# REHABILITATION/UPGRADATION OF 5 NOS. EXISTING SEWAGE TREATMENT PLANTS (STPS) AND CONSTRUCTION OF 1 NO. NEW STP ON DESIGN, BUILD AND OPERATE (ONE YEAR DLP PLUS 15 YEARS O&M) BASIS AT CHANDIGARH UNDER SMART CITY PROJECT

## REQUEST FOR PROPOSAL

**31-12-2018**

## VOLUME 1


***Chandigarh Smart City Limited***

**New Bridge Building – 2, 2nd Floor, Near TDI Mall, Sector 17 – A, Chandigarh – 160017**

## Disclaimer

The information contained in this Request for Proposal document (the "RFP") or subsequently provided to Bidder(s), whether verbally or in documentary or any other form by or on behalf of the Chandigarh Smart City Ltd. (CSCL) or any of its employees or advisors, is provided to Bidder(s) on the terms and conditions set out in this RFP and such other terms and conditions subject to which such information is provided.

This RFP is not an Agreement and is neither an offer nor invitation by the Chandigarh Smart City Ltd. (CSCL) to the prospective Bidders or any other person. The purpose of this RFP is to provide interested parties with information that may be useful to them in making their financial offers (BIDs) pursuant to this RFP. This RFP includes statements, which reflect various assumptions and assessments arrived at by the Chandigarh Smart City Ltd. (CSCL) in relation to the Project. Such assumptions, assessments and statements do not purport to contain all the information that each Bidder may require. This RFP may not be appropriate for all persons, and it is not possible for the Chandigarh Smