality was upgraded to Corporation in 1981. The rail and road trunk route link Madras, Delhi, Calcutta, Machilipatnam and Hyderabad at Vijayawada, which is one of the largest traffic, centres in South India. An Autonagar, which is the hub of automobile, related activities.

Vijayawada is a major tourist destination in the state having a number of pilgrimage and historical sites. The most prominent ones being Prakasam Barrage, Kanaka Durga Temple, a 56 feet Stupa on the Gandhi Hill, a Planetarium and the Mogalrajapuram caves, which are one of the unique caves in the entire South India. The other famous caves are the Undavalli caves, situated about 8 Kms from Vijayawada. These caves were built in 7th century A.D

The total population of the city according to the 2001 census is 851282. The growth rate of population between 1991 and 2001 is 22%. The population density is 10152. The sex ratio is 974, while the literacy rate is 69%. A brief of social economic profile of Vijayawada is given in table below:

Vijayawada had an estimated slum population of 0.15 million in 1987 spread over an area of 758 acres in 136 slum pockets. The slum population has gone up to 0.22 million

by 1997 constituting 26 percent of the total city's population. The concentration of slums in Vijayawada city is more on the south eastern part of the city. The slums are predominantly spread along the riverbanks of Krishna and its tributaries / canals.

Existing conditions

Climate:

The climate of Vijayawada is tropical in nature with hot summers and moderate winters. The months of April to June are the summer months with the temperature ranging from a minimum of 27^0 C to 45^0 C. The temperature during winter months ranges from 28^0 C to 17^0 C. The average humidity ranges from 68% to 80% during summer season. The annual rainfall in the region is about 965mm and is contributed by the south west monsoons.

Geology:

The region forms a part of Eastern Ghats comprising of Khondalites, Charnockites, Quartiles and Quartz Veins, Minerals like Khandalites and Charnackites are predominantly found in the region of the Vijayawada, Guntur, Tenali Urban Development Area. Three types of soils namely, Alluvial, Black, Reger and Red ferrogineous are predominantly found in the area with fertile alluvial soils in the Krishna delta area of Vijayawada.

Topography:

The Northern, North-Western and South-Western parts of this region are covered by a low range of hills while the Central, South-Western and South-Eastern parts are covered by rich fertile agricultural lands irrigated by left and right canal systems under the Krishna barrage constructed across the river. The prominent hills in this region are Kondapalli, Indrakiladri and Mogalrajapuram hills.

Hydrology

The city is located on the bank of river Krishna and 3 canals and there is a one rivulet passing in the city.

Demography

The city has witnessed a rapid growth over the past two decades with an average decennial growth rate of 43.15%. During the period 1971-81 the net growth has been

about 57.57% attributed to a large influx of the rural population to the city. However, during the past decade 1981-91, the growth has stabilised with a decadal population growth of 29.16%. The growth in the city's population is as detailed in table.

Population Growth

Year	Population (lakh)	Average annual growth rate (%)
	454527	43.26%
	701827	54.41%
	851282	21.30%
Estimated)	10,00,000	14.87%
Projected)*	11,50,000	13.04%

The development of the town has largely been confined to few of the central wards comprising of wards 4 to 21 and wards 26 to 35. On the other hand 15 of the total 50 wards are sparsely populated. There are over 27500 persons per square kilometre in developed areas and the trend is towards further consolidation and concentration of these densities. While the wards 1, 2, 49 and 50 exhibit a high rate of growth, the central wards like 15, 16, 17 exhibited a rather low growth rate. The average density of the Corporation is about 121 persons per hectare with a maximum density of 73600 persons/Sq.Kms in ward No.36. Vijayawada city has a density of about 12,000 persons per square kilometre.

The contributors to population growth are mainly the natural increase and the in migration from the surrounding villages.

Slums and the Urban Poor:

Vijayawada with an estimated slum population of 2.27 lakhs in 1987 spreads over an area of 758 acres, comprising of 136 pockets. The spatial distribution of slums has been indicated in plate No.3. the concentration of the slums is more on the South-Eastern parts of the city and are predominantly spread over the banks of river Krishna and its tributaries / canals.

The population in 1991 was about 2.48 lakhs constituting 32% of the total city's population of the total 0.5 lakhs of employed persons, about 60% are casual labourers followed by the salaried class at 22% and petty business at 11. A slum improvement project with an ODA assistance is in progress. Table 2.3 below categorises slums based on the type of land on which they are situated.

Vijayawada had an estimated slum population of 0.15 million in 1987 spread over an area of 758 acres in 112 slum pockets. The slum population has gone up to 0.22 million by 1997 constituting 26 percent of the total city's population. The concentration of slums in Vijayawada city is more on the south-eastern part of the city. The slums are predominantly spread along the riverbanks of Krishna and its tributaries / canals.

There are 112 notified slums in the Vijayawada city with a population of 2,25,000 for which the basic infrastructure including Roads, Drains, Water Supply, Electrification etc., were created under the ODA Scheme. Further the rehabilitation and relocation settlements were taken up under ODA at Singh Nagar area by providing all basic civic amenities.

As per 2001 census there were 1,80,000 residential houses with assessments Numbers having a population of 8,51,282.

Annexure – III

BRIEF INFORMATION ON SEWAGE SCHEMES

The city areas, to the West and East of the Chennai – Howrah Railway line are considered as Western area, central, Eastern and South-Eastern areas for the Water Supply System.

Central Area:

The Central area is divided into seven drainage blocks in consideration of the railway lines and irrigation canals alignments. The Water Supply system for Blocks I & II the areas bounded by Railway Station, Eluru canals and Ryves Canal, were completed and commissioned during 1964, Water Supplys of Block-III, between Ryves canal and Bandar canal and lying to the West of Mogalrajapuram and Block-IV covering Labbipet, Prajasakthi Nagar, Giripuram and Bandar road proximities, were completed and commissioned during 1965. The sewages of Block-I to IV are being collected at the pumping stations located in Kedareswara Peta, Poornandampet and Hanumanpet, Gandhi Nagar, Mutyalampadu, Durga Agraharam and North end of stadium respectively and are being pumped to the treatment works at Ajithsingh Nagar.

The sewage from these collected by gravity will be pumped to Block-II D.P.Station No.3 at Sitarampuram. From this pumping station the sewage will be pumped to the treatment works at Ajithsingh Nagar i.e., finally the total sewage from these six blocks of central portion of Vijayawada city will be pumped to Ajithsingh Nagar through, two drainage pumping stations No.2 & 3.

The existing scheme is functioning well and it serves the Water Supply facilities to 2.50 lack population with scientific method of treatment. The sewage schemes for the entire central area has been functioning with 18000nos of Water Supply connections.

At northern part of the city sewage treatment plant has been located for the central area Water Supply scheme. The treatment plant has been devised based on the conventional method of treatment with oxidation ponds and the digester.

The waste water collected at the primary treatment units will be loaded on to the primary sedimentation tank then the treated waste will be allowed in to oxidation ponds For biological treatment. The final treated wastewater will be let out in to the Budameru after achieving the desired effluent standards .the sludge generated in the sludge drying beds has been taken out by the farmers for manure on cost basis. The details of the plan are as follows.

Annexure – IV

DESIGN PARAMETERS

Characteristics of Wastewater

1. Input wastewater	-	Domestic sewage
2. Average flow	-	40 MLD
3. Peak factor	-	2
4. PH	-	6.5
5. Temperature	-	32^0 C
6. Biological Oxygen Demand	-	200 mg/l
7. Chemical Oxygen Demand	-	600 mg/l
8. Total Suspended Solids at 105^0C	-	425 mg/l
9. Alkalinity	-	420 mg/l
10. Total dissolved solids at 105^0C	-	1000 mg/l
11. Sulphates	-	60 mg/l
12. Chlorides	-	200 mg/l

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MATERIALS AND WORKMANSHIP

1.1 MATERIALS GENERALLY

a. The term "Materials" shall mean all materials, goods and articles of every kind whether raw, processed or manufactured and equipment and plant of every kind to be supplied by the Contractor for incorporation in the works.

b. Except as may be otherwise specified for particular parts of the Works the provision of clauses in "materials and workmanship" shall apply to materials and workmanship for any part of the works.

c. All materials shall be new and of the kinds and qualities described in the Contract and shall be at least equal to approved samples.

d. As soon as practicable after receiving the order to commence the works, the Contractor shall inform the Engineer of the names of the suppliers from whom he proposes to obtain any materials but he shall not place any order without the approval of the Engineer which may be withheld until samples have been submitted and satisfactorily tested. The Contractor shall thereafter keep the Engineer informed of orders for and delivery dates of all materials.

e. Materials shall be transported, handled and stored in such a manner as to prevent deterioration, damage or contamination failing which such damaged materials will be rejected and shall not be used on any part of the Works under this contract.

1.2 SAMPLES AND TESTS OF MATERIALS

a. The Contractor shall submit samples of such materials as may be required by the Engineer and shall carry out the specified tests directed by the Engineer at the Site, at the supplier's premises or at a laboratory approved by the Engineer.

b. Samples shall be submitted and tests carried out sufficiently early to enable further samples to be submitted and tested if required by the Engineer.

c. The Contractor shall give the Engineer seven days notice in writing of the date on which any of the materials will be ready for testing or inspection at the supplier's premises or at a laboratory approved by the Engineer. The Engineer shall attend the test at the appointed place within seven days of the said date on which the materials are expected to be ready for testing or inspection according to the Contractor, failing which the test may proceed in his absence unless instructed by the Engineer to carry out such a test on a mutually agreed upon date in his presence. The Contractor shall in any case submit to the Engineer within seven days of every test such number of certified copies (not exceeding six) of the test readings as the Engineer may require.

d. Approval by the Engineer as to the placing of orders for materials or as to samples or tests shall not prejudice any of the Engineer's powers under the Contract particularly as to the provisions of under the Conditions of Contract.

1.3 STANDARDS

a. The special attention of the Contractor is drawn to the relevant sections and clauses of the National Building Code of India 1984 and Andhra Pradesh Standard Specifications and latest I.S. Specifications (latest editions as amended) and should follow all the specifications and conditions strictly.

b. Materials and workmanship shall comply with the relevant Indian Standards (with amendments) current at the thirty-first day of December 2001, unless a more recent amendment is specified hereinafter, or with the requirements of any other authoritative standard approved by the Engineer which shall be no less exacting in the opinion of the Engineer than the corresponding standard quoted herein.

c. Where the relevant standard provides for the furnishing of a certificate to the Engineer, at his request, stating that the materials supplied comply in all respects with the standard, the Contractor shall obtain the certificate and forward it to the Engineer.

d. The specifications, standards and codes listed below are made a part of this specification. All standards, tentative specifications, specifications, codes of practices referred to herein shall be the latest editions including all applicable official amendments and revisions.

e. If no standard is indicated, the relevant Indian Standard, if any, shall apply. Indian Standards are published by:

Indian Standards Institution,
Manak Bhavan,
9, Bahadur Shah Zafar Marg,
NEW DELHI - 110 002.

f. In case of discrepancy between the Specification and the Standards referred to herein, the Specification shall govern.

(i) Materials

IS:226 - Specification for structural steel (Standard Quality)
IS:269 - Specification for ordinary and low-heat portland cement
IS:383 - Specification for coarse and fine aggregates from natural sources for concrete.
IS:428 - Specification for distemper, oil emulsion, colour as required.

IS:432 (Parts I & VI) - Specification for mild steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement.

IS:455 - Specification for portland slag cement.

IS:458 - Specification for concrete pipes.

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 rolled steel beam, channel and angle sections. (Parts I & II)

IS:814 - Specifications for covered electrodes for metal arc welding of structural steel. (Parts I & II)

IS:961 - Specification for structural steel (High Tensile).

IS:1003 - Specification for timber panelled 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 (upto 40 mm diameter) for structural purposes.

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, nuts (Parts-I&II) and lock nuts (diameter 6to 39mm) and black hexagonal screws (diameter 6 to 24mm).
IS:1364	-	Specification for precision and semi-precision hexagonal bolts, screws, nuts and lock nuts (diameter 6 to 39 mm).
IS:1367	-	Technical supply conditions for threaded (Parts I to XVIII) fasteners.
IS:1489	-	Specification for portland - Pozzolana Cement.
IS:1566	-	Specification for hard drawn steel wire for concrete reinforcement.
IS:1580	-	Specification for bituminous compounds for water proofing and caulking purposes.
IS:1786	-	Specification for cold worked steel high strength deformed bars for concrete reinforcement.
IS:1852	-	Specification for rolling and cutting tolerances for hot ventilators.
IS:1948	-	Specification for aluminium doors, windows and ventilators.
IS:2016	-	Specification for plain washers.
IS:2062	-	Specification for structural steel (Fusion welding quality)
IS:2074	-	Specification for ready mixed paint, air drying, red oxide zinc chrome and priming.
IS:2185 (Part-I)	-	Specification for concrete masonry units, hollow and solid concrete blocks.
IS:2202 (Parts I & II)	-	Specification for wooden flush door shutters
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 chequered plates.
IS:3757	-	Specification for high tensile friction grip bolts.
IS:4021	-	Specification for timber door, window and ventilator frames.
IS:4350	-	Specification for concrete porous pipes for underdrainage.
IS:4351	-	Specification for steel door frames.
IS:4990	-	Specification for plywood for concrete shuttering work.
IS:5369	-	General requirements for plain washers and lock washers.
IS:7280	-	Specification for bar wire electrodes for submerged arc welding of structural steel.

IS:10262- Recommended guidelines for concrete mix design. (ii) Tests

IS:516 - Method of test for strength of concrete.

IS:1182 - Recommended practice for radiographic examination of fusion-welded butt joints in steel plates.

IS:1199 - Method of sampling and analysis of concrete.

IS:2386 - Methods of test for aggregate for concrete.
(Parts I to VIII)

IS:2720 - Methods of test for soils.
(Parts I to XLI)

IS:3025 - Method for sampling and test (physical and chemical) for water used in industry.

IS:3495 - Method of burnt clay building bricks.

IS:3613 - Acceptance tests for wire flux combinations for submerged arc welding of structural steel.

IS:4020 - Methods of tests for wooden flush doors; type tests.

IS:4031 - Methods of physical tests for hydraulic cement.

IS:5807 - Methods of test for clear finishes for wooden furniture.
(Parts I to V)

IS:7318 - Qualifying tests when welding procedure approval is not required.
(Parts I & II)

(iii) 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 use of structural steel in general building construction.

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 general construction in mild steel.

IS:817 - Code of practice for training and testing of metal arc welders.

IS:875 - Code of practice for structural safety of building - loading standards.

IS:919 - Recommendations for limits and fits for engineering.

IS:1081 - Code of practice for fixing and glazing of metal (steel and aluminium) doors, windows and ventilators.

IS:1172 - Code of basic requirements for water supply, Drainage and sanitation.

IS:1477 - Code of practice for painting of ferrous metals in building.
(Parts I & II)

IS:1597 - Code of practice for construction of stone masonry.
(Parts I & II)

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 - Code of practice for finishing of wood and wood based materials.
(Parts I & II)

IS:2394 - Code of practice for application of lime plaster finish.

IS:2395 - Code of practice for painting concrete, masonry and plaster surfaces.
(Parts I & II)

IS:2502 - Code of practice for bending and fixing bars for concrete reinforcement.
IS:2571 - Code of practice for laying insitue cement concrete flooring.

IS:2595 - Code of practice for radiographic testing.

IS:2571 - Code of practice for welding of mild steel bars used for reinforced concrete construction.

IS:2994 - Code of practice for design and construction of machine foundations.
(Parts I to IV)

IS:3114 - Code of practice for laying of Cast Iron Pipes.

IS:3370 - Code of practice for concrete structures for storage of liquids.
(Parts I to IV)

IS:3414 - Code of practice for design and installation of joints in building.

IS:3558 - Code of practice for use of immersion vibrators for consolidating concrete.

IS:3935 - Code of practice for composite construction.

IS:4000 - Code of practice for assembly of structural joints using high tensile friction grip fasteners.

IS:4014 - Code of practice for steel tubular scaffolding
(Parts I & II)

IS:4111 - Code of practice for ancillary structures in sewerage system.

IS:4127 - Code of practice for laying of glazed stone-ware 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 building.

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 and carbon manganese steels.

IS:10005 - International system of units (SI) and guide to its use.

IS:4990 - Specifications for concrete shuttering.

IS 1597 - Code of Practice for Construction of Stone Masonary

(iv) Construction Safety

IS:3696 - Safety code for scaffolds and ladders. (Parts I & II)

IS:3764 - Safety code for excavation work.

IS:7205 - Safety code for erection of structural steel work.

EARTHWORK

DEFINITIONS

The following terms shall have the meanings hereby assigned to them:

Top Soil: Means any surface material, including turf, suitable for use in soiling areas to be grassed or cultivated.

Excavation: Means excavation in open cut (excluding trench excavation) down to levels required as per approved Drawings or otherwise as being the general levels after completion of excavation.

SITE CLEARANCE

All area of the Site, marked in the Specification Drawings for clearance are from which material is to be excavated or upon which filling is to be deposited shall be cleared to the extent required by the Engineer of all buildings, walls, gates, fence and other structure and obstructions of all bushes, hedges, trees, stumps, roots and other vegetation except for trees marked for preservation. Material so cleared shall so far as suitable be preserved and stacked for further use but shall otherwise be burnt to ash or disposed off the Site as directed by the Engineer.

GENERAL EXCAVATION

General excavation means excavation required for structures and from borrow areas, and shall not include trench excavation. General excavation may also include miscellaneous isolated lengths of trenches beneath or adjacent to other structures.

The ground shall be excavated by such methods and to such dimensions and depths as shall allow for the proper construction of the works and safety of personnel and equipment used on excavation. Slopes required for stable formation of sides shall be provided.

The excavation in earth, murum, boulders, soft and hard rock shall be carried out to the correct levels required and specified and no tolerance, plus or minus, shall be permitted. However, if any depressions are formed due to removal of boulders, they shall be made good by filling with M-10 concrete up to the bottom layer of the footing/raft. Excavation in hard rock may be done either by blasting or chiseling depending upon the site conditions. When excavation has reached within 300 mm of the required formation level, further excavation shall be carried out carefully either by blasting or chiseling. Where blasting is resorted to, small charges shall be used to minimise occurrence of heavy over cuts. The Contractor shall make every afford to carry out the excavation to correct formation level as far as practicable. In order to minimise the overbreak and loosening of materials at the finished surfaces, final cutting for the last 450 mm to 600 mm in rock shall be carried out by controlled blasting and trimming with the help of pneumatic or other power tools. Unless otherwise specified, the overbreak shall not exceed 75 mm. The overbreakage of 75 mm shall not be measured for payment and therefore the Contractor while quoting his rates for rock excavation has to take into account the directly possible from the sections, it may be arrived at measuring compactly formed stacks of the excavated rock. Deduction of 40% or higher percentage as may be desired by the Executive Engineer shall be made to allow for the voids. Stacks shall not be of width greater than 1.5 m wide nor of height less than 1 mt.

Payment for all types of excavation shall be made by detailed measurement supported by ground levels recorded prior to and after completion of excavation, subject to the limit for payment indicated by the slopes of excavation indicated in the specification drawing. Any additional excavation will be at the contractor's expense, unless specifically approved by the Engineer.

EXCAVATION IN HARD ROCK BY CHISELING

This includes rock which is easily excavated by blasting, but due to close proximity of structures or any other reason that the Engineer may consider, will have to be excavated by chiseling.

The Contractor may report to any of the following methods to excavate rock by chiseling:

i) Wedging by means of crowbars, pick axes or pneumatic drills
ii) Heating and quenching

iii) Controlled blasting with a small charge just sufficient to make a crack in rock which will be subsequently removed by wedging

No extra payment shall be made for removal of rock by chiseling and controlled blasting.

EXCESS EXCAVATION TO BE MADE GOOD

The contractor, at his own expense, shall, if directed, remove from the Site all material resulting from excess excavation and shall make good the same with such kind of fill material or in such class of concrete as may be reasonably required by the Engineer having regard to the circumstances.

STRIPPING TOP SOIL

Where ordered by the Engineer, topsoil shall be stripped to such depths and over such areas as he may direct, as a separate operation prior to any further excavation which may be required.

SUPPORTING EXCAVATION

The Contractor shall well and effectually support the sides and ends of all excavations to prevent any fall or run from any portion of the ground outside the excavation and to prevent settlement or damage to structures adjacent to the excavation. Any excavation necessary to provide space for such support or other working space shall be carried out. If, for any reason, any portion of the bottoms, sides or ends of any excavations shall give way, the contractor shall at his own expense take all necessary remedial measures including the excavation and removal of all the ground thereby distributed.

Where the Contractor elects and is permitted by the Engineer to perform excavations with sloping faces (other than sloping excavations shown on the Drawings or required as permanent features of the Works) and without shoring, the excavated faces shall be to stable slopes and heights.

TRIMMING EXCAVATION

When excavating to specified or required levels for the foundation of any structure or to specified or required limits for the face of any structure required to abut undisturbed ground, the Contractor shall not excavate the last 150 mm until immediately before commencing the constructional work, except where the Engineer shall permit otherwise. Should the Contractor have excavated to within 150 mm above these specified limits before he is ready or able to commence the constructional work he shall, where required by the Engineer, excavate further so as to remove not less than 150 mm of material immediately before commencing the constructional work.

Before commencement of any constructional work all shattered and loose materials shall be removed from the excavations by hand so as to ensure that the work rests on a solid and perfectly clean foundation or abuts against solid ground.

INSPECTION BY THE ENGINEER

When the specified levels or limits 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. Such further excavation shall be refilled to the specified levels or limits with concrete, selected excavated material or selected imported material as directed by the Engineer.

Should the material forming the bottom of any excavation, while acceptable to the Engineer at the time of his inspection, subsequently become unacceptable to him due to exposure to weather conditions or due to flooding or have puddled, soft or loss during the progress of the works, the Contractor shall remove such damaged, softened or loosened material and excavate further by hand.

DISPOSING EXCAVATED MATERIAL

All excavated material shall remain the property of the HMWSSB.

The Contractor shall ensure that no excavated material which is suitable for and is required for re-use in the Works is transported unless so ordered by the Engineer.
Surplus Excavated earth more than the specified quantity in BOQ shall be either spread within the premises or carted out at no extra cost.

BACK FILLING GENERAL SITE GRADING AND SAND FILLING

Fill Material

i. All fill material whether such material is brought from outside borrow areas or excavation within the site, will be subject to Engineer's approval. Notwithstanding any approval given to the fill material or borrow areas from which fill material is proposed to be brought, the Engineer reserves the right to reject such material which in his opinion either does not meet the specification requirements or unsuitable for purpose for which it is intended.

ii. Roads, of a temporary nature, required to be constructed of access and for movement of men, materials, equipment, transport vehicles, vehicles carrying fill material, etc. to or over borrow areas and or to or over areas on which fill has to be deposited shall be constructed by the Contractor. Such access roads shall be maintained in good condition during all seasons to ensure completion of the work according to the time schedule. No separate payment shall be made for such items of work.

Backfilling

i. Excavated material used as backfilling to excavations or completed structures shall be free from rubbish, vegetation, clods and lumps and shall be approved by the Engineer. The approved materials shall be placed in layers, not exceeding 225 mm in depth before compaction and shall be compacted.

ii. Soft material shall not be used as backfilling around structures in rock. The Contractor shall backfill such excess excavation with concrete, rubble, stone or rockfill as directed by the Engineer. Filling other than concrete shall be placed in layers not exceeding 225 mm in thickness, shall be thoroughly compacted and have adequate fined content to fill the voids.

iii. Should the material being placed as backfilling, while acceptable at time of selection, 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 the works, the Contractor shall remove such damaged, softened or segregated material and replace it with fresh approved material at his expense.

iv. The Contractor shall when placing the backfilling make due allowance for any settlement that may occur before the end of the Defects Liability Period, remove any excess material or make up any deficiency by backfilling to the specified levels. As a rule material to be backfilled shall be stacked temporarily at a suitable place.

v. Payment for backfilling of earth shall be made on the basis of measurement arrived at by measuring the quantity of excavation less the volume occupied by the structure below formation level subject to the limits for payment discussed in clause 68 of the General Conditions of the Contract.

General Site Grading

a. Site grading shall be carried out as directed by the Engineer. Excavation shall be carried out as specified in the specification. Filling and compaction shall be carried out as specified under (6) of this Clause unless otherwise indicated below.

b. The approved material shall be placed in layers not exceeding 225 mm in depth before compaction and shall be compacted.

c. The Contractor shall protect the earthfill from being washed away by rain or damaged in any other way. Should any slip occur, the Contractor shall remove the affected materials and make good the slip.

d. The fill shall be carried out to such dimensions and levels as directed by the Engineer, after the compaction.

Sand filling below Plinth and other places

Backfilling shall be carried out with sand at places as directed by the Engineer. The sand used shall be clean, medium grained and free from impurities. The filled-in-sand shall be kept flooded with water for 24 hours to ensure maximum consolidation. Any temporary work required to contain sand under flooded conditions shall be to the Contractor's account. The surface of the Consolidated sand shall be dressed to the required level or slope. Construction of floors or other structures on sand fill shall not be started until the Engineer has inspected and approved the fill.

LOCAL RULES AND REGULATIONS

The Contractor shall familiarise himself with the local rules and regulations governing the excavation, quarrying operations, etc. and the work shall be carried out strictly in accordance with rules and regulations, if any. Whenever a quarry is required to be opened in connection with the execution of work covered under this Contract, the Contractor shall investigate that it shall yield stones and other materials such as sand, morrum, soil etc. of approved quality and shall satisfy himself as to the availability in desired quantity. He shall supply necessary quantity of sand, stone, metal aggregate etc. to the Engineer for carrying out tests as desired by the Engineer and well in advance of its use so as to get approval to the quality of the material. The cost of opening and operating the quarry shall be borne entirely by the Contractor.

The Contractor shall obtain necessary permission from the concerned authorities before opening the quarry . In case of quarries in private land on payment of whatever charges as may be due to the owner. The Contractor shall note that seigniorage surcharge will be deducted from his bills for the materials used on works at prescribed in G.O.No.238, dated 09.07.1992.

DEWATERING

All excavations shall be kept free of water. Grading in the vicinity of excavations shall be controlled to prevent surface water running into excavated areas. The Contractor shall remove by pumping or other means approved by Engineer any water inclusive of rain water and sub-soil water accumulated in excavation and keep all excavations dewatered until the foundation work is completed and backfilled. Sumps made for dewatering must be kept clear of the excavations/trenches required for further work. Method of pumping shall be approved by Engineer; but in any case, the pumping arrangement shall be such that there shall be no movement of sub-soil or blowing in due to differential head of water during pumping. Pumping arrangements shall be adequate to ensure no delays in construction.

TIMBER SHORING

Close timbering shall be done by completely covering the sides of the trenches and pits generally with short, upright members called `polling boards'. The boards shall generally be placed in position vertically side by side without any gap on each side of the Excavation and shall be secured by horizontal walings of strong wood at maximum 1.2 m spacing and suitably strutted. If the soil is very soft and loose, the boards shall be placed horizontally against each side of the excavation and supported by vertical walings, which in turn shall be suitably strutted. The lowest boards supporting the sides shall be taken into the ground and no portion of the vertical side of the trench or pit shall remain exposed, so as to render the earth liable to slip out.

The shoring material shall not be sizes less than those specified below unless steel sheet piling is used or unless otherwise approved by the Engineer in writing:

i)	Planks	-	5 cm x 25 cm
ii)	Waling pieces	-	10 cm x 20 cm
iii)	Struts	-	15 cm x 20 cm

Timber shoring shall be `close' or `open' type, depending on the nature of soil and the depth of pit or trench. The type of timbering shall be as approved by Engineer. It shall be the responsibility of the Contractor to take all necessary steps to prevent the sides of excavations, trenches, pits, etc., from collapsing.

Timber shoring may be required to keep the sides of excavations vertical to ensure safety of adjoining structures or to limit the slope of excavations, or due to space restrictions or for other reasons. Such shoring shall be carried out, except in an emergency, only under instructions from the Engineer.

The withdrawal of the timber shall be done very carefully to prevent the collapse of the pit or trench. It shall be started at one end and proceeded systematically to the other end. Concrete or masonry shall not be damaged during the removal of the timber. No claim shall be entertained for any timber which can not be retrieved.

In the case of open timbering, the entire surface of the side of trench or pit is not required to be covered. The vertical boards of minimum 25 cm X 5 cm sections shall be spaced sufficiently apart to leave unsupported strips of maximum 50 cm average width. The detailed arrangement, sizes of the timber and the spacings shall be subject to the approval of the Engineer. In all other respects, the specification for close timbering shall apply to open timbering.

In case of large pits and open excavations, where shoring is required for securing safety of adjoining structures or for any other reasons and where the planking across sides of excavations/pits cannot be strutted against, suitable inclined struts supported on the excavated bed shall be provided. Load from such struts shall be suitably distributed on the bed to ensure no yielding of the strut.

No extra payment shall be made for this item of work.

EMBANKMENT

These specifications shall apply to the construction of embankments, shoulders and miscellaneous back fils with approved material obtained either excavated earth from the site or brought from outside by the contractor. All embankments shall be constructed in accordance with the requirements of these specifications and in conformity with the lines, grades and cross sections shown on the drawings or as directed by the Departmental Engineer.

Materials

The materials used in the embankment shall be earth murum, gravel or any other material approved by the engineer. Such material shall be free of logs, lumps, roots, rubbish or any other ingredient likely to deteriorate or affect the stability of the embankment. The work shall be so planned and executed that the best available materials are saved for the top portion of the embankment.

The size of the coarse material in the mixture of earth shall originally not exceed 75 mm. However, the engineer may at his discretion permit the use of material coarser than this also if he is satisfied that the same will not present any difficulty as regards the placement of fill material and its compaction to the specification requirements.

Ordinarily, only the materials satisfying the density requirements given in table 1.1 shall be employed for embankment construction. The engineer may, however, change these requirements at his discretion taking into account the availability of materials for construction and other relevant factors.

TABLE 1.1 : DENSITY REQUIREMENTS OF EMBANKMENT MATERIALS

SN	TYPE OF WORK	MINIMUM LABORATORY DRY DENSITY WHEN TESTED AS PER IS:2720 (PART VII)
1	Top 0.5 metre of the embankment below the subgrade level and shoulders (where earth shoulders are specified)	Not less than 1.65 gm/cc
2	Embankments upto 3.0 metres height	Not less than 1.44 gm/cc
3	Embankment exceeding 3.0 metre height or any height subject to long period of inundation	Not less than 1.52 gm/cc
Note: The soaked CBR value of the embankment material shall not be less than 4.		

Construction Operation

After the site has been cleared, the work shall be set out as per drawing. The limits of the embankment shall be marked by fixing batter pegs on both sides regular intervals as guides before commencing the earthwork. To ensure their safety, it is desirable to fix the pegs about 0.5 metre back from the actual limits to the fill and to paint them in distinctive colour.

In all cases, the original ground shall be compacted by rolling as directed by the engineer. When the height of the embankment is less than 0.5 m and the original ground does not already have a relative compaction of at least 95% then same shall be loosened to a depth of 0.5 m. Watered and compacted in layers not exceeding 225 mm in loose thickness to the maximum dry density of the material, determined in accordance with IS:2720 Part VII. However, before relaying and compacting the loosened material, the surface below this level shall be suitably compacted as directed by the engineer. When so directed by the engineer, any suitable materials occurring in the embankment foundation shall be removed and replaced by approved material suitably compacted. Embankment work shall not proceed until the foundations for embankment have been inspected by the engineer, found satisfactory and approved.

Spreading materials in layers and bringing to appropriate moisture content

The embankment material shall be spread uniformly over the entire width of the embankment in layers not exceeding 225 mm in loose thickness. Successive layers of embankment shall not be placed until the layer under construction has been thoroughly compacted to the requirements set down herein under.

Moisture content of the material shall be checked at the source of supply and if found less than specified for compaction, the same shall be made good either at the source or after spreading the soil in loose thickness for compaction. In latter case, water shall be sprinkled directly from hose line or from a water tank mounted on a truck and flooding shall not be permitted under any circumstances.

If the material delivered to the road bed is too wet, it shall be dried, by compaction. Should circumstances arise where owing to wet weather, the moisture content cannot be reduced to the required amount by the above procedure, work on compaction shall be suspended.

Moisture content of each layer of soil shall be adjusted (making due allowance for evaporation loss), so that at the time of compaction, it is in the range of 1% above 2% below the optimum moisture content.

After adding the required amount of water, soil shall be processed by means of hammer rotary mixer or as otherwise until the layer is uniformly wet.

Clods or hard lumps of earth shall be broken to have maximum size of 150 mm when being placed in the lower layers of the embankment and maximum size of 60 mm when being placed in the top 0.5 m portion of the embankment below the subgrade.

Compaction

Each layer of the material shall be thoroughly compacted by using a power roller of not less than 8-10 tonne or any other approved plant. Rolling shall be done as specified by Engineer. The field dry density of material after compaction shall be not less than 95% of the maximum laboratory dry density as per IS:2720 (Part VII).

Subsequent layers shall be placed only after the finished layer has been tested.

When density measurements reveal any soft areas in the embankment, further compaction shall be carried out as directed by the Engineer. If in spite of that the specified compaction is not achieved, the material in the soft areas shall be removed and replaced by approved material, compacted to the density requirements and satisfaction of the Engineer.

The surface of the embankment at all times during construction be maintained at such a cross fall as will shed water and prevent flooding.

Rolling

A power roller shall, as a rule, be not less than 10 tonnes, but if at any time still heavier rollers are required on the works, the contractors shall have to bring them as may be directed by the engineer. In case of trenches not more than 8 inches in width, a earth master or any other similar equipment manually or machine operated, shall be invariable employed.

Rolling shall progress from edges to the centre of the road in strips parallel to the centre line of the road.

Rolling shall be done by lapping uniformly each proceeding rear wheel track by at least one half width of the track.

On super elevations rolling shall be started at inner edge and shall progress towards outer edge.

During and after rolling the surface shall be checked for grade and camber.

Rolling shall be started, worked or stopped without jerks.

Rolling shall not normally be done in length less than 100 m (300').

On completion of days work the roller shall be made to stand on the side width of the road and shall be guarded by a watchman.

A red lantern shall be hung on the roller at night so as to be visible from both sides of the road.

Finishing operations

These shall include the work of shaping and dressing the shoulders, road bed and side slopes to conform to the alignment, levels, cross sections and dimensions shown on the drawings or as directed by the engineer, subject to the surface tolerances described in clause 19. Both the upper and lower ends of the side slopes shall be rounded off to improve appearance and merge the embankment with the adjacent terrain.

When earthwork operations have been substantially, compacted the roadway area shall be cleared of all debris and ugly scars in the construction areas, responsible for objectionable appearance eliminated.

The rate for embankment or filling in with contractors earth or murum shall include the cost of materials, fencing, lighting, watching, haulage, spreading, levelling, watering, rolling etc. complete.

Preparation of Subgrade

The subgrade shall be leveled approximately to proper level and camber by filling depressions with excavated material and cutting off protuberances.

The subgrade shall be made to have as nearly as practicable a uniform bearing power and all hard spots therefore be properly excavated and refilled.

All soft and spongy parts of the subgrade shall also be excavated and refilled with approved materials in 15 cm (6") layers for the same reason. (The cost of this excavation will be paid under the item for excavation).

The sub grade shall be watered adequately as directed before a roller is put on it.

After rolling the camber super elevation and longitudinal slope etc. of the subgrade shall conform in shape to those of the finished road surface. This should be checked with the help of level stakes, strings and camber board if necessary.

SOIL TURFING

Sods of grass which form a thick short turf shall be used. All area to be turfed shall be trimmed or filled to the profile required so that the finished work after laying the sods shall be the required line and grade. The area to be sodded shall be free from stones, roots or other undesirable foreign materials. The soil in the area to be so added shall be loosened and raked to a depth of not less than 25 mm. All clods and lumps shall be broken to

provide a uniform texture. The proposed bed shall be moistured adequately to permit the sods to adhere properly.

The sods shall be cut in rectangular shape 80 to 100 mm thick laid so that their edges are in close contact and than welded gently ramming till they form a level and compact mat.

Sods shall be thoroughly water immediately after placing. They shall be kept thoroughly wet at least for a period of three months.

The work shall be carried out as per the standard specification of A.P.S.> referred to in the tender schedule the special rectification, the accompanying drawings, and authorised deviations here to an as may be directed to during execution by the Engineer-in-charge with reference to the working drawings.

CONCRETE AND ALLIED WORKS

GENERAL

The quality of materials and method and control of manufacture and transportation of all concrete work irrespective of mix, whether reinforced or otherwise shall conform to the applicable portions of this specification.

The Engineer in-charge shall have the right to inspect the source/s of material/s, the layout and operation of procurement and storage of materials, the concrete batching and mixing equipment, and the quality control system. Such an inspection shall be arranged and Engineer-in-charge's approval obtained, prior to starting of concrete work. However, this shall not relieve the contractor with any of his responsibilities and all the materials, which do not conform to the specifications, will be rejected.

APPLICABLE CODES

The following specifications, standards and codes, including all official amendments/revisions and other specifications & codes referred to therein to therein, should be considered a part of this specification. In all cases the latest issue/edition/revision shall apply. In case of discrepancy between this specification and those referred to herein this bid document, this specification shall govern.

Materials

IS: 269 - Specification for 33 grade ordinary Portland cement
IS: 455 - Specification for Portland slag cement.
IS: 1489 - Specification for Portland-pozzolana cement.
IS: 8112 - Specification for 43 grade ordinary Portland cement.
IS: 12330 - Specification for Sulphate resisting Portland cement.
IS: 383 - Specification for coarse and fine aggregates from natural sources for concrete.
IS: 432 - Specification for mild steel and medium tensile steel (Parts-I & II) bars and hard-drawn steel wires for concrete reinforcement.
IS: 1786 - Specification for high strength deformed steel bars and wires for concrete reinforcement.
IS: 1566 - Specification for hard-drawn steel wire fabric for (Part-I) concrete reinforcement.
IS: 9103 - Specification for admixtures for concrete.
IS: 2645 - Specification for integral cement waterproofing compounds.
IS: 4990 - Specification for plywood for concrete shuttering work.
IS Specification for 53 grade ordinary Portland cement.

Material Testing

IS: 4021 - Methods of physical tests for hydraulic cement. (Parts-1 to 13)
IS: 4032 - Method of chemical analysis of hydraulic cement.
IS: 650 - Specification for standard sand for testing of cement.
IS: 2430 - Methods for sampling of aggregates for concrete.
IS: 2386 - Methods of test for aggregates for concrete. (Parts-I to VIII)
IS: 3025 - Methods of sampling and test (physical and chemical) water used in industry.
IS: 6925 - Methods of test for determination of water-soluble chlorides in concrete admixtures.

Materials Storage

IS: 4082 - Recommendations on stacking and storing of construction materials at site.

Concrete Mix Design

IS: 10262 - Recommended guidelines for concrete mix design.
SP: 23 - Handbook on Concrete Mixes. (S & T)

Concrete Testing

IS: 1199 - Method of sampling and analysis of concrete.
IS: 516 - Method of test for strength of concrete.
IS: 9013 - Method of making, curing and determining compressive strength of

accelerated cured concrete test specimens.

IS: 8142 - Method of test for determining setting time of concrete by penetration resistance.

IS: 9284 - Method of test for abrasion resistance of concrete.

IS: 2770 - Methods of testing bond in reinforced concrete.

Equipment

IS:1791 - Specification for batch type concrete mixers.

IS:2438 - Specification for roller pan mixer.

IS:4925 - Specification for concrete batching and mixing plant.

IS:5892 - Specification for concrete transit mixer and agitator.

IS:7242 - Specification for concrete spreaders.

IS:2505 - General Requirements for concrete vibrators: Immersion type.

IS:2506 - General Requirements for screed board concrete vibrators.

IS:2514 - Specification for concrete vibrating tables.

IS:3366 - Specification for pan vibrators.

IS:4656 - Specification for form vibrators for concrete.

IS:11993 - Code of practice for use of screed board concrete vibrators.

IS:7251 - Specification for concrete finishers.

IS:2722 - Specification for portable swing weigh batchers for concrete (single and double bucket type).

IS:2750 - Specification for steel scaffoldings.

Codes of Practice

IS:456 - Code of practice for plain and reinforced concrete.

IS:457 - Code of practice for general construction of plain and reinforced concrete for dams and other massive structures.

IS:3370 - Code of practice for concrete structures for storage of liquids. (Parts-I to IV)

IS:3935 - Code of practice for composite construction.

IS:2204 - Code of practice for construction of reinforced concrete shell roof.

IS:2210 - Criteria for the design of reinforced concrete shell structures and folded plates.

IS:2502 - Code of practice for bending and fixing of bars for concrete reinforcement.

IS:5525 - Recommendation for detailing of reinforcement in reinforced concrete works.

IS:2751 - Code of practice for welding of mild steel plain and deformed bars used for reinforced concrete construction.

IS:9417 - Specification for welding cold worked bars for reinforced concrete construction.

IS:3558 - Code of practice for use of immersion vibrators for consolidating concrete.

IS:3414 - Code of practice for design and installation of joints in building.

IS:4326 - Code of practice for earthquake resistant construction of building.

IS:4014 - Code of practice for steel tubular scaffolding. (Parts-I & II)

IS:2571 - Code of practice for laying in-situ cement concrete flooring.

IS:7861 - Code of practice for extreme weather concreting.
Part-I : Recommended practice for hot weather concreting.
Part-II : Recommended practice for cold weather concreting.

IS:13920 - Ductile Detailing of Reinforced Concrete Structure subjected to 1993 seismic forces.

SP-16 - Design Aids for Reinforcement Concrete to IS: 456-1978 (S&T) - 1980

SP-24 - Explanatory Handbook on IS: 456-1978

SP-34 - Handbook on Concrete Reinforcement and Detailing (S&T) - 1987

Construction Safety

IS:3696 - Safety code for scaffolds and ladders. (Parts-I & II)

IS:7969 - Safety code for handling and storage of building materials

IS:8989 - Safety code for erection of concrete framed structures.

Measurement

IS:1200 - Method of measurement of building and engineering works.
IS:3385 - Code of practice for measurement of civil engineering works.

MATERIALS FOR STANDARD CONCRETE

The ingredients to be used in the manufacture of concrete shall consist solely of Ordinary Portland Cement, clean sand, natural coarse aggregate, clean water, and admixtures, if specifically called for on conditions at site warrant its use.

Cement

Unless otherwise specified in the specification are called for by the Engineer, cement shall be Ordinary Portland cement in 50 kg.bags. The use of bulk cement will be permitted only with the approval of the engineer. Changing of brands or type of cement within the same structure should be avoided as far as possible.

The contractor will have to make his own arrangements for procurement and storage of adequate quantity of cement. Cement in bulk may be stored in bins or silos which will provide comlplete protection from dampness, contamination and minimize caking and false set. Cement bags shall be stored in a dry enclosed shed (storage under tarpaulins will not be permitted) well away from the outer walls and insulated from the floor to avoid contact with moisture from the ground and so arranged as to provided ready access. Damaged or reclaimed or partly set cement will not be permitted to be used and shall be removed from the site. The storage bins and storage arrangements shall be such that there is no dead storage. Not more than 12 bags shall be stacked in any tier. The storage arrangement shall be approved by the Engineer. Consignments of cement shall be stored as received and shall be consumed in the order of their delivery.
Cement held in storage for a period of ninety (90) days or longer shall be tested. Should at any time the Engineer-in-charge have reasons to consider that any cement is defective, then irrespective of its origin, date of manufacture and or manufacturer's test certificate, such cement shall be tested immediately at the Contractor's cost at an approved laboratory and until the results of such tests are found satisfactory, it shall not be used in any work. . The Contractor shall not be entitled to any claim of any nature on this account.

Aggregates

General

"Aggregate" in general designates both fine and coarse inert materials used in themanufacture of concrete

"Fine Aggregate" is aggregate most of which is retained on 4.75mm IS sieve.

"Coarse Aggregate" is aggregate most of which is passed through on 4.75 mm BIS sieve.

All fine and coarse aggregates proposed for use in the works shall be subject to the Engineer-in-charge's approval and after specific materials have been accepted, the source of supply of such materials shall not be changed without prior approval of the Engineer-in-charge.

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

Sampling and Testing

Samples of the aggregates for mixed design and determination of suitabilityshall be taken under the supervision of the Engineer in-charge and delivered to the laboratory, well in advance of the

scheduled placing of concrete. Records of tests which have been made on proposed aggregates and on concrete made from this source of aggregates shall be furnished to Engineer in-charge in advance of the work, for use in determining aggregate suitability. The costs of all such tests, sampling etc. shall be borne by the contractor.

1.1.1.3 Storage of Aggregates

All coarse and fine aggregates shall be stacked separately in stock piles in the material yard near the work site in bins properly constructed to avoid inter mixing of different aggregates. Contamination with foreign material and earth during storage and while heaping the materials shall be avoided. The aggregates must be of specified quality not only at the time of receiving at site but more so at the time of loading into mixer. Rakers shall be used for lifting the coarse aggregates from bins or stock piles. Coarse Aggregate shall be piled in layers not exceeding 1.20 m in height to prevent coning or segregation. Each layer shall cover the entire area of stockpile before succeeding layers are started. Aggregates that have become segregated shall be rejected. Rejected material after remixing may be accepted if subsequent tests demonstrate conformance with required gradiation.

Specific Gravity

Aggregates having a specific gravity below 2.6 (saturated surface dry basis) shall not be used without special permission of the Engineer in charge.

Fine Aggregate

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

b. Machine - made sand: Machine – made sand will be acceptable, provided the constituent rock – gravel composition shall be sound, hard, dense, non –organic, uncoated and durable against weathering.

c. **Screening and Washing**: Sand shall be prepared for use by such screening or washing, or both, as necessary, to remove all objectionable foreign matter while separating the sand grains to the required size fraction.

d. **Foreign Material limitations** : The percentage of deleterious substances in sand delivered to the mixer shall not exceed the following:

Table 1: Foreign Material Limitations in Fine Aggregate

	Foreign material	**Percentage by weight**	
	Material finer than 75 micron IS sieve		
	Shale		
	Coal & Lignite		
	Clay		

	Foreign material	Percentage by weight	
	Lumps		
	Total		

e. **Gradation** : Unless otherwise directed or approved by the Engineer-in-charge, the grading of sand shall be within the limits indicated hereunder:

Table 2 : Grading of Sand for Fine Aggregate

IS : Sieve Designation	Percentage Passing For			
	Grading Zone I	Grading Zone II	Grading Zone III	Grading Zone IV
10 mm	100	100	100	100
4.75 mm	90-100	90-100	90-100	95-100
2.36 mm	60-95	75-100	85-100	95-100
1.18 mm	30-70	55-90	75-100	90-100
600 microns	15-34	35-59	60-79	80-100
300 microns	5-20	8-30	12-40	15-50
150 microns	0-10	0-10	0-10	0-15

Where the grading falls outside the limits of any particular grading zone of sieves, other than 600 microns IS sieve, by total amount not exceeding 5%, it shall be regarded as falling within that grading zone. This tolerance shall not be applied to percentage passing the 600 micron IS sieve or to percentage passing any other sieve size on the coarser limit of grading zone I or the finer limit of grading zone IV. Fine aggregates conforming to grading zone IV shall not be used for RCC work.
Mix designs and preliminary tests shall show its suitability for producing concrete of specified strength and workability.

Fineness Modulus: The sand shall have a fineness modulus of not less than 2.2 or more than 4.2. The fineness modulus is determined by adding the cumulative percentages retained on the following IS sieve sizes (4.75 mm, 2.36 mm, 1.18 mm, 600 microns, 300 micronsand 150 microns) and dividing the sum by 100.

Coarse Aggregate

Coarse aggregate for concrete, except as noted above, shall conform to IS 383 & IS 2386. This shall consist of crushed stone and shall be clean and free from elongated, flaky or laminated pieces, adhering coatings, clay lumps, coal residue, clinkers, slag, alkali, mica, organic matter or other deleterious matter.

Screening and Washing: Crushed rock shall be screened and/or washed for the removal of dirt or dust coating, if so requested by the Engineer in-Charge.

Grading

i) Coarse aggregate shall be either in single size or graded, in both cases the grading shall be within the following limits:

IS Sieve Designation (mm)	Percentage passing for single sized aggregate of normal size					Percentage Passing For Graded Aggregate of Normal Size			
	40 mm	20 mm	16mm	12.5 mm	10 mm	40 mm	20 mm	16mm	12.5 mm
63 mm	100	-		-	-	100	-		-
40 mm	85-100	100		-	-	95-100	100		-
20 mm	0-20	85-100	-	-	-	30-70	95-100	-	-100
16 mm	-	100	-	-	-	-	-	-	-
12.5 mm	-	-85-100			100	-	-		95-100
10 mm	0-5	0-20	-	0-45	85-100	10-35	25-55	-	40-85
4.75 mm	-	0-5 -	-	0-10	0-45	0-5	0-10	-	0-10
2.36 mm	-	-		-0-5		-	-		-

ii) The pieces shall be angular in shape and shall have granular or crystalline surfaces. Friable, flaky and laminated pieces, mica and shale, if present, shall be only in such a quantities that will not in the opinion of Engineer – in charge, affect adversely the strength and or durability of concrete. The maximum size of coarse aggregate shall be 40 mm for M-10 and 20mm for M-15 to M- 40 concrete, or as directed by the Engineer-in-charge or specified otherwise. The maximum size of coarse aggregate shall be the maximum size specified above, but in no case greater than 1/4th of the minimum thickness of the member, provided that the concrete can be placed without difficulty so as to surround all reinforcement thoroughly and fill the corners of the form. For plain concrete the maximum size of aggregate shall be of 40 mm. For heavily reinforced concrete members, the nominal maximum size of the aggregate shall be 5 mm less than the minimum clear distance between the reinforcing main bars or 5 mm less than the minimum cover to reinforcement whichever is smaller. The amount of fine particles accuring in the free state or as loose adherent shall not exceed 1% when determined by laboratory sedimentation tests as per IS 2386. After 24 hours immersion in water, a previously dried sample shall not have gained more than 10% of its oven dry weight in air, as determined by IS 2386.

Foreign material limitations

The percentage of deleterious materials in the aggregate delivered to the mixer shall not exceed the following:

Table 3: Foreign Material Limitations in Coarse Aggregate

No	Foreign Material	Percentage by weight	
	Material finer than 75 micron IS Sieve		
	Coal and lignite		
	Clay Lumps		
	Soft Fragments		
	Total of all the above substances		

Water

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

b. In case of doubt, the suitability of water for making concrete shall be ascertained by the compressive strength and initial setting time test specified in IS 456. The sample of water taken for testing shall be typical of the water proposed to be used for concreting, due account being paid to seasonal variation. The sample shall not receive any treatment before testing other than that envisaged in the regular supply of water proposed for use in concrete. The sample shall be stored in a clean container previously rinsed out with similar water.

c. Average 28 days compressive strength of at least three 15 cm concrete cubes prepared with water proposed to be used shall not be less than 90% of the average strength of three similar concrete cubes prepared with distilled water. The cubes shall be prepared, cured and tested in accordance with the requirements of IS: 516.

d. The initial setting time of test block must be made with the appropriate test cement and the water proposed to be used. It shall not be less than 30 minutes and shall not differ by more than $\pm$ 30 minutes from the initial setting time of control test block prepared with the appropriate test cement and distilled water. The test block shall be prepared and tested in accordance with the requirements of IS: 4031.

e. Where water can be shown to contain an excess of acid, alkali, sugar or salt, Engineer-in-charge may refuse to permit its use. As a guide, the following concentrations represent the maximum permissible values.

   To neutralise 200 ml sample of water, using phenolphthalein as indicator, it should not require more than 2 ml of 0.1 normal NaOH. The details of test shall be as given in IS: 3025.

To neutralise 200 ml sample of water, using methyl orange as an indicator, it should not require more than 10 ml of 0.1 Normal HCl. The details of test shall be as given in IS: 3025. Percentage of solids, when tested in accordance with the method indicated below shall not exceed the following:

Solids	**Percent**	**Method of test (Refer to Clause No : in IS 3025**
Organic	0.02	10 and 11 (Organic Solids = Total solids minus ignited residue)
Inorganic	.3	11(ignited residue)
Sulphates (as So4)	0.05	20
Alkali Chlorides (as Cl)	0.20	24
Suspended matter	0.20	12
The pH value of water shall not generally be less than 6.		

Steel and Members Encased in Concrete

Structural steel columns, beams, girders and bracings to be encased in concrete shall be unpainted. The encasing shall be done in concrete with 10 mm, maximum size aggregate and a works cube strength not less than 150 kg/sq.cm. at 28 days unless otherwise specified. The steel member shall be wrapped with galvanized wire mesh of adequate size. The galvanized wire mesh shall be kept 20 mm from the edge or surface of the steel member and shall be held in position securely. The steel member will have a minimum cover of 50 mm unless otherwise indicated in the drawings. Where the clear cover to steel is more than 75 mm, concrete with 20 mm coarse aggregate can be used.

REINFORCED CONCRETE

Reinforced cement concrete in the works shall be "Design Mix concrete" as defined in IS 456/200 for M20 and M30 grades. Nominal mix concrete may be used for concrete of lower grades i.e lower than M20 grade concrete.

The specified charecteristic compressive strength of 150mm size cube at 28 days attained for M20 grade concrete shall be 20N/sq.mm and for M30 grade concrete shall be 30N/sq.mm respectively. The contractor is required to carry out the mix design and the mix so designed need to be got approved by the concerned General Managers (Engg), Project Division, HMWSSB within the limitations of parameters and other stipulations laid down in IS – 456/2000. The mix shall be designed to produce the grade of concrete having the required workability and characteristic strength at 28 days not less than the appropriate values mentioned in Table 2 of IS – 456/2000 i.e 20N/sq.mm for M20 grade concrete and 30N/sq.mm for M30 grade concrete respectively. The target mean strength of the concrete mix should be equal to the charecteristics strength plus 1.65 Standard deviation.

IS 3370 (Part I), 1965, prescribes that the minimum quantity of cement used for the reinforced concrete work in the case of water retaining structures shall not be less than 330kg/cum. IS – 456/2000 prescribes the minimum cement quantity to be used for M20 grade reinforced cement concrete as 300 kg/cum and M30 grade reinforced cement concrete as 320kg/cum respectively. The Ministry of Surface Transport (MOST) specifications prescribes quantity of cement to be used in the case of M20 grade reinforced cement concrete as 380kg/cum. and in the case of M30 grade reinforced cement concrete as 420kg/cum. In the preparation of estimates for this work in the datas the said quantities of cement as prescribed by MOST and as approved by Government vide G.O Ms.No 30, dt:19-03-2002, Irrigation & CAD Department (Project swing COD), has been adopted. The contractor shall use the quantities of cement at site during execution of reinforced cement concrete work by design mix not less than as adopted in the detailed estimates i.e in the case of M20 grade reinforced cement concrete 380kg/cum. and in the case of M30 grade reinforced cement concrete 420kg/cum. and shall use even more cement in both the cases if required for attaining not less than the prescribed specified charecteristic comprehensive strength of 150mm cubes at 28 days i.e 20N/sq.mm for M20 grade concrete and 30N/sq.mm for M30 grade concrete respectively without extra cost.

3.5 Mix Design

3.5.1 General

This is to investigate the grading of aggregates, water-cement ratio, workability and the quality of cement required to give preliminary and works cubes of the minimum strength specified. The proportions of the mix shall be determined by weight. Adjustment of aggregate proportions due to moisture present in the aggregate shall be made. Determination of mix proportions shall be carried out according to "Recommended guidelines for Concrete Mix Design" conforming to IS: 10262.

Whenever there is a change either in required strength of concrete, or water-cement ratio or workability or the source of aggregates and/or cement, preliminary tests shall be repeated to determine the revised proportions of the mix to suit the altered conditions. While designing proportions, over-wet mixes shall always be avoided.

While fixing the value for water/cement ratio for preliminary mixes, assistance may be derived from the graph (Appendix A, IS 456 showing the relationship between the 28 day compressive strengths of concrete mixes with different water/cement ratios and the 7-day compressive strength of cement tested in accordance with IS: 269.

3.5.2 Preliminary tests

Test specimens shall be prepared with at-least two different water/cement ratios for each class of concrete, consistent with workability required for the nature of the work. The materials and proportions used in making preliminary tests shall be similar in all respects to those to be actually employed in the works as the object of these tests is to determine the properties of cement, aggregates and water necessary to produce concrete of required consistency and to give the specified strength. It will be contractor's sole responsibility to carry out these tests and he shall therefore furnish to Engineer-in-Charge a statement of proportions proposed to be used for the various concrete mixes. For preliminary tests, the following procedure shall be followed.

Materials shall be brought to the room temperature and all materials shall be in a dry condition. The quantities of water cement and aggregates for each batch shall be determined by weight to an accuracy of 1 part in 1000 parts.

3.5.2.1 Mixing concrete: It shall be done by hand or in a small batch mixer as per IS: 516 in such a manner as to avoid loss of water. The cement and fine aggregate shall first be mixed dry until the mixture is uniform in color. The coarse aggregate shall then be added, mixed and water added and the whole batch mixed thoroughly for a period of not less than two minutes until the resulting concrete is uniform in appearance. Each batch of concrete shall be of such a size as to leave about 10% excess concrete, after moulding the desired number of test specimens.

Consistency: The Consistency of each batch of concrete shall be measured immediately after mixing, by the slump test in accordance with IS: 1199. If in the slump test, care is taken to ensure that no water or other material is lost, the material used for the slump test may be re-mixed with the remainder of the concrete for making the specimen test cubes. The period of re-mixing shall be as short as possible yet sufficient to produce a homogeneous mass.

3.5.2.3 Size of Test Cubes: Compression tests of concrete shall be made as per IS: 516 on 15 cm cubes. Each mould shall be provided with a metal base plate having a plate surface so as to support the mould during filling without leakage. The base plate shall be preferably attached to the mould by springs or screws. The parts of the mould when assembled shall be positively and rigidly held together. Before placing concrete, the mould and base plate shall be cleaned and oiled. The dimensions and internal faces of the mould shall be accurate within the following limits. Height and distance between the opposite faces of the mould shall be of specified size ±0.2 mm. The angle between the adjacent internal faces and between internal faces and top and bottom faces of mould shall be 90-degree ±0.5 degree. The interior faces of the mould shall be plane surfaces with a permissible variation of 0.03 mm.

3.5.2.4 Compacting: Concrete test cubes shall be moulded by placing fresh concrete in the mould and compacted as specified in IS 516.

3.5.2.5 Curing : Curing shall be as specified in IS 516. The cubes shall be kept in moist air of at least 90% relative humidity at a temperature of 27^{o}C ±2^{o}C for 24 hours ±2 hours from the time of adding water to the dry

ingredients. Thereafter they shall be removed from the moulds and kept immersed in clean, fresh water and kept at 27^{o}C ±2 degree C temperature until required for test. Curing water shall be renewed every seven days. A record of maximum and minimum temperatures at the place of storage of the cubes shall be maintained during the period they remain in storage.

3.5.2.6 Testing of Specimens: The strength shall be determined based on not less than five cube test specimens for each age and each water cement ratio. All these laboratory test results shall be tabulated and furnished to the Engineer-in-charge. The test results shall be accepted by the Engineer-in-charge if the average compressive strengths of the specimens tested is not less than the compressive strength specified for the age at which specimens are tested subject to the condition that only one out of the five consecutive tests may give a value less than the specified strength for that age. The Engineer-in-charge may direct the contractor to repeat the tests if the results are not satisfactory and also make such changes, as he considers necessary to meet the requirements specified. All these preliminary tests shall be conducted by the contractor at his own cost in an approved laboratory or in laboratory. .

3.6 Proportioning, Consistency, Batching And Mixing Of Concrete

a) Proportioning
i) Aggregate

The proportions which shall be decided by conducting preliminary tests shall be by weight. These proportions of Cement, fine and coarse aggregates shall be maintained during subsequent concrete batching by means of weigh batchers conforming to IS.2722 capable of controlling the weights within one percent of the desired value. Except where it can be shown to the satisfaction of the Engineer that supply of properly graded aggregate of uniform quality can be maintained over the period of work, the grading of aggregate shall be controlled by obtaining the coarse aggregate in different sizes and blending them in the right proportions. The different sizes shall be stocked in separate stock piles. The grading of coarse and fine aggregate shall be checked as frequently as possible, as determined by the Engineer in charge, to ensure maintaining of grading in accordance with the samples used in preliminary mix design. The material shall be stock piled well in advance of use.

i. Cement shall be measured by weight.

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

iii. Definition of Water/Cement Ration: The water cement (W/C) ration is defined as the weight of water in the mix (including the surface moisture of the aggregates) divided by the weight of cement in the mix.

iv. Water/Cement Ratio: The actual water cement ration to be adopted shall be determined in each instance by the Contractor and approved by the Engineer.

v. Proportioning by Water/Cement Ration: The W/C ration specified for use by the Engineer shall be maintained. The Contractor shall determine the water content of the aggregates as frequently as directed by the Engineer as the work progresses and as specified in IS.2386 (Part III) and the amount of mixing water added at the mixer shall be adjusted as directed by the Engineer so as to maintain the specified W/C Ratio. To allow for the variation in weight of aggregates due to variation in their moisure content, suitable adjustments in the weights of aggregates shall also be made.

b. Consistency and Slump

i. Concrete shall be of a consistency and workability suitable for the conditions of the job. After the amount of water required is determined, the consistency of the mix shall be maintained, throughtout the progress of the corresponding parts of the work and approved tests eg. Slump tests, compacting factor tests, in accordance with IS.1199, shall be conducted from time to time ensure the maintenance of such consistency.

ii. The following tabulation gives a range of slumps which shall generally be used for various types of construction unless otherwise instructed by the Engineer:

3.6.1 Slumps For Various Types Of Construction

Placing Conditions (1)	O of Workability (2)	Slump (mm) (3)
Blinging concrete; Shallow sections; Pavements using pavers	Very low	In the 'very low' category of workability where strict control is necessary, for example pavement quality concrete, measurement of workability by determination of compacting factor will be more appropriate than slump (see IS 1199) and a value of compacting factor of 0.75 to 0.80 suggested.
Mass concrete; Lightly reinforced sections in slabs, beams, walls, columns; Floors; Hand placed pavements; Canal lining; Strip footings	Low	25-75
Heavily reinforced sections in slabs, beams, walls, columns; Slip form work; Pumped concrete	Medium	50-100 75-100
Trench fill ; In-situ piling Tremie concrete	High Very High	100-150 In the 'very high' category of workability, measurement of workability by determination of flow will be appropriae (see IS 9103)

C. Batching and Mixing of Concrete

i. The materials and proportions of concrete materials as established by the preliminary tests for the mix designs shall be rigidly followed for all concrete on the Works and shall not be changed except when specifically permitted by the Engineer.

ii. Concrete shall be produced only by weigh batching the ingredients. The mixer and weigh batchers shall be maintained in clean, serviceable condition. The accuracy of weigh batchers shall be periodically checked. They shall be set up level on a firm base and the hopper shall be loaded evenly. The needle shall be adjusted to zero when the hopper is empty. Fine and coarse aggregates shall be weighed separately. Volume batching will not be permitted. However, the Engineer may permit volume batching by subsequent conversion of the weights of the aggregate into their equivalent volumes knowing their bulk densities, only in the case of small and less important pours involving concrete of not more than 0.25 cubic meres, on days when other pours involving weigh batching are not likely to be taken up. Concrete shall be of strength stipulated in the respective items. All concrete shall be mixed in mechanically operated batch mixers complying with IS:1791 and of the approved make with suitable provision for correctly controlling he water delivered to the drum. The quantity of water actually entering the drum shall be checked with the reading of the guage or valve setting, when starting a job. The test should be made while the mixer is running. The volume of the mixed material shall not exceed the manufacturer's rated mixer capacity. The batch shall be charged into the mixer so that some water will enter the drum in advance of cement and aggregates. All water shall be in the drum by the end of the firsst 15 secornds of the specified mixing time. Each batch shall be mixed until the concrete is uniform in colour, for a minimum period of two minutes after all the materials and water are in the drum. The entire contents of the drum shall be discharged in one operation before the raw materials for the succeeding bathces are fed into the drum.

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

3.6.2 SAMPLING AND TESTING CONCRETE IN THE FIELD

a) Facilities required for sampling materials and concrete including whether proof buildings to house the facilities in the field, should be provided by the contractor at no extra cost. The following equipment with operator shall be made available in serviceable conditions.

i. Concrete cube-testing machine suitable for 15 cm cubes of 100 tonnes capacity with proving calibration ring - 1 no.
ii. Cast iron cube moulds 15 cm size - 6 nos. (min)
iii. Slump cone complete with tamping rod - 1 set
iv. Laboratory balance to weigh upto 5 kg with sensitivity of 10 gm - 1 no.
v. IS sieves for coarse and fine aggregates - 1 set
vi. Set of measures from 5 litres to 0.1 litre - 1 set
vii. Electric oven with thermostat upto 120^{o}C - 1 no.
viii. Flakiness gauge - 1 no.
ix. Elongation index gauge - 1 no.
x. Sedimentation pipette - 1 no.
xi. Calibrated glass jar 1.0 litre capacity - 2 nos.
xii. Glass flasks and metal containers - As required
xiii. Chemical reagents like sodium hydroxide, tannic acid, litmus paper etc. - As required
xiv. Laboratory balance of 2 kg capacity and sensitivity of 1 gm - 1 no.

b) No concrete of any kind may be placed until the field concrete testing laboratory as specified is provided to the satisfaction of the Engineer. The contractor shall notify the Engineer in advance of all concrete and concrete material testing as provided in the clause to provide the Engineer/his representative with an opportunity to witness all prescribed tests.

c) At least 6 test cubes of each class of concrete shall be made of every 50cum concrete or part thereof or from different batches as directed by Engineer-in-charge. Such samples shall be drawn on each day for each type of concrete. Of each set of 6 cubes, three shall be tested at 7 days age and three at 28 days age. The cubes must be casted from various batches to arrive at an average strength. The laboratory test results shall be tabulated and furnished to the Engineer. The Engineer will pass the concrete if average strength of the specimens tested is not less than the strength specified, subject to the condition that only one out of three consecutive tests may give a value less than the specified strength but this shall not be less than 90% of the specified strength.

d) Consistency: Slump tests shall be carried out as often as requested by the Engineer and invariably from the same batch of concrete from which the test cubes are made. Slump tests shall be done immediately after sampling.

1.7 CONCRETE TESTS

The Engineer-in-Charge, may order tests to be carried out on cement, sand, coarse aggregate, and water in accordance with the relevant Indian standards.

Tests on Cement shall include:

- Fineness test
- Test for normal consistency
- Test for setting time
- Test for soundness
- Test for tensile strength
- Test for compressive strength
- Test for heat of hydration (by experiment and by calculations) in accordance with IS 269

Tests on Sand shall include:

- Sieve test
- Test for organic impurities
- Decantation test for determining clay and silt content
- Specific gravity test
- Test for unit weight and bulkage factor
- Test for sieve analysis and fineness modulus

Tests on Coarse Aggregate shall include:

- Sieve analysis
- Specific gravity and unit weight of dry, loose and rodded aggregate
- Soundness and alkali aggregate reactivity
- Petrography examination
- Deleterious materials and organic impurities
- Test for aggregate crushing value

Sampling for strength of concrete : A random sampling procedure shall be adopted to ensure that each concrete batch shall have a reasonable chance of being tested that is, the sampling should be spread over the entire period of concreting and cover all mixing units.
The minimum frequency of sampling of concrete of each grade shall be in accordance with the following:

Quantity of Concrete in the Work, m3	Number of Samples
1-5	1
6-15	2
16-30	3
31-50	4
51 and above	4 plus one additional sample for each additional 50 m3 or part thereof.

Note: At least one sample shall be taken from each shift. Where concrete is produced at continuous production unit, such as ready – mixed concrete plant, frequency of sampling may be agreed upon mutually by suppliers and purchasers.

Three test specimens shall be made for each sample for testing at 28 days. Additional samples may be required for various purposes such as to determine the strength of concrete at 7 days or at the time of striking the formwork, or to determine the duration of curing, or to check the testing error. Additional samples may also be required for testing samples cured by accelerated methods as described in IS 9103. The specimen shall be tested as described in IS 516.

The laboratory test results shall be tabulated and furnished to the Engineer. The test results of the sample shall be the average of the strength of three specimens. The individual variation should not be more than ±15 percent of the average. If more, the test results of the sample are invalid.

Load test on Members or any other tests

i. In the event of any work being suspected of material or workmanship or both, the Engineer-in-charge requiring its removal and reconstruction may order, or the contractor may request that it should be load tested in accordance with the following provisions.

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

iii. If within 24 hours of the removal of the load, the structure does not show a recovery of at least 75% of the maximum deflection shown during the 24 hours under load, the test loading shall be repeated after a lapse of at least 72 hours. The structure shall be considered to have failed to pass the test if the recovery after the second test is not at least 75% of the maximum deflection shown during the second test. If the structure is certified as failed by the Engineer-in-Charge, the cost of all the new construction and the load tests shall be borne by the contractor.

iv. Any other tests, e.g. taking out in an approved manner concrete cores, examination and tests on such cores removed from such parts of the structure as directed by the Engineer-in-charge, sonic testing etc. shall be carried out by the contractor, if so directed, at no extra cost.

Unsatisfactory tests

Should the results of any test prove unsatisfactory, or the structure shows signs of weakness, undue deflection or faulty construction, the contractor shall remove and rebuild the member or members involved or carry out such other remedial measures as may be required by the Engineer-in-Charge, without any additional cost.

ADMIXTURES

General

Admixtures may be used in concrete where required, only with the approval of the Engineer-in-Charge based upon evidence that with the passage of time, neither the compressive strength nor its durability is reduced. Calcium chloride shall not be used for accelerating set of the cement for any concrete containing reinforcement or embedded steel parts. When calcium chloride is permitted to be used, such as in mass concrete works, it shall be dissolved in water and added to the mixing water in an amount not to exceed 1.5% of the weight of the cement in each batch of concrete. When admixtures are used, the designed concrete mix shall be corrected accordingly. Admixtures shall be used as per manufacturer's instruction and in the manner and with the control specified by the Engineer-in-Charge.

Air Entraining Agents

Neutralized vinsol resin or other approved air in the concrete mix agents shall conform to the requirements of ASTM standard 6.260; Air Entraining Admixtures for Concrete. The recommended total air content of the concrete is 4% $\pm$ 1%. The method of measuring air content shall be as per IS: 1199.

Water Reducing Admixtures

Water reducing lignosulfonate admixture may be added in quantities approved by the Engineer-in-charge. The admixtures shall be added in the form of a solution.

Retarding Admixtures

Retarding agents may be added to the concrete mix in quantities approved by the Engineer-in-Charge.

Water Proofing Agent

Water proofing agents shall conform to IS: 2645.

3.8.6 Other Admixtures

The Engineer-in-Charge may at his discretion allow the contractor to use any other admixture in the concrete.

PREPARATION PRIOR TO CONCRETE PLACEMENT, FINAL INSPECTION AND APPROVAL

a. Before the concrete is actually placed in position, the insides of the Formwork shall be inspected to see that they have been cleaned and oiled. Temporary openings shall be provided to facilitate inspection, especially at bottoms of columns and wall forms, to permit removal of sawdust, wood shavings, binding wire, dirt etc. Openings shall be placed or holes drilled so that these materials and water can be removed easily. Such openings/holes shall be suitably plugged later.
b. The various agencies shall be permitted ample time to install drainage and plumbing lines, floor and trench drains, conduits, hangers, anchors, inserts, sleeves, bolts, frames and other miscellaneous embedment to be cast in the concrete as specified or required or as is necessary for the proper execution of the work .
c. All embedded parts, inserts, etc. supplied by the HMWSSB or the contractor shall be correctly positioned and securely held in the forms to prevent displacement during depositing and vibrating of concrete.
d. All anchor bolts shall be positioned and kept in place with the help of properly manufactured templates unless specifically waived in writing by the Engineer-in-charge.
e. Slots, openings, holes, pockets etc. shall be provided in the concrete work in the position specified in drawing or required or as directed by the Engineer-in-charge.
f. Reinforcement and other items to be cast in concrete shall have clean surfaces that will not impair bond.
g. Prior to concrete placement, all work shall be inspected and approved by the Engineer-in-Charge and if found unsatisfactory, concrete shall not be poured until after all defects have been corrected.
h. Approval by the Engineer-in-Charge of any and all materials and work as required herein shall not relieve the contractor from his obligation to produce finished concrete in accordance with the requirements of the specifications.

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

j. Bonding Mortar: Where the concrete has not fully hardened, all laitince shall be removed by scrubbing the west surface with wire or bristle brushes, care being taken to avoid dislodgement of particles of aggregate. The surface shall be throughly wetted and all free water removed. The surface shall then be coated with neat cement slurry. On this surface, a layer of concrete not exceeding 150mm in thickness shall first be placed and shall well rammed against old work, particular attention being paid to corners and close spots; work thereafter shall proceed in the normal way.

TRANSPORTATION

General

All buckets, containers or conveyors used for transporting concrete shall be mortar-tight, irrespective of the method of transportation adopted, concrete shall be delivered with the required consistency and plasticity without segregation or loss of slump. However, chutes shall not be used for transport of concrete without the written permission of the Engineer-in-charge and concrete shall not be re-handled before placing.

Retempered or Contaminated Concrete

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

Cleaning of Equipment

All equipments used for mixing, transporting and placing of concrete shall be maintained in clean conditions. All pans, buckets, hoppers, shuts, pipelines and other equipments shall be throughly cleaned after each period of placement.

- **Procedure for Placing of concrete:**

Engineers approval of Equipment & Methods: Before any concrete is placed, the entire placing program, consisting of equipment, layout, proposed procedures and methods shall be submitted to the Engineer in charge for approval if so demanded by the Engineer in charge and no concrete shall be placed until Engineers approval has been received. Equipment for conveying concrete shall be of such size and design as to ensure a practically continuous flow of concrete during depositing without segregation of materials, considering the size of the job and placement location.

Time Interval between Mixing & Placing:

Concrete shall be placed in its final position before the cement reaches its initial set and concrete shall normally be compacted in its final position within 30 minutes of leaving the mixture and once compacted, it shall not be disturbed.

Avoiding Segregation

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

Placing by Manual Labour

Except when otherwise approved by the Engineer-in-Charge, concrete shall be placed in the shuttering by shovels or other approved implements, and shall not be dropped from a height more than 1.0 m or handled in a manner, which will cause segregation.

Placing by Mechanical Equipment

The following specification shall apply when placing concrete by use of mechanical equipment is warranted considering the nature of work involved. The control of placing shall begin at the mixer discharge. Concrete shall be discharged by a vertical drop into the middle of the bucket or hopper and this principle of a vertical discharge of concrete shall be adhered to throughout all stages of delivery until the concrete comes to rest in its final position.

Types of Buckets

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

In placing concrete in large open areas, the bucket shall be spotted directly over the position designated and then lowered for dumping. The open bucket shall clear the concrete already in place and the height of drop shall not exceed 1.0 m. The bucket shall be opened slowly to avoid high vertical bounce. Dumping of buckets on the swing or in any manner, which results in separation of ingredients or disturbance of previously placed concrete, will not be permitted.

Operation of Buckets:

In placing concretes in large open areas the buckets shall be spotted directly over the position designated and then lowered for dumping. The open bucket shall clear the concrete already in place and the height of drop; shall not exceed 1.0m. The buckets shall be operated slowly to avoid high vertical bounce. Dumping of buckets on the swing or in any manner which results in seperation of ingredients of disturbance of previously placed concrete will not be permitted.

Placement in Restricted Forms

Concrete placed in restricted forms by barrows, buggles, cars, short chutes or hand shoveling shall be subject to the requirement for vertical delivery of limited height to avoid segregation and shall be deposited as nearly as practicable in its final position.

Chuting

Where it is necessary to use transfer chutes, specific approval of Engineer-in-charge must be obtained to type, length slopes, baffles, vertical terminals and timing of operations. These shall be so arranged that an almost continuous flow of concrete be obtained at the discharge and without segregation.. To allow for the loss of mortar against the sides of the chutes, the first mixes shall have less coarse aggregate. During cleaning of chutes, the wastewater shall be kept clear of the forms. Concrete shall not be permitted to fall from the end of the chutes by more than 1.0 m. Chutes, when approved for use shall have slopes not flatter than 1 vertical, 3 horizontal and not steeper than 1 vertical, 2 horizontal. Chutes shall be of metal or metal lines end of rounded cross section. The slopes of all chute sections shall be approximately the same. The slopes of all chute sections shall be approximately the same. The discharge end of the chutes shall be maintained above the surface of the concrete in the forms.

Placing by Pumping/Pneumatic Placers

Concrete may be conveyed and placed by mechanically operated equipment e.g., pumps or pneumatic placers only with the written permission of the Engineer-in-Charge at . The slump shall be held to the minimum necessary for conveying concrete by this method.

When pumping is adopted, before pumping of concrete is started, the pipeline shall be lubricated with one or two batches of mortar composed of one part cement and two parts sand. Care shall be taken to avoid stoppages in work once pumping has started.

When a pneumatic placer is used, the manufacturer's advice on layout of the pipeline shall be followed to avoid blockages and excessive wear. Restraint shall be provided at the discharge box to cater for the reaction at this end. Manufacturer's recommendations shall be followed regarding concrete quality and all other related matters when pumping/ pneumatic placing equipment is used.

Concrete in layers

Concreting, once started, shall be continuous until the pour is completed. Concrete shall be placed in successive horizontal layers of uniform thickness ranging from 15 cm to 90 cm directed by Engineer-in-Charge. These shall be placed as rapidly practicable to prevent the formation of cold joints or planes of weakness between each succeeding layer within the pour. The thickness of each layer shall be such that it can be deposited before the previous layer has stiffened. The bucket loads or other units of deposit, shall be spotted progressively along the face of the layer with such overlap as will facilitate spreading the layer to uniform depth and texture with a minimum shoveling. Any tendency to segregation shall be corrected by shoveling stones into mortar rather than mortar on to stones. Such a condition shall be corrected by redesign of mix or other means, as directed by the Engineer-in-charge.

Bedding of layers

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

Compaction

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

Type of vibrators

Vibrators shall conform to IS specifications. Type of vibrator to be used shall depend on the structures where concrete is to be placed. Shutter vibrators to be effective, shall be firmly secured to the formwork which must be sufficiently rigid to transmit the vibration and strong enough not to be damaged by it. Immersion vibrators in sufficient numbers and each of adequate size shall be used to properly consolidate all concrete. Tapping or external vibrating of forms by hand tools or immersion vibrators will not be permitted.

Use of Vibrators

The exact manner of application and the most suitable machines for the purpose must be carefully considered and operated by experienced men. Immersion vibrators shall be inserted vertically at points not more than 450 mm apart and withdrawn when air bubbles cease to come to the surface. Immersion vibrators shall be withdrawn very slowly. In no case shall immersion vibrators be used to transport concrete inside the forms. Particular attention be paid to vibration at the top of a lift e.g. in a column or wall.

Melding Successive Batches

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

Penetration of Vibrators

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

Vibrating against Reinforcement

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

Use of Form Attached Vibrators

Form attached vibrators shall be used only with specific authorization of the Engineer-in-Charge.

Use of surface vibrators

The use of surface vibrators will not be permitted under normal conditions. However, for thin slabs and similar construction, surface vibrating by specially designed vibrators may be permitted, upon approval of Engineer-in-charge.

Stone Pockets And Mortar Pondages

The formation of stone pockets and mortar pondages in corners and against faces of forms shall not be permitted. Should these occur , they should be dug out, reformed and refilled to sufficient depth and shape for thorough bonding, as directed by the Engineer-in-charge.

Placement Interval

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

Special Provision in Placing

When placing concrete in walls with openings, in floors of integral slabs and beam construction and other similar conditions, the placing shall stop when the concrete reaches the top of the opening in walls or bottom horizontal surface of the slab, as the case may be.

Placing shall be resumed before the concrete in place takes initial set, but not until it has had time to settle as determined by the Engineer-in-Charge.

Placing Concrete Through Reinforcing Steel

When placing concrete through reinforcing steel, care shall be taken to prevent segregation of the coarse aggregate. Where the congestion of steel makes placing difficult, it may be necessary to temporarily move the top steel aside to get proper placement and restore reinforcing steel to design position and Engineer's approval shall be obtained prior to adopting this method..

Bleeding

Bleeding or free water on top of concrete being deposited into the forms, shall be the cause to stop the concrete pour and the conditions causing this defect corrected before any further concreting is resumed.

APPLICATION OF ARALDITE FOR BONDING OF NEW AND OLD CONCRETE

General

Araldite epoxy resins may be used to bond fresh concrete to concrete that is fully cured, to give a monolithic bond capable of transmitting high stresses when traditional bonding agents such as cement slurry cannot always be relied upon to provide good adhesion which is particularly the case when large areas are involved.

a. The Araldite based formulation shall be applied to suitably prepared concrete sub-strata and the fresh concrete poured as soon as possible, but always during the 'open time' of the adhesive.
b. Materials used shall be only as approved by the Engineer in charge
c. Manufacturer's instructions shall be followed in all respects.
d. General requirements pertaining to the use of Araldite for bonding of new and old concrete are described therein.

Formulation

Araldite GY250	100	Parts by weight	
Hardener	HY825	20	Parts by weight
Hardener	HY830	20	Parts by weight
Hardener	HY850	20	Parts by weight
Silica Flour		20	Parts by weight

Application

Preparation of the Substrata

To obtain good adhesion, it is necessary to have clean and sound substrata. Preparation can be carried out using a variety of techniques including chemical treatment and mechanical methods such as grinding, milling, abrading, planing and sand blasting. Dust and loose particles resulting from the pretreatment should be removed by vacuum cleaning or oil-free or blast.

Mixing

The resin and hardener should be thoroughly mixed before mixing in the dry filler. The mixed, ready to use adhesive should not contain lumps of unwetted filler and should be of uniform color. For a total weight of 1 kg or less hand mixing should be sufficient. For quantities in excess of 1 kg, the use of a mechanical mixer is recommended.

Pot life and 'Open time'

The pot life is the period during which the ready to use ARALDITE based formulation must be applied. After this period, the mix can no longer be worked and will have begun to set in its container. The table below indicates the pot life at different temperatures:

Mix Temperature	**Pot life (minutes)**
25 ^{o} C	90
30 ^{o} C	60
35 ^{o} C	45

(The figures in this table are for batches less than 1 kilogram).

The 'Open time' is the maximum period of time allowable between application of the ARALDITE adhesive and pouring the fresh concrete. Exceeding the 'Open time' would result in considerably reduced adhesion. The adhesive should be applied to the pre-treated substrata as soon as the components have been mixed and fresh concrete poured immediately afterwards.

Accurate knowledge of the 'Open time' is essential in case the work is interrupted.
Table gives the 'Open time' of ARALDITE based formulations as a function of substrata temperature. In all cases, the adhesives shall be applied immediately after mixing. Any delay between mixing and application will reduce the 'Open time'. Fresh concrete must be poured before the adhesive begins to gel. New to old concrete bonding is not recommended at temperatures below 5^{o}C, as curing cannot be assured under these circumstances.

Methods of Application

The shape and size of the concrete structure will determine the method of application used. The ARALDITE based adhesive may be applied by hand using brushed, brooms or any other suitable applicator.

Suitability of Fresh Concrete

Best results are obtained when the water/ cement ratio of the new concrete is as low as is practicable.

Coverage

One kilogram of the mixed ARALDITE adhesive including hardeners and filler covers an area of 2 to 3 sq.m. when applied with a stiff nylon bristle brush. However, the coverage is very much dependent on the finish in the concrete.

HANDLING PRECAUTIONS

Epoxy resins can cause irritation of the skin in sensitive person if incorrectly handled. Certain safety precautions must therefore be observed and those handling the resins and hardeners should be given suitable instructions. Those working with epoxy resins should, above all, be instructed that personal cleanliness at the place of work is essential. The resin and hardener should not be allowed to come into direct contact with the skin. The most effective protection is achieved by wearing rubber or polythene gloves, the latter having the advantage that they can be replaced when dirty. They are more pleasant to wear if cotton gloves are worn underneath. Parts of the skins, which have come into contact with the resin or hardener, should be washed with lukewarm water and a mild soap. Special cleaning creams have proved to be highly suitable.

CONSTRUCTION JOINTS

a. A construction joint is defined as a joint in the concrete introduced for convenience in construction at which special measures are taken to achieve subsequent continuity without provision for further relative movement.
b. All the drawings submitted for the Engineers approval shall indicate position of all construction joints and lifts. No concreting shall be started until the Engineer in charge has approved the method of placing the positions and form of the construction joints and lifts. The construction joints shall be so located as not to impair the strength of the structure. Rebates, keys or notches shall be formed and water stops inserted as the Engineer may require. The position of construction

joints and the size of the formwork panel shall be so co-ordinated that were possible, the line of any construction joints coincides with the line of a formwork joint and that in any case all construction jointlines and formwork jointlines appear as a regular and uniform series. For all exposed horizontal joints and purposely inclained joints, a uniform joint shall be formed with a batten of approve dimensions to give a straight and neat joint line.

c. Concrete placed to form the face of a construction joint shall have all Laitance removed and the aggregate exposed prior to the placing of fresh concrete. The Laitance shall wherever practicable be removed by spraying the concrete surface with water under pressure and be removed while the concrete is still green. The whole of the concrete surface forming part of the joint shall be hacked to expose the aggregate. Where aggregate is damaged during hacking, it shall be removed from the concrete face by further hacking. All loose matter shall be removed and the exposed surface thoroughly cleaned by wire brushing, air blasting or washing, leaving the surface throughly clean by wire brushing, air blasting or washing, leaving the surface clean and damp. Immediately before fresh concrete is placed, a 12 mm thick layer of sand/cement mortar mixed in the same proportions as in the concrete shall be spread in the horizontal face of the construction joint. A drier mix shall be used for the top lift of horizontal face of the construction joint. A drier mix shall be used for the top lift of horizontal pours to avoid Laitance. The new concrete shall be well worked against the prepared face before the mortar sets. Special care shall be taken to obtain thorough compaction and to avoid segregation of the concrete along the joint plane.

MOVEMENT JOINTS

1. Movement joints are defined as all joints intended to accommodate relative movement between adjoining parts of a structure, special provision being made where necessary for maintaining the water tightness of the joint. The contractor shall comply with the instructions of manufacturers of proprietary jointing materials and shall, if required by the Engineer-in-Charge, demonstrate that the jointing materials can be applied satisfactorily.
2. Contractor shall show locations of all movement joints and details there of on drawings submitted for the Engineer's approval.
3. The surface of set concrete in a movement joint shall, as shown on the drawings, be painted with two coats of bituminous paint and new concrete shall be placed against it only when the paint is dry. Expansion joints shall be formed by a separating strip of approved preformed joint filler.
4. Caulking grooves shall be provided. At all joints where a caulking groove is formed, immediately prior to caulking, the groove shall be wire brushed and loose material removed and blown out by compressed air. After the groove has dried, it shall be primed and caulked with approved sealing compound applied in accordance with the manufacturer's instructions. At all caulked joints, the face of the strip and a width of concrete on either side shall be painted with two coats of paint having the same base as the sealing compound.

WATER STOPS AND JOINT FILLERS

Water stops

a. At all construction, contraction and expansion joints in the water retaining structures and wherever specified or directed by the Engineer-in-Charge, water stops shall be provided. The water stops shall be PVC type or of any other equivalent material as approved by the Engineer-in-Charge. PVC water stops shall have a tensile strength of not less than 14 MN/sq.m and elongation at break of not less than 300%. Water stops shall not be exposed to direct sunlight for long periods. Before being concreted in water stops shall be cleaned of all foreign materials. Wherever provided, water stops shall be placed in such a manner that they are embedded in the adjacent sections of the panels for equal width.

b. As far as possible, jointing on site shall be confined to the making of butt joints in straight runs of water stops. Where it is agreed with the Engineer-in-charge that it is necessary to make an intersection or change of direction of any joint, other than a butt joint in a straight run on site, a preliminary joint, intersection or change of direction piece shall be made and submitted to such tests as the Engineer-in-charge may require.

c. Flexible water stops shall be fully supported in the formwork, free of nails and clear of reinforcement and other fixtures. Damaged water stops shall be replaced and during concreting care shall be taken to place the concrete so that water stops do not bend or distort.

d. The different types of water stops to be used in liquid retaining structures will be as per "*Table 4 : Types of Water Stops*".

Table 4 : Types of Water Stops

Sl.No	Type of Joint	Type of water stops

1.	Partial/complete contraction joint in walls and slabs	150mm wide, ribbed with hollow centre bulb & 5 mm minimum thickness
2.	Expansion joints in walls and slabs	225 mm wide, ribbed with hollow centre bulb & 9 mm minimum thickness
3.	Construction joint in raft	225 mm wide, ribbed without hollow centre bulb & 9 mm minimum thickness
4.	Construction joint in wall	150 mm wide, ribbed with hollow centre bulb & 5 mm minimum thickness
5.	Expansion joint raft	225 mm wide, ribbed with hollow centre bulb & 9 mm minimum thickness

Jointing fillers

Joint fillers shall be of durable, compressible and non-extruding material.

SEALING COMPOUNDS

Horizontal joints shall, where used in water-retaining structures be sealed with a cold pouring polysulphide rubber sealing compound of quality equal to, or better than serviced "Paraseal". Horizontal joints in roofs, floors and other non-water retaining structures shall be sealed with an approved sealant with properties equal to or better than serviced "Paraplastic 41". Vertical joints and joints in the soffits of slabs in both water retaining as well as non-water retaining structures shall be sealed with a trowel or gun applied polysulphide rubber sealing compound such as serviced "Vertiseal" or equivalent. Sealing compounds shall be fully cured before water is permitted to come in contact. At 40^0C, the curing time would be approximately 7 weeks for polysulphide compound.

TOLERANCES IN CONCRETE SURFACES

- Concrete surfaces for the various classes of unformed and formed finishes specified in various clauses shall comply with the tolerances shown in Table hereunder, except where different tolerances are expressly required by the specification.
- In the table 'line and level' and 'dimension' shall mean the lines, levels and cross-sectional dimensions as specified and required.
- Surface irregularities shall be classified as 'abrupt' or 'gradual'. Abrupt irregularities include by shall not be limited to offsets and fins caused by displaced or misplaced formwork, loose knots and other defects in formwork materials, and shall be tested by direct measurement. Gradual irregularities shall be tested by means of a straight template for plane surfaces or its suitable equipment for curved surfaces the template being 3m long for unformed surfaces and 1.5 m long formed surfaces.

Class of finish	**Maximum tolerance (mm) in:**			
	Line & level	Abrupt irregularity	Gradual irregularity	Dimension
U 1	12	6	6	-
U 2	6	3	3	-
U 3	6	3	3	-
F 1	12	6	6	+12-6
F 2	6	6	6	+12-6
F 3	3	3	3	+6-

UNFORMED SURFACE – CLAUSE OF FINISH

i. Finishes to unformed surface of concrete shall be classified as U1, U2, U3, speed or bounded concrete. Where the clause of finish is not specified the concrete shall be finished to clause – U1.

ii. Clause – U1 finish is the first age for Clause – U2 and Clause – U3 finishes and for bonded concrete surface. Clause – U1 finish shall be a levelled and screeded uniform plane or ridged, finish which (unless it is being converted to Clause – U2 , U3 or bonded concrete) shall not be disturbed in any way after the initial set and during period of curing, surplus concrete being struck off immediately after compaction.

iii. Where a bonded concrete surface is specified the liatance shall be removed from the Clause – U1 finished surface and the aggregate exposed while the concrete is still green.

iv. A spaded finish shall be a surface free from voids and brought to a reasonably uniform appearance by the use of showels as it is placed in the works.

v. Clause – U2 finish shall be a Wood float finish. Floating shall be done after the initial set of the concrete as taken place and the surface had hardened sufficiently. The concrete shall be worked no more than is necessary to produce a uniform surface free from screed marks.

vi. Clause – U3 finish shall be a hard smooth steel trowelled finish. Trowelling shall not commence until the moisture film has disappeared and the concrete has hardened sufficiently to prevent excess laitance from being worked into the surface. The surface shall be trowelled under firm pressure and left free from trowel marks.

vii. The addition of dry cement, mortar or water shall not be permitted during any of the above operation.

3.19 CURING, PROTECTING, REPAIRING AND FINISHING

3.19.1 Curing

All concrete shall be cured by keeping it continuously damp for the period of time required for complete hydration and hardening to take place.Preference shall be given to the use of continuous sprays, or ponded water, continuously saturated coverings of sacking, canvas, hessain or other absorbent materials, or approved effective curing compounds applied with spraying equipment capable of producing a smooth, even textured coat. Extra precautions shall be exercised in curing

concrete during cold and hot weather as outlined hereinafter. The quality of curing water shall be the same as that used for mixing concrete.

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

Curing of concrete made of high alumina cement and super sulphated cement shall be carried out as directed by Engineer in charge.

3.19.2 Curing with Water

Fresh concrete shall be kept continuously wet for a minimum period of 10 days from the date of placing of concrete, following a lapse of 12 to 14 hours after laying of concrete. The curing of horizontal surfaces exposed to the drying winds shall however begin as soon as the concrete has hardened. Water shall be applied to formed surfaces immediately upon removal of forms. Quantity of water applied shall be controlled so as to prevent erosion of freshly placed concrete.

3.19.3 Continuous Spraying

Curing shall be assured by use of an ample water supply under pressure in pipes, with all necessary appliances of house, sprinklers and spraying devices. Continuous fine mist spraying or sprinkling shall be used, unless otherwise specified or approved by the Engineer-in-charge.

3.19.4 Alternate Curing Methods

Whenever in the judgement of the Engineer-in-charge, it is necessary to omit the continuous spray method, a covering of clean sand or other approved means such as wet gunny bags, which will prevent loss of moisture from the concrete, may be used. No type of covering will be approved which would stain or damage the concrete during or after the curing period. Covering shall be kept continuously wet during curing period. For curing of concrete in pavements, sidewalks, floors, flat roofs of other level surfaces, the ponding method of curing is preferred. The method of containing the ponded water shall be approved by the Engineer-in-charge. Special attention shall be given to edges and corners of the slabs to ensure proper protection to these areas. The ponded areas shall be kept continuously filled with water during the curing period.

3.19.5 Curing Compound

Surface coating type-curing compounds shall be used only by special permission of Engineer-in-Charge. Curing compounds shall be liquid type white pigmented, conforming to US Bureau of Reclamation specification. No curing compound shall be used on surfaces where future blending with concrete, water of acid proof membrane or painting is specified.

3.19.6 Curing Equipment

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

3.19.7 Protecting Fresh Concrete

Fresh concrete shall be protected from defacements and damage due to construction operations by leaving forms in place for an ample period as specified in section D3 of this specification. Newly placed concrete shall be protected by approved means such as tarpaulins from rain, sun and winds. Steps as approved by the Engineer-in-Charge shall also be taken to protect immature concrete from damage by debris, excessive lading, vibration, abrasion or contact with other materials, etc. that may impair the strength and/or durability of the concrete. Workmen shall be warned against and prevented from disturbing green concrete during its setting period. If it is necessary that the workmen enter the area of freshly placed concrete, the Engineer-in-Charge may require that bridges be placed over the area.

3.19.8 Repair and Replacement of Unsatisfactory Concrete

3.19.8.1 Immediately after the shuttering is removed, the surface of concrete shall be very carefully gone over and all defective areas called to the attention of the Engineer-in-charge who may permit patching of the defective areas or also reject the concrete unit either partially or in its entirety. Rejected concrete shall be removed and replaced by the contractor. Holes mortar composed of one part of cement to one and half parts of sand passing 2.36 mm IS sieve after removing any loose stones adhering to the concrete. Concrete surfaces shall be finished as described in specifications or as directed by the Engineer-in-charge.

3.19.8.2 Superficial honey combed surfaces and rough patches shall be similarly made good immediately after removal of shuttering, in the presence of the Engineer-in-charge and superficial water and air holes shall be filled in. The mortar shall be well worked into the surface with a wooden float. Excess water shall be avoided. Unless instructed otherwise by the Engineer-in-charge, the surface of the exposed concrete placed against shuttering shall be rubbed down immediately on removal of shuttering to remove fine or other irregularities, care being taken to avoid damaging the surface. Surface irregularities shall be removed by grinding.

3.19.8.3If reinforcement is exposed or the honeycombing occurs at vulnerable positions e.g. ends of beams or columns, it may be necessary to cut out the member completely or in part and reconstruct. The decision of the Engineer-in-charge shall be final in this regard. If only patching is necessary, the edges being cut perpendicular to the affected surface or with a small under cut if possible. Anchors, tees or dovetail slots shall be provided whenever necessary to attach the new concrete securely in place. An area extending several centimeters beyond the edges and the surfaces of the prepared voids shall be saturated with water for 24 hours immediately before the patching material is placed.

3.19.8.4 Use of Epoxy

The use of epoxy for bonding fresh concrete used for repairs will be permitted upon written approval of the Engineer-in-charge. Epoxies shall be applied in strict accordance with the instructions of the manufacturer.

1. Method of Repair

Small size holes having surface dimensions about equal to the depth of the hole, holes left after removal of form bolts, grout insert holes and slots cut for repair of cracks shall be repaired as follows.

2. The hole to be patched shall be roughened and thoroughly soaked with clean water until absorption stops. A 5 mm thick layer of grout of equal parts of cement and sand shall be well brushed into the surface to be patched, followed immediately by the patching concrete which shall be well consolidated with a wooden float and left slightly protrude of the surrounding surface. The concrete patch shall be built up in 10 mm thick layers, after an hour or more, depending upon weather conditions, it shall be worked off flush with a wooden float and a smooth finish obtained by wiping with hessian. A steel trowel shall be used for this purpose. The mix for patching shall be of the same materials and in the same proportion as that used in the concrete being repaired, although some reduction in the maximum size of the coarse aggregates may be necessary and the mix shall be kept as dry as possible. Mortar filling by air pressure (gunniting) shall be used for repair of areas too large and/or too shallow for patching with mortar. Patched surfaces shall be given a final treatment to match the colour and texture of the surrounding concrete. White cement shall be substituted for ordinary cement, if so directed by the Engineer-in-charge, to match the shade of the patch with the original concrete.

3. Curing of Patched Work

The patched area shall be covered immediately with an approved non-staining, water-saturated material such as gunny bags which shall be kept continuously wet and protected against sun and wind for a period of 24 hours. Thereafter, the patched area shall be kept wet continuously by a fine spray, or sprinkling for not less than 10 days. All fillings shall be tightly bounded to the concrete and shall be sound, free from shrinkage cracks after the fillings have been cured and dried.

4. Approval by the Engineer-in-Charge

All materials, procedures and operations used in the repair work shall be subject to the approval of the Engineer-in-Charge.

1.20 FINISHING

3.20.1 General

The type of finish for formed concrete surfaces shall be as follows, unless varied by the Engineer-in-Charge.

When the structure is in service all the surfaces shall receive no special finish, except repair of damaged or defective concrete, removal of fine and abrupt irregularities, filling defective concrete, filling of holes left by form ties and rods and clean up of loose or adhering debris. Surfaces which will be exposed to the weather and which would normally be level, shall be sloped for drainage. Unless a horizontal surface or the slope required is specified, the tops of narrow surfaces such as stair treads, walls, curbs and parapets shall be sloped across the width approximately 1 in 30. Broader surfaces such as walkways, roads, parking areas and platforms shall be sloped about 1 in 50. Surfaces that will be covered by backfill or concrete, subfloors to be covered with concrete topping, terrazzo or quarry tiles and similar surfaces shall be smooth screened and leveled to produce even surfaces. Surface irregularities shall not exceed 6 mm. Surfaces which will not be covered by backfill, concrete or tile toppings such as outside decks, floors of galleries and sumps, parapets, gutters, side-walks, floors and slabs, shall be consolidated, screened and floated. Excess water and laitance shall be removed before final finishing. Floating may be done with hand or power tools and started as soon as the screened surface has attained a stiffness to permit finishing operations and these shall be the minimum required to produce a surface uniform in texture and free from screened marks or other imperfections. Joints and edges shall be tooled as specified or as directed by the Engineer-in-Charge.

3.20.2. Standard Finish For Exposed Concrete

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

3.20.3 Integral cement concrete finish

When specified, an integral cement concrete finish of specified thickness for floors and slabs shall be applied either monolithic or bonded, as specified or directed by the Engineer-in-charge. The surface shall be tested with a straight edge and any high and low spots eliminated. Floating or trowelling of the finish shall be permitted only after all surface water has evaporated. Dry cement or a mixture of dry cement and sand shall not be sprinkled directly on the surface of the cement finish to absorb moisture or to stiffen the mix.

3.20.4 Rubbed finish

A rubbed finish shall be provided only on exposed concrete surfaces. Upon removal of forms, all fins and other projections on the surfaces shall be carefully removed, offsets leveled and voids and/or damaged sections immediately saturated with water and repaired by filling with a concrete or mortar of the same composition as was used in the surface. The surfaces shall then be thoroughly wetted and rubbed with carborundum or other abrasive. Cement mortar may be used in the rubbing, but the finished surfaces shall not be brush coated with either cement or grout after rubbing. The finished surfaces shall present a uniform and smooth appearance.

3.20.5 Protection

All concrete shall be protected against damage until final acceptance by the Engineer-in-Charge.

3.21 Preparation of Earth Strata For Foundations

3.21.1General : All earth surfaces upon which or against which concrete is to be placed, shall be well compacted and free from standing water mud or debris. Soft, yielding soil shall be removed and replaced with suitable earth well compacted or lean concrete as directed by Engineer. Where specified, lean concrete shall be provided on the earth stratum for receiving concrete, the surface of abosrptive soils against which concrete is to be placed shall be moistened thoroughly so that no moisture will be drawn from the freshly placed concrete and later shall help to cure the concrete.

The preparation of concrete surfaces upon which additional concrete is to be placed later, shall preferably be done by scarifying and cleaning while the concrete is between its initial and final set. This method shall be used wherever practicable and shall consist of cutting the surface with picks and stiff brooms and by use of an approved combination of air and water jet as directed by the Engineer. Great care shall be taken in performing this work to avoid removal of too much mortar and the weakening of the surface by loosening of aggregate. When it is not practicable to follow the above method, it will be necessary to employ air tools to remove laitance and roughen the surface. The final required result shall be a pitted surface from which all dirt, unsound concrete, laitance and glazed mortar have been removed.

3.21.2Bonding Treatment (Mortar)

After rock and concrete surfaces upon which new concrete is to be placed have been scarfied, cleaned and wetted as specified herein, they shall receive a bonding treatment, immediately before placement of the concrete.

The bonding medium shall be a coat of cement – sand mortar. The mortar shall have the same cement – sand proportions as the concrete which shall be placed on it. The water – cement ratio shall be determined by placing conditions and as approved by the Engineer.

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

Mortar shall be placed at such a rate that it can be brushed over the surface just in advance of the placement of concrete only as much area shall be covered with mortar takes place. The amount of mortar that will be

permitted to be placed at any one time, or the area which it is to cover, shall be in accordance with the Engineer's directions.

3.21.3 Cleaning and Bonding formed construction joints: Vertical construction joints shall be cleaned as specified above or by other methods approved by the Engineer in charge. In placing concrete against formed construction joints, the surface of the joints, where accessible, shall be coated thoroughly with the specifieid be – joints, bonding mortar immediatley before they are covered with concrete or by scrubbing with wire brushes dipped into the fresh concrete. Where it is impracticable to apply such a mortar coating, special precautions shall be taken to ensure that the concrete is brought into intimate contact with the surface of the joint by careful pudding and spading with the aid of vibrators and suitable tools.

3.21.4Expansion and contraction Joints: Provision shall be made for expansion and contraction in concrete by use of special type joints located wherever necessary and as shown on approved drawings.

3.22HOT WEATHER REQUIREMENT

a. All Concrete work performed in hot weather shall be in accordance with IS: 456, except as herein modified.
b. Admixtures may be used only when approved by the Engineer-in-Charge.
c. Adequate provisions shall be made to lower concrete temperatures by cool ingredients, eliminating excessive mixing, preventing exposure of mixers and conveyors to direct sunlight and the use of reflective paint on mixers, etc. The temperature of the freshly placed concrete shall not be permitted to exceed 38 degrees centigrade.
d. Consideration shall be given to shading aggregate stockpiles from direct rays of the sun and spraying stockpiles with water, use of cold water when available, and burying, insulating, shading and/or painting white the pipelines and water storage tanks and conveyance.
e. In order to reduce loss of mixing water, the aggregate, wooden forms, subgrade, adjacent concrete and other moisture absorbing surfaces shall be well wetted prior to concreting, placement and finishing shall be done as quickly as possible.
f. Extra precautions shall be taken for the protection and curing of concrete. Consideration shall be given to continuous water curing and protection against high temperatures and drying hot winds for a period of at least 7 days immediately after concrete has set and after which normal curing procedures may be resumed.

1.23 Placing Concrete Underwater

a. Under all ordinary conditions, all foundations shall be completely dewatered and concrete placed in the dry. However, when concrete placement under water is necessary, all work shall conform to IS: 456 and the procedure shall be as follows:
   - **Method of Placement**: Concrete shall be deposited underwater by means of tremises, or drop bottom buckets of approved type.
   - **Direction, Inspection and Approval**: All work requiring placement of concrete underwater shall be designed, directed and inspected with due regard to local circumstances and purposes. All underwater concrete shall be placed according to plans or specifications approved by the Engineer-in-Charge.

PRECAST CONCRETE

General

Precast concrete units, whether manufactured on or off site, shall comply in every way with the provisions of the contract for in situ concrete. Wherever possible, precast units shall be hydraulically pressed. When ready for incorporation in the works, precast units shall be responsible for the accuracy of the level, shape of the bed or platform. A suitable serial number and the date of casting shall be impressed or painted on each unit.

Striking Forms

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

Precast Units

The lifting and removal of precast units shall be undertaken without causing shock, vibration or undue bending stresses to or in the units. Before lifting and removal takes place, contractor shall satisfy the Engineer-in-charge or his representative that the methods he proposes to adopt for these operations will not over-stress or otherwise effect seriously the strength of the precast units. The reinforced side of the units shall be distinctly marked.

Curing

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

Precast Concrete Pipes For A Ground Water Drainage

Concrete porous pipes for a ground water drainage shall be made of porous concrete with materials generally in accordance with IS 4350. The pipe shall be of uniform cross section and bore and not more than 1m in length with square ends. The pipes shall have ogee or rebated joints, the axial length of which shall not be less than (D/36+12)mm, where D is the Nominal Internal diameter of the pipe in mm.

SLOTS, OPENINGS, GROUTINGS ETC.

General

Slots, openings or holes, pockets, etc., shall be provided in the concrete work in the approved positions or as directed by Engineer-in-charge.. Any deviation from the approved drawings shall be made good by contractor at own expense, without damaging any other work. Sleeves, bolts, inserts etc., shall also be provided in concrete work where so required.

Grouting

Standard Grout: Grout shall be provided as specified herein below:

The proportions of grout shall one such as to produce a flowable mixture consistent with minimum water content and shrinkage. The grout proportions shall be limited as follows*Table* 5: Proportions for Standard Grout".

Table 5: Proportions for Standard Grout

Sl.No	Use	Grout thickness	Mix proportions	W/c ratio (max.)
1.	Fluid	Under 25 mm	One part Portland cement to one part sand	0.44
2.	General	25mm & over but less than 50mm	One part Portland cement to 2 parts of sand	0.53
3.	Stiff Mix	50mm & over	One part Portland cement to 3 parts of sand	0.53

I i)Sand shall be such as to produce a flowable grout without any tendency to segregate.
ii)Sand for general grouting purposes, shall be graded within the following limits:

- Passing IS 2.36 mm sieve 95 to 100%
- Passing IS 1.18 mm sieve 65 to 95%
- Passing IS 300 micron sieve 10 to 30%
- Passing IS 150 micron sieve 3 to 10%

iii)Sand for fluid grouts, shall have the fine material passing the 300 and 150 micron sieves at the upper limits specified above.
iv)Sand, for stiff grouts, shall meet the usual grading specifications for concrete.

II i)Surface to be grouted shall be throughly roughened and cleaned of all foreign matters and laitance.

ii)Anchor bolts, anchor bolt holes and the bottoms of equipment and column base plates shall be cleaned of all oil, grease, dirt and loose material. The use of hot, strong caustic solution for this purpose will be permitted.

iii) Prior to grouting, the hardened concrete surfaces to be grouted shall be saturated with water.

iv) Water in anchor boltholes shall be removed before grouting is started.

v) Forms around base plates shall be reasonably tight to prevent leakage of the grout.

vi) Adequate clearance shall be provided between forms and base plate to permit grout to be worked properly into place.

vii) Grouting, once started, shall be done quickly and continuously to prevent segregation, bleeding and breakdown of initial set. Grout shall be worked from one side of one end to the other to prevent entrapment of air. To distribute the grout and to ensure more complete contact between base plate and foundation and to help release trapped air, link chains can be used to work the grout into place.

viii) Grout throughout holes in base plates shall be by pressure grouting.

ix) Variations in grout mixes and procedures shall be permitted if approved by the Engineer-in-charge.

Non-Shrinking Grout for Equipment Foundation

Non-shrinking grout shall be used for grouting of machine base plates, anchor bolts, other anchoring devices and at locations where ordinary grouts are ineffective due to shrinkage. It shall be composed of a type of expansive hydraulic sheeting binder and select-graded aggregates. It shall have properties as mentioned belowTable 6: Proportions for Non-Shrinking Grout

Sl.No	Properties	Values
1	Maximum grain size	6 mm
2	Water % (for 80% flow)	15.17
3	Density of hardened grout gm/ml	2.27 - 2.30
4	Compressive strength N/sq.mm	
	- Minimum 3 days	23
	- 7 days	34
	- 28 days	45
5	Expansion %	
	- Free	0.15 - 0.20
	- Restrained	0.08 - 0.12

Mixing, batching, cleaning, preparation of surface and curing of non-shrinking grout shall be done as per manufacturer's instructions.

INSPECTION

a. All materials, workmanship and finished construction shall be subject to continuous inspection and approval of the Engineer-in-Charge.

b. All materials supplied by the Contractor and all work or construction performed by the Contractor which is rejected as not being in conformity with the specifications and requirements, shall be immediately replaced.

c. All concrete shall be protected against damage until final acceptance by the Engineer-in-Charge.

CLEAN-UP

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

b. All debris i.e. empty containers, scrap wood, etc., shall be removed to "dump" daily, or as directed by the Engineer-in-Charge.

c. The finished concrete surfaces shall be left in a clean condition satisfactory to the Engineer-in-Charge.

RECORDS OF CONCRETING

An accurate and up to date record showing times, dates, weather and temperature conditions when various positions of all the concrete structures forming the works were concreted will be kept by the Engineer-in-charge and shall be countersigned by the Contractor. If the Contractor fails to sign the Engineer-in-Charge's record; it shall nevertheless be regarded as correct and binding on the Contractor.

SUPPLY OF CEMENT

Contractor shall make their own arrangements for the supply of cement. Further, the Contractor shall be responsible for payments of applicable duties and taxes, port clearance, inland transport etc.,

FOUNDATION BEDDING, BONDING AND JOINTING

a. All surfaces upon or against which concrete will be placed shall be suitably prepared by thoroughly cleaning, washing and dewatering, as specified or as the Engineer-in-charge may direct, to meet the various situations encountered in the work.
b. Soft or spongy areas shall be cleaned out and backfilled with either soil-cement mixture, lean concrete or clean sand fill compacted to a minimum density of 90% of modified proctor.
c. Prior to construction of formwork for any item where soil will act as bottom form, approval shall be obtained from the Engineer-in-Charge as to the suitability of the soil.

PREPARATION OF ROCK STRATA OF FOUNDATIONS

a. To provide tight bond with rock foundations, the rock surface shall be prepared and the following general requirements shall be observed.
b. Concrete shall not be deposited on large sloping rock surfaces. Where required by the Engineer-in-charge, the rock shall be cut to form rough steps or benches to provide roughness or a more suitable bearing surface.
c. Rock foundation stratum shall be prepared by picking, barring, wedging and similar methods which will leave the rock in an entirely sound and unshattered condition.
d. Shortly before concrete is placed, the rock surface shall be cleaned with high pressure water and air jet even though it may have been previously cleaned in that manner.
e. Prior to placing concrete, the rock surface shall be kept wet for a period of 2 to 4 hours unless otherwise directed by the Engineer-in-Charge.
f. Before placing concrete on rock surfaces all water shall be removed from depressions to permit thorough inspection and proper bonding of the concrete to the rock.

Formwork

FIXING OF FORMWORK

All formwork shall be constructed of plywood or sheet metal Plywood used for form work shall be conforming to IS:4990 i.e Specification for plywood for concrete shuttering works. The materials for form work shall got approved by the Engineer before starting the work. Form work shall be firmly supported, adequately strutted, braced and tied to withstand the placing and vibrating of concrete and the effects of weather. The tolerance on line and level shall not exceed 3 mm and the soffits of beams other than prestressed beams shall in the absence of any specified camber, be erected with an upward camber of 6 mm for each 3 meters of span.

The Contractor shall be responsible for the calculations and designs for the formwork, and if required, shall submit them to the Engineer for approval before construction. on formwork to external faces which will be permanently exposed, all horizontal and vertical formwork joints shall be so arranged that joint lines will form a uniform pattern on the face of the concrete. Where the Contractor proposes to make up the formwork for standard sized manufactured formwork panels, the size of such panels shall be approved by the Engineer before they are used in the construction of the Works. The finished appearance of the entire elevation of the structure and adjoining structures shall be considered when planning the pattern of joint lines caused by formwork and by construction joint to ensure continuity of horizontal and vertical lines.

Faces of formwork in contact with concrete shall be free from adhering foreign matter, projecting nails and the like, splits or other defects, and all formwork shall be clean and free from standing water, dirt, shavings, chippings or other foreign matter. Joints shall be sufficiently watertight to prevent the escape of mortar or the formation of fins or other blemishes on the face of the concrete.

Formwork shall be provided for the top surfaces of sloping work where the slope exceeds fifteen degrees from the horizontal (except where such top surface is specified as spaded finish) and shall be anchored to enable the concrete to be properly compacted and to prevent flotation, care being taken to prevent air being trapped.

Openings for inspection of the inside of the formwork and for the removal of water used for washing down shall be provided and so formed as to be easily closed before placing concrete. Before placing concrete, all bolts, pipes or conduits or other fixtures which are to be built in shall be fixed in their correct positions, and cores and other devices for forming holes shall be held fast by fixing to the formwork or otherwise. Holes shall not be cut in any concrete without approval of the Engineer.

All exterior angles on the finished concrete of 90 degree or less shall be given 20 mm x 20 mm chamfers unless otherwise ordered by the Engineer.

No ties or bolts or other device shall be built into the concrete for the purpose of supporting formwork without the prior approval of the Engineer. The whole or part of any such supports shall be capable of removal so that no part remaining embedded in the concrete shall be nearer than 50 mm from the surface in the case of reinforced concrete and 150 mm in the case of un-reinforced concrete. Holes left after removal of such supports shall be neatly filled with well rammed dry-pack mortar.

Formwork in contact with the concrete shall be treated with a suitable non-staining mould oil to prevent adherence of the concrete except where the surface is subsequently to be rendered. Care shall be taken to prevent the oil from coming in contact with reinforcement or with concrete at construction joints. Surface retarding agents shall be used only where ordered by the Engineer.

REMOVAL OF FORMWORK

Formwork shall be so designed as to permit any removal without resorting to hammering or levering against the surface of the concrete.

The periods of time elapsing between the placing of the concrete and the striking of the loads likely to be imposed on the concrete and shall in any case be not less than the periods shown in Table below. Where soffit formwork is constructed in a manner during and after such removal of a sufficient number of adequate supporting props in an undisturbed condition, the Contractor may, with the agreement of the Engineer, remove the formwork at the earlier times listed below provided that the props are left in position.

TABLE

TYPE OF FORMWORK	Minimum Period Before Striking Formwork
Vertical formwork to columns,walls,beams	16-24 hours
Soffit formwork to slabs (Props to be refixed immediately after removal of form work)	3 days
Soffit formwork to beams (Props to be refixed immediately after removal of form work)	7 days 7 days14 days
Props to slabs (span not exceeding 4.5m) Props to slabs (span exceeding 4.5 m) Props to beams and arches (span not exceeding 6 m) Props to beams and arches(span exceeding 6 m)	14 days 21 days

Notwithstanding the foregoing, the Contractor shall be held responsible for any damage arising from removal of formwork before the structure is capable of carrying its own weight and any incidental loading.

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

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

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

For liquid retaining structures, no sleeves for through bolts shall be used nor shall through bolts be removed as indicated above. The bolts, in this case, shall be cut at 25 mm depth or more from the surface and then the hole shall be made good by cement sand mortar of the same proportions as the concrete just after striking the formwork.

FORMED SURFACES – CLASSES OF FINISH

Finishes to formed surfaces of concrete shall be classified as F1, F2, or F3, or such other special finish as may be particularly specified. Where the class of finish is not specified the concrete shall be finished to Class F1.

Formwork for Class F3 finish shall be lined with as large panels as possible of non-staining material with a smooth unblemished surface such as sanded plywood or hard compressed fibre board, arranged in a uniform approved pattern and fixed to back formwork by oval nails. Unfaced wrought boarding or standard steel panels shall not be permitted.

Formwork for Class F2 finish shall be faced with wrought tongued and grooved boards or plywood or metal panels arranged in a uniform approved pattern free from defects likely to detract from the appearance of the surface.

Formwork for Class F1 finish shall be constructed in Timber,sheet metal or any suitable materials which will prevent loss of grout when the concrete is vibrated.Surfaces subsequently to be rendered, plastered or tiled shall be adequately scrabbled or hacked as soon as the formwork is removed to reduce the irregularities to not more than half the thickness of such rendering, plastering or bedding for tiles and to provide a satisfactory key.

DEFECTS IN FORMED SURFACES

Workmanship in formwork and concreting shall be such that concrete shall normally require no making good, surfaces being perfectly compacted and smooth.

If any blemishes are revealed after removal of formwork, the Engineer's decisions concerning remedial measures shall be obtained immediately. These measures may include, but shall not be limited to the following:

i) Fins, pinhole bubbles, surface discolouration and minor defects may be rubbed down with sacking immediately after the formwork is removed.

ii) Abrupt and gradual irregularities may be rubbed down with carborundum and water after the concrete has been fully cured. These and any other defects shall be remedied by methods approved by the Engineer which may include using a suitable epoxy resin or, where necessary, cutting out to a regular dovetails shape at least 75 mm deep and refilling with concrete over steel mesh reinforcement sprung into the dovetail.

HOLES TO BE FILLED

Holes formed in concrete surfaces by formwork supports or the like shall be filled with dry-pack mortar made from one part by weight of ordinary Portland cement and three parts fine aggregate passing IS sieve 1.18 mm. The mortar shall be mixed with only sufficient water to make the materials stick together when being moulded in the hands.

The contractor shall thoroughly clean any hole that is to be filled with dry-pack mortar and where the surface has been damaged, the contractor shall break out any loose, broken or cracked concrete or aggregate. The concrete surrounding the hole shall then be thoroughly soaked after which the surface shall be dried so as to leave a small amount of free water on the surface. The surface shall then be dusted lightly with ordinary Portland cement by means of a small dry brush until the whole surface that will come into contact with the dry-pack mortar has been covered and darkened by absorption of the free water by the cement. Any dry cement in the hole shall be removed.

The dry-pack material shall then be placed and packed in layers having a compacted thickness not greater then 15 mm. The compaction shall be carried out by use of a hardwood stick and a hammer and shall extend over the full area of the layer, particular care being taken to compact the dry-pack against the sides of the hole. After compaction, the surface of each layer shall be scratched before further loose material is added . The hole shall be finished by laying a hard wood block against the dry-pack fill and striking the block several times. Steel finishing tools shall not be used and water shall not be added to facilitate finishing.

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 construed to permit encroachment beyond the legal boundaries. Unless otherwise specified, the following tolerances will be permitted:

Tolerances for RCC Structures

i) Variation from the plumb

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

b) For exposed corner columns and other conspicuous lines

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

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

a) In slab soffits, ceilings, beam soffit, and in arises

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

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

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

iv) Variation in the sizes and locations of sleeves, openings in walls and floors

Except in the case of and for anchor bolts	5 mm

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

a) Variation in dimension in plan

Minus	5 mm
Plus	10 mm

b) Misplacement or eccentricity

2% of footing width in the direction of misplacement but not more than 50 mm

c) Reduction in thickness

Minus 5% of specified thickness subject to a maximum of 50 mm

vii) Variation in steps

a) In a flight of stairs

Rise	3 mm
Tread	5 mm

b) In consecutive steps

Rise	1.5 mm
Tread	3 mm

Tolerances in other Concrete Structures

viii All structures

a) Variation of the constructed linear outlines from established position in plan

In 5 m	10 mm
In 10 m or more	15 mm

b) Variations of dimensions to individual structural features from established positions

In 20 m or more	25 mm
In buried construction	50 mm

c) Variation from plumb, from specified batter or from curved surfaces of all structures

In 2.5 m	10 mm
In 5 m	15 mm
In 10 m or more	25 mm

In buried construction	Twice the above amounts

d) 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 amounts

e) Variation in cross-sectional dimensions of columns, beams, buttresses, piers and similar members

Minus	5 mm
Plus	10 mm

ix) Footings for columns, piers, walls, buttresses and similar members

a) Variation of dimensions in plan

Minus	10 mm
Plus	50 mm

b) Misplacement or eccentricity

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

c) Reduction in thickness

5% of specified thickness subject to a maximum of 50 mm

x) Tolerance in other types of structures shall generally conform to those given in Clause 2.4 of Recommended Practice for Concrete Formwork (American Concrete Institute Act 347).

xi) Tolerance in fixing anchor bolts shall be as follows:

a)	Anchor bolts without sleeves	$\pm$ 5 mm
b)	Anchor bolts with sleeves	$\pm$ 5 mm for bolts up to 28 mm dia $\pm$ 3 mm for bolts above 32 mm dia
c)	Embedded parts	$\pm$ 5 mm in all directions

BRACING, STRUTS AND PROPS

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

The formwork for beams and slabs shall be so erected that the formwork on the sides of the beams and under the soffit of slabs can be removed without disturbing the beam bottoms. Repropping of beams shall not be done except when props have to be reinstated to take car of construction loads anticipated to be in excess of the design load. Vertical props shall be supported on wedges or other measures shall be taken whereby the props can be gently lowered vertically while striking the formwork.

If the formwork for a column is erected for the full height of the column, one side shall be left open and built up in sections as placing of the concrete proceeds, or windows may be left for pouring concrete from the sides to limit the drop of concrete to 1.0 m as directed by the Engineer.

REINFORCEMENT

GENERAL

Reinforcement shall be either plain round mild steel bars grade I as per IS 432 (Part I) or medium tensile steel bars as per IS 432 (Part I) or high strength deformed bars as per IS:1786. Wire mesh or fabric shall be in accordance with IS:1566. Substitution of reinforcement will not be permitted except upon written approval from the Engineer.

STORAGE

The reinforcement shall not be kept in direct contact with the ground but stacked on top of an arrangement of timber sleepers or the like.

If the reinforcing rods have to be stored for a long duration, they shall be coated with cement wash before stacking and/or be kept under cover or stored as directed by the Engineer.

Fabricated reinforcement shall be carefully stored to prevent damage, distortion, corrosion and deterioration.

QUALITY

All steel be of grade I quality unless specifically permitted by the Engineer. No re-rolled material will be accepted. If requested by the Engineer, the contractor shall submit the manufacturer's test certificate for the steel. Random tests on steel supplied by the contractor may be performed by the Engineer as per relevant Indian Standards. All costs incidental to such tests shall be at the contractor's expenses. Steel not conforming to specifications shall be rejected.

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

LAPS

Laps and splices for reinforcement shall be as shown on the approved drawings.. Splices in adjacent bars shall be staggered and the locations of all splices, except those specified on the approved

drawings, shall be only as approved by the Engineer.The bars shall not be lapped unless the length required exceeds the maximum available lengths of bars at site.

BENDING

Reinforcement bars supplied bent or in coils, shall be straightened before they are cut to size. Straightening of bars shall be done cold and without damaging the bars.

All bars shall be accurately bent according to the sizes and shapes shown on the approved detailed working drawings/bar bending schedules. They shall be bent gradually by machine or other approved means. Reinforcing bars shall not be straightened and rebent in a manner that will injure the material; bars containing cracks or splits shall be rejected. They shall be bent cold, except bars of over 25 mm in diameter which may be bent hot if specifically approved by the Engineer. Bars which depend for their strength on cold working, shall not be bent hot. Bars bent hot shall not be treated beyond cherry red colour (nor exceeding 845°C) and after bending shall be allowed to cool slowly without quenching. Bars incorrectly bent shall be used only if the means used for straightening and rebending be such as shall not, in the opinion of the Engineer, injure the material. No reinforcement shall be bent when in position in the work without approval, whether or not it is partially embedded in hardened concrete. Bars having kinks or bends other than those required by design shall not be used.

FIXING

Reinforcement shall be accurately fixed by any approved means and maintained in the correct position shown in the approved Drawings by the use of blocks, spacers and chairs, as per IS:2502, to prevent

displacement during placing and compaction of concrete. Bars intended to be in contact at crossing points shall be securely bound together at all such points with number 16 gauge annealed soft iron wire. The vertical distances required between successive layers of bars in beams or similar members shall be maintained by the provision of mild steel spacer bars at such intervals that the main bars do not perceptibly sag between adjacent spacer bars.

NOMINAL COVER TO REINFORCEMENT

Nominal cover is the design depth of concrete cover to all steel reinforcements, including links. It is the dimension used in design and indicated in the drawings. It shall be not less than the diameter of the bar.
Minimum values for the nominal cover of normal weight aggregate concrete which should be provided to all reinforcement, including links depending on the condition of exposure as given in Table –16 of IS:456/2000.
However for a longitudinal reinforcing bar in a column nominal cover shall in any case not be less than 40 mm, or less than the diameter of such bar. In the case of columns of minimum dimension of 200 mm or under, whose reinforcing bars do not exceed 12 mm, a nominal cover of 25 mm may be used.
For footings minimum cover shall be 50 mm.

Table-16 of IS:456/2000 – Nominal cover to Meet Durability Requirements

Exposure	Nominal Concrete cover in mm not less than
Mild	20
Moderate	30
Severe	45
Very severe	50
Extreme	75

The correct cover shall be maintained by cement mortar cubes or other approved means. Reinforcement for footings, grade beams and slabs on sub-grade shall be supported on pre-cast concrete blocks as approved by the Engineer. The use of pebbles or stones shall not be permitted.

The 28 days crushing strength of cement mortar cubes/precast concrete cover blocks shall be at least equal to the specified strength of concrete in which these cubes/blocks are embedded.

The minimum clear distance between reinforcing bars shall be in accordance with IS:456.

INSPECTION

Erected and secured reinforcement shall be inspected and approved by the Engineer prior to placement of concrete.

WELDING OF REINFORCEMENT

Reinforcement which is specified to be welded shall be welded by any process which conforms with the requirements of IS:2751 and which the Contractor can demonstrate by bend and tensile tests will ensure that the strength of the parent metal is not reduced and that the weld possesses a strength not less than that of the parent metal. The welding procedure established by successful test welds shall be maintained and no departure from this procedure shall be permitted.

Welds in positions other than those shown on the approved Drawings shall not be permitted. Tack welding to lightly secure reinforcement in place will be permitted subject to approval of the Engineer.

SUPPLY OF REINFORCING BARS

Contractor shall make their own arrangements for the supply of steel reinforcement, MS bars/high yield strength deformed bars etc. required for the works. In procurement of reinforcing bars, the contractor shall follow all the regulations of the Engineer/G.O.I in respect of import licenes etc., if they choose to procure cement from imports. Further, the Contractor shall be responsible for payments of applicable duties and taxes,port clearance,inland transport etc.

FRP, PVC and other Fabricated Items

FRP

Technical details

Fibre Reinforced Plastic (FRP) products shall be used in the USAB reactor wherever the environment is highly corrosive, and where alternative materials like concrete, cast iron, etc. are not recommended. FRP will be used for the construction of feed inlet boxes, effluent gutters, baffle plates, gas hoods, gas pipes and specials etc. At some places, pipes and flanges of FRP will also be used.

The FRP products shall be manufactured using contact moulding process being proposed for construction of the various components in the UASB reactor. The isophthalic acid resin shall be used alongwith the E-glass reinforcement as specified in the specifications. The compound structure is cured under heat and pressure to a solid material which is light weight, strong and shatter resistant. The resin rich surface texture gives the sheet weather resistance as well as resistance to corrosive substances. The moulding of FRP products shall be done using the contact moulding process.

The FRP products shall also be of thermal stability and low heat transmission. The uniform thickness of FRP products facilitates even and uniform construction of gutters and boxes as well as the V-notches used for even distribution of flow. One piece moulding of each item shall be done at factory. The minimum thickness of sheet for all the FRP items shall be 8 mm and the pipes should be designed for minimum 6kg/cm^2. The curing shall be done by heat to obtain absolute polymerization of the resin and also a better composite laminate integrating the fibreglass in the resin. There shall be no patches, resin rich areas and other surface defects. Care shall be taken during fabrication that the whether is not very hot and the sunlight is not strong. In such a case the area will be properly covered during fabrication.

The details of various FRP components

Feed Inlet Boxes
The feed inlet boxes shall be prepared at site as per approved drawings. The minimum thickness of the FRP product shall be 8 mm. V-notch are also fabricated in FRP and shall be of minimum 8 mm thickness.

Effluent Gutters
The effluent gutters shall be prepared at factory as per approved drawings. The effluent gutters shall be one piece moulded of minimum 3 m length. The thickness of FRP effluent gutters shall be 8 mm. The gutters shall have smooth internal finish and will be butt jointed on all connecting ends. V- notches are cut in the effluent gutters.

Gas Hoods
The gas hood of gas domes is an inverted U structure made up of FRP of 8 mm thickness. All these gas hoods are connected separately with a 50mm dia flexible nylon reinforced plastic pipe to a 100 ID FRP pipe. These gas hoods shall also be one piece moulded and fabricated as per approved drawings.

Baffle Plate
Baffle plate is provided next to the effluent gutters to stop the floating material going into the effluent gutters. The baffle plate is made up of 8 mm thickness FRP. Single piece shall be of minimum 3.0m long.
All the FRP products prepared at factory will be inspected by the HMWSSB representative for approval before its dispatch to site.

FRP Pipes, Specials, Fittings and Flanges
FRP gas pipes shall be of 100 mm, 200 mm & 250 mm nominal/ effective diameter. Common header pipe is of 100 mm nominal/ effective diameter pipe is laid along the gas dome in the reactor. Main pipe of 250 mm nominal/ effective diameter shall be used for gas utilization and distribution system. Internal pressure of these pipes is 6 kg/cm^2

The Material Specifications:

1. Resin system to be used throughout shall be Isophthalic grade resin
2. Top and bottom layers will be of surface tissue to provide resin rich surface for increased chemical resistance.

3. Intermediate layers will be a sequence of woven roving and chopped strand mat fully impregnated with resin.

FRP fabricated items
The material for FRP fabricated items shall consist of FRP sheets having required thickness as mentioned on drawings.

The FRP to be used for fabrication shall essentially consist of following:

- Resin Unsaturated Polyester (UP) based on Isophthalic

- Glass Alkali free (Aluminium boro silicate) glass (E-glass) with a Reinforcement chromium bonding agent. Alkali percentage to be less than 1%

- Filler Substances to improve viscosity of laminate. Resin is permitted to have maximum of 5% by weight of the Thixotropic agent. The substance must not have any harmful effects on other components

- Gel coat Resin –rich layer at the mould side
  Resin must be unsaturated polyestrer based on Isophthalic
  Reinforcement : 2 layers of E-glass
  Type : fibre mat or roving
  Total thickness : 0.6 mm
- Top coat Same as gel-coat

Filler of top Resins for top and gel coat have to be coated with substances which will improve the resistance against aggressive fluid, mechanical damage or aging by UV- radiation.

Fabrication & Erection

All items shall be finished with smooth like surface.

All the dimensions shall be exact and uniform in order to erect the FRP items in their places correctly with respect to location, verticality etc.

All FRP edges or cuts have to be covered immediately after cutting with Resin

In case this precaution is not taken the fabricated FRP item will start to disintegrate and loose strength.

A fabrication workshop may be set up for FRP items at site during erection and commissioning of the prefabricated FRP products. However the contractor shall have to make all arrangements including electricity, water etc., on his own. All testing facilities shall be properly laid out in the field workshop.

Guidelines for Fabrication of FRP items

1. Thicknesses specified above are minimum values. The contractor may increase the same if required with the approval of Engineer-in-Charge considering the function of each item.

2. All items shall be finished smooth with glass like surfaces.

3. All fixtures, specials like sockets, feeds, and nipples etc shall be moulded monolithic with the main unit.

4. Exact and uniform dimensioning is essential, in order to erect the FRP items in their places correctly.

IS codes for FRP specification are given in Table 9.1

Table 13.1:IS codes for FRP Specifications

IS: 6746-1972	Unsaturated polyester resin systems for low pressure fibre reinforced plastic
IS: 9845-1986	Method of analysis for the determination of specific and/or overall migration of constituents of plastic materials and articles intended to come into contact with foodstuffs
IS: 11273-1985	Woven roving fabrics of `E' glass fibre
IS: 11320-1985	Glass fibre roving for reinforcement of polyester and of epoxide resin systems
IS: 11551-1986	Glass fibre chopped strand mat for the reinforcement of polyester resin system
IS: 12709-1989	Specifications for glass fibre reinforced plastics (GRP) pipes for use for water supply and sewerage.

Approved Makes
Fibre Glass : Saint Gobin, Goa Glass & Owen Corning
Resin : Bakelite Hylam, Jwel Polymers, Crest Composite & Chemicals, Mechamco Resins

PVC ITEMS AND PIPES

GLSS (gas liquid solid separator) is made of PVC sheets supported on PVC angle frame. The GLSS is supported by PVC pipes filled with RCC supported on the deflector beams. The PVC sheets are of 6 mm thick rigid PVC sheets produced by extrusion or calendering. These sheets are supported at the ends and at the center by `A' shaped PVC frame which has extruded PVC angle braces in X and Y direction. These frames are further supported over the deflector beam through rigid PVC pipe filled with RCC. The angle frame of 6 mm thick, 60 mm x 40 mm shall be made of rigid PVC extruded angles. Care shall be taken during fabrication that the weather is not very hot and the sunlight is not strong. In such a case during summer a covered fabrication shall be carried out. The fabrication of these elements can be carried out at site in the contractor's workshop.

PVC Sheets

General

These specifications cover the guideline for general-purpose rigid PVC sheets.

Material

Rigid PVC sheets conforming to IS: 6307 – 1985 shall be used.

It shall essentially consist of polyvinyl chloride and a copolymer of which major constituent is vinyl chloride compounded with other ingredients.

The PVC sheet may be transparent, opaque, colored or colorless as directed

The sheet shall be uniform in color (if coloured) and finished (transparent or opaque) and shall be free from scratches, creases, streaks, dents, holes etc.

The thickness of sheet shall be as specified on the drawings. The thickness shall be measured with a micrometer. The tolerance in thickness of plate shall be nil for calendered sheet and plus or minus 10% of thickness for extruded sheet.

Stacking

The rigid PVC sheets shall be stacked horizontally on clean, firm and level ground and in accordance with the manufacturer's instructions. On uneven grounds timber sleeper shall be used. The sheets shall not be stacked above 15 cm in full height.

The sampling of sheets shall be done as per IS: 6307 – 1985.

Cutting and fabrication

For the purpose of fabrication approved fixtures & fastening as specified on drawings shall be used.

The sheets shall be cut true to sizes as shown in drawings with a tolerance of +5 mm is length or width.

Approved vendors: Caprihans, Finolex, Tainwala

PVC Pipes

Material

The pipes shall be class 3 PVC pipes conforming to IS: 4985 – 1981 with a working pressure of 6 kg/cm^2.
Tolerances in dimensions shall be as specified in IS: 4985 – 1981. Physical and chemical characteristics and mechanical properties shall be as per IS: 4985 – 1981.

Approved vendors: Finolex, Jain irrigation, Manmohan Plastics, Tirupati Structures

Testing

For testing of pipes for hydrostatic characteristics, Appendix 1 of IS: 4985 – 1981, shall be followed.
All the PVC, FRP item should be protected from the direct sun light exposure during storing & erection at site until the rector is filled with water/ sewage.

OTHER FABRICATION ITEMS

Following aluminum items made of 6 mm thick aluminum sheets of approved make and sizes shall be fabricated and provided in the different units of STP as per requirement and as directed by the Engineer-in-charge. The list of items and their description are as follows:
Open channel Gates with operating stock
Sharp Crested Weir plates in distribution boxes
Sharp Crested Weir plates in division boxesStop log gates in feeding channel of SDBs
Aluminium Plates in Mechanical degritting tank
Proportional weir in the manual grit channel

Approved Makes : Hindalco, Jindal, Mahavir, Indian Aluminum

PIPING WORK AND VALVES

CAST IRON PIPES

The metal used for manufacture of pipes shall conform to the appropriate grade LA Class as specified in IS:210-1978 in commensurate with the requirements laid down in the standard.

The pipes shall be stripped with all precautions to avoid warping or shrinkage defects, detrimental to their good quality. The pipes shall be sound and free from surface or other defects. The pipes shall be such that they could be drilled or machined.

Mechanical tests shall be carried out during manufacture. Tests for every four hours of production shall be conducted. The result obtained shall be taken to represent all the pipes of all sizes made during that period.

RING TEST AND TENSILE TEST

Two test pieces obtained by cutting rings or bars from the spigot end of two pipes selected for testing except for pipes manufactured under controlled cooled process described in 8.0 of IS: 1536 when tested in accordance with the methods specified in Annex.A of IS:1536-1989 shall satisfy the following requirements.

a)	Ring test (for pipes Centrigufally cast in metal moulds)	Nominal diameter upto and including 300 mm	Modulus of Rupture, min. MPa 400
b)	Tensile test (for pipes centrifugally cast in metal moulds)	Over 300 mm and upto 600 mm	Tensile strength, min. 200 MPa
		Over 600 mm	180 MPa

2.1 Brinells Hardness Test

The test shall be carried out on the test ring or bars cut from the pipes and shall be in accordance with IS:1500-1983.

Re test

If any piece representing a lot fails in the first instance two additional tests shall be made on test pieces selected from two other pipes from the same lot. If both the test results satisfy specified requirements, the lot shall be accepted or else deemed as not complying with this standard.

HYDROSTATIC TEST

Pipes shall be tested hydrostatically at the pressures specified below. To perform the tests the pressure shall be applied internally and shal be steadily maintained for a period of minimum 15 seconds during which pipes may be struck moderately with a 700 g hammer. The pipes shall withstand the pressure test and shall not show any sign of leakage, sweating or other defects. As far as possible the hydrostatic test shall be conducted before coating of the pipe.

HYDROSTATIC TEST PRESSURE FOR CENTRIFUGALLY CAST SOCKET AND SPIGOT PIPES

For CI `LA' Class pipes, the pipes shall be tested to a hydraulic test pressure of 35 Kg/Cm² at works for pipes upto dia 600 mm and 15 Kg/ Cm² for pipes above 600 mm dia.

If necessary, the pipes may be subjected to reheat treatment to ensure that Brinell hardness does not exceed the specified value.

In case of push-on joint, the spigot ends shall be suitably chambered for smooth entry of pipe in the socket fitted with the rubber gasket. In the case of lead joint pipes, the spigot may or may not have chambered ends.

Dimensions for socket and spigot of pipes for lead joints and for push-on joint irrespective of class shall be in conformity to Table 3 and Table 4 of IS:1536-1989.

TOLERANCES

The tolerances shall be in accordance with Clause 11 of IS:1536-1989.

Coating: Each pipe shall be coated in accordance with 12.1.1 to 12.1.5 of IS:1536-1989.

RUBBER GASKETS

Rubber Gaskets for use with push-on joints shall confirm to IS:12820-1989.

Tolerance on length:

The tolerance on length of pipe shall be as follows:

	Type of casting	Tolerance in mm
a)	Socket and spigot and plain ended pipes	± 25
b)	Flanged pipes	± 10

DEVIATION FROM STRAIGHT LINE

The pipes shall be straight. When rolled along two gentries seperated by approximately two thirds the length of the pipe to be checked the maximum deviation from a straight line in mm shall not be greater than 1.25 the length 'L' in meters of the pipe thus: $fm \leq 1.25\ L$

MARKING

Each pipe shall have cast, stamped or indelibly painted on it the following appropriate marks.

a) Manufacturer's name, initials or identification mark.
b) The nominal diameter.
c) Class reference.
d) Mass of pipe.
e) The last two digits of the year of manufacture.

CI SPECIALS

Tail Pieces and Adapters

CI specials, like tail pieces and adapters confirming to Part VII and VIII, XI of IS:1538 (Parts I to XXIII) - 1993 are to be used.

The general requirements for materials, manufacture, mechanical test, Brinell hardness test, hydrostatic test, tolerances and coating shall confirm to those mentioned earlier or IS:1538-1993 (Part-I) and shall be conducted in presence of Engineer deputed by HMWSSB. and after clearance given by the Engineer the material may be:

1) Transporting and handling coated pipes, specials, appurtenances etc.

Pipes, specials, valves etc. shall be handled at all times with equipment such as stout wide belt slings and wide padded skids designed to prevent damage to the coating. Bare cables, chains, hooks, metal bars or narrow skids shall not be permitted to come in contact with the coating.
In truck shipments, the pipe shal be supported in wide cradles of suitably padded timbers hollowed out on the supporting surface to fit the curvature of pipe, and all chains, cables, or other equipment used for fastening the load shall be carefully padded. For smaller diameter pipes, sand or saw-dust filled bags may be used instead of hollowed out timbers.

The Engineer shall inspect the pipe and pipe protection on truck at destination, and if the pipe protection is found damaged, the same shall be repaired to the satisfaction of the Engineer by the contractor at his cost.

2) Handling coated pipe in field or at trench

The laying of pipes shall generally conform to IS:3114.
Pipe shall be stored along the trench side suitably supported off the ground to avoid damage to the coating.

Pipe shall be hoisted from the trench side to the trench by means of wide belt slings. Chains, cables, tongs or other equipment likely to cause damage to the enamel coating will not be permitted, not to the dragging or skidding of the pipe. The contractor shall allow inspection of the coating on the underside of the pipe while it is suspended from the slings. Any damage shall be repaired before the piep is lowered into the trench.

At all times during construction of the pipeline, the contractor shall use every precaution to prevent damage to protective coating on the pipe. No metal tools or heavy objects shall be permitted to come into contact unnecessarily with the finished coating. Workmen will be permitted to work upon the coating only when necessary in which case they shall weal shoes with rubber or composition soles and heels. This rule shall apply to all surfaces. Any damage to the pipe or protective coating from any cause during the installation of the pipeline shall be repaired, as directed, and at the expense of the contractor.

3) Internal cleaning of Pipeline
When a section of pipeline has been laid and all the work inside it, has been completed to the satisfaction of the Engineer, its internal surface shall be cleared of all dirt, debris, dust or other deposit.

Cleaning shall be done to the satisfaction of the Engineer. The section of the pipeline once cleaned to the satisfaction of the Engineer shall not be entered into for any purpose later. Sufficient precaution shall be taken to prevent the ingress of any dirt, debris etc. just inside the section. Failing this, the section shall be cleaned again at the discretion of the Engineer.

No separate payment will be made for the work of cleaning. The item rates quoted for laying the pipes etc. shall include the cost thereof.

In the case of above-ground pipeline, the length of the section to be taken up for cleaning shall be decided in consultation with the Engineer from the point of view of ventilation etc.

In case of buried pipeline a section shall be taken up for cleaning after the work of back filling around and over the pipeline is completed and the spiders, etc. have been removed from inside.

During the pipe laying operations in the adjoining sections, the contractor shall take all precautions to prevent ingress of water, much, debris, dirt, dust etc. in the cleaned section, failing which the section shall be cleaned again at the discretion of the Engineer. Where deemed necessary by the Engineer, suitable closures shall be provided at the open end or the ends of the cleaned sections.

At the end of a day's work, closure shall invariably be provided at all the open ends to protect the pipeline from ingress of sub-soil water, mud, much, etc.

INSPECTIONS

The contractor shall provide facilities for inspection of the following at manufacturer's factory and the hydrostatic test pressure at works shall be arranged by the contractor in the presence of the Engineers of HMWSSB deputed for this purpose time to time.

C.I Pipes	-	After casting
C.I Specials	-	After Casting
Sluice Valves	-	After assembling
All other parts	-	As such stages of manufacture that vital parts can be examined and on completion.

The CI pipes, specials and valves and other appurtenances which fail in the hydrostatic test for work pressure at factory will be summarily rejected.

No material is to be delivered to site without the above described inspection having been carried and have been passed the work's tests thereon. The CI pipes, specials and valves and other appurtenances shall be tested at the factory to the required hydrostatic test pressure at works as applicable for the relevant classes of pipes, specials and valves as per the latest IS Codes.

FIELD TESTING OF CI PIPELINE INCLUDING CI SLUICE VALVES AND SPECIALS

After the work of laying of pipe line is completed and before putting into commission, the CI pipeline shall be hydraulically tested in the field for a test pressure of 8 Kg/Cm² as per IS: 3114. The procedure for the test shall be as follows:

Preliminaries:

For purpose of pressure testing, the pipe line shall be divided into sections as defined by the Engineer.

Each valved section of the pipe line shall be subjected to a hydraulic test in full length or in part as may be found necessary. For this test, the pipe shall be slowly filled with clean water as directed and all air shall be expelled from the pipe line through hydrants, as valves and blow off fixed on the pipe line. Once the pipe line is fill the pressure in the line should then be raised and built up and maintained by means of suitable approved pumps, to the specified test pressure based on the elevation of the lowest point on the line or section under test. The test pressure shall be maintained for one hour. The gravity of water added to re-establish the pressure should not exceed 0.1 liter per mm of pipe diameter per KM of pipe line per day for each 30 Mts. head of pressure applied.

The leaking joints noticed during testing shall be repaired. The repaired joint shall be subjected to a re-test. No section shall be accepted unless it is put in a perfectly water tight condition and retested satisfactorily. The contractors shall make all arrangements for all labour, pumps, pressure gauges, equipment etc. No main valves or cross connections either on the new or the existing main shall be operated by the contractor, and only the Engineer's representative shall operate the same. The contractor shall arrange for labour required for operating the air valves etc.

DEFECT LIABILITY PERIOD

The entire CI pipe line along with the appurtenances shall be under satisfactory performance for a period of 24 months of the date of commissioning the pipeline and taken over by the Engineer, or 30 months from the date of completion and taking over by the Engineer, whichever is earlier.

Valves

Gate (Sluice) Valves

Gate Valves shall be either solid wedge or knife gate unless specifically defined on the drawings.

Solid Wedge Gate-Type Sluice Valves

General

All valves shall be double-flanged. Sluice Valves and shall conform to IS:14846-2000. Imported valves shall conform to the relevant British or American Standards. The materials used in construction, the design and all other relevant features shall be such that the valves are entirely suitable for use on sewer/sludge pipelines, force mains and within sewage pumping stations. Valve shall be of suitable pressure rating which shall not be less than twice the normal operating pressure.

Design

The design of the valves will be such that erosion, cavitation, vibration and head loss (in the fully open position) shall be a minimum external lubrication. The valves should be capable of being opened and closed against working pressure which exceed the maximum working pressures by 15 percent.

Materials

The materials used for the manufacture of each component shall be the best available for the specific purpose and shall not, in any case be inferior to the following:

Cast Iron - IS. 210 Grade 20

Stainless Steel - IS. 1570 Grade, B.S. 970 Type EN, ASTM A 473.

Gun Metal - BS.1400-LG 2 -C or the equivalent Indian Standard.

Cast Steel - Plain Carbon Steel complying with IS. 1570 Grade, or BS: 970 Grade 431 S 29.

Valve Bodies

a. Castings
The structure of the castings shall be homogeneous and free from non-metallic inclusions and other injurious defects. All surface of castings which are not machined shall be smooth and shall be carefully fettled to remove all foundry irregularities.

b. Forgings
All major stress bearing forgings shall be made to a standard specification which shall be submitted if required to the Engineer for approval before work is commenced. Forgings shall be subjected to non destructive tests to detect flaws if any. Forgings shall be heat treated for the relief of residual stresses. The name of the maker and particulars of the heat treatment proposed for such forging shall be submitted to the HMWSSB. The Executive Engineer or his inspector may inspect such forgings at the place of manufacture with a representative of the Contractor.

c. Workmanship
Workmanship and general finish shall be of first class commercial quality and in accordance with best workshop practice.

All similar items of the valve and their component parts shall be completely interchangeable. Spare parts shall be manufactured from the same materials as the originals and shall fit in place of all similar items. machining fits on renewable parts shall be accurate and to specified tolerances so that replacements made to manufacturer's drawings may be readily installed.

All parts which can be worn or damaged by dust shall be totally enclosed in dust proof housings.

d. Protective coating shall comply with B.S. 1218 Clause 16, for use in tropics, or IS 2906, Clause 7.

Spindle Details
The spindles shall be of stainless steel and to permit the solid wedge gate to be so raised as to permit an unimpeded flow passage through the valve in open position. Where handwheels are provided, the direction of rotation and the words 'OPEN' shall be marked prominently on the upper side. All spindle contacting surfaces in the valve body shall be bushed with gun metal.

Valve Gates
Each face of the gate shall be lined with heavy gun metal rings which will match with corresponding rings in the body. The rings shall be force fitted by special fixtures and rivetted in the case of valves in the size range 450 mm and larger. When finally assembled, the body and wedge faces shall provide a water-tight bearing surface. When shut, the gates shall ride on the body seats, to allow for wear.

Operation
The tops of the spindles or gears operated with extension spindles or tee keys shall be provided with caps of dimensions conforming to IS 14846-2000. The direction of opening shall be indicated on the caps.

Lubrication
At the points where lubrication is needed the Contractor shall furnish full details of the method to be employed. The supply of the requisite lubricating equipment and lubricants for commissioning and operating and maintaining the valves for one year is included in this contract and shall be included in the contract rates.

Spare Parts
One spare spindle and nut shall be supplied under this contract for each group of 10 sluice valves or less of the different sizes. In addition of the Contractor shall submit a list of recommended spares for 5 years of operation. Spares supplied shall be new, unused and interchangeable with the corresponding components they are intended to replace.

Flanges
Valves of sizes 80 mm - 300 mm shall have flat flanges as per ISS:1538 Part IV Table I. Valves of sizes 350 mm and larger shall have raised flanges as per BS: 4504, Table 10/11 for 10 bar valves. The flange to flange distances shall be as per IS:780 for 80 mm - 300 mm valves and IS : 2906 for 350 mm and larger valves.

Jointing Materials
Each valve shall be supplied under this Contract, with all requisite joint rings, nuts, bolts and washers for making the joints on all the valves to be installed under this Contract. Jointing material between the connecting flanges shall conform to the requirements of I.S. 638- 1965. Unless otherwise specified bolting used for jointing exposed connections shall be carbon steel, conforming to IS 210 Grade 20 Grade B, with galvanized finish. Bolting for buried joints and joints that could come into contact with raw sewage shall be Stainless Steel, as per Clause 2.02 A3. Bolt holes shall be off-centre and in correct adjustment longitudinally.

Special Requirements - 450 mm and Larger Valves
Sluice valves in the size range 450 mm to 1200 mm shall have, in addition to the above requirements, the following features:

a. The valves shall have machined gun metal gate slides. Hard bronze shoes shall be provided on the gate and machined gun metal channels in the body. The bronze shoes will be machined accurately to give a close working clearance with the channels. They shall provide corrosion resistant bearing surfaces and minimise sliding friction and vibration while maintaining accurate alignment. The use of cast iron channels with brass lining will be permitted if the lining is at least 6mm thick. The use of other materials for holding the channels in position will not be permitted.

b. The valves shall be provided with spur gearing consisting of machined mild steel pinions and cast iron wheels for valves installed underground. The pinion shafts shall run in gun metal bushes in a cast iron bearing bracket with provision for lubricating by a grease gun.

Gear wheel ratios will be such that a force of 270 Newtons applied on each end of a bar in combination with a Tee Key or extension spindle at the following distances from the key centre will permit smooth operation.

Valve size range (mm)	Distance of application of force (mm)
450 - 900	600

Valves installed above ground shall be provided with worm gearing. These shall be machined cut, with bronze wheel and steel worm enclosed in a cast iron gear case which shall be mounted on a fitting connected to the valve cover flange and shall be complete with indicator column.

The worm shafts shall be equipped with ball thrust bearing and gun metal bushes. The gear box shall be oil filled and sealed. The worm shaft bearing shall be provided with grease gun nipples. the gear ratios shall be so selected that the maximum force required to develop the requisite operating torque shall not exceed 180 Newtons.

All valves of sizes 450 mm or more shall have valve gate indicator columns with 10 mm graduations and indicating the fully open and closed positions. The indicator assembly should be sufficiently water-tight to prevent entry of rain water into the worm gear box in outdoor valves.

Factory Tests
All the valves shall be tested at the factory for smooth, trouble free operation and operating torque requirements by operating between fully open and fully closed position three times.

The hydrostatic tests shall consists of -

a. application of a pressure equal to 1 and a half times the maximum working pressure specified in this section with both ends closed and valve fully open, for ten minutes. No leakage of water should occur through the metal, flanged joints or valve packing gland, nor should any permanent deformation of any part occur.

b. the pressure shall then be reduced to the working pressure and the wedge gate lowered, thus closing the valve. The stipulated pressures shall then be maintained for 5 minutes on each side in turn during which no leakage should occur on the downstream side of valve seating.

Cast Iron Check Valves

60 mm to 350 mm diameter valves shall be swing check- valves of the lever and spring type, flanged, and shall have cast iron body and renewable bronze seat, bronze hinge, stainless steel hinge shaft. The valve shall conform to I.S. 5312 and, where any of the requirements specified are not covered therein, to U.S. Federal Specification WW-V-51 D, Type IV, Class A.

Cast Iron shall conform to ASTM A-126-66 and flanges to ANSI B 16.1. The valves shall be designed for low head loss, shall be adjustable for non-slamming closure with hydraulic dampner and shall be seat-tight. An arrow showing direction of flow shall be prominently cast on body of valve. The water working pressure shall be 10 kg/cm square except that the valve shall have pressure rating same as the piping where the pipe class is higher. Valves shall be from approved manufacturer only.

All check valves larger than 400 mm diameter installed on the pump discharge shall be flanged ductile iron body, cover disc, arm and levers. The seat shall be of renewable bronze ASTM B 148. The disc shall be hinged on a stainless steel shaft. The gate pins shall also be of stainless steel. The valves shall be designed for a working, pressure of 10kg/cm square. Valve operation shall be of the oil cushioned type such that the valve swing to 90 percent closed immediately upon stoppage of flow and cushioning cylinders shall control the final closure, to prevent mechanical slamming, within an adjustable timing of one to three seconds. The valves shall be from approved manufacturers only.

Inspection

The contractor shall provide facilities for inspection of the following at manufacturer's factory and the hydrostatic test pressure at works shall be arranged by the contractor in the presence of the Engineers of HMWSSB deputed for this purpose time to time.

Sluice Valves	-	After assembling
All other parts	-	As such stages of manufacture that vital parts can be examined and on completion.

The valves and other appurtenances which fail in the hydrostatic test for work pressure at factory will be summarly rejected.

No material is to be delivered to site without the above described inspection having been carried and have been passed the work's tests thereon. The other appurtenances shall be tested at the factory to the required hydrostatic test pressure at works as applicable for the relevant classes of pipes, specials and valves as per the latest IS Codes.

HDPE PIPES

These pipes have been used for carrying the effluent from distribution boxes to Feeding boxes of the Reactors. These pipes shall meet specifications as per IS: 4984.

Jointing

HDPE pipe shall be jointed properly with HDPE socketted specials to get smooth inner side surface without any extrusion to avoid any obstruction to the flow of wastewater. If in any particular case butt-welding has to be done, smooth inner surface of pipe without intrusion inside shall be ensured.

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SCOPE OF WORK

Manufacture, testing and inspection at places of manufacturer, painting, supply, delivery to site, storage at site, installation / erection, final painting, testing, commissioning and manning, operation and maintenance of the electrical equipment as lisetd the in price schedule.

It is not the intent to specify herein all the details pertaining to the design, selection of material/ equipment, procurement, manufacture, installation, testing and commissioning, however, the same shall be of high standard of engineering and shall comply to all currently applicable standards, regulations and safety codes.

The scope of work starts from receiving 11kV power after APCPDCL metering point at a suitable point of supply as indicated in the plant layout by supplying and erecting 4-pole structure & equipment as per power supply company standards in the plant premises and further power distribution, indoor & outdoor lighting system, earthing system and cable & cable carrier system.

In addition to the above, the following services are included in the Scope of the Contract:

A. The contractor shall assist the VMC in getting the working load sanction and power release from power supply company by co-ordinating and liasioning with the power supply company authorities.

B. The contractor shall also be responsible for getting the complete installation approved by the electrical inspector.

C. Submison of 6 sets of test certificates, inspection reports, operation & maintenance manuals for the material/ equipment supplied.

D. Supply of Safety equipment such as Shock treatment Chart, Dry Co2 Fire Extinguisher for indoor substation, Sand Bucket Stand for outdoor substation yard, Antiskid Insulated Rubbet Mats of appropriate voltage grade, Danger Boards etc.

E. Furnishing of drawings, documents, operation and maintenance manual

F. Making good any damage done to the civil structure

Standard Of Workmanship

The work shall be carried out in a neat and skilled manner. All works shall be carried out in accordance with the requirements of:
i. VMC
ii. Standard rules and regulations of power supply company
iii. IE Rules, and
iv. The standards in this specification

The contractor shall ensure workmanship of good quality and shall assign qualified supervisor / engineers and competent labour who are skilled, careful and experienced in carrying out similar works.
VMC shall reserve the right to reject non-competent person/s employed by the contractor, if the workmanship is found unsatisfactory.

POWER DISRTRIBUTION NETWORK

Power Supply Condition

Nominal System Voltage

Incoming Power Supply	:	11 kV, 3 ph,3 wire, 50 Hz AC
Voltage Variation	:	+ 10 %, -10%
Frequency Variation	:	50 Hz ± 3%
Combined voltage and Frequency Variation	:	± 10%
Three Phase Symmetrical Fault Level	:	500 MVA at 11 kV

2.2 Utilization Voltages

Levels of Utilization voltages in the plant shall comply with local standards.

Incoming Power Supply	:	11 kV, 50 Hz, 3 phase,3 wire
Plant power distribution voltage	:	415 V, 50 Hz, 3 phase,4 wire
MEP/MCC control voltage	:	230 V, 50 Hz, 1 phase,2 wire
Potential transformer secondary	:	110 V, 3 phase, 50 Hz, AC
Motors < 0.37 kW	:	230V, 50Hz, 1 phase
Motors ≥ 0.37 kW ≤ 350 kW	:	415V, 50Hz, 3 phase
Welding Receptacles	:	415V, 50Hz, 3 phase, 4 wire
Lighting Power Distribution	:	415V, 50Hz, 3 phase, 4 wire
Lighting Fixtures	:	230V, 50Hz, 1 phase, 2 wire
Lighting Receptacles	:	230V, 50Hz, 1 phase, 2 wire
Convenience Receptacl	:	230V, 50Hz, 1 phase, 2 wire

2.2.2 System Earthing

a. 11 kV, 3 ph AC system	:	Neutral solidly earthed
b.415 V, 3 ph, AC system	:	Neutral solidly earthed
c.240 V, 1 ph, AC system	:	Neutral solidly earthed
d. 110 V DC system	:	Unearthed

POWER TRANSFORMER

Scope

Manufacture, testing at manufacturer's works, delivery to site, installation, testing and commissioning of One no. 11/0.433 kV 800 KVA ONAN cooled Transformer and On Load Tap Changer Cubicle & Remote Tap Changer Cubicle.

Codes And Standerds

The design, manufacture and performance of equipment shall comply with currently applicable statutory, regulations and safety codes in the locality where the equipment will be installed. Nothing in this specification shall be construed to relive vendor from his responsibility.

Unless otherwise specified, equipment shall conform to the latest applicable Indian or IES standards. Equipment complying with any other authoritative standards, such as British, U.S.A., VDE etc. will also be considered if offered. The relevant Indian standards are :

Code No.	Title
IS2026/BS171/IEC76	Power Transformer
IS3639	Fittings and Accessories
IS1180	Auxiliary Transformer
IS6600/BSCP.1010/IEC354	Loading of oil immersed transformer
IS335/BS 148/IEC296	Transformer Oil
IS2099/BS223/IEC137	Bushings for > 1000V, AC
IS7421	Bushings for ≤ 1000V, AC
IS13947 (Part 1) / IEC947-1	Degree of Protection
IS3637	Buchholz Relay
IS 1271/BS2757/IEC85	Insulation Materials for Electrical Machinery
IS 3202/ BSCP1014/ IEC354	Climate Proofing
IS 1886	Installation & Maintenance of Transformers
IS 2705	Current Transformers

Climatic Conditions

Ambient temperature : 50 Deg. C outdoor
Altitude above MSL : Less than 1000M.
Relative Humidity : 90% maximum
Atmosphere : Tropical

Performance & Characteristics

1. Transformer shall be capable of operating continuously and without adverse effects of overheating under all specified conditions of operation including variation in system of + 10% voltage and + 3% frequency or + 10% combined voltage and frequency unless otherwise specified separately.

2. Transformer shall be suitable for parallel operation with other transformers of similar characteristics.

3. Transformer shall be designed to withstand without any injury the thermal and mechanical stress caused by the short circuit currents of magnitude and duration of 1 sec.

4. Operation Over Overloads: It shall be possible to operate all transformers as per loading guide IS: 6600 up to overloads of 150 %. There shall be no limitations imposed by bushing, tap changers, auxiliary equipment etc. to meet this requirement.

Constructional Features

GENERAL

Similar parts, particularly removable ones, shall be interchangeable. Screws, studs, nuts and bolts shall be as per Indian Standards. Nuts, bolts, pins used inside the transformers and tap changer compartments shall be locked.

Exposed parts shall not leave pockets where water can collect.

Internal design of transformer shall ensure that air is not trapped in any location.

Facility shall be provided for lubrication of bearings and mechanisms. Mechanisms shall be constructed of non- corrodible material.

Material in contact with oil shall be such as not to contribute the formation of acid in oil. Surfaces in contacts with oil shall not be galvanized or cadmium plated.

Labels, indelibly marked, shall be provided for all accessories like relays, switches, fans, current transformers etc.

TANK

Tank shall be made from good, commercial grade low carbon steel and shall be of electrically welded construction type. Tank shall be designed to permit lifting, by crane or jacks of the complete transformer assembly filled with oil. Suitable lugs and bosses shall be provided for this purpose. Tank together with radiators, conservator, bushings and other fittings shall be designed to withstand without permanent distortion the following conditions:

Full vacuum of 760mm of Hg for filling with oil by vacuum.

Internal gas pressure of 0.35Kg/sq.cm (5lbs/sq. in. with oil at operating level).

Adequate space shall be provided at the bottom of the tank for collection of sediment.

The transformer top shall be provided with a detachable tank cover with a bolted flanged gasket joint. Lifting lugs shall be provided for removing the cover. The surface of the cover shall be suitably sloped so that it does not retain rainwater.

Manholes with bolted covers shall be provided in the top or sides of transformer for easy access to the power ends of bushings, tap changers and to permit replacement of auxiliaries without removing tank cover.

The material used for gaskets shall be cork-neoprene or approved equivalent. Gasket joints for tank and manhole covers, bushings and other bolted attachments shall be so designed that the gasket will not be exposed to the weather.

The transformer base shall be designed to permit skidding of the complete transformer unit in any direction, when using plates or rails. The under base shall be detachable unless transport facilities permit a fixed base

CORE

The magnetic circuit shall be of “core type” constructions. The core shall be built out of high grade, non-aging, low loss and high permeability, cold rolled grain oriented silicon steel laminations.

The core laminations, shall be insulated from each other by a suitable high temperature resistant, oil-proof, adherent coating material. The core clamps and clamping bolts shall be heavily insulated from the core laminations.

The insulation of core bolt shall be minimum of Class 'B'. The bottom and top frames shall be connected with tie rods to make a complete structure rigid for carrying the weight of core-coil assembly without unduly stressing the laminations or windings.

All the core sections shall be bonded together with a metallic strip and connected to the tank for earthing, to ensure earth return and operation of protective gear in the event of a winding to core fault. The core shall be provided with lifting eyes/lugs suitable for lifting the complete core and coil assembly from the tank.

Completed core shall be flash tested for insulation with 2500 Volts between the core and each clamps for core bolts (core being connected to earth)

The finally assembled core shall be free from distortion. It shall be rigidly clamped to ensure adequate mechanical strength and to prevent vibrations during operation.

The core clamped structure shall be designed to minimize eddy current loss.

The operating flux density shall be such that an over voltage of 10% shall not cause saturation of the core.

WINDINGS

Winding shall be three phase with minimum Class 'A' insulation.
Properly insulated and stacked high conductivity electrolytic grade copper (and not aluminium) shall be used for winding. Windings shall be suitable braced to withstand the dynamic forces due to short circuit.

The transformers shall be two winding type.

Winding shall be individually vacuum dried in hermetically sealed drying ovens and pre-shrunk fully under hot conditions. After assembly of windings on core, the complete assembly shall again be vacuum dried until the desired insulation resistance of each winding is obtained.

Windings shall be subjected to a shrinking and seasoning process, so that no further shrinkage occurs during service. Adjustable devices shall be provided for taking up possible shrinkage in service.

Coils shall be supported at frequent intervals by means of wedge type insulation spacers permanently secured in place and arranged to ensure proper oil circulation. To ensure permanent tightness of winding assembly, the insulation spacers shall be dried and compressed at high pressure before use.

Windings shall not contain sharp bends, which might damage the insulation or produce high dielectric stresses. No strip conductor wound on edge shall have width exceeding six times the thickness.

Materials used in the insulation and the assembly of the windings shall be insoluble, non- catalytic and chemically inactive in the hot transformer oil, and shall not soften or be otherwise affected under the operating conditions.

All threaded connections shall be locked. Leads from the winding to the terminal board and bushing shall be rigidly supported to prevent injury from vibrations. Guide tubes shall be used where practicable.

Clamping bolts for current carrying parts inside oil shall be made of oil resistant material which shall not be affected by acidity in oil.

Terminals of all windings including unloaded stabilizing windings shall be brought out of the tank through bushing for external connections.

INTERNAL EARTHING

All internal metals part of the transformers, with the individual clamping plates; shall be earthed. Core clamps and core bolts shall be insulated form the core by class B insulation unless other insulation is approved by purchaser.

The top clamping structure shall be connected to the tank by a copper strap.

The bottom clamping structure shall be earthed by one of the following methods.

By connection through vertical tie –rods to the top structure.

By direct metal to metal contact with the tank base.

By a connection to the top structure on the same side of the core as the main earth connection to the tank.

The magnetic circuit shall be connected to the clamping structure at one point only, through a link placed in an accessible position beneath an inspection on the tank cover. The link shall be on the same side of the core as the main earth connection.

When the magnetic circuit is sub-divided by oil ducts or insulated barriers above 0.25 mm thick, tinned copper strip bridging pieces shall be inserted to maintain electrical continuity between packets.

Coil clamping rings of metal at earth potential, shall be connected to the adjacent core clamping structure on the same side as the main earth connection.

UNDER CARRIAGE

The undercarriage of the transformer shall be provided with detachable steel flanged heels or flat rollers. Flanged wheels shall be spaced to allow specified rail gauge. Wheels shall be provided with suitable bearings, which will resist rust and corrosion and shall be equipped with fittings for lubrications. Unless otherwise approved, it shall be possible to swivel the wheels or rollers in two directions, at right angles to or parallel to the main axis of the transformer, thereby permitting movement in two directions. The wheels or rollers will be swiveled after jacking the transformer and they shall be lockable in the two positions.

INSULATING OIL

Transformer oil will be mineral type (not synthetic, PCB based) confirming to IS: 335. Comparatively small transformers shall be supplied "Under Oil". For large transformers with radiator banks, it may not be feasible to ship the transformer "Under Oil", oil being supplied separately. Tested insulating oil required for filling or topping up the transformers including radiator banks and conservator shall be supplied loose, in non-returnable drums. The quantity of oil shall be sufficient for filling at site with 10% extra quantity of oil in non-returnable drums.

No inhibitors shall be used in the oil.

TERMINAL ARRANGEMENT

1. Throat Connection for Bus Duct

   When Bus-duct termination is specified, terminals shall be brought out into the terminal chamber with a flanged throat connection suitable for connection to the bus duct with copper bus bars. The LV winding terminations shall be on outdoor type of bushings. Necessary flexibles shall be supplied for connecting the bushing terminals to the bus bars. The material of the bus-duct termination shall be non-magnetic unless otherwise approved by the purchaser. Facility shall be provided for take-off of the bus-duct in either horizontal direction or vertically from the top.

   During dispatch, a blank cover, gasket and hardware shall be provided for the throat connection.

2. Separate Neutral Bushing for Earthing

Separate neutral terminal (other than that provided in the terminal chamber) of star connected winding of transformer shall be brought out with an outdoor type bushing. The terminal shall be suitable for connection of two flat earth conductors.

MARSHALLING BOX

For the required fittings on the transformer, a dust-tight, vermin proof and weatherproof, sheet steel (2 mm thick) enclosed, marshalling box with hinged door having padlocking facility shall be provided on the transformer tank.

Marshalling box shall be provided with a rain hood at top, removable gland plate at bottom and a hinged door at the front.

All doors covers and plates shall be fitted with neoprene gaskets. Bottom shall be at least 600mm from floor level.

All devices mounted on the transformer and requiring electrical connections, such as Buchholz relay, oil & winding temperature indicator contacts, pressure release valve contacts, cooler fan motors and their controls, shall be wired to marshalling box.

All interconnections between these devices and marshalling boxes shall be carried out with either 1100/650V grade PVC insulated armoured cables OR PVC insulated wires in GI conduits.

The size of the conductor shall be minimum 2.5 sq.mm. Copper.

All internal wiring with marshalling box shall be carried out with PVC insulated, copper conductor wires of minimum size 2.5 sq.mm. Marked ferrules shall be provided at the wire terminations.

All contacts for alarm, trip and indication circuits shall each be electrically free, wired for auxiliary D.C. supply as specified and brought out to separate terminals at the terminal blocks in the marshalling box.

Marshaling box shall have one door switch operated 230V AC fluorescent lamp; thermostat controlled 20W space heater and one 5A plug socket.

Transformer Cooling Equipment

Radiators and coolers shall be designed to withstand the vacuum and pressure conditions specified for the tank and made of pressed sheet steel of thickness not less than 1.4 mm. They shall be so designed as to avoid pockets in which moisture may collect.

SEPARATELY MOUNTED RADIATORS

Separately mounted radiator banks shall have bolted & gasketted flanged connections and pipe extensions to permit withdrawal of transformer tank without disturbing the radiators. Flexible joints shall be provided in the interconnecting pipes (unless otherwise approved) to facilitate erection & dismantling and reduce transfer of vibrations from tank to radiator. The interconnecting pipes shall be provided with drain plug and air release vents. The following accessories shall be provided for each radiator bank.
Shut-off valves and blanking plates for transformer tank at each point of connection hut-off valves and blanking plates for each radiator bank.

Lifting lugs, pulling eyes and wheels, if necessary.

Top and bottom oil filtering valves.

Air release plug at top.

A drain valve at bottom.

A thermometer pocket fitted with a captive screwed cap on the inlet and outlet.

On Load Tap Changing Gear (OLTC)

The tap changer shall be suitable for connection to tapping brought out from H.T. winding (Delta Connected) covering a range of sixteen steps from +5% to -15% making a total of seventeen positions (Taps). All taps shall be rated for maximum continuous KVA rating of the transformer and shall be suitable for operation at sustained voltage of 110% of the rated tap voltage.

OLTC gear shall be high-speed resistor transition type. Following fittings and accessories shall be provided for the OLTC. Some of the accessories may not be necessary, depending on the design and construction of the OLTC gear.

Local Control with AVR
Remote Control Panel
Conservator with oil level gauge, oil filling hole and cap
Pressure wave protection device or Oil surge operated relay
Oil drain valve and vent plug
Silica gel breather
Filter valves at top and bottom
Air release plug

OPERATION

The tap changer shall change the taps by one step only at a time, when a tap change impulse is given manually or automatically. Further tap changing operation should take place only if a fresh impulse is given. Under auto-operation, the tap change should be initiated when the actual voltage deviates from the reference voltage by more than one step and remains at that level for more than a present time. (Time range:30-180 seconds).

Fittings And Accessories

Transformers shall be supplied with fittings and accessories as indicated in the table below :-

Sl. No	**Description**	R-Required
1	Rating & diagram plate	R
2	Dial type magnetic oil level gauge with low level alarm contacts	R
3	Silica Gel breather with a seal, & connecting pipe, in a transparent enclosure	R
4	Explosion Vent with diaphragm Equalizing pipe	R
5	Conservator with filling hole, cap and drain valve and isolating valve for conservator.	R
6	Double floats buchholz relay with alarm and trip contacts and a test level for simulating operation of buchholz relay and shut off valve on tank side.	R
7	Dial thermometer for oil temperature marked in ^{o}C with alarm and trip contacts (adjustable) with a maximum reading pointer	R
8	Image coil with C.T. test terminals, calibrating resistors etc. for	

Sl. No	**Description**	R-Required
	winding temperature with dial type thermometer having alarm & trip contacts (adjustable) with a maximum reading pointer (for 4000 KVA & above)	NR
9	Weatherproof marshalling box with terminal blocks complete with PVC armoured cables terminated with glands from buchholz relay, alarm/trip contacts of oil level temperature gauge etc.	R
10	Thermometer pocket (for top oil temp.)	R
11	Lifting lugs	NR
12	Jacking pads – 4 Nos.	NR
13	Draw eyes	R
14	Top Filter valve	R
15	Bottom filter valve	R
16	Drain valve with plug	R
17	Oil sampling valve	R
18	Inspection cover	R
19	Air release vent	R
20	Bi-directional rollers	R
21	Two earthing terminals	R
22	Plain oil level indicator with minimum marking	

NOTES

a) All instruments shall not be less than 96 mm dia or sq.

b) All instruments shall be readable from ground level.
All alarm and trip contacts of instruments shall be suitable for 1A.250 Volts D.C. or 5A.250 Volts A.C.

Earthing pads : Two earthing pads of copper or other non-corrodible material on transformer tank together with clamp type terminals suitable for Purchaser earthing conductors.

Suitable earthing terminals on cable boxes and separately mounted radiator banks.

Terminal marking and rating plates shall be as per IS : 2026.

Requirements Of Fittings And Accessories

A Conservator (for transformer rating as per IS : 2026). The conservator shall be of sufficient volume to maintain the oil seal from the minimum ambient temperature of –5 deg.C upto an oil temperature of 100 deg.C, with oil level varying within the minimum and maximum visible levels. The conservator shall be provided with the following accessories :

1. Filling plug, sump and drain valve.

2. 150 mm diameter magnetic type oil level gauge & oil sight gauge, both provided with markings for minimum oil level, and oil level at 30 deg. C.

3. A bolted cover for cleaning.

4. Valve for shutting off oil to the transformer.

B Valves

1. The following valves shall be fitted on the transformer tank.

2. Main tank drain valve with flanged or threaded connection.

3. Top filtering valve with plug located on the same side as the main drain valve.

4. Bottom filter connection with plug to drain oil from the lowest part of the tank. This connection shall not be tapped through the bottom of the transformer.

5. Oil sampling devices at top and bottom of the main tank. These shall be distinct from other valves.

6. Adequate number of air relief vents.

7. Two plugged pipe outlets at top for applying vacuum. All valve opening shall be plugged or blank flanged.

8. Valves for the cooler systems are indicated in the respective sections. These valves shall be lockable in closed or open positions and shall be provided with an indicator to show position of the valve.

C Pressure Relief Devices

A pressure relief vent (explosion vent) mounted on the tank shall be provided for relieving pressure within the transformer. It shall operate for pressure less than the hydraulic test pressure for the tank. The explosion vent shall be provided with diaphragm (s) and a screen to prevent fragments of a shuttered diaphragm being sucked into the transformer under vacuum.

Equalization of air pressure in the vent may be achieved by a pipe connection to the conservator. (This device shall be provided for all transformers rated 500 KVA and above.)

D Gas And Oil Actuated Relay (Buchholz Relay)

A double float type Buchholz relay as per IS : 3637/8 shall be provided. All gas evolved in the transformer shall collect in this relay. The relay shall be provided with a test cock suitable for a flexible pipe connection for checking its operation. A copper tube shall be connected from the gas collector to a valve located about 1.25 M above ground level to facilitate sampling with the transformer in service. The device shall be provided with two electrically independent ungrounded contacts, one for alarm on gas accumulation and the other for tripping on sudden rise of pressure.

E Temperature Indicators

1. Dial type Thermometer

All transformers shall be provided with a 150 mm dial type thermometer for top oil temperature indication. The thermometer shall have adjustable, electrically independent, ungrounded alarm and trip contacts, maximum reading pointer and resetting device.

2. Winding Temperature Indicator

A device for measuring the hot spot temperature of the winding shall be provided.

It shall comprise of the following:

a. Temperature sensing element.

b. Image coil

c. Current transformer

d. 150 mm dia local indicating instrument with four adjustable electrically independent ungrounded contacts, two for control of cooling equipment and two for winding alarm and trip.

e. Calibration device.

f. Automatic ambient temperature compensation

g. In addition to the above, the Analogue signal transmitter for remote indication and remote indicating flush mounted instrument for mounting onclient's panel shall be provided (when specifically called for).

Radio Influence And Noise Level

The transformer shall be designed with particular attention to the suppression of maximum harmonic voltage, especially the third and fifth, so as to minimize interference with communication circuits.

The noise – level when energized at normal voltage and frequency with fans and pumps running shall not exceed 80 db when measured under standard conditions.

Painting

A The interior of all transformer tanks and other oil filled chambers and internal structure steel work shall be cleaned of all scale and dust by shot – blasting unless otherwise approved. These surfaces shall be painted with not less than two coats of heat resistance, oil insoluble and insulating varnish. Steel surfaces exposed to the weather shall be thoroughly cleaned and applied a priming coat of zinc chromate. The second coat shall be of an oil and weather resistant nature, preferably of distinct colour from the prime and finish coats. The final coat shall be of glossy oil and weather resisting non fading paint of specified shade.

B All exposed bolts, nuts and washers shall be of galvanized steel unless otherwise approved.

C Metal parts not accessible for painting shall be made of corrosion-resistant material. Machined finished and bright surfaces shall be coated with a suitable compound and wrapped.

D Interior surfaces of mechanism chambers and knocks shall receive three coats of paint after cleaning the final coat shall be of a light-coloured anti-condensation paint.

Tests

All transformers shall be completely assembled at Works to ascertain that all parts fit correctly.

A Routine Tests

Routine tests as per IS shall be performed on all transformers.
The following additional points may be noted:

1. Resistance of winding shall be measured at principal and the two extreme taps.

2. Impedance voltage shall be measured at principal and the two extreme taps.

3. No load loss and exciting current shall be measured at rated frequency at 100 % and 110 % rated voltage. These tests shall be done before and after impulse tests if the later are specified. Exciting current shall be measured on each phase and recorded.

4. No load loss and exciting current shall be measured and recorded with 415 V, 3 phase, 50 Hz, input on LV side (assuming LV is rated higher than 415 V).

5 Oil Pressure Test : All oil filled compartments shall be filled with transformer oil and subjected to a pressure of 035 Kg/cm above the pressure that would obtain under normal conditions with full head of oil. The pressure shall be maintained for 12 hours during which time no oil leakage shall occur. When heat run test is specified, the oil pressure test shall be performed immediately after the heat run. Otherwise the test may be performed at ambient temperature.

6. Temperature rise test.

B Type Test

Contractor shall submit the certificates for the following type tests :

1. Impulse Test

C Auxiliary Equipment

All equipment shall be tested as per the relevant IS. Test certificates shall be submitted for bought out items. High voltage withstand test shall be performed on auxiliary equipment and writing after complete assembly.

D Test Reports

Four copies of preliminary test results shall be submitted for Purchaser's approval before dispatch of transformer.

Additional bound copies as per enclosed distribution schedule of complete test results including all tests on transformer, auxiliaries, current transformer characteristics shall be furnished with the transformer.

Losses

If the measured losses on the transformer are found to exceed guaranteed loss figures by more than the + 10% tolerance permitted, following penalties shall be levied on the contractor.

A No Load Loss

B Indian Rupees. 2,58,000, for every kW in excess of the tolerance on guaranteed losses.

C Load Loss

D Indian Rupees. 1,00,300, for every kW in excess of the tolerance on guaranteed losses.

Rejection

A Purchaser may reject any transformer if during tests or service any of the following conditions arise :

1. No load loss exceeds the guaranteed value by 15% or more.

2. Load loss exceeds the guaranteed value by 15% or more.

3. Impedance voltage at principal tapping not within the limits of tolerance (+ 10%) over guaranteed value.

4. Oil or winding temperature rise exceeds the specified value by 5 deg. C.

5. A transformer fails on impulse test.

6. Transformer fails on power frequency voltage withstand test.

B The rejected transformer, shall be replaced by transformers complying with the requirements to this specification at the contractor's cost.

C If the commissioning of the project is likely to be delayed by the rejection of a transformer, the Engineer reserves the right to accept the rejected transformer until the replacement transformer is made available. Transporting the rejected and replacement transformers as well as installation and commissioning of both the transformers shall be at the contractor's cost.

Spares

Bidder shall quote item wise prices for recommended spares, including the following:

1. One (1) completely wound limb comprising HV / MV / LV winding.

2 Complete set of gaskets.

3. One bushing of each type.

4. One CT of each type.

5. Cooler fan / fan motor.

6. Dial type thermometer.

7. Oil level Gauge.

8. Complete set of winding temperature indicating equipment.

9. One cable sealing end of each type.

10. OLTC motor.

11. One motor contactor of each type.

12 Explosion vent diaphragms.

13 Silica gel breather.

14 One valve of each type.

MV SWITCHGEAR

Scope

Manufacture, inspection and testing at the VENDOR's /his Sub-VENDOR's works, delivery to site and performance testing of metal enclosed medium voltage switchgear of voltage not exceeding 1000 V AC.

The switchgears would comprise of Main Electrical Panel, Motor Control Centres (MCCs) and Lighting Distribution Boards required for the supply of power to and for the control of the plant medium voltage equipment.

Codes & Standards

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

The relevant Indian Standards are :

Code No.	Title
IS 375	**MARKING AND ARRANGEMENT FOR SWITCHGEAR BUS BARS, MAIN CONNECTION AND AUXILIARY WIRING.**
IS 3202	Code of Practice for climate – proofing of electrical equipment
IS 2516	Alternating current Circuit Breakers (Relevant part/Section)
IS 3231	Electric Relays for Power System Protection
IS13947	Switchgear General Requirements
IS 3427	Metal Enclosed switchgear and control gear
IS 4237	General requirements for switch gear and control gear for voltage not exceeding 1000 volts
IS 694 Part I & II	PVC insulated cables (for voltages up to 1100V with copper and aluminium conductors)
IS 8623	Factory Built Assemblies of SWGR and Controlgear for Voltages upto and including 1000V AC & 1200V DC
IS 13947-P3	Air Break Switches
IS 8828	Miniature Circuit Breakers
IS 13703	Low voltage Fuses
IS13947	Contactors
IS13947	Starters
IS 6875	Control Switches / Push buttons
IS 2705	Current Transformers
IS 3156	Voltage Transformers
IS 1248	Direct Acting Electrical Indicating instruments
IS 2147	Degree of protection provided by enclosures for low voltage switch gears.
IS 2959	AC Contactors of voltage not exceeding 1000 volts
IS 11353	Marking and Identification of Conductors and Apparatus Terminals
IS 722	A.C. Electricity Meters
IS 10118	Selection installation and maintenance of switchgear

Code No.	Title
	and controlgear

In absence of specific Indian Standard Specifications, Inter-national Electrotechnical Committee Specifications shall be followed.

Construction

CONSTRUCTIONAL FEATURES

Switchgear shall be sheet steel enclosed, INDOOR, fully compartmentalized made up of the requisite vertical sections.

Switchgear shall be floor mounting, free standing, totally enclosed and dust damp and vermin proof. Non- deteriorating gaskets shall be used all round the perimeter of adjacent panels, panel and base frame, removable covers and doors for dust proofing.

Indoor switchgear shall be provided with a degree of protection of IP 52. For the switchgear to be installed in plant area a degree of protection of IP 54 shall be provided. For Outdoor installations degree of protection of IP 55 shall be provided.

All switchgear panels shall be of same height. Panels shall be bolted together to form a continuous flush front switchboard suitable for front of board operation.

Switchgear shall be suitable for extension at both ends by the addition of vertical sections after removing the end covers. Ends of bus bars shall be drilled for extension.

Switchgear shall be provided with a metal steel frame made of structural steel channel section properly drilled for mounting the switchgear along with necessary mounting hardware. Hardware shall be zinc plated and passivated.

Switchgear shall be provided with labels on the front and rear indicating the switchgear designation.

Provision of cable entry shall be made at top/bottom, as specified, with 3 mm thick removable gland plates.

Switchgear shall be of uniform height of not more than 2300 mm.

The maximum mounting height of operating handle / switch shall not exceed 1800 mm from FFL and the minimum height not below 300 mm.

Indicating instruments shall not be located higher than 2000mm.from floor level to facilitate reading.

Except Incoming Switchgear of the Main Electrical Panel, all switchgears of all the LV Panels shall be of Fixed type.

Switchgear shall be provided with bus bars running at the top or bottom, as required, all along the length of the switchgear in a separate sheet steel enclosure. The bus bar compartment shall be provided with bolted cover plates.

An enclosure of minimum 250mm height shall be reserved on the top part of the cubicle for housing the bus bars. Similarly an enclosure of minimum 250mm height shall be reserved at the bottom.

Operating devices shall be incorporated only in the front of the switchgear. The switchgear shall be divided into distinct vertical sections each comprising:

i. A completely metal enclosed bus bar compartment running horizontally.
ii. Individual feeder modules arranged in multi-tier formation. It is essential that the modules are integral multiples of the basic unit size to provide for flexibility in changes, if any, at site.
iii. Enclosed vertical bus bars serving all modules in the vertical section. For safety isolation of the vertical bus bars, insulating barrier with cut-outs shall be provided to allow the power stab contacts to engage with vertical bus bars.
iv. A vertical cable alley covering the entire height. The cable alley shall be minimum 300 mm wide for motor control modules and 500 mm wide for circuit breaker controlled modules.
v. A horizontal separate enclosure for all auxiliary power & control buses, as required, shall be located so as to enable easy identification, maintenance and segregation from the main power buses. Tap - off connections from these buses shall be arranged separately for each vertical section.

The power terminals for feeders up to 100 Amps rating shall comprise suitable terminal blocks located in the cable alley. For higher size feeders, suitably staggered taped bus bars shall be provided to permit direct terminations of cables.

Each vertical section shall be equipped with 50W thermostat controlled space heater, which may be located in the cable alley.

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

All equipments associated with a single circuit shall be housed in a separate module compartment of the vertical section. The compartment shall be sheet steel enclosed on all sides and the rear, with the withdrawable units in position or removed, except on the cable alley side. A plate cover with a slot to permit wiring connections shall be provided on the side corresponding to the cable alley. The front of the compartment shall be provided with a hinged door.

All doors shall be provided with concealed type hinges and captive screws. Hinges provided for doors shall not be visible from front.

Switchgear shall be suitable for single/double front operation as specified in the SLD.

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

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

In breaker compartments, suitable barriers shall be placed between circuit breakers and all control, protective and indication circuit equipment including instrument transformers. External cable connections shall be carried out in separate cable compartments for power and control cables.

After isolation of the power and control connections of a circuit, it shall be possible to safety carry out maintenance in a compartment with the bus bars and adjacent circuits live.

All circuit breaker feeders of the switchgear be draw out type irrespective of switchgear is fixed type or draw out type.

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

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

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

Interchangeability

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

Components and equipment that are not fully interchangeable are liable for rejection.

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

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

Ventilating louvers shall be provided with fine-screened brass or GI meshes to prevent entry of vermin and dust.

All dummy cubicles necessary to meet the requirements of this specification shall be included in the CONTRACTOR's scope.

SHEET METAL WORK

The switchgear frame shall be fabricated using suitable mild steel structural sections or pressed and shaped cold rolled annealed sheet steel of thickness as specified below:

Base Frame / Channel : 3 mm

Load Bearing Members : 2 mm

Internal Partitions(Doors/covers) : 1.6 mm

Construction shall be rigid and robust. Stiffeners shall be provided wherever necessary.

All panel edges and door edges shall be reinforced against distortion by rolling, bending or by the addition of welded reinforcement members.

Cut-outs shall be true in shape and avoid of sharp edges.

The complete structure shall be rigid, self-supporting, and free from vibration, twists and bends.

Painting

All panels shall be synthetic enamel painted in siemens grey shade/or colour shade approved by the engineer-in-charge.

All sheet steel work shall be phosphated in accordance with the following procedure and in accordance with applicable standards mentioned.

Oil, grease, dirt and swarf shall be thoroughly removed by emulsion cleaning.

Rust and scale shall be removed by pickling with dilute acid followed by washing and running water, rinsing with slightly alkaline hot water and drying.

After phosphating, thorough, rinsing shall be carried out with clean water, followed by final rinsing with dilute dichromate solution and oven drying.

The phosphate coating shall be sealed by the application of two coats of ready mixed, stoving type zinc chromate primer. The first coat may be 'flash dried' while the second coat shall be stoved.

After application of the primer, two coats of finishing paint shall be applied, with each coat followed by stoving. The second finishing coat for the exterior of panels shall be applied after completion of tests.

Each coat of primer and finishing paint shall be of a slightly different shade to enable inspection of the painting.

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

Finished painted appearance of equipment shall present an aesthetically pleasing appearance, free from dents and uneven surfaces.

Main And Auxiliary Bus And Bus Bar Insulating Material

Main Buses & Taps

Switchgear shall be provided with three phase or three phase and neutral bus bars as specified.

Bus bars shall be of uniform cross section throughout the length of the switchgear, and up to the incoming terminals of feeder circuit breaker / switch.

The bus bars shall be made of high conductivity aluminum alloy of E91E grade as specified.

Bus bars shall be provided with at least the minimum clearances in air as per applicable standards for a 500 V, 3-phase system.

Bus bars shall be adequately supported with high quality non-hygroscopic, insulating, self extinguishing and fire retardant insulating material, of adequate mechanical strength so as to withstand, without damage, effects of available short circuit current. Bus bar supports shall be SMC/DMC.

Separate supports shall be provided for each phase of the bus bars. If a common support is provided for all three phases, antitracking barriers shall be incorporated.

The connections to individual units shall be taken by taped bus bars for feeders rated 100 Amps and above. For feeders below 100 Amps, heavy duty PVC insulated copper conductor cables may be used.

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

Auxiliary Buses

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

Bus bar Insulating Material

All bus-bars, bus-taps shall be insulated with close fittings sleeve of hard, smooth, dust and dirt free heat shrink PVC insulation of high dielectric strength (450 V/mil) to provide a permanent high dielectric non-ageing and non-tracking protection, impervious to water, tropical conditions and fungi.

Circuit Breakers

Circuit breakers shall be -

1. of the air break draw out type and of horizontal draw out construction mounted along with its operating mechanism on a wheeled carriage moving on guides, designed to align correctly and allow easy movements.

2. either hand operated or Electrically operated as specified in the SLD.

3. A series or shunt trip coil, shall be provided for tripping the circuit breaker. Wattage of the shunt trip coil will be sufficiently high to prevent it from picking up or holding on with specified number of indicating lamps wired in series with the same.

4. provided with mechanically operated targets to show 'Open', 'Closed', 'Service' and 'Test' positions of the circuit breaker.

5. provided with mechanical trip device by means of Red 'Trip' push button suitable for front of board operation, shrouded to prevent accidental operation.

6. provided with locking facilities in the 'Service', 'Test', and 'Isolated', positions. In test position the breaker will be tested without energising the power circuits. The breaker shall remain fully housed inside the compartment in the test position.

7. provided with 6 NO & 6 NC potential free auxiliary contacts, rated 10 A at 240 V AC and 1A (inductive breaking) at 220 V DC.

8. provided with 'Red', 'Green', and 'Amber' indicating lamps to show 'Closed' 'Open', and 'Auto-trip' conditions of the circuit breaker when breaker operation is controlled by a control switch.

9. Circuit breakers shall be provided with the following interlocks :

It shall not be possible to plug-in a closed circuit breaker, or to draw out a circuit breaker in the closed position.

It shall not be possible to operate a circuit breaker unless it is in the fully plugged-in, test, or fully isolated position.

10. Circuit breaker closing and trip coils shall be rated for satisfactory operation on a 110V DC control supply system.

11. Whenever specified, breakers shall be provided with key interlocking device to prevent paralleling of two breakers.

12. Closing and trip coil shall operate satisfactorily under the following conditions of supply voltage variation :

- Closing coils 85 % to 110 % of rated voltage.
- Trip coils - 50 % to 110 % of rated voltage.

B Operating Mechanism

Circuit breaker shall be provided with a power operated mechanism.

Power operated mechanism shall be of the motor wound spring charging stored energy type.

All stored energy mechanism shall be provided with mechanical indicators to show the 'Charged' and 'Discharged' conditions of the spring.

Circuit breakers provided with stored energy operating mechanisms shall be provided with the following interlocks.

a. The circuit breaker shall not close unless the spring is fully charged.

b. Shocks, vibrations, or failure of springs shall not operate the breaker or prevent intended tripping.

Power operated mechanism shall be :

a. Provided with a universal motor suitable for operation on 230V A.C. control supplies with voltage variation from 85 % to 110 % rated voltage.

b. Designed to enable a continuous sequence of closing and opening operation as long as power is available and at least one opening operation on power supply failure.

c. Provided with emergency manual charging facilities.

d. Provided with facilities for remote panel closing and opening operations whenever specifically asked for, as per breaker module designation and respective enclosed control scheme drawing.

Spring charging time for power operated mechanism shall not exceed 15 seconds.

Power operating mechanism shall be provided with the following additional features.

a. Closing of the circuit breaker shall automatically initiate recharging of the spring ready for the next closing stroke.

b. The motor shall be mechanically decoupled as soon as the emergency manual-charging handle is coupled.

c. The circuit breaker mechanism shall make one complete closing operation once the control switch has been operated and the first device in the control scheme has responded even though the control switch is released before the closing operation is complete provided there is no counter trip impulse.

d. Closing controls shall be so arranged that only one closing operation of the circuit breaker shall result from each close initiating impulse, even if the breaker trips while the initiating device is held in the 'Close' position. An electrical anti pumping relay shall be provided on the circuit breaker chassis for this purpose, in addition to the mechanical anti pumping feature incorporated in the circuit breaker.

Protection Coordination

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

Switch Fuse Unit

Switch Fuse Unit shall be of the heavy duty, group operated load-break, fault-make type, complying with the requirements of applicable ‘standards’.

The switches shall be capable of withstanding the thermal stresses caused by overloads, locked rotor and short circuit currents of values associated with protective relays settings and the let through current of the associated fuse.

The switches shall be capable of withstanding the mechanical stress caused by the peak short circuit current of value equal to the cut-off current of the associated fuse.

Continuous current rating of switches shall be as specified in the SLD.

Whenever solid links are used for the connections between switches and fuses, such links shall be fitted with insulated sleeves.

All live parts of the switch shall be shrouded.

Switch operating handles shall be suitable for padlocking in 'OFF' position.

Each switch shall be interlocked with the associated compartment door to achieve the following interlocks.

It shall be possible to open the door only when the switch is in the 'OFF' position.

It shall not be possible to close the switch with the door open.

Fuses

Fuses generally shall be of the HRC cartridge fuse-link type having a certified rupturing capacity of not less than 80 KA at 440 V. Fuses upto 63A for distribution systems of medium short

circuit levels may be of HRC cartridge screw-cap type, having a certified rupturing capacity of not less than 46 KA at 440 V and 16 KA at 250 V DC.

Fuses shall be provided with visible indication to show that they have operated.

Fuse ratings chosen by the CONTRACTOR for application in various circuits shall be subject to the Engineer-in-charge's approval.

Fuses shall preferably be mounted in moulded plastic carriers and shall be complete with fuse bases.

Wherever it is not possible to mount fuses on carriers, fuses shall be directly mounted on plug-in type of bases. In such cases an insulated fuse pulling handle shall be provided for each size of fuse for each switchboard.

Motor Starters

Selection of the starter

Selection of the motor starter shall be based on the motor ratings as mentioned below-

- For motors up to 10 HP : Direct On Line Starter
- For Motors above 10 HP & up to 50 HP : Automatic Star Delta Starter
- For Motors above 50 HP : Auto transformer starter

Each starters shall comprise

- One main TP Switch fuse unit/Moulded Case circuit breaker/Motor Protection Circuit Breaker (as specified in SLD)
- HRC fuses for Power & Control
- Main power contactor, auxiliary contractor/s
- Bimetallic thermal overload relay with built in single phasing preventor
- Stop / Reset Push Buttons
- On, Off, Trip indication lamps, and
- Provision for Local Push Button Station
- Spare NO,NC terminals brought on the terminal block

Contactors

Motor starter contactors shall be of the electromagnetic type rated for uninterrupted duty as defined in applicable standards, unless otherwise specified.

Main contacts of motor-starter contactors shall be of silver plated copper.

Each motor-starter contactor shall be provided with two NO and two NC auxiliary contacts.

Insulation class of operating coils shall be Class E or better.

Operating coils of contactors shall be suitable for operation from the control supply system specified.

Contactors shall comply with all other requirements of applicable standards mentioned.

Contactors shall be of the double break, non-gravity type.

Direct on-line starters

Direct on-line starters shall be suitable for Class AC 3 utilization category as specified in applicable standards, unless otherwise mentioned elsewhere.

Automatic Star-Delta Starters

Automatic star-Delta starters shall comprise three sets of contactors one for the line, one for the star point and one for the delta, and a timer relay to automatically change the connections from star to delta.

Star-delta contactors shall be electrically interlocked to permit starting of the motor in the proper sequence, namely star contactor closing, line contactor closing, timer energized, timer contact de-energizing the star contactor, and delta contactor closing.

Start delta starters shall be suitable for AC 3 utilization category as specified in applicable standards, unless otherwise mentioned.

Auto Transformer Starter

The autotransformer shall be sheet steel enclosed.

The auto transformer starter shall comprise 3phase transformer of adequate KVA rating.

The type of transformer cooling shall be either ONAN or ANAN

Transformer shall have Tappings at 50%, 65%, 80%

For transformer sizing purpose, maximum starting duration shall be considered as 20 seconds.

The transformer shall be suitable for maximum of 4 no of starts per hour.

The autotransformer shall be complete with Minimum Fittings and accessories as per Statutory (IS / BS) requirements.

SINGLE PHASING PREVENTERS

Single phasing preventer relays shall be provided built in with the Bimetallic overload relay to protect motors against single phasing. The relay shall not operate for supply voltage unbalance of $\pm$ 5 %. The relay shall operate in the event of a single phase fuse blowing even though the motor e.m.f. in the concerned phase is of the order of 85 %.

After sensing single phasing, the relay shall operate with a time delay of 2 to 3 secs. The relay shall not operate for a 3 phase power supply failure. The relay shall be of the hand reset type with a hand reset push button. Resetting shall be instantaneous and independent of the adjusted time delay in the tripping of the unit. Visual indication for the operation of the relay shall be provided.

The relay shall be suitable for application to protect reversible and non-reversible motors. The relay operation shall be independent of the motor KW rating, the loading conditions prior to the occurrence of the single phasing and rpm of the motor. The relay shall be of the fail-safe type and shall operate to trip the motor when the relay internal wiring is accidentally open circuited.

Moulded Case Circuit Breakers

Moulded case circuit breakers (MCCBs) shall be provided when called for in the SLD, for use in lieu of switch fuse for the motor controls. The MCCBs shall conform to the latest application standards.

MCCBs in AC circuits shall be of triple pole construction arranged for simultaneous three-pole manual closing and opening and for automatic instantaneous tripping on short circuit. Operating mechanism shall be quick- make, quick-break and trip-free type. The ON, OFF and TRIP positions of the MCCB shall be clearly indicated and visible to the operator when mounted as in service. Front of board operating handle shall be provided.

MCCBs shall be capable of withstanding the thermal stresses caused by overloads and locked rotor currents of values associated with protective relays settings of the motor starting equipment and the mechanical stress caused by the peak short-circuit current of value associated with the switchgear rating. The maximum tripping time under short circuit shall not exceed 20 milliseconds.

The instantaneous short circuit release shall be so chosen by the CONTRACTOR as to operate at a current in excess of the peak motor in rush current and a range of settings shall be provided for the PURCHASER'S selection.

MCCB terminals shall be shrouded and designed to receive cable lugs for cable sizes relevant to circuit ratings.

Under-voltage release and overload inverse time release shall be provided if specified.

Miniature Circuit Breakers

Miniature circuit breakers for use on motor space heater control circuits shall comply with the requirements of applicable standards.

Current Transformers

Current transformers shall be of the dry type resin cast.

Current transformer shall have a short time withstand rating equal to the short time withstand rating of the associated switchgear for one second.

Unless otherwise specified, the minimum performance requirement of current transformers are as follows:

Measuring CT-10 VA, accuracy class 1.0 and an instrument safety factor of 5.

Protective CT - 15 VA, accuracy class 5P and an accuracy limit factor of 10.

Test links shall be provided in both secondary leads of the CTs to easily carry out current and phase angle measurement tests.

All current transformers shall be earthed through a separate earth link on the terminal block to permit easy measurement of the current transformer insulation resistance. (CTs built-in with the thermal relays of the contactors are excluded)

Voltage Transformers

Voltage transformers shall be of dry type cast resin.

Unless otherwise specified, the minimum performance requirements of voltage transformers are as follows :

Measuring VTs - 50 VA per phase and accuracy class 1.0.

Protective VTs - 50 VA per phase and accuracy class 3.0

Dual purpose VTs - 100 VA and dual accuracy class 1.0 / 3.0 for metering and protection respectively. VA is per phase.

All secondary windings of voltage transformers including open delta windings shall be rated for 110 V per phase.

Voltage transformers shall have a continuous over- voltage factor of 1.2 and short time over-voltage factor as follows:

A 1.5 for 30 seconds in case of effectively earthed system.

B 1.9 for 8 hours in case of non-effectively earthed system.

Voltage transformers shall be complete with suitable rated primary, secondary and tertiary fuses. Primary fuses shall have a rupturing capacity equal to the rupturing capacity rating of the associated switchgear. Fuses shall be provided on each sub circuit.

It shall be possible to replace voltage transformers without having to de-energise the main bus bars.

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

Relays

The following clauses shall apply to the protective relays.

Relays shall be -

Enclosed in dust proof flush mounting draw-out type cases.

Accessible for setting and resetting from the front

Provided with positive acting hand-reset flat indicators visible from the front.

Access to setting devices shall be possible only after the front covers are removed. Access to resetting devices shall be external to the case.

Auxiliary relays shall be rated to operate satisfactorily between 70 % and 110 % rated voltage.

Each relay shall be provided with at least two separate voltage free contacts.

Indicating Instruments And Meters

Electrical indicating instruments shall be of minimum 144 / 96 / 72 mm square size, suitable for flush mounting.

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

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

Ammeters provided on motor circuits shall be provided with a suppressed extended scale to indicate motor starting current.

Watt-hour meters shall be of the direct reading elecltrodynamometer type complete with cyclometer type dials and reverse running stops.

Meters shall be Analog / Digital..

Indicating Lamps

Indicating lamps shall be:

a. of the LED type.

The colors of the indicating lamps shall be as follows:

Red	:	C.B. “ON”
Green	:	C.B. “OFF”
White	:	“Trip Supply Supervision”
Amber	:	Auto trip
White	:	“Spring Charged”
RYB	:	Phase Indication

Control And Selector Switches

Control and selector switches shall be :

a. of the rotary type

b adequately rated for the purpose intended (minimum acceptable rating is 10 A continuous at 240 V AC and 1A (inductive break) 220 V DC.

c. provided with escutcheon plates clearly marked to show the positions.

Control switches shall be :

a. of the spring return to normal type

b. provided with pistol grip type handles.

Control switches for circuit breaker control shall be provided with:

- contact development as specified.
- sequencing device

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

Selector switches shall be :

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

- Provided with oval handle.

Push Buttons

Push buttons shall be:

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

b. fitted with self reset, 2 NO and 2 NC contacts.

c. provided with integral escutcheon plates marked with its function.

d. 'Start', push buttons shall be green in colour.

e. 'Stop' push buttons shall be red in colour.

f. All other push buttons shall be black in colour.

'Emergency Stop' push buttons shall be of the lockable in the pushed position type and rotate to release and shall be shrouded to prevent accidental operation. Key shall be required for the operation of the push button if specifically asked for.

Push button switches with a built-in indicating lamp if specified under Notes.

Space Heaters

Adequately rated anti-condensation space heaters shall be provided in each breaker panel and in cable alleys of the switchgear to maintain switchgear inside temperature 10°C above outside ambient temperature.

Space heaters shall be strip type, rated for operation on 240V single phase, 50Hz A.C. supply unless otherwise specified.

Each space heater shall be complete with single pole MCB with overload and short circuit release, and neutral link in neutral and thermostat to cut off the heaters at 45 deg. C.

Internal Wiring

Switchgear shall be complete with all internal wiring and ready for the external cable connections at the outgoing terminals.

Wiring inside the switchgear shall be carried out with 1100 / 650 V grade, PVC insulated, stranded conductor wires.

Minimum size of conductor for power circuits is 4 Sq.mm. copper or equivalent size aluminium conductor. Control circuits shall be wired with copper conductor of at least 2.5 sq.mm. for CT circuits & 1.5 sq.mm. for other circuits.

Self-locking engraved identification ferrules, marked to correspond with the wiring diagrams shall be fitted to each wire. Ferrules shall be of yellow colour with black lettering.

Wires forming part of a tripping circuit of circuit breaker shall be provided with an additional red ferrule marked 'T'.

Spare auxiliary contacts of all equipment forming part of the switchgear shall be wired up to the terminal blocks.

Spare and unassigned modules shall be complete with internal wiring.

Wiring shall be terminated on preferably stud type terminal blocks such that the wires are connected by cable lugs with nuts & washers/lock-nuts.

Not more than two connections shall be made on any one terminal.

Terminal Blocks

Terminal blocks (both for power dand control circuits) shall be of reputed make specially for CT and VT circuits. It shall comprise finely threaded pairs of brass studs of at least 6 mm diameter, links between each pair of studs, washers, nuts and locknuts.

The studs, shall be securely locked within the mounting base to prevent their turning. Insulated barriers shall be provided between adjacent terminals.

Terminals for circuits with voltage exceeding 125 V shall be shrouded. Terminal blocks shall be grouped depending on circuit voltage. Different voltage groups of terminal blocks shall be segregated.

Terminal blocks shall be adequately rated to carry the current of the associated circuit. Minimum rating of the terminal block is 10 A.

Terminals shall be numbered for identification as per enclosed drawings. Engraved white-on-black labels shall be provided on the terminal blocks, describing the function of the circuit.

Where duplication of a terminal block is necessary, it shall be achieved by solid bonding links.

Terminal blocks for CT secondary lead wires shall be provided with shorting and disconnecting/earthing facilities.

Terminal blocks shall be arranged with at least 100 mm clearance between two sets of terminal blocks.

Control terminals for external connections shall be suitable for terminating at least two conductors each of 2.5 sq.mm. size.

Name Plates And Labels

One nameplate giving designation of the switchboard shall be affixed prominently on the top of the switchgear. Details of the switchgear shall be as per SLD.

Labels giving following details shall be affixed on each feeder panel:

Feeder No.

Equipment Reference Number and Description

Rating (kW / kVA / Amp)

All components whether mounted inside the switchgear or on the door shall be permanently and clearly labeled with reference number and / or letter of their function.

Labels shall be made of non-corrodible, preferable laminated plastic with white letters engraved on black background.

Labels for feeder panel designation shall be fixed on the front side of the respective panels with chrome plated self-tapping, counter shrunk head screws. These labels shall be identical size to permit interchange.

Size of lettering shall be 6 mm, unless otherwise specified.

Earthing

Each PCC, MCC and PMCC shall be provided with a continuous earth bus bar running along the entire length of the board. The cross section of the earth bus bar shall be sufficient to carry the fault current carrying for the specified duration without exceeding the safe temperature through out its entire length.

All non-current carrying metal work of the switchgear shall be effectively bonded to this earth bus. Bonding washers (star washers) shall be used when sections of switchgear are bolted together to ensure earth continuity.

Material and size of the earth bus bar shall be G.I.

Earth bus bars shall be supported at suitable intervals.

Positive connection between all the frames of equipment mounted in the switchboard and earth bus bar shall be provided by using insulated copper wires/bare bus bars of cross section equal to that of the bus bar, or equal to half the size of circuit load current carrying conductor, whichever is smaller.

All instrument and relay cases, feeder panel doors shall be connected to the earth bus bar using 1100/650 V grade, 2.5 sq.mm. stranded, green color flexible copper earthing conductor.

Miscellaneous Accessories

Each switchgear panel shall be provided with 240 Volts, 1 phase, 50 Hz, 5 amps. 3 pin receptacle with MCB located at a convenient position.

An 20 W F.T. L. interior illuminating lamp together with operating door switch and protective fuse shall be provided.

Testing And Inspection

After completion of all work at the manufacturer's works, the switchgear shall be inspected and tests witnessed by the Purchaser's Representative. However, stage inspection may be carried out from time to time to check progress of work and workmanship.

The following tests shall be carried out:

All routine tests specified in relevant Indian Standards shall be carried out on all circuit breakers.

Test for protective relay operation by primary or secondary injection method.

Operation of all meters.

Secondary wiring continuity test with a low voltage (6 volts) tester.

Insulation test with 500 Volts megger, before and after H.V. test

H.V. test on power and control circuits / components (2kV for One minute)

Earth continuity test with a low voltage (6 Volts) tester.

C.T. polarity test.

POWER CAPACITORS

Scope

Manufacture, inspection and testing at the VENDOR's /his Sub-VENDOR's works, delivery to site and performance testing of metal enclosed medium voltage switchgear of power capacitor and capacitor control panel.

Codes And Standards

The design, manufacture and performance of power capacitors and accessories shall comply with all currently applicable statutory regulations and safety codes in the localities where the equipment will be installed. Nothing in this specification shall be construed to relieve Vendor of this responsibility.

Unless otherwise specified, L.T. Shunt Capacitors and accessories shall conform to the latest applicable Indian or IEC standards such as BS, ANSI, VDE etc. will also be considered if offered. The relevant Indian Standards are :

Code No.	Title
IS : 2834	**Shunt capacitors for power systems**
IS : 2544	**Specification for Porcelain Post Insulators (3.3 KV and above)**
IS : 5553	**Series Reactors (Part II)**
IS : 12672	**Internal fuses and internal overpressure disconnectors for shunt capacitors**

Design Features

Constructional Features

The capacitor banks shall be complete with all parts that are necessary or essential for efficient operation. Such parts shall be deemed to be within the scope of supply whether specifically mentioned or not.

The capacitor bank shall be complete with the required capacitors along with the supporting post insulators, steel rack assembly, copper bus bars, copper connecting strips to maintain the overall plant power factor at not below 0.95, foundation channels, fuses, fuse clips, etc. The steel rack assembly shall be hot dip galvanized.

The capacitor bank may comprise of suitable number of single phase units in series parallel combination. However, the number of parallel units in each of the series racks shall be such that failure of one unit shall not create an over voltage on the units in parallel with it, which will result in the failure of the parallel units.

The complete banks with its accessories shall be metal enclosed (in sheet steel cubicle), indoor floor mounting and free standing type. The sheet steel cubicle shall conform to specification entitled Control Cabinets.

The assembly of the banks shall be such that it provides sufficient ventilation for each unit. Necessary louvers shall be provided in the cubicle to ensure proper ventilation.

Each capacitor case and the cubicle shall be earthed to a separate earth bus in the cubicle.

The voltage rating shall be selected to form an economical and compact design. The selection of voltage rating shall take into account the increase of voltage at the capacitor terminals above the actual system voltage due to the presence of series reactors, if any. The permissible over voltage will be based on this increased voltage rating.

Each capacitor unit/bank shall be fitted with directly connected continuously rated, low loss discharge device to discharge the capacitors to reduce the voltage to 50 Volts within one minute in accordance with the provisions of IS : 2834.

Individual Capacitor Unit

Each unit shall be a self-contained, indoor type, with a rating at 50 cycles of 10, 25, 50, 100 or 200 KVAr as required to give approximate bank capacitors. Other things being equal larger sized units shall be provided.

Bushings may be either of glass or porcelain and shall be joined to the case by solder-welded or other method which ensures an adequate and permanent seal.

Each unit shall be non-inflammable dielectric immersed self cooled and hermetically sealed.

Each unit shall satisfactorily operate at 135 % of rated KVAr including factors of over voltage, harmonic currents and manufacturing tolerance. The units shall be capable of continuously withstanding satisfactorily any over voltage up to a maximum of 10 % above the rated voltage, excluding transients.

A weather-proof and corrosion-proof name plate shall be provided on each capacitor unit. The nameplate shall contain the information setout in IS : 2834.

Series Reactors

When specified, the capacitor banks shall be provided with series reactors. The reactor design shall be such that they will not be overloaded due to harmonics in the supply system. The reactor shall be:

a. Indoor

b. Completely sealed unit.

c. Either dry type or non-inflammable dielectric immersed case of indoor units.

d. Designed to have a linear V-I characteristic upto 150 % of rated capacitor current.

e. Designed to have temperature rise within limits as specified in IS : 2026.

Unit Protection

Each capacitor unit shall be individually protected by an HRC fuse suitably rated for load current and interrupting capacity, so that a faulty capacitor unit shall be disconnected by the fuse without causing the bank to be disconnected. Thus, the fuse shall disconnect only the faulty unit and shall leave the rest of the units undisturbed. An blown fuse shall give visual indication so that it may be detected during periodic inspection. The fuse blowing time shall co- ordinate with the pressure built up within the unit to avoid explosion.

Mounting of the individual fuse may be internal or external as per capacitor case.

Control Requirements : Capacitor Control Panel

This shall generally conform to below mentioned specifications.

The control equipment shall be mounted in a panel made of 14 gauge sheet steel. The panel shall be of indoor or outdoor type as specified.

The panel shall consist of -

a. isolating switch fuse unit/ moulded case circuit breaker

b. contactor

c. relays responsive to current/voltage/KVAR/PF for automatic switching.

d. sequencing devices, timer and auxiliary relays for automatic sequential switching of the capacitors in and out of circuit.

e. Auto manual selector switches

f. Push button for opening and closing the power circuit.

g. Red and green lamps for capacitors ON/OFF indication.

h. Protective relays to protect the healthy capacitor units when one unit fails in a series connection.

Temperature Rise

The temperature rise above the specified ambient of any part of the capacitor and associated equipment shall not exceed the maximum permissible temperature limit as specified in IS : 2834.

Tests And Test Reports

All tests shall be conducted in accordance with the latest edition of IS: 2834.

Type test certificates for similar capacitor units shall be furnished with the unit.

Tests on control panel as per specification shall be conducted.

Routine test certificates for bought out components shall be submitted.

Spares

Bidder shall submit a list of spares recommended by him for the capacitor installation for 2 years of service. Item wise price shall be quoted.

Rating Plate

The following information shall be given on the rating plate of each capacitor unit.

a. Reference to IS.

b. Manufacturer's name and or trade mark

c. Manufacturer's Identification Number

d. Rated output in kVAr

e. Rated Voltage

f. Rated Frequency in Hertz

g. Upper Limit of temperature category

h. No. of phases

i. Connection Symbol

j. Discharge Device

k. Type of Dielectric

l. Reference to Self Heating Design

m. Total Weight

n. Type of Impregnant

LOW VOLTAGE POWER AND CONTROL CABLES

Scope

Manufacture, inspection and testing at works, delivery to site and performance testing of 650/1100V grade electrical cables PVC type for the system voltage of 415/240 V, 3 phase and neutral and frequency 50 Hz.

Applicable Codes And Standards

The following codes and/or standards (latest editions inclusive of all amendments) are applicable.

Code No.	Title
IS : 694	PVC insulated cables (for voltage up to 1100 V)
IS : 1554 (Part I)	PVC insulated heavy duty electric cables for working voltage up to and including 1100 volts
IS : 5831	PVC insulation and sheath of electric cables
IS : 6474	Polyethylene insulation and sheath for electric cables
IS : 8130	Conductors for insulated electric cables
IS : 3975	Mild Steel wires, strips and tapes for armouring of cables
IS : 10810	Methods of test for cables
IS : 3961 (Part II)	Recommended current ratings for cables PVC insulated and PVC sheathed heavy duty cables
IS : 1753	Aluminium Conductors for insulated cables
IS : 10418	Specification for drums of electric cables
IS : 2633	Methods of testing weight, thickness and uniformity of coating on hot dipped galvanized articles
IS : 209	Specifications for Zinc

Design And Construction

GENERAL

The design and construction of electrical power and control cables shall be in accordance with the codes and standards as specified.

All electrical power and control cables shall have coloured cores as follows.

Power Cables	Control Cables
Single core	- red or black
Two cores	- red and black
Three cores	- red, yellow, blue
Four cores	- red, yellow, blue, black
	Five cores - red, yellow, blue, black, green

white numericals printed on black insulation

The black sheath is for the neutral and the other colours are for the phase conductors.

For multicore cables (i.e. above 4 cores) for control applications, the core numbers shall be printed on each cable core for identification (i.e. nos. 1,2,3,4,5,6,7... upward).

All cables shall be suitable for operation under the following conditions:

- Directly buried in ground.
- Run in buried P.V.C., concrete or all steel ducts.
- Runs fastened to cable rack or tray in open air.

The cables shall be capable of continuous operation at highest system voltage as specified with maximum conductor operating temperature of 90°C and maximum temperature under fault conditions of not more than 250°C.

CONDUCTOR

The cable conductors shall be of stranded, high purity aluminium conductors laid up and rendered smooth and free from defects likely to
injure the insulation and conforming to IS 8130.
Smaller sizes shall be circular in formation and comprise several strands. Larger conductors to be stranded and shaped to produce a compact, less costly design. For cables having two or more than two cores, shall have all cores of uniform cross section.

INSULATION

Core insulation of Power and control cables shall be of PVC and applied over conductor by extrusion. The PVC compound shall conform to type A of IS 5831. The core identification shall be as per IS 1554 Part I. The insulation shall have uniform thickness through out its length. The average thickness of insulation and tolerance on the same shall be as per IS 1554 Part I.

INNER SHEATH

For all cables having two or more cores, inner sheath shall be applied over laid cores either by extrusion or by wrapping. The inner sheath shall be applied as circular as possible and to fit closely on the laid up cores so that it can be removed without damage to the insulation.
The inner sheath shall be of vulcanized rubber/proofed or plastic tap and shall not be harder than PVC used for insulation. This shall conform to requirement of types ST-I of IS 5831.

ARMOURING

Armouring shall be applied over inner sheath, where specified and shall be of galvanized steel strip as per IS 3975. The armour shall be applied as closely as possible with left hand direction of lay. For cables having diameter over the inner sheath less than 13 mm, the armour shall be of galvanized round steel wires or galvanized steel strips. The dimensions and resistance of armour shall be as per IS 1554 part I.

OUTER SHEATH

The outer sheath of cables shall be applied by extrusion and shall be of black colour PVC compound conforming to requirements of type ST-1 compound of IS 5831. The thickness of outer PVC sheath and its tolerance shall be as per IS 1554 Part I. To protect the cable against rodent and termite attack, suitable chemicals may be added into the PVC compound of the outer sheath.

Sealing And Drumming

Both ends of every length of cable shall be sealed properly immediately after tests at manufacturer's premises. The cables shall be rolled on suitable wooden or steel drums.

The cables shall be rolled on suitable wooden or steel drums. The drum shall be marked with following.

a. Trade Name

b. Cross sectional area of the cable with no. of cores.

c. Voltage grade and type of cable.

d. Length of cable, wt. of cable drum including cable.

e. Direction of rotation of drum by arrow marking.

f. ISI certification mark.

For all cut lengths of cables which are to be delivered to the client, approved sealing caps of correct size shall be supplied and properly mounted immediately after the respective cable length is cut.

Inspection And Testing

Performance and acceptance tests for electrical power and control cables shall be carried out at manufacturer's works which shall be witnessed by the Client/ Engineer- in charge deputed by the client shall be accepted. Copies of type test certificates, as per relevant standards, shall be furnished by the contractor along with the bid.

The required tests on the cables shall include but not limited to the following:

- High Voltage Test
- Conductor Resistance Test
- Armour Resistance Test
- Thickness of Insulation
- Test for Flame Retardance
- Insulation Resistance Test

CABLE CARRIER SYSTEM

Scope

Manufacture, supply, installation of hot dip galvanized Cable tray for cabling system.

General

The cable carrier system covers the supply of cable racks, cable trays and its supporting accessories.

Applicable Standards

[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]

Cable Racks and Trays

Typical cable tray arrangement/trench arrangement/directly buried cable arrangement etc. shall be shown in the individual layout drawings.

Cable racks/trays shall be fabricated from standard structural steel members.

All cable trays, vertical raceways, cable racks and cable tray supporting structures shall be hot dip galvanised.

Galvanising

Wherever galvanising has been specified, the hot dip process shall be used. The galvanised coating shall be of uniform thickness. Weight of Zinc coatings for various applications shall not be less than those indicated below

a) Fabricated Steel	
Thickness less than 2 mm, but not less than 1.2 mm	340 gms/sq.m
Thickness less than 5 mm, but not less than 2 mm	460 gms/sq.m
Thickness 5 mm and over	610 gms/sq.m
b) Fasteners	
Upto nominal size M10	270 gms/sq.m
Over M10	300 gms/sq.m

Galvanizing shall be carried out after all drilling, punching, cutting; bending and welding operations have been carried out. Burrs shall be removed before galvanizing. Any site modification of galvanized parts should be covered well by zinc rich primer and aluminium paint.

LIGHTING SYSTEM

Scope

Manufacture, supply, installation, testing & commissioning of Lighting fixtures/lamps and accessories required for lighting system.

Codes & Standadrds

Electrical lighting fittings general and Safety Requirements	IS:1913/BS:4533
Code of practice for industrial lighting	IS:6665
Calculation of co-efficient of utilisation	IS:3646 (Part-III)
Industrial lighting fittings with metal reflectors	IS:1777
Decorative lighting outfits	IS:5077
Dust proof electric lighting fittings	IS:4012
Dust tight electric lighting fittings	IS:4013
Flood lights	IS:10322/BS:4533
Luminaries for street lighting	IS:10322 Part 5
Water tight electric lighting fittings	IS:3553/BS:4533, 5225 (1)
Bayonet lamp holders	IS:1258/BS:EN61184 /IEC:60061
Edison screw lamp holders	IS:10276/BS:EN 60238
Bi-Pin Lamp holders for tubular Fluorescent lamps	IS:3323
Starters for fluorescent lamp	IS:2215/BS:EN 60155
Holders for starters for tubular Fluorescent lamps	IS:3324/BS:EN60400 / IEC:60400
Ballast for use in fluorescent lighting	IS:1534 (Part 1)/BS:EN 60920 and 60921
Fittings	IEC:60082
Transistorised ballast for fluorescent lamps	IS:7027
Ballast for HP mercury vapour lamp	IS:6616
Capacitors for use in fluorescent, HPMV & LP sodium vapour discharge circuits	IS:1569/BS:EN61048 and 61049/IEC:60586

Vitreous enamel reflector for tungsten filament lamp	IS:8017
Tubular fluorescent lamps	IS:2418 (Part 1)/BS:EN 60081/IEC:60081
High pressure mercury vapour lamps	IS:9900/BS:3677/ IEC:60188
Tungsten filament general electric lamps	IS:418/IEC:60432
Cast acrylic sheets for use in Luminaries	IS:7569
Screwless terminal and electrical connections for lighting fittings	IS:10322
High pressure sodium vapour lamps	IS:9974
Emergency lighting units	IS:9583
Ignition proof enclosures, dust-tight for elect. Equipment	IS:11005
Luminaries (Part I to V)	IS:10322

Indoor Lighting system

All indoor areas will be provided with A.C. lighting and the same will be available as long as A.C. supply is healthy.

A. Normal A.C. Lighting.

All indoor and outdoor areas will be provided with A.C. lighting and the same will be available as long as A.C. supply is healthy.

B. Emergency D.C. Lighting for other areas.

In other areas, at important locations, built in battery operated instalite fixtures will be provided which will come in service when A.C. supply fails.

The wiring for lighting circuits shall be done by 2:1.5 sq.mm. copper flexible (red & black colour) wires for phase & neutral and 1: 1.0 sq.mm. green wire for earthing, run in heavy duty GI conduits for indoor areas. For outdoor lighting, wiring shall be done by armoured cables.

C. Illumination levels

The illumination levels shall be as given below:

Sr.	Area	Illumination Level (Lux)
1	Pump house	200
2	Battery room	150
3	Machinery service area	150
4	Offices/conference room	300
5	H.V./L.V. switchgear rooms	250
6	Plant/Switchyard control rooms	300
7	Chemical/general stores	150
8	Chemical plant room	200
9	Cable basement	100
10	All other indoor areas	100
11	Outdoor platforms and walkways	50
12	Building entrances	100
13	Outdoor plant areas	20
14	Switchyard and transformer yard - General - On equipment	 10 30
15	Roads	10

Lighting Design & Distribution

A. Lighting Fixtures

The fixtures shall be suitable for operation on a nominal supply of 240V 1 ph 50Hz AC with a voltage variation of + 10% (ie 216V to 264V).

All lighting fixtures shall be with lamps and all necessary accessories for their satisfactory operation.

Each capacitor shall be suitable for operation at 240V + 10% 1 ph 50Hz with a suitable value of capacitance so as to correct the factor of its corresponding lamp circuit to the extent of 0.98 lag.
Each fixture shall be complete with 1 four way terminal block for the connection and looping of incoming & outgoing supply cables. Each terminal shall be able to accept 2-1.5sq.mm. copper stranded conductors.

Each lighting fixture shall be provided with agrounding terminal suitable for connecting 12 SWG G.I. wire.

Type of Fixtures

I. Type –A : 1 x 36W / 2 x 36W Industrial Indoor fluorescent lighting fittings :
The luminaire shall be complete with mounting bend pipe, electronic ballast & other accessories.
The luminaire shall consist of channel made from heavy gauge C.R.C.A. sheet seel. The fitting shall be powder coated and provided with detachable stoved enamelled reflector made from heavy gauge sheet steel. Accessories such as electronic ballast, P.F. improvement capacitor, and lamp holders etc. are to be wired upto a terminal block with provision for earthing.

II. Type –B :Emergency lighting fixtures :
Emergency lighting fixtures shall be 20W DC operated & rechargeable on AC supply. In normal case these fixtures shall be connected to AC supply & remain OFF but in case of power failure the lamp will be switched ON automatically.

B. Ceiling / exhaust fans:
Ceiling fans shall be 1200 mm sweep in size complete with electronic regulator.
Domestic exhaust fans shall be installed in admin block & laboratory and heavy duty industrial exhaust fans in MEP & DFG room. The fans shall be complete with mounting frame. The fan opening shall be covered by netted louvers to prevent the access of birds.

Outdoor Lighting System

All outdoor areas will be provided with A.C. lighting and the same will be available as long as A.C. supply is healthy.
Outdoor lighting shall be done with steel tubular poles of adequate height, at every 30meters to give the required illuymination levels. Outdoor lighting shall be controlled from a lighting panel having a timer switch for automatic switching On & Off the street lights. In case of failure of the timer switch the panel shall have a provision by means of AUTO/MANUAL siwtch for Manual switching of the street lights.

Street Light Pole

The material of construction of the tubular street light poles shall be either steel or Aluminium. The street light pole shall comply to te following-

- The pole shall conform to latest wind loading resistance.
- The pole shall have an excellent resistance to atmospheric corrosion and ground rot.
- The pole should withstand a minimum vertical load of 16kg per side at maximum wind speed.
- The pole should not deflect more than 7.5% of the above ground height under full load and maximum wind speed condition.
- The pole shall have self draining ¼" dia. weeping hole at a height of 150mm from the ground.
- A through hole of ¼" dia. shall be provided at a height of 300mm from the ground.

Street Light Pole Accessories

The street light pole shall be 9M long as per IS : 2713(Part –II) and flood light pole of 12 M long as per IS : 2713 (Part-II). The poles shall be provided with 2 coats of black bitumen paint from inside as well as outside and 1 coat of red oxide primer form outside. The pole shall be painted with 2 coats of silver paint after completion of erection work. The installation scope includes excavation required for pole, construction of 600x600mm concrete base for pole etc., earthing of pole, junction box & luminaire & laying of 3x2.5 AYY cable from junction box to luminaire from inside of the pole.

The street light pole erection shall be complete with -
1 no: 9M/12M long street light pole
1 no: 250W/400W luminaire with HPSV lamp
2 nos : 50mm dia. G.I. conduit sleeves for incoming & outgoing cables upto J.B.
1.5 M long 20mm dia. Galvanised MS rod earth electrode for earthing of each pole
Loop-in-loop-out type weatherproof Junction box with terminal blocks suitable for terminating 4X16 sq.mm. AYFY incoming cable & fuse. The Junction box shall be earthed from the same rod by 25 sq.mm. G.I. stranded wire.
The lighting cable shall be laid underground at a depth of minimum 750 mm below ground level with a protection of sand & bricks.

Street Light Luminaire :

The fitting shall be single piece drawn aluminium housing with built in bright anodized reflector with a provision to control distribution of light on street side conforming to IS 10322 Part 5 / Sec1 : 1987 and complete with gasketing, heavy duty copper wound ballast & PF capacitor, die cast aluminium pole mount arrangement having aesthetic finish and hinged toughned glass lamp shield.
"U" clamps are to be provided on to the control gear housing with 2 nuts for firm gripping to the supporting pole bracket of maximum angle at which fitting can be installed.

Receptacle Units

Industrial type receptacle units of 5/15A, 15A, 30A sp/tp with switches/ MCBs shall be confirming to latest IS 3854 and sockets confirming to IS 1293. The units shall be suitable for mounting on stove enamelled sheet steel boxes generally confirming to IS 5133 Part-I.

5/15A, 5 pin convenient switch socket outlets with indication lamp & fuse mounted on a PVC surface mounting box shall be installed in administration block & laboratory area. Wiring from lighting panel to each socket is covered in point wiring.

15A single phase industrial sockets with 15A SP MCB & 2 earthing terminals shall be installed in rest of the area. 3x4 sq,mm. AYWY cable shll be laid on wall from lighting panel to socket alongwith earth wire.

Lighting Distribution Boards

General

The DBs shall comply with IEC 60439-3 and have a certificate of suitability. It shall be an assembly of incoming device, busbars, outgoing MCBs and terminals in an enclosure. The rated incoming circuit shall not exceed 125A per phase and the rated individual outgoing shall not exceed 63A.

The distribution board shall be of the same brand as the MCBs. Where locking of hinged door is required, the door shall conceal the retaining screws of the front cover to prevent unauthorized personnel to remove the front cover.

Construction

The enclosure shall be robust, constructed of sheet steel with a minimum thickness of not less than 1.2mm and epoxy powder coated of light grey in colour. Door shall be provided and should preferably be reversible to open from left to right or vice verse and be equipped with latch or keylock. DIN-rail system shall be provided for fixing incoming and outgoing devices.

Outgoing MCBs circuits shall be capable of being removed or replaced without having to remove the adjacent MCBs. The arrangement and ratings shall be as indicated on the drawings.

Information and Labelling

The manufacturer shall provide the information and name plates as required in IEC 60439-3. Adequate labeling shall also be provided to comply with the wiring code of practice.

Bus bars and Terminals

All busbars shall be electro-tinned copper busbar. Multi-terminals busbars shall be provided for neutral and earth circuits. Each single-phase of a three-phase DB shall have its own neutral and earth terminals.

The earth terminal shall be suitable for internal and external connection. If the earthing terminal has a stem or bolt to receive a cable socket, it shall not be less than 6mm diameter for incoming rating up to 100A, nor less than 8mm diameter for rating exceeding 100A.

When the earth terminal is of steel, it shall be plated for protection against corrosion.
Earthing screws or bolts shall be hexagon headed.

Protection Against Electric Shock

DBs shall be provided with appropriate constructional measures to protect against electric shock by direct contact or indirect contact. Electrical continuity of the protective circuit and exposed metal parts shall be ensured by effective interconnection either directly or by means of protective conductors.

Quality Assurance

Components incorporated in the DBs shall comply with their relevant standard specifications.

Specifications

Standard	: IEC 60439-3
Rated Voltage	: 240/415V 50Hz
Short-circuit Strength	: 10kA
Degree of Protection	: IP 42 minimum

LOCAL PUSH BUTON STATIONS

Scope

Manufacture, inspection and testing at vendor's works, delivery to site, installation & commissioning of industrial Local Control Stations.

Standards

The design, manufacture and performance of the equipment to be supplied under the scope of this specification shall comply with latest revisions of relevant Indian standards IS 8623 & IS 4237.

The design and workmanship shall be in accordance with best engineering practices as applicable to electrical equipment enclosures

Construction

ENCLOSURE

Industrial local Control station enclosures shall be of Cast Aluminium LM6 alloy enclosure having minimum 3 mm thickness.

The enclosure shall be weatherproof, IP -55 suitable for outdoor installation. All mating surfaces of industrial LCS shall be with continuous non-deteriorating type special rubber gaskets/ neoprene gaskets. An additional 2-mm thick Aluminium canopy shall be provided to give adequate protection against weather.

For ease in cable termination, the minimum distance between the terminal blocks and the cable entry gland plate shall be 50 mm for 2.5 mm2 size cables.

CABLES ENTRIES

Two threaded entries shall of 20 mm ET shall provided on each local control stations at the bottom for fixing cable glands. Metallic plug shall be provided for sealing one of the cable entries.

EARTHING

The enclosure shall be provided with two- (2) nos. of external earthing terminals and one (1) no. internal earthing terminal each of 2.5 mm diameter complete with nut, spring washers for termination of 2.5 mm ^{2} Copper conductors.

WIRING

All internal wiring up to the terminal block in the local control station shall be carried out with 1.5 mm2 stranded copper conductors. Wires shall be PVC insulated types of 650 / 1100 V grade. The wire shall be terminated with crimping type lugs only and shall be provided with ferrules at both the ends.

PAINTING

The Local stations shall be treated with two coats of epoxy primer after thorough cleaning and treating of the surfaces and shall be finally provided with two coats of epoxy paint. Shade of final coat shall be 631 as per IS 5.

NAME PLATE

Nameplates shall be made from rear engraved perspex with white letters of size minimum 6 mm on black background. All nameplates shall be identical in size for interchangeability and shall be fixed with screws on the cover. A typical name plate detail is shown below:

SEWAGE PUMP (Equipment No as per PID)

Components Specifications

PUSH BUTTONS

Each push button shall be provided with 1 NO +1 NC contacts, each rated to carry, make and break 10A at 240 V AC or 1A at 220V DC or 2A at 110 V DC.

Colour of the actuators of ‘Stop’ push button shall be Red and that of ‘Start’ push button shall be Green.

Stop Push Button actuator shall be mushroom head type and shall have stay-put feature i.e. once the Stop push button is pressed, it remains in pressed position until its actuator is turned in either direction.

Start Push button shall be Spring Return type. Start push button shall be totally shrouded type to prevent accidental start of the motor.

TERMINALS BLOCKS

Voltage grade of terminal block shall be Clip on type 660V grade. Current rating of the terminal shall be 10A suitable for 2.5 sq.mm. multi-strand copper conductor cable. Two nos. spare terminals shall be provided in each local control station.

CABLES LUGS

Cables lugs for internal wires shall be crimping type. Material of lugs shall be tinned copper. Lugs shall be pin/ring type.

Inspection & Testing

The local control stations shall be routine tested at manufacture's works in the presence of Purchaser/ Purchaser's representative before dispatch to site. Vendor shall give at least 7 days written notice before equipment is offered for inspection.

Routine Tests:

I. Physical checks.
Megger tests before and after H.V. test with 500V DC megger.
iii. Continuity and operation tests.
iv. H.V. test at 2 kV for one minute on the control wiring.

Certified copies of routine test certificates along with those of all components shall be furnished after the inspection.

Scope of Work

General

The scope of work for the bidder under this component of the scheme include supply erection, testing and commissioning of Mechanical Works for 40 mld UASB based STP & its MPS at Ajitsinghnagar, Vijayawada under NRCD. The bidder should provide his rates as per Bill of Quantities given in the tender document. The contractor shall carry out his work as per guidelines and specifications given in this tender document. The various Mechanical and Electrical items for which the contractor has to submit his technical and price bids are given herein.

In case of any allied missing item the decision of Engineer-in-Charge shall be followed accordingly.

Wherever reference is made to Indian Standard Specifications, the latest specifications shall be applied. The Scope of Work for which the bidder has to submit his Technical and Price Bid is given below.

Scope Of Work For Mechanical Items

The components of Mechanical works of the Sewage Treatment Plant for the bidder are as under:

1. Gates
2. Mechanical screen channels
3. Mechanical grit chambers
4. Main sewage pumps
5. Sludge pumps
6. Fixed type surface aerators
7. Monorail trolley and chain pulley block
8. Biogas holder
9. Chlorine mixer
10. Gas scrubber unit and gas blowers
11. Biogas flaring system
12. Dual Fuel
13. Chlorination system
14. Instrumentation

As Built Drawings

After construction and commissioning of all Electrical (equipment associated panels) & Mechanical works mentioned above for STP, the contractor shall submit the five complete sets of As-built Drawings to VMC. The As-built Drawings are the Detailed Engineering Drawings showing the actual details on which the Fabrication/Erection has been carried out. The contractor shall have to obtain approval of the As-built Drawings from VMC.

Activity Bar Chart

The successful contractor/bidder shall submit Activity Bar Chart, giving Time Schedule for each activity. The project activities shall be based on this Bar Chart, after it has been approved by VMC. Whenever there is a deviation from the approved Bar Chart, a revised Bar Chart shall be submitted by the Contractor. During the project duration the updated Bar Chart shall be submitted to the Engineer-in-Charge every month.

General Requirements for Mechanical Works

This section covers mainly the job requirements before and after the supply of mechanical equipment at site and before/after start of work. This section also covers the liabilities of the contractor and the quality standards that the contractor has to maintain for the work to be carried out by him.

Pre-Requisites Before The Supply Of Equipment

Submission of Drawings/design sheets/Data sheets

Drawing Submission

The Contractor shall submit the detailed drawings for review and approval of the Engineer-in-Charge (EIC).

i) Detailed Design Calculation sheets for electrical and mechanical works/equipment
ii) General arrangement drawings for all equipment to be supplied.
iii) Technical Specification sheets showing rating, make and quantity of various components used in a specific mechanical/electrical item.

Form of Drawings

Every drawing shall be clearly readable having a title block in the bottom right corner showing.

Client	VMC
Contractor	
Equipment Manufacturer	
Project Name	
Drawing Title	
Drawing Number	
Revision Number	
Date of submission	
Date of approval	

Approval of Drawings/Documents/Technical Data Sheets

- Drawings will either be approved by EIC or he will convey comments that contractor shall incorporate by modifying the drawings accordingly.
- The review of design calculations and drawings shall be carried out only in respect of orientation and sizes of important members, general design principles and approach, adherence to requirements of the relevant IS or other statutory codes, compliance with the technical specifications given in the tender document, general or specific notes and with the requirements of good engineering practice. Check for any interference and taking remedial action is the responsibility of the contractor.
- Approval by the EIC of the contractors design or drawings shall not relieve the contractor of any of the contractual obligations or liabilities under the contract or his responsibilities for correctness of dimensions, material of construction, weights, quantities, design details, assembly fits, performance particulars and conformity of the supplies with the Indian statutory laws as may be applicable.
- Should it be found at any time after approval has been given by the EIC that any drawings or documents submitted by contractor are not consistent with any technical data, drawings or documents submitted or approved previously or substantially deviate from any major aspect of the contract, then such alterations or additions as may be deemed necessary by the EIC shall be made therein by the contractor and the works carried out accordingly without any extra cost.
- The contractor shall make no revision after a design, drawing or documents is “approved” by the EIC. In case the contractor desires to incorporate any amendments in an “approved” drawing, he shall re-submit the same for formal approval giving reason for the change required.

Tests and Inspection before supply of equipment

Prior to the supply of any equipment, the contractor shall submit a schedule to Engineer-in-charge for inspection of shop tests to be carried out at the manufacturer's factory from where the equipment is supposed to be brought/supplied. The contractor shall inform Engineer-in-charge at least 15 days prior to the commencement of the shop tests for the equipment he wishes to supply as per the schedule of supply of equipment. Engineer-in-charge shall either witness the tests or representative authorised by him shall witness the tests.

Shop Tests

For the shop test to be witnessed by Engineer-in-charge, a list showing all necessary tests and mentioning their respective significance shall be submitted by the contractor for his consideration and if some additional tests or changes are required as deemed by the Engineer-in-charge, the same shall be incorporated by the contractor.

For tests carried out at the manufacturer's factory, relevant test certificates shall accompany the supply of equipment, however, two copies of test certificates shall be provided by the contractor immediately to the Engineer-in-charge at the time of completion of the shop test. Some of the equipment may have to be tested for certain parameters only when installed in position at site. The Engineer-in-charge or his representative reserves the right to visit manufacturer's workshop or at site on his own without informing the contractor. Where certificates are required by the specification or relevant reference standard, the original and one copy of each such certificate shall be provided by the contractor.

Final Tests at Site

Final tests shall be carried out at Site after successful installation and commissioning of the equipments. Engineer-in-charge shall either witness the tests or representative authorised by him shall witness the tests. These tests shall be carried out to establish the guaranteed figures given by the contractor at the time of submission of the bid. Penalty as per the clauses applicable to equipments shall be applicable for any failure to achieve the guaranteed figures.

Pre-Requisite along with supply of equipment

Submission of Document related to Installation, Operation and Maintenance

The contractor shall submit 5 copies of instructions/operation and maintenance manual to the Engineer-in-charge at the time of delivery of items at site.

- Information supplied by the Manufacturers employed by the contractor shall be coordinated into the comprehensive manual. The instruction manual shall describe the installation as a whole and shall give a step by step procedure for any operation likely to be carried out during the life of each item of the plant including the erection, commissioning, testing, operation maintenance, dismantling and repair.
- Where applicable, fault location charts shall be included to facilitate tracing the cause of malfunction of breakdown.
- A section dealing with procedures for ordering spares shall also be included in the instruction manual.
- Technical Specifications of equipment
- Schedule of preventive, maintenance, calibration and repair instructions.
- Parts list and spare parts recommendations
- Safety precautions to be furnished while handling different units and First aid instructions

- Do's and don'ts in equipment operation. Operators attention shall be drawn to all operations considered to be dangerous to operate or likely to cause damage to the plant.
- A complete list of recommended lubricants, oils and their charts.

Pre-Requisite After Completion Of Supply Of Equipment

- Contractor shall make arrangements for proper storage of the equipment supplied by him at site before being installed at their respective positions

- All equipment shall be installed in full accordance with the equipment manufacturer's recommendations and good practice. Sufficient notice shall be given to the EIC prior to equipment installation in order that the EIC or his representative may be present during installation.
- Some of the equipment may have to be tested for certain parameters only when installed in position at site.
- Contractor shall also submit a proper commissioning schedule for commissioning of the STP as agreed by the Engineer-in-Charge. The commissioning of machinery shall be run in order to ensure the normal functioning of the plant to the satisfaction of EIC. The problems faced shall be trouble-shooted immediately.
- Final test certificates carried out during the construction or on completion of the whole works/at the successful commissioning of the equipment shall be submitted within seven days of the completion of the test.

Tests on items of Plant during Erection

- Devices and equipment shall be checked for correct functional performance in accordance with apparatus rating, operating sequence and code requirements. All motor shall be checked and adjust for correct direction of rotation. Loading of circuits and feeders in panel boards shall be checked and balanced. Contractor shall provide eight copies of above data for approval.

- Interior installation and distribution systems, 600 volts and less, shall be tested for insulation resistance after all wiring is completed and fixtures and equipment are connected being ready for use. Tests shall be made with an instrument capable of measuring accurately the resistance involved and having a voltage rating as specified by IS. Heading shall be taken after the high voltage test of insulation resistance between conductors and also between each conductor and ground.

- The contractor shall carry out all tests on plant witnessed by the Engineer-in-Charge or his authorised representative and shall supply two copies of all test results to the Engineer-in-charge. All tests shall be to the satisfaction of the Engineer-in-charge/authorized representative appointed by him who may require tests to be repeated prolonged or modified as may be necessary to ensure that any or all items of plant confirm with the contract.

- If during or after testing any item of plant fails to achieve its intended duty or otherwise proves defective, it shall be modified or altered as necessary and re-tested and re-inspected as required by the Engineer-in-charge and the contractor shall bear all costs for such rectification/ modification/replacement work.

- The Engineer-in-charge or his representative will have the power to omit, add, modify or adjust during stages of erection of any item of work as may be necessary or expedient for the work. No claim for compensation or damage will be entertained on the account of such changes.

Commissioning and Testing

Commissioning shall commence after installation of all equipment and their installation checks carried out successfully and inspected/approved by the Engineer-in-charge's or his authorised representative.

Ground Tests

- Ground readings shall not exceed 5 ohms and tested as per I.S. 3043.

- After installation and before placing in service, the system shall be given a high potential test by applying alternating or direct current between each conductor of the system as one terminal consisting of the ground. Prior to making the test, the wires and cables shall be disconnected from the equipment. The method, voltage, length of time shall be in accordance with the cable manufacturers and I.S.I. Standards.

Special Tools and Accessories

- All special tools, equipment, or accessories required for the installation and maintenance for plant equipment as well as five sets of copies each of instruction manuals necessary for the proper use of such tools, equipment or accessories shall be provided by the equipment manufacturer.

Quality Assurance From Contractor's Side

The contractor shall provide all the required labour, permanent equipment and materials, tools, safety equipment, transportation and test equipment for supplying, installing, adjusting and fully testing all the mechanical work shown on the approved drawings or included in the tender document or ordered by the Engineer-in-charge.

Standards

All mechanical equipment and the materials used shall comply with the relevant Indian Standards unless a more rigorous requirement is specifically stipulated. If no applicable Indian Standard is available for any item of equipment or materials, the specifications will be decided by EIC. In every situation the latest specifications, standards etc. shall supply unless otherwise stated.

Packing and Transport

The equipment shall be transported to site packed in wooden crates. They shall be wrapped with polythene sheets to prevent damage to the finish.

Materials and Workmanship

All equipment furnished under this or allied sections shall be new and guaranteed to be free from defects in materials, design and workmanship. If inadequate information is provided in the specifications, it shall be the contractor's responsibility to ascertain the conditions and service under which the equipment is required to operate and to warrant accordingly that operation under such conditions shall be successful. All parts of the equipment shall be adequately proportioned to safely withstand all stresses that may occur or be induced in them during fabrication, erection and intermittent or continuous operation.

All equipment shall be designed, fabricated and assembled in accordance with the latest standards and workshop practice. Individual parts shall be manufactured to standard sizes and gauges so those spares, furnished at any time, can be installed in the field. Corresponding parts of duplicate units shall be fully interchangeable. Equipment shall not have been in service at any time prior to delivery, except as required for tests.

All materials used shall be appropriate for the service conditions, iron castings shall be tough, close-grained grey iron free from blowholes, flaws or excessive shrinkage and shall comply with the requirements of IS 210. Except where otherwise specified structural and miscellaneous fabricated steel used in items of equipment shall conform to the relevant Indian Standards. All structural members shall be considered as subject to shock or vibratory loads.

Cutting, Drilling and Welding

1. The contractor shall provide the required cutting, drilling and welding etc. that will be required for the mechanical/electrical construction work.

2. Cutting and drilling of structural members shall not be permitted, except when approved by the Engineer-in-charge. A core drill shall be used wherever it is necessary to drill through concrete or masonry.

3. The contractor shall provide the required welding for equipment supports as desired by Engineer-in-charge.

4. Junction Pull Boxes and Hand holes shall have covers stenciled with box number when shown on the drawings. Data shall be lettered in a conspicuous manner with a colour contrasting to finish.

5. Switch plates in designed areas shall be suitably engraved with a legend showing function or areas when required by Code or shown on the drawings

Drives

To ensure vibration free operation all rotating components of each pumping shall be statically and dynamically balanced. The mass of the unit and its distribution shall be such that resonance at normal operating speeds is avoided. In any case, the amplitude of vibration as measured at any point on the pumping unit shall not exceed the limits set forth in the latest edition of the Indian Standards.

Upon completion of the electrical work, the contractor shall remove all surplus materials, rubbish, and debris that accumulated during the construction work. The entire areas shall be left neat and acceptable to the Engineer-in-charge.

Lubrication

Contractor shall ensure constant presence of lubricant on all wearing surfaces. Lubricant filling and draining openings shall be readily accessible. Easy means for checking the lubricant level shall be provided. Prior to testing and/or operation, the equipment shall receive the prescribed amount and type of lubricant as required by the equipment manufacturer.

Painting

- Shop painting should conform to the standard requirements. Electric motors, gears, starters and other similar self-contained or enclosed components shall be shop primed and finished with high-grade, oil-resistant acrylic enamel or other coating approved in writing by the Engineer-in-charge. Surfaces that will be accessible after assembly shall be painted or otherwise protected before assembly by a method that provides effective protection throughout the expected economic life of the equipment.

- Unless otherwise required in the detailed equipment specification, surfaces to be painted at the paint site shall be shop-painted with one or more coats of a primer, which will adequately protect the equipment until finishing coats, are supplied at site.

- Machined and polished metallic surfaces that are not to be painted shall be coated with an approved rust-preventive compound.

- Before applying paint, the surfaces to be painted shall be cleaned and shall be free from rust, dust, oil etc. The painting shall be with two coats of zinc rich/chrome primer and two coats of finish paint. Each coat shall not be less than 50 micron.

- Contractor shall provide the required painting for all unfinished surfaces of electrical materials, including supports.

All scratched or marred surfaces shall be refinished with touch-up paint to match the original finish.

Equipment Guarantee

This requirement shall conform to the conditions given in volume 1 of the tender document. Unless specified otherwise elsewhere, the Contractor shall furnish and replace at no cost to the HMWSSB, any component of the equipment that is defective or shows undue wear upto one year from the date of testing and commissioning of STP. In addition to performance guarantees, processes or systems shall comply with the requirements stipulated in the relevant sections of the specifications.

Liability Of The Contractor

- The contractor shall obtain and pay for the required bonds, insurance's licenses, permits and inspections and pay all taxes, fees and utility charges that shall be required for the mechanical/electrical works.

- If during the period of erection, Contractor or his workmen damage willingly or accidentally any part of the building structure or materials without written permission of the Engineer-in-Charge, the contractor shall be completely responsible for the damages and he will have to make rectification/replacement at his own cost.

- Incidental items not included in the tender drawing and specifications, that can legitimately and reasonably be inferred to belong to the electrical work shall be provided by the Contractor at no additional cost to the HMWSSB. The decision of the Engineer-in-Charge in this matter shall be final.

- All equipment and materials shall be of latest design and standard products of established manufacturers.

- The equipment approval at the factory only allows the manufacturer to ship the equipment to the project site. The contractor shall be responsible for the proper installation and satisfactory start-Up operation of the equipment in accordance with the manufacturer's requirement and to the satisfaction of the Engineer-in-Charge. After proper installation, the performance of each equipment shall be tested according to the Data Sheets enclosed with the tender. The penalty shall be imposed in case the performance is not satisfactory.

- Inspection of the equipment at the factory by the Engineer-in-charge or his representative will be made after the manufacturer has performed satisfactory checks, adjustment tests and operations.

- Contractor shall make arrangement of all power required during the construction period.

- The contractor shall be absolutely and solely responsible for damages due to accidents, injuries or losses, occurring to any person and property by his employees involved in the execution of the work.

Technical Specifications for Mechanical Works

With reference to the scope of work for Mechanical items given in Section - 1 of these Tender Documents, the Technical Specifications are given below. The Mechanical works are to be carried out with reference to the design and technical specifications provided. The Contractor should prepare his technical bid and estimate his cost for mechanical works with reference to the designed values and technical specifications of various items given below. For electrical works for electrical panel, contractor should follow the technical specifications given in Volume II (C). Mechanical equipment specifications data sheet is given in the end of Volume II (D). Contractor is required to fill the data sheets.

Gates

For the control of the flow and for maintenance of the mechanically raked screens, rising spindle Stainless steel gates shall be provided. The gates shall be single faced, rising spindle, flush bottom closing, wall mounted flange back frame. sluice gates suitable for seating water head of 1.5m and mounting on the flat face of a wall, water sealing at two vertical sides, top an bottom side of gate frame by means of neoprene rubber seal fitted in gate aperture and having forced contact with gate slide, to be provided with frame and shutter, SS 304 spindle to suit distances as specified in the bill of quantities. All fasteners shall be in SS 304 and anchor bolts, EPDM rubber seals, SS 304 rubber seal retainer bars, CI stem guide bracket, SS 304 coupling, CI manually operated head stock.

The size of gates shall be as follows

1.0 m width x 1.5 m height	6 Nos.
2.2 m width x 1.2 m height	2 Nos.

Screens

Mechanical Coarse Screens

There will be three coarse screen channels, each of 1000 mm width and 5800 mm depth (600 mm LD + 300 mm head loss + 4900 mm freeboard). Two channels are working and one channel is standby. All the screen channels will have mechanically cleaned coarse bar screens with bar clear opening of 20 mm.

Each equipment shall mainly consist of the Screen Surface (bar screens), Rotor Arm (raking arrangement), Chute and Drive System.

The frame is rigidly framed on all ends and anchored to the RCC channel top surface and to the bottom of the channel. The frame is curved in shape the curvature radius will match the rotor arm tip radius. The entire channel width and depth will be covered by the screen surface.

The rotor arm assembly will be placed on the inlet side of the screen. The rotor consists of two main Bearing Blocks having an axle running in their journals across the channel. Two rake arms at 180 degrees to each other, fixed to the axle, shall carry the retriever combs made of cast steel. The outer radius of the combs shall match the radius of the screen surface and the combs will engage into the bars to carry the trapped screenings to the top end of the screen. The bearing blocks are anchored to the RCC channel, parallel to the screen surface.

The cleaning rake will be revolving rake type with four steel combs. The rake will be suitably sized for heavy duty and shaped to effectively clean the bar screen. The sprocket chain will be split type. The screenings is to be dropped on conveyor about 600 mm above the top of the screen channel.

Alternatively, other type of raking arrangement will also be considered.

The chute shall be placed on the outlet side of the screen surface, near the top end and shall receive the screenings through an interceptor plate from the rotor arms combs. The client shall have to either place a conveyor belt to receive the screenings or have a mobile trolley under the chute.

The drive system operates the axle and correspondingly the rotor arms. The system consists of a motor of required HP driving a reduction gearbox, which in turn drives another gearbox through chain and sprocket transmission to obtain the desired RPM on the rotor. The system is assembled over a base frame that is anchored to the RCC channel top near the rotor.

The drive machinery includes TEFC motor, speed reducer, head shaft, etc. All fasteners will be of SS 316. All the steel structures shall be sand/ball blasted to near white and painted with two coats of zinc rich primer followed with two coats of epoxy paint.

The bar screens are fabricated from 50 mm x 10 mm mild steel flats spaced at 20 mm centre to centre and fixed at an inclination of 75° to the structural steel frame work such that all bars project on upstream side and teeth of the rake engages within the clearances of the bars without hindrance. The bar screen size will be 1000 mm x 5800 mm.

A dead plate of not less than 6 mm thick is provided from top of the bar screen to prevent falling of screenings in the channel. It shall have pivot plate at the bottom for preventing jamming of bottom shaft. The complete unit above the floor will be totally enclosed with hinged clean out and inspection doors.

Mechanical Fine Screens

There will be three screen channels, each of 1000 mm width 600 mm LD The head loss across screen shall be 400 mm with a minimum free board of 500 mm at peak flow condition. Two channels are working and one channel is standby. All the screen channels will have mechanically cleaned fine bar screens with bar clear opening of 6 mm.

Mechanically operated step screen completely made of Stainless Steel having 6mm clear spacing shall be provided in screen channel for screening out floating materials such as plastic pouches, bags, rags, floating debris, weeds, paper wastes and other floating materials from the raw sewage coming from the pumping station / gravity mains.

The screen shall include discharge chute as required to discharge the screenings on the belt conveyor without employing any external mechanism/rake mechanism.

The mechanical screen shall consist of the following:

Mechanized step screen having 6mm spacing between bars and suitable for installation at an inclination of not less than 40 degrees in channel. Level sensing instrument with local control panel and probe for automatic operation of screen mechanism and belt conveyor. Local control panel shall be installed near screen.

The fixed as well as movable bars, mechanism, support frame, fixings discharge chute shall be manufactured from stainless steel for long life in the aggressive sewage environment.

The step screen shall be a complete unit comprising of main frame with an integral mechanism containing movable bars located in between fixed bars with out engagement of external mechanism/ rake mechanism for pulling out the screened material ensuring minimum movement of the mechanism. The mechanism comprising of movable bars located between fixed bars shall gradually move the screened material upward in the form of a mat and deliver up to the discharge chute.

The fixed as well as movable bars shall contain a series of steps to prevent the screenings from falling back into the main flow. The mechanism shall be mechanically operated by Electro-motor or hydraulic system and shall be suitable for automatic operation controlled by a level sensor.

The screen shall operate automatically when the upstream water level of the screen increases beyond a pre-set limit and it shall stop when the upstream level decreases to a preset low level due to upward travel of screened material.

The fine bar screen shall be capable of being tilted out of the sewage flow up to horizontal position for the purpose of cleaning & maintenance.

The base of the screen shall be fitted with a specially profiled stainless steel plate to direct any grit that may be present towards the screen and taken out along with other screened material thus reducing the possibility of building up of grit in front of the screen.

The level controller shall be upstream type Ultrasonic level switch. The drive motor shall be TEFC type with IP 55 protection and shall be suitable for operation on 415 +/- 10% Volts and 50 +/- 5% Hz, three phase AC supply.

The Control Panel shall have IP 65 protection, Epoxy pained and shall comprise of,

The screen shall be factory assembled & movement tested at plant before dispatch to site & shall only be installed at the site in factory assembled condition.

The Fine bar screen shall be Factory assembled and subjected to following tests at the manufacturer's premises.

Dimensional Check: The overall dimensions of the screen shall be conforming to the approved drawings.

Operational Test: The complete screen including its mechanism, Electro-motor/hydraulic operating mechanism level probing system and control panel shall be integrated and mechanically operated to verify free movement and satisfactory working.

Belt Conveyor

A common Belt conveyor shall be provided for collecting screenings from three mechanical coarse screens and will drop the screening in a trolley type container kept at one end of the conveyor for taking out the screening for disposal. The belt conveyor shall be 750 mm wide with 5 m length to cover all the three screens.

A Common Belt conveyor shall be provided for collecting screenings from five mechanical fine screens each and will drop the screening in a trolley type container kept at one end of the conveyor for taking out the screening for disposal. The belt conveyor shall be 750 mm wide with 5 m length to cover all the five screens.

Each assembly of conveyor will consists of two pulleys with their shaft and bearings for driving the belt and idler pulleys for supporting the belt. The upper level idler pulleys will have three roll twenty degree roughing idlers. The bottom level idlers for belt return will be flat roll-type.

At the end of the belt drive, an adjustable scrapper is provided on the screening hopper for diverting the screening through hopper to the container. The whole conveyor will be supported on steel structure over the screen channel.

The belt material will be two - ply nylon or equivalent with 3 mm neoprene covering on carrying side and 0.75 mm neoprene covering on pulley side. The speed of the belt will be between 25 m to 30 m per minutes.

The power transmission shall be by means of TEFC motor coupled to the worm reduction gear box. The Gear box shall have a minimum service factor of 2. The drive motor shall be TEFC type with IP 55 protection and shall be suitable for operation on 415 +/- 10% Volts and 50 +/- 5% Hz, three phase AC supply.

Detritor Tank

A detritor tank is provided for grit removal. It has a rotating grit scraping mechanism, adjustable influent deflector, reciprocating rake mechanism to remove the grit and organic return pump. The Detritor tank size shall be 9.5 m X 9.5 m with 0.7 m SWD.

The grit scraping mechanism shall have fixed bridge with rotating scrapper arms. The scrapper arms will have adjustable squeezes, which will scrap the grit to the grit sump. An overload alarm shall be provided. This arrangement shall trip the machine in case of overload.

Suitable classifier mechanism along with the organic return pump shall be provided. The reciprocating rake mechanism will lift the grit up. The reciprocating rake mechanism will be installed at about 35^{o} inclination. Chute is located at the top, through chute grit will fall into a container kept on the ground, for further disposal.

The power transmission shall be by means of TEFC motor coupled to the worm reduction gear box. The Gear box shall have a minimum service factor of 2. The drive motor shall be TEFC type with IP 55 protection and shall be suitable for operation on 415 +/- 10% Volts and 50 +/- 5% Hz, three phase AC supply.

A grit cleaning arrangement shall be provided to remove organic particles from the grit and pump it back to the inlet by means of an organic pump. The grit pump shall have volute and impeller of Ni – Ci with Ni content of not less than 2%. The grit pump shall have a drive motor of suitable speed. The motor shall be TEFC type with IP 55 protection and shall be suitable for operation on 415 +/- 10% Volts and 50 +/- 5% Hz, three phase AC supply.

The gears used shall have minimum service factor of 2.0
6mm thick chequered plate walk way platform of 1000mm wide shall be provided with ISMC 200 channels for support.

Main Sewage Pumps

There will be a Main pumping station to pump the 40 mld of average flow to sewage treatment plant via. 800mm diameter, rising main as per hydraulic requirement. Main pumping station will have eleven pumps, seven working and four standbys during peak flows. Eleven pumps (7W+4S) shall be connected to rising main, which will lead to STP. The capacity of the pumps shall be 417 Cum/hr. The operating head of the pump shall be 16 m.

Pump
The total head / capacity curve shall be continuously rising towards the shut off with the highest at shut off. Pumps shall be suitable for single as well ass parallel efficient operation at any point in between the maximum and minimum system resistances. The pumps shall be designed to handle solid sizes of upto 80 mm. Pumps shall run smooth without undue noise and vibration. The pump set shall be capable of withstanding the accidental rotation in reverse direction.

Pump shall be submersible nonclog, wear resisting, single stage type. Pump casing shall be of robust construction. Liquid passages shall be finished smooth and designed as to allow free passage of solids. The volute tongue shall be filed to a smooth rounded edge. Double Mechanical seal shall be provided to protect the motor from ingress of sewage along the shaft. The preliminary and secondary seals shall be oil-lubricated with silicon-carbide faces and they shall be equipped with an electrical monitoring system for seal failure detection as the case may be. Impeller shall be non-clog enclosed type with smooth blunt edges and large water ways so as to allow free passage of the large size solids. It shall be free from sharp corners and projections likely to catch and hold rags and stringy materials. The critical speed of the rotor shall be atleast 30% above the operating speed. Pumpsets shall have double bearings. The bearing life shall be minimum 40,000 hrs of operation.

Each pump shall be complete with a cast iron delivery connection arrangement for fixing to the concrete floor of the suction well. The joint between the pump discharge flange and the delivery piping shall be made by merely lowering the pump into guide rails from access level. It shall be provided with all necessary fixings for guiding the pumps during lifting/lowering. Each pump shall be provided with a stainless steel lifting chain conforming to BS 1663 and BS 4942. Each pump shall be provided with an automatic coupling device for attaching the crane hook to the pump at low level, even whilst the pump is submerged, without the need for personnel to enter the well. This automatic coupling device shall easily and automatically couple and uncouple the hoist hook and be complete with necessary accessories. All links and cables shall be multi-stranded stainless steel.

The pump parameters for the raw sewage pumps in terminal sewage pumping station shall be as follows

Description	Particulars
Type of pump	Submersible
Synchronous Speed at 48.5 Hz (rpm)	1500 (maximum)
Solids Handling Capacity (mm)	100
Specific gravity of Sewage	1.02
Minimum acceptable pump effciency subject to tolerance as per applicable standards (%).	75 %

The materials of construction for pumps shall be as follows:

Component	Material
Impeller *	Stainless Steel : ASTM A 743 CF8M
Casing *	Cast Iron to IS:210 Gr FG 200 with 1.5 to 2% Nickel
Shaft *	Stainless Steel : BS:970 Gr 410
Guide rail pipe	Stainless Steel : BS:970 Gr 304
Fasteners and Foundation Bolts	Stainless Steel : BS:970 Gr 410

- Material test certificates shall be furnished by the Contractor

Induction Motor

The motor shall conform to IS:9283:1979 or IS 325 and the cable shall conform to clause no. 4.4 of the IS:9283:1979. Motors shall be capable of giving rated output without reduction in the expected life span when operated continuously under the following supply conditions :

(i) Variation of supply voltage from rated motor voltage 10%
(ii) Variation of supply frequency from rated frequency 5%
(iii) Combined voltage and frequency variation 10%

Motors shall be suitable for full voltage starting. Motors shall be capable of starting and accelerating the load with the applicable method of starting, without exceeding acceptable winding temperatures, when the supply voltage is in the range 85% of the rated motor voltage to maximum permissible voltage. The locked rotor current of the motor shall not exceed 600% of full load current (subject to tolerance as per the applicable standard) unless otherwise specified. Motors shall be designed to withstand 120% of rated speed for two minutes without any mechanical damage, in either direction of rotation. The motor vibrations shall be within the limits specified in applicable standard unless otherwise specified for the driven equipment. Except as mentioned herein, the guaranteed performances of the motor shall be met with tolerances specified in applicable standard, IS: 9283 - 1979. or IS 325 Protection against increase in stator winding temperature (15OC) bearing temperature, leakage in stator housing and terminal box shall be provided. Minimum three number thermistors in series are to be provided to sense the stator winding temperature. Sensors are to be provided to detect if leakage of sewage into the oil housing is above 30 % concentration.Bimetallic thermal switch to trip the motor against increase in temperature shall be provided.

The power rating of the motor shall be larger of the following :

a) 110% of the power input to the pump at duty point at a speed corresponding to the frequency of 50 Hz.
b) Maximum power input while operating single pump corresponding to the speed of 50 Hz.

Submersible Cable

PVC insulated and PVC sheathed, flexible, 3.5 core flat type. The size of
equate for continuous use under water and air. The half core shall be used
cable shall be PVC insulated PVC sheathed, flexible, flat type and shall be
use under water and air. The control cable for stator winding temperature
ore X 2.5 sq. mm copper conductor and for bimetallic thermal switch 2 core
luctor shall be provided. The size of the conductor and length of cable
ed so that the voltage drop at motor terminals does not exceed 3 percent of
ng of the motor shall be done in accordance with the relevant provisions of
rpose of earthing these motors, earthing connection may be made to

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 the slot sections of the coil. The insulation shall be given tropical and fungicidal treatment for successful operation of the motor in hot, humid and tropical climate. The tropicalising treatment shall be as per the applicable standard. The stator winding shall made from high conductivity annealed copper conductor, PVC insulated winding wires conforming to IS:8783:1978 for wet type motors. The stator winding shall be of high conductivity annealed copper enameled insulated wires conforming to IS:4800(Part-VII):1970 for dry type motors.

The temperature-rise test of the motor shall be taken with the motor coupled to the suitable pump to give the full load output of the motor. When the various temperatures are stabilized, the set is stopped and the temperature-rise of the stator winding by the resistance method shall no exceed 350C. As the cable resistance will also be substantial, it is necessary that while calculating the temperature rise by resistance method, due care is taken to account for the correct hot and cold resistance of windings.

The motor shall be suitable for continuous use in fully or partially submerged condition. A built in cooling system must allow the motor to operate continuously at its rated output regardless of whether the electric motor is submerged or not, by providing either external or internal cooling arrangement.

Terminal box shall be of weather proof construction to eliminate entry of water and dust. The terminals shall be of the stud type with necessary plain washers, spring washers and check nuts. They shall be substantially designed for the current carrying capacity and shall ensure ample phase to phase and phase to ground clearance.

Sludge Pumps

There will be one sludge pumping stations to pump out the sludge to sludge drying beds. Sludge pumping station will have two pumps, one working and one standby. The capacity of the pumps has been fixed at 100 cum/hr so that sludge withdrawal from all reactors is completed during general shift of eight hours, with sufficient safety in operating time. The operating head of the pump will be 6.0 m. The sludge volume to be withdrawn from UASB reactors will be about 122.00 cum/day. The sludge withdrawal operation is described under electrical system.

The sludge pumps shall be progressing cavity pumps. Pump shall be suitable for outddor installation for 6 – 8 % solids at ambient temperature with 6.5-8 pH and 1.1 specific gravity. Pump shall be with flanged suction and delivery connections. Pump body shall be Cast Iron to Gr. FG 260 with inspection port and with flushing and drain connections in suction hand hole end. Stator shall be Elastomer best suited for the application with minimum shore hardness of 70. Rotor shall be Stainless Steel SS316. Seal shall be 6 ring stuffing box with split packing and lantern ring. Shaft shall be solid single piece shaft through bearings and seal, Shaft and Shaft Sleeve shall be in Stainless Steel SS 316. Bearings shall be balland tapered roller bearings with grease lubrication.

The pump shall be complete with drive motor of TEFC type with IP 55 protection and shall be suitable for operation on 415 +/- 10% Volts and 50 +/- 5% Hz, three phase AC supply.

Fixed Type Surface Aerators

9 Nos. of 20 HP fixed type surface aerators are provided in the facultative type of aerated lagoon. The purpose of aeration is for removal of anerobicity of the effluent and also for removal of residual BOD and sulphides present in the UASB effluent. Aerator will be of slow speed.

Biogas Holder

The biogas produced is to be utilised for power generation using fuel engine generator. The expected maximum gas generation will be about 512 m3/day. The capacity of biogas holder is provided for its storage for 6 hrs of retention time. I.e. 128m3. The generation will depend on ambient temperature. To have uniform supply of required gas for power generation a Gasholder has been included. Provision has been made for flaring of gas if there is excess.

The gas produced in the UASB reactors is to be led to the Gasholder through a moisture trap and gas flow meter. The tap-offs are provided after the gas pipe enters the Gasholder, one going to the generator room for supply to dual fuel engines and the other to the gas flaring equipment.

The biogas holder will be of the wet type with a sealing of water. The biogas holder would be a RCC circular structure. The gas dome would be fabricated from mild steel plate having minimum 6 mm thickness. Guide rails embedded in RCC structure facilitate the vertical movement of the gas dome. The gas dome surface shall be coated with 350-micron thickness.

One pressure release valve will be provided at the top of the dome, which will open out when the level reaches 100% value. One High-Level limit switch will be provided at 95% to give an audible alarm signal in the control room.

At low-level, say 20%, the running engines will be shut off and the biogas holder will be allowed to rise again. However, in case of heavy leakage, or otherwise, if the level goes to a very low level of say 5%, the Vacuum Breaking Glass will break and will prevent the biogas holder from any damages due to vacuum condition.

Gas Scrubber & Accessories

Quantity: 2 Units (1W + 1S) of H_2S Gas Scrubber System of individual 37 N m3/hr (min) gas flow capacity
The gases emitted from Sewage Treatment Plant are a homogeneous mixture of CH_4 (Methane), CO_2, N_2, H_2S. The H_2S present in the gases is highly corrosive and need to be eliminated before the gases passed for combustion in pure gas engines. The H_2S gas present shall be treated with water and caustic and the percentage of the H_2S with gases after treatment shall not be more than 0.1%.

Main specifications of the various equipments provided in the package covers:

- **Packed bed scrubber columns** of adequate capacity & nos. Scrubber shall be made of PVC /HDPE material In the packed column, gas and the cleaning solution are brought in contact counter currently. Mist eliminator system should be included in the scrubber itself.
- **Settling/ Reaction Tanks** of adequate capacity and nos. made of PVC/HDPE material Functions of reaction tanks are to collect scrubbing, scrubbed and filtered liquid.
- **Centrifuge Filter** of adequate capacity and nos., to thicken the sulphur slurry. Each filter centrifuge shall be designed for an 8 hour loading operation.
- **Regenerator Columns** for the regeneration of scrubbing liquid. MOC of columns shall be of PVC/HDPA material.
- Chemical for packed bed scrubber with spare chemicals of 10,000 litres to make up the losses.
- Chemical recirculation pumps
- Gas pressure (blowers) & flow meters
- Moisture separation system
- Gas piping system
- Control panel

Gas Compressor & Accessories

Quantity: 2 Nos. (1W + 1S)

Two numbers Gas compressor of 135 N m3/hr (min) capacity each shall be provided to compress the Biogas (coming from biogas scrubber unit) before feeding it to Bio gas Genset. Compressor should be able to compress the incoming biogas from 100 mm of WC pressure to 3.0 Kg/cm2.

A compressor shall be of positive rotary or reciprocating type, water cooled, single stage oil free gas compressors. The cylinder shall be cast such that gas and water passage shall be separated by metallic wall and shall not have any gasket separating the two. The gas compressors shall be designed and works tested complete with compressor unit, motor, base plate, water cooling system gas and water pipework, valves, water separators, and all regulating and control equipment as required to provide an adequate and efficient compressed high pressure gas supply. The compressors shall have water seals. The compressors shall be designed to compress wet and sludge gas comprising methane and CO_3 with trace elements including H.N. & H_2S. The gas shall be assumed to be water saturated. All metal parts in contract with gas shall be of stainless steel (type CF8M or 316). Gas compressor gearbox shall be suitable for continuous running and intermittent starting under maximum load with the resultant high torque and shock loads. The gearbox shall be a service factor of 2.0 (Minimum).

A pressure relief system shall be included to operate on shut off pressure of compressors. This shall consist of actuated bypass and main gas valves which shall operate to dissipate the high pressure in the delivery main to the low pressure digestion tank.

A temperature sensor shall be installed to give a warning alarm and shut down facility in the event of the pressure relief valve operating.

Manual control via start/stop pushbuttons at the control panel with auto switch off in case of temperature bypass or over pressure switch operating.The compressors are to run on either a timed or continuous control selected by a two position selector switch mounted on the control panel. When 'continuous' is selected, the compressor is to run continuously. Where 'timed' is selected the compressor is to run for fixed duration and to be off for fixed duration. The time cycle shall be controlled by two adjustable timers (0-60min) provided for each compressor.

Compressor is to trip and lock out due to the following : (reset shall be manual).

i) Electrical overload

ii) Earth fault
iii) Motor over-temperature, monitored by thermistors in each phase
iv) Over-temperature in the compressor gas delivery pipeline
v) Cooling water over-temperature
vi) Rise in discharge pressure

vii) Vacuum in suction line

Each compressor shall be provided with a self-contained cooling water circuit with an air blast water cooler and water circulation pump. These shall be driven by a TEFC motor and mounted on a separable fabricated steel bedplate. Interconnecting pipework and connections to the compressor cooling water inlet and outlet shall be provided.

Each cooling water circulation unit shall be fed with water from a galvanised mild steel header tank manufactured to BS 417 Grade A. The header tank shall be supported on a galvanised mild steel framwork and shall be fitted with a ball valve, overflow pipe, outlet pipe and bottom drain down pipe. All cooling water pipework shall be of galvanised steel to IS 1239 with malleable iron screwed fittings.

The Compressor complete with the following accessories shall be provided:

- Base frame in MS
- Safety Valve
- Suction Filter
- Silencer on suction & discharge side
- Non return valve
- Pressure relief valve
- Pressure gauge
- Anti vibration pads
- V-belt & Belt guard
- Drive & Driven pulleys
- Moisture separator

Biogas Flaring System

Gas flaring system shall be installed to burn excess biogas generated at the STP. The burning capacity of the flare shall be 50 m3/hr. The biogas flaring system shall consist of the following equipment.

- Moisture separator
- Flame Arrestor
- Check valve
- Pressure regulating valve
- Flare gas burner (6m height from ground level)
- Pilot gas burner with push button ignition complete with ignition electrode
- Diaphragm type pressure gauge
- Low gas pressure switches.

Flare Gas Burner

The Flare Burner for biogas incinerates the biogas completely and releases environment friendly gases after combustion. It thus protects the environment and surrounding equipment.

Complete incineration can be done by having high temperature, stociometric gas mixtures flame. To achieve this aspirator type pre-mixing burner is made for complete combustion.

To start flare burner, spark igniter initiates the pilot burner. The pilot flame is checked with the help of flame monitor (Flame Rod). As soon as the pilot flame is provided a visual indication on the panel will appear than the main biogas control valve can be opened. To prevent blow off at high winds the aerodynamically designed windshield is provided.

Flare Burner

Duty	To flare biogas completely
Capacity	0 - 50 cum/hr
Quantity	1 No
Type	Aspirator type

Inlet Mounting	Flanged 6” NB as per BS Table 10D.
Working pressure	50 mm WC to 500 mm WC

Accessories

SS 316 Wind Shield to prevent blow off at high winds

Provision for fixing of Pilot Burner, HT Electrode and Thermal flame sensor.

Material of Construction

Wind shield	SS 316
Burner	CI
Mounting Flange	CI
Mounting	Flange mounted vertical position

Pilot Burner & Acessories

Pilot Burner

Duty	To ignite the biogas
Type	Premixing type with air aspirations
Material of construction	SS 316
Mounting	Threaded on to Flare Burner
	Ignition System

It consists of SS 316 ignition electrode. The Pilot Burner will have flame proof solenoid valve.

Pressure Gauge

Type	Diaphragm type with isolation valve
Range	0-1000 mm WC
Type	Diaphragm type
Dial size	6”
Wetted Parts	SS 304

Check Valve

Size	6”
Type	Flap type
End flanges	As per SS table 10D

Material of Construction

Body	CI
Valve seat	Aluminum/SS/Bronze
Flap	SS 304 / Nylon

Gas Flowmeter With Indicator And Totaliser Unit

Flow Indicator / Totaliser Unit (Electronic Registration)

Flow indicator Totaliser is used to monitor the flow of gas. Input from Venturi type Gas Flow Meter is processed linearly or square rooted to the requirement. Flow rate is indicated on 3½ digit 7 segment LED / LCD

display and totalized value of flow on Electromech / LCD / LED counter having reset facility. The general technical specifications are given below:

Power supply	:	230/110V AC ± 10%, 50 Hz
Operating temperature	:	0^{o} C to 55^{o} C
Input	:	220 V AC / 24V DC ± 10%,
Flow rate	:	--
Display for flow rate	:	3½ digit 7 segment LED / LCD
Polarity indication	:	Automatic
Decimal point indication	:	Factory set to suit range/scale of indication of Engineering unit selected
Accuracy	:	Better than ± 0.5% of span
Relay contact rating	:	1A one changeover at 230V AC resistive
Specifications for totalizing	:	Totalizing accuracy ± 0.5% of full scale, input clipping i.e. flow cut-off 0 to 17% of span
Specifications for square Rooting	:	Square rooting accuracy ± 0.5% of full scale.

Total 2 Nos. Gas flow meters of suitable capacity shall be provided for measuring flow rate of biogas at the STP before gas dome and before main line going to dual fuel engine station.

Each flow meter shall be provided with electronic gas flow registration unit. These registration units shall be placed in a composite panel at the STP Panel room. Single phase, 230 Volt AC supply shall be given to the composite panel for gas flow registration units from STP MEP Panel.

Technical Specifications

Type	:	Microprocessor based Panel mounted Flow Indicator/Totaliser
Input	:	Analog user configurable to 4-20 m A, 0.5 V, and 0-10 V
Display	:	LED, toggle between Rate of gas flow, Totaliser, Peak and Valley
Totaliser	:	6 digit confurigable to reset/non-reset options
Rate of Flow	:	5 digit, configurable to any engineer unit or time base
Alarm/Presets	:	10A relays configurable to Rate of flow of alarms or preset batching
Control Output	:	2 potential free relays, configurable to flow rate alarms or batching
Reset	:	From front keypad to remote pulse
Programming	:	User configured zero/span settings for input and output.
Memory	:	Upto 10 years memory retention in the event of main failure
Transmitter power	:	24 V DC transmitter supply available from 7000 TR.
Output	:	4-20 m a, analog output linear to flow
Power Supply	:	230 V (10% 50 Hz AC)
Housing	:	Standard 1/8 D/N ABS panel mounting enclosure

Flame Arrestor

Flame arrestor is provided to prevent the passage of flames if formed accidentally in Gasholder or associated pipe network. The flame arrestor, a safety device is recommended for use in venting vessels, storage or transport tanks, protection of fuel / air supply line to gas burners and in industrial plants at temperatures not exceeding above 200^{o}C.

The flame arrestor shall be mounted with the axis vertical and as close as possible to the potential source of ignition. The flame arrestors are provided at the top of each Gasholder. Two nos. flame arrestors are also provided in gas pipeline going to the gas burner and pilot ignition of the Gas Flare System.

Flame Arrestor consists of a tube bank made of spirally wound alternate layers of flat and corrugated stainless steel sheets built around a solid core. The tube offers a multiplicity of small holes parallel to the line of flow. The tube element is retained between two flanged end sections and contained within a steel outer shell. The Arrestor assembly shall be fitted with a Weather Hood. The flame arrestor shall be provided with crimped ribbon

design. This enables the unit to be manufactured to very low tolerances and hence can be efficiently size selected to suit the range of application. Pressure drop across the arrestor shall be very low and the unit shall be suitable to take high gas flow rates.

The flame arrestors are designed as per British Standards BS. 7244-1990 to ensure maximum safety.

The flame arrestors mainly consist of an arrestor element, an arrestor housing and associated fittings necessary for preventing flame de-flagration.

The flame arrestor has been designed specifically for Biogas falling in Group 1 of British Standards. (Classification of gases BS 4663 Part 2 and BS 5501 Part 1).

The flame arrestor element is a crimped metal element and is made up of SS 316 to have long life and maximum quenching of flame.

Technical Specifications

Size	:	6" NB line
Element	:	Crimped metal element
End connections	:	Flanged as per BS Table 10D
Hydrostatic Test Pressure	:	5.0 Kg/cm^2
Gaskets	:	CAF Gaskets

Material of Construction

Housing	:	CI
Flame bank	:	SS 316
Nut & Bolts	:	CS
Flanges	:	CI

Quantity

6" for Gas Holders	:	1 No
6" for Pipeline in Main Gas Burner	:	1 No
2" for pipeline to Pilot Burner	:	1 No

Moisture Trap

The moisture trap is device used for separation of moisture/vapors in two-phase flow in order to reduce corrosion, control problems, efficient and safe combustion of biogas.

The biogas has H_2O vapours and traces of H_2S. The gas becomes acidic after H_2O and H_2S combines thus starts corroding the piping and equipment. The presence of this causes a deposition of surfaces and control valves thus affecting that function.

The effect of moisture in biogas burning is to have quenching of flame. Also, latent heat of vaporization is consumed by the vapors during combustion thus reducing the efficiency.

The moisture separation can be done by the following methods.

- Centrifugal action
- Impingement action

In centrifugal action the gas is made to rotate at high velocities. The centrifugal force causes the vapours to hit the wall of the chamber. When the vapours hit the wall they also coalesce together to form biogas droplets. These droplets get accumulated in the reservoir just below the moisture separator chamber.

In impingement action the biogas is made to hit a perforated steel wall at high velocity. Due to inertia the vapours do not accompany the biogas after it hits the wall. The moisture vapours then coalesce together to form big droplets and get accumulated in the reservoir. The water accumulated in the reservoir is taken out through auto or manual drain valve. It is proposed to use impingement type moisture trap.

The material for the moisture separator conforms to IS 2062. An epoxy coating is done after surface preparation by sand blasting. The Drip-trap is tested for a pressure of 3.5 kg/cm^2 for any leakage or joints. Compressed asbestos gaskets are provided for strong leak proof joints.

Installation and Operation

Moisture traps shall be installed as specified below in Quantity and Size.
Connect the drain line to a drain-pit through suitable pipe.
Observe the drain level in the peeping window and if the drain level is high open the drain valve till all the accumulated water is drained.

Type

Impingement baffle type. The impingement of the gas on specially designed perforated baffles are used to achieve moisture separation. The baffles shall be to the drip trap tank for easy accent for cleaning

Inlet & Outlet Connections

Flanged 4"/6"/8" NB. The flanges will be as per British Standard Table 'D'. The flange shall have two nos. joint grooves 25 mm apart.

Moisture Drain

1" NB outlet port with auto-drain valve.

Baffles
The baffling arrangement of perforated sheets of SS 304 to remove moisture from the biogas. The baffle will have guides so that moisture will coalesce and the droplets are drained and accumulated in the drip tank.

The baffling arrangement is fitted onto the tank so that it can be removed and cleaned for routine maintenance. The top cover shall be flanged for easy access to internals of drip trap.

Testing
The drip traps shall be pressure-tested up to 3.5 kg/cm^2 with compressed air/hydraulically

Painting
All the parts of the equipment shall be painted with two coats of epoxy primer. The external surface shall be painted with epoxy paint. The paint will be done after proper surface preparation i.e. sand blasting as per out standard practice.

Welding Joints

All the parts of the equipment – All welding / joints shall be done as per IS specifications.

Flanges and Gaskets
The flanges will be as per British Standard Table 'D' CAP gaskets of 3 mm thickness

Quantity and Sizes

For common pipelines coming from each UASB Reactor Battery	:	8 Nos.
For main gas pipeline	:	4 No
For pipeline going to Gas Flare	:	1 No
For pipeline going to DF Gensets	:	1 No.

Dual Fuel Genset Engine and accessories

Quantity: 2 Nos. of 62.5 KVA capacity each with fuel storage tank

The contractor shall submit the complete design, drawings and technical specifications for the complete Gas Utilisation System including H_2S Gas Scrubbers, Pure Gas Compressor, Dual Fuel Engines, piping, valves, storage tanks etc. The contractor shall assess the quantity of gas generation and accordingly will provide DFGs (assuming maximum power cut). Based on this selection contractor will design the capacities of H_2S Gas Scrubbers, Pure Gas Compressor, Dual Fuel Engines, Cooling tower system, Power receiving Panels, Synchronisation Panel and Changeover Panel etc. Contractor shall submit the General Arrangement drawing of the complete Gas Utilisation System.

The contractor shall give in his tender the total quantity of gas produced per day. In case. In case the contractor feels that there will be seasonal variation in the quantity of gas produced during winter, the same may be specifically brought out and indicated. The quantity of gas production generated be firm and the contractor should fully satisfy with all the parameters which may affect gas production before quoting guaranteed gas productions per day.

The Contractor shall clearly specify the extent of diesel consumption per day for generating the power. The detailed percentage of gas and diesel fuel consumption required will be clearly specified.

General

A dual fuel engine is basically a diesel engine with a conversion kit to run the engine with diesel and natural gas (or any other suitable gas). This works on the diesel cycle. Gaseous fuel is added to the air, which is included at air intake manifold or before Turbocharger. This mixture of air and gas is compressed in the cylinder just as air compressed in normal IC engine. At the end of compression, diesel is injected through a conventional fuel system. This pilot injection acts as a source of ignition. The power output of the engine is mainly determined by the supply of gaseous fuel. The percentage substitution of diesel by gas depends on the type and compositions of gas used and engine design. The engine can run either on diesel or with diesel and gas. This is achieved by electrical changeover system. Adequate controls are provided for duel fuel operation.

2 Nos. 62.5 KVA Dual Fuel Engine Generators are installed.

Key Components

- Gas control valve
- Gas pressure regulators
- Gas shut-off valves
- Fuel pump throttle and gas control valve linkage
- Two solenoid valve for diesel flow restriction
- Selector switch for diesel flow restriction
- Modified air intake manifold
- Gas piping and its insulation
- Separate water circuit for after-cooler in case of turbo-charged after-cooled engines
- Vibration Dampers for each Genset

The Generators shall be of self-regulating type with facility for remote governor control for speed adjustments. The exhaust pipe of DFE should be insulated. The engine material should be such that it does not show excessive wear and tear due to presence of H_2S gas (up to 0.1%) in the biogas. The details of the components of the DFE Genset are given below.

Alternator

Alternator shall be screen protected drip proof, brush-less type in IP 21 enclosure, continuously rated at 0.8 PF, 415 V, 3 Phase, 4 Wire, 50 Hz AC at 1500 rpm. The alternator shall be provided with automatic voltage regulator based on voltage regulation within ± 1% of rated voltage from no load to full load. Insulation used is of Class F, Alternator shall have Alternator shall conform to BS 2613 / IS 4722.

Engine

Engine shall be complete with:

- Flywheel

- Lubricating Oil Filter
- Heavy Duty Air Filter
- Standard Exhaust Silencer with exhaust bend
- Lubricating Oil Cooler
- 24 V electric Starting equipment consisting of
- 24 Volt start motor
- Battery charging alternator
- 2 Nos. 12 Volt 25 plates batteries along with a set of battery leads
- Engine protection unit against low lubricating oil pressure, high cooling temperature
- Radiator and fan assembly
- Engine instrument panel consisting of
- Battery charging Ammeter
- Control Fuse
- Lubricating Oil Pressure Gauge
- Water Temperature Gauge
- Mechanical Taco cum hour meter
- Fuel Tank complete with drain valve
- Standard set of tools

Dual Fuel Kit comprising of Gas induction system mounted on engine include the following:

- Two way normally closed 1.1/4", 230 volts, 50 Hz AC Gas Shut-off Valve
- Flame Trap in Gas Line
- Air/Fuel Control Valve
- Mixing Chamber with Air/Fuel Control Valve
- Piping for Gas (Gas shut-off valve to Mixing Chamber)
- Ball Valve for manual gas shut-off (Loose supply)

Flexible Coupling
Engine and alternator shall be coupled together using flexible coupling with coupling guard.

Base Frame
Engine and alternator shall be mounted on sturdy fabricated, welded construction, channel base frame manufactured by the DG manufacturer.

HOT for Dual Fuel Genset /Compressor house.

HOT for Dual Fuel Genset
Quantity: 1 Nos. of 2 Ton capacity hand operated travelling (HOT) crane & accessories for Dual Fuel Genset House.

HOT for Compressor house.
Quantity: 1 Nos. of 1.5 Ton capacity hand operated travelling (HOT) crane & accessories for Compressor House.

Diesel Engine Generator and accessories
Quantity: 1 No. of 100 KVA capacity to run the Indoor lighting, outdoor lighting, buildings (including staff quarters) and tube well pumps power load.

Alternator
Alternator shall be screen protected drip proof, brush-less type in IP 21 enclosure, continuously rated at 0.8 PF, 415 V, 3 Phase, 4 Wire, 50 Hz AC at 1500 rpm. The alternator shall be provided with automatic voltage regulator based on voltage regulation within ± 1% of rated voltage from no load to full load. Insulation used is of Class F, Alternator shall have Alternator shall conform to BS 2613 / IS 4722.

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- Engine instrument panel consisting of
- Battery charging Ammeter
- Control Fuse
- Lubricating Oil Pressure Gauge
- Water Temperature Gauge
- Mechanical Tacho cum hour meter
- Fuel Tank complete with drain valve
- Standard set of tools

Chlorination System

Chlorination system consisting of Vacuum Feed Chlorinator, Chlorine Toners of 1 Ton capacity, Water Booster Feed pumps, 2 Ton capacity HOT, Safety Equipment & associated accessories like valves, piping, roller stand etc. complete shall be provided.

General

a) Chlorine solution diffusers shall be supplied and installed at the dosing point.

b) Treated sewage shall be dosed with chlorine gas at an average concentration of 5 mg/l and a maximum concentration of not more than 10 mg/l. Effluent from the chlorine contact tank shall not have more than 1 mg/l of residual chlorine.

Chlorinator

a) Vacuum type chlorinators with electrically heated evaporator shall be supplied with one duty and one standby unit.

b) Chlorinators shall be freestanding, floor-mounted, and shall have a turn down ratio of 10:1 over the full range of works operation.

c) Each chlorinator shall be equipped with a motorised plug positioned to be actuated by a sewage flow at the works outlet.

d) The dosing rate shall be manually set and each chlorinator shall be equipped with a 0 to 10 mg/l scale and a manual dose setter over the complete range.

e) Mal-operation of the duty chlorination system shall be indicated in the chlorination room and the central MMI. The change to the standby system shall be carried out automatically in the event of a duty chlorinator failure.

Water Booster Feed Pumps

a) Water Booster Feed pumps (1 working + 1 standby) of required capacity shall be installed.

b) The dosing pumps shall draw their supply from plant water supply.

c) One ground surface water tank of one day required capacity shall be constructed near chlorination room for required water supply.

d) The pumps shall be placed inside the chlorination room and shall be made from material resistant to corrosion by chlorine.

Ijectors

Two Ijectors shall be provided, each serving a duty/standby pair of chlorinators. The ijectors shall be located in the chlorination room.

Chlorine

Chlorine shall be supplied as liquid from nominal chlorine tonners. Number of chlorine tonner in operation at a time shall be decided based on the maximum drawl rate of chlorine from single tonner to avoid freezing.

Tonner Room

a) Storage shall be provided for chlorine tonners sufficient for at least one month's usage at normal rates of application.

b) The system shall be designed to prevent freezing of the liquid chlorine at the maximum rate of withdrawal.

c) Tonners on line, tonners on standby and full and empty tonners, shall be stored separately in the tonner room.

d) 16 sets of tonner rollers shall be provided. Tonners not in use shall be stored on concrete cradles.

e) A 2 tonne overhead single girder hand operated trolley crane shall be provided in the chlorine tonner room for the following functions:

   i) Offloading (and reloading) of tonner from trucks;
   ii) Handling of tonners within the storage area.

f) The system shall serve the tonner store width over the entire length including the loading/unloading area.

g) The hoist and traverse speeds shall be as follows:

i)	Long traverse speed	:	5 m/min
ii)	Cross traverse speed	:	not more than 5m/min
iii)	Slow lifting speed	:	1m/min
iv)	High lifting speed	:	5m/min

h) The container lifting beam shall be specifically designed for handling chlorine containers and equipped with necessary shackles and hooks.

i) Operation of crane system shall be from the floor level

j) Two lifting beams shall be provided (a duty and a spare) and a one tonner weigher to be suspended from the crane hoist.

k) When the pressure in the duty chlorine tonner falls to less than 1 kg/cm^2 the automatic changeover device shall operate to isolate the empty tonner and to bring the full standby tonner on line.

l) A pit and alkali absorption system shall be provided to contain and neutralise chlorine in the event of a leak. The system shall comprise a pit located in the tonner storage room and accessible by the overhead crane system. The pit shall be surrounded with removable guard railing. The pit shall be kept full with a neutralising solution of lime. The pit shall be capable of holding side by side two chlorine tonners. A provision shall be made to drain the pit.

m) Special consideration shall be given to any floor drainage system in the tonner building adequate traps shall be provided to ensure that chlorine gas cannot escape. All leader tuber carrying cables or pipes out of the building shall be sealed at either end to prevent any chlorine gas leaking out.

Chlorine Leak Detectors

a) Not less than five chlorine gas leak detectors shall be provided each, with a single detector cell. At least four sensors shall be located in the chlorine tonner storage room and at least one sensor in the chlorination room.

b) The chlorine leak detectors in the tonner room shall be mounted at each end of the tonner room.

c) The chlorine leak detectors shall have two adjustable alarm levels sensitive to chlorine concentrations above 1 mg/m^3. The range of adjustment of alarm levels shall facilitate selection of the following alarms:

i) low level 2 mg/m^3
ii) high level 4 mg/m^3

d) The low level alarm shall:

i) initiate a local audible and visual alarm;
ii) start the ventilation fans in the tonner and chlorination rooms;
iii) raise the alarm at the local control panel and at the central MMI.

e) The high level alarm shall :

i) initiate local audible and visual alarm;
ii) initiate audible and visual alarms outside the buildings (the alarm shall be sufficiently loud to be heard in all buildings at the STP);
iii) raise an alarm at the local control panel and at the central MMI;
iv) shut down the chlorination systems:
v) stop the tonner room and chlorination room exhaust fans.

f) The chlorine detectors shall have self-checking circuitry and detector failure alarms shall be provided at the local control panel and central MMI.
g) Detector failure alarms shall not be combined with the leak alarms.
h) Statutory warning notices relating to the storage and handling of chlorine shall be provided. The signs shall be pictorial and provided in Hindi and English.

Ventilation System

a) Each area where chlorine is stored or used as gas or liquid shall be provided with a forced ventilation system.
b) Air intakes shall be sized to allow uniform ventilation and positioned to prevent possible recirculation.
c) Exhaust air shall be ducted from low level and discharged at high level.
d) An air change rate of four per hour under normal condition and a minimum of twenty changes of air per hour under shall be used in the event that a chlorine leak is detected.
e) Exhaust fans shall be heavy-duty industrial pattern manufactured from chlorine resistant materials.
f) Ducts shall be manufactured from U-PVC extruded sheets or circular sections.
g) Ducts shall be designed in accordance with relevant Indian standard specifications.
h) Fan controls shall be linked to the gas leak detection system.
i) Hardwired fan controls shall be provided and shall be manually controlled. An override shall be provided to operate the fans in the event of a chlorine leak alarm.
j) Fan controls shall be grouped in an enclosure outside the ventilated area and shall include the following:
k) fan off/on;
l) fan running/failed indication lights;
m) low and high gas leakage indication alarm light.

Chlorine Residual Monitors

a) Chlorine residual monitors shall be provided at the plant outlet.
b) The monitor installation shall be located in a covered location easily accessible for viewing and maintenance and shall be provided complete with sample pumps as necessary to ensure the continuity of the sample.
c) The sampling pipework complete with isolation valves etc. shall be designed to ensure the sample reaches the monitor in a time not greater than 1 minute. The monitor drainage pipework shall permit the visual checking of the presence of flow and shall discharge to the foul drain. Sample sewage not passed through the monitor shall be returned to the process.
d) The residual signals shall be displayed at the local control panel.
e) High and low chlorine residual levels shall raise alarms at the local control panel.

Safety Equipment

a) Materials and equipment necessary to ensure the safety of personnel operating the chlorination plant and others shall be provided.

b) The equipment shall include:

i) two sets of approved self-contained breathing apparatus, each comprising an air set, carrying harness, face mask and valves and ancillary equipment. Each set shall be provided with three 1200 litre capacity, 140 mm diameter, air tonners;

ii) two sets of approved positive airline breathing apparatus, each comprising body harness, face masks and valves and 30m of airline. One air trolley, comprising wheeled frame with two air tonners, control manifold, airline hose and hose winding drum. Two spare tonners suitable for changeover shall be provided;

iii) one portable electric motor driven air compressor for recharging air tonners, complete with quick-release air hose couplings.

iv) two 'instant action' resuscitators:

v) four sets of safety clothing in various sizes, each comprising PVC overalls, wellington boots with steel toe caps, goggles, gloves and safety helmets.

c) Each set of safety equipment shall be mounted in a glass-fronted, non-locking PVC coated steel cabinet in approved locations on the outside of the building.

d) Two emergency showers shall be provided and shall be installed outside on either side of the tonner room.

e) Each shower shall be operated automatically by quick acting hand or foot valve.

f) Four eyebaths shall be supplied. Two eyebaths shall be adjacent to each of the showers.

g) Water for the showers, etc, shall be drawn from the 2 kL capacity overhead tank provided over chlorination room. Supply to overhead tank shall be from service water supply.

Chlorine Mixer

One number Mechanical chlorine mixer suitable for chlorine mixing tank shall be provided. The mixer shall have a self-cleaning propeller optimised for effective mixing and vibration free running. The propeller and propeller shaft shall be of SS 316.

The mixer shall be driven by a motor shall be TEFC type with IP 55 protection and shall be suitable for operation on 415 +/- 10% Volts and 50 +/- 5% Hz, three phase AC supply

Monorail Trolley And Chain Pulley Block

Monorail trolley and the chain pulley block will be provided for lifting of sludge pumps. The trolley and the chain pulley block will be hand driven. The capacity of trolley and chain pulley block is 2 tonne, which is sufficient to remove complete pump set.

The trolley will be gear-less and will have four wheels to run on the lower flange of the rolled steel joist. The wheels will be of carbon steel casting. The trolley will have arrangement to fix the chain pulley block.

The chain pulley block will have spur type gears, load sheave, brake unit, hand chain wheel, loan chain wheel and hooks for suspension on monorail trolley and load.

Electrically Operated Traveling Crane For MPS

2 tonne capacity crane shall be electrically operated, bridge type complete with all accessories including down shop conductor, crane rails and fixtures, and shall conform to IS: 3177 or relevant internationally approved standards.

The Crane Bridge shall consist of bridge girders on which a wheeled trolley is to run. The bridge trucks and trolley frames shall be fabricated from structural steel. Access walkway with safe hand railing as is required along the full span length of the bridge girder. Steel shall be tested quality conforming to ASTM A36 except that, plates more than 20 mm thick shall conform to IS: 2062, BS: 4360 or relevant internationally approved standards. The bridge shall be designed to carry safely the loads specified in IS: 807, BS: 2573 or relevant internationally approved standards. All anti-friction bearings for bridge and trolley track wheels, gearboxes and

bottom sheaves on hook shall be lubricated manually by hand operated grease pump through respective grease nipples.

Construction

1. The load chain shall be made of alloy steel as per IS 3109, it shall be heat treated to give ductility and toughness so that it will stretch before breaking it shall be of welded construction with a factor of safety not less than 5.
2. The hand chain for the hoisting and traverse mechanism shall hang well clear of the hook and both the chain shall be on same side. The hand chain wheel shall be made from pressed sheet steel and shall be provided with roller type guarding to prevent snagging and fouling of the chain.
3. All the gearing shall be totally encased. Proper lubricating arrangement shall be provided for bearings and pinions. Gear shall be cut from forged steel blanks. Pinion shall be of heat-treated alloy steel. Gears shall be as per BS: 436/IS4460.
4. The trolley track wheels shall be rim toughened, heat -treated carbon steel or low alloy steel or CI and shall be single flanged and shall have anti-friction ball bearings. The wheels shall be machined on their trades to match the flanges of the track joints.

5. The traveling trolley frame shall be made of rolled steel conforming to IS: 2062. The size plates of trolley frame shall extend beyond wheel flanges, thus providing bumper size plates of trolley frame shall extend beyond wheel flanges, thus providing bumper protection for wheels. The two side plates shall be connected by means of an equalising pin.
6. Axles and shafts shall be made of carbon steel and shall be accurately machined and properly supported.
7. The lifting hooks shall be forged, heat-treated alloy or carbon steel of rugged construction. They shall be single hook type provided with a standard depress type safety latch. They shall swivel and operate on anti-friction bearings with hardened races. Locks to prevent hooks from swiveling shall be provided. Hooks shall be as per BS: 2903/IS: 3815.
8. The break for the lifting gear shall be automatic and always in action. It shall be screw and friction disc type self-actuating load pressure brake. Brakes shall offer no resistance during hoisting.

Instrumentation For Wastewater And Sludge Flow Measurement

The flow of Waste Water in STP shall be measured using an open channel flow measuring system. The flow through the parshall / venturi flume shall be measured using temperature compensated ultrasonic techniques. Sludge flow shall be measured using an electromagnetic flow meter. Sludge Flow meter shall be located at outlet of Sludge sumps. A local indicator shall be provided to read instantaneous flow rate in cum/hr as well as a Totaliser in MLD. Provision for the remote indication shall also be provided at a distance of 100 m for all the Flow Meters.

Waste water flow meter or any other flow measuring device is to be provided at a suitable location in the STP. However, it should fit in the proposed hydraulics.

Ultrasonic flow meter in open channel (For wastewater)	:	1 Nos.
Electro Magnetic Sludge Flow meter	:	1 Nos.
Instrumentation, Alarm annunciate panel , Mimic panel	:	1 No
Real time Reactor sludge blanket thickness meausure	:	1No
online DO meter	:	1No

Ultrasonic Flow Meter

Service	:	Measurement of flow through STP
Type of channel	:	Open - rectangular
Overall accuracy of	:	+/-1 of full scale with facility for range
Measurement loop selection	:	Required necessary hardware and
Interfacing with auto Sampler	:	software shall be provided

Level Measuring Unit

Type	:	Ultrasonic
Mounting	:	On flow channel
Output	:	4-20m A DC

Enclosure material	:	Die cast aluminum
Integral cable and sensor	:	Required
Weather protection	:	IP-65 of IS 13947

Flow Computer and Transmitter

Type	:	Microprocessor based
Mounting	:	Field
Input	:	From level measuring unit
Output	:	4-20m A DC
Unit of display	:	Flow rate – m3/hr Totalized flow - ML
Facility to fee data like the type Of Channel, channel dimensions	:	Required
Engg. Unit, dead band etc, weather Protection	:	IP-65 of IS 13947

Remote Flow Indicator and Integrator

Type	:	Electronic (combined unit)
Display	:	Digital, seven segment backlit LCD/LED display
Display height	:	14 mm or higher
Input	:	4-20 Ma-DC (Isolated) from flow Transmitter
Zero & span adjustment	:	Required (shall be key operated)
Manual reset facility For flow integrato		
Engineering units for Flow rate indicator	:	m^3/hr
Flow integrator	:	ML and Litres
Accuracy	:	+-0.25% of span
Power supply to Transmitters	:	Required
Battery back-up for Integrator	:	Required
Retransmission output	:	4-20 Ma proportional to flow rate
Weather protection	:	IP-5D of IS 13947

Electromagnetic Flow meter

General Service	:	flow measurement in pumping main for sludge
Overall accuracy of Measurement loop	:	+-0.5% of full scale

Flow Sensor/Transmitter

Type	:	Full bore electromagnetic type
Sensor	:	As per ISO
Transmitter Housing	:	Die-Cast Aluminum with Glass Window
Process connection	:	Flanged
Weather protection	:	IP68 (Sensor)/ IP65(Transmitter) of IS 13947
Flow indication	:	Back lit LCD/LED display of 3 line To indicate Actual Flow rate, Forward & Reverse Flow Direction, Total Flow Indication with Status Indication

Remote Flow Indicator and Integrator

Type	:	Electronic (combined unit)
Display	:	Digital, 3 Line Backlit

		LCD/LED DISPLAY
Digit height		: 14mm or higher
Input	:	4 -20 ma proportional to flow rate
Engineering units for Flow Rate indicator	:	m3/hr
Flow Integrator		: ML
Weather protection	:	IP-52 of IS 13947

LIST OF IS CODE

List Of IS Codes For Mechanical And Electrical Engineering Works

The following list includes the various Indian Standards that are very commonly referred to and used for the works included in this tender. These standards are to be strictly adhered to unless otherwise is applicable in the relevant context. These standards are to be followed both in respect of materials and execution of mechanical and electrical engineering works included in the tenders.

The list is not exhaustive but contains only the standards that are very frequently used. If a standard exists for a particular item of material or equipment or code of practice the same shall be followed whether the same is included in this list, specifications, other parts of the tender documents or not. Some Indian Standards are referred to in the specifications/drawings/other parts of the tender documents and they are supplementing the list if they do not find a place in the list.

	Title/Description
	Sewage and drainage pumps
	Abrasion resistance iron castings
	Grey iron castings (part-1)
	Pressure pipe for water, gas and sewage centrifugally cast (spun) iron
	Pressure pipes for water, gas and sewage cast iron fittings

	Title/Description
	Sluice valves for water works purposes (50 to 300 mm sizes)
	Sluice valves for water works purposes (300 to 1200 mm sizes)
	Steel plates for pressure vessel
	Structural steel
	Weldable structural steel
	Use of metal are welding for general construction in mild steel, code of practice
	Manual metal arc welding of mild steel, code of practice
	Carbon steel castings for general purposes

	Title/Description
	Carbon steel billets, slabs and bars for forging
	Calibrated load chain for pulley blocks and other appliances
	Round steel short link chains (electric butt welded)
	Sewage screens
	Single faced sluice gate
	Chain rail sections
	National electrical code
	Axial flow fan

	Title/Description
	General requirement of switch gear and control gear for voltages not exceeding1000 V.A.C or 1200 V.D.C
	Code of practice for installation and maintenance of switch gear
	Heavy duty air break switches and composite units of air break switches and fuses for voltage not exceeding 1000V
	Miniature air-break circuit breaks for AC voltage not exceeding 1000V
	HRC cartridge fuses
	Code of practice for earthing
	Three phase induction motors

	Title/Description
	Dimensions of three phase, foot mounted induction motors
	Dimensions of flange mounted induction motors
	Types of construction of mounting arrangement of rotating electrical machinery
	Degrees of protection provided by enclosures for rotating electrical machinery
	Method of determination of efficiency of electrical machines
	Rotating electrical machines
	Guide for testing 3 –phase induction motors

	Title/Description
	Rotation electrical machines, vibration of measurement and evaluation
	AC contractors
	Marking and arrangement for switchgear busbar, main connections and Auxiliary wiring

List of Approved vendors for Mechanical Equipment

Sl.no	Equipment	Manufacturer/Make
1.	Pumps	KSB/ Grundfose / Kishore / Kirloskar Bros. Ltd./ Mather and Platt Pumps (P) Ltd. / Beacon Weir Ltd. / Jyoti / Worthington / Flow more/Roto/ Tushaco
2.	Motors	Kirloskar / New Government Electronics Factory Ltd. / Siemens India Ltd. / Crompton Greaves Ltd. / Bharat Heavy Electrical Ltd. / Jyoti / Alstom
3.	Compressor	SLM-Maneklal / Swam/ Usha Engg / Kay International/ Everest / Ingersoll-Rand / Kirloskar Pneumatic / K G Khosla
4.	Exhaust Fans	Bajaj Electrical Ltd. / Crompton Greaves Ltd. / General Electric Company
5.	Instrument Control Panels	Industrial Control & Appliances (P) Ltd. / Electric Automation / Jaisun & Hutchison Controls (P) Ltd. / Industrial Switch Gear & Controls
6.	Motor Control Panel	ECS / IMPL / Jasper / Kilburn / Weather Proof Subhelec Phillicon / CAS
7.	Chain Pulley Block	ACE Mfg. Engg. P. Ltd., / Indef/ Morris/Eqv
8.	Sluice Valve	Kirloskar Bros. Ltd. / Indian Valve Co / Fouress / Jash / R & D Multiple / Intervalve/ Durga
9.	Non Return Valves	Kirloskar Bros. Ltd. / Indian Valve Co / Fouress / Advance /

Sl.no	Equipment	Manufacturer/Make
		Intervalve/ Durga
10.	GI Pipes	Tata / Jindal
14.	Gravity Feed Type Chlorinators	Banaco / Chlorocontrol / Metito / Precession / Penwalt
15.	Free Residual Chlorine Compartor	Glaxo / Lovibond
16.	Chlorination Plant Accessories for connecting chlorine tonner container upto injector	Banaco / Chlorocontrol / Metito / Penwalt
17.	PVC Pipes	Finolex/ Manmohan Plastics/ Jain Irrigation/ Tirupati Structures/ Balaji Industries/ Chemical Process Equipment
18.	Self Sustaining Breathing Apparatus	Drager
19.	Gas Mask	Drager
20.	Water Feed Pumps / Chemical Pumps	Kirloskar / M& P / Sulzer / KSB
21.	HOT Cranes	Indef / ACME Manufactures Engineers / Electromech Engineers / FAFECO, Mumbai / Batliboi Ltd. / SMACO Engineering Ltd
22.	Mechanical Screens	Hindustan Dorr Oliver / Voltas / Triveni / Geomiller / Batliboi / Jash / Smith & Swami
23.	Belt Conveyor	Indiana / Konal Corporation / Voltas / Batliboi / Dynamic
24.	Degritter	Voltas / Hindustan Dorr Oliver / Batliboi / Geomiller / Triveni/ EIMCO-KCP Limited
25.	Floating Aerator	Voltas / Hindustan Dorr Oliver / Batliboi / Geomiller
26	Gear Box	Radicon-Greaves/ Elecon / Flender
27.	Alternators	Crompton / KEC / Alstom / BHEL / Jyoti
28.	Gas Flaring System	Combustion Research Associates / Teltech Inst. P. Ltd, / Batliboi/ Boitech Adore Technologies
29.	Electro-Magnetic Flow Meters	Endress + Hauser / Krone-Marshall / Fisher Rosemount
30.	Gas Flowmeter with Indicator and Totaliser	Krone-Marshall / Endress + Hauser / Rockwin / Flowmeter India P. Ltd. / Combustion Research Associates
31.	Open Channel Flow Meter	JN Marshall / Fisher Rosemount
32.	Electrical Actuators	AUMA/ Marshal/ Rotark
33.	Gates	Jash / Yashwant / Geeta
34	FRP Material	Balaji Industries Vadodra/ Chemical Process Equipment Ltd., Mumbai.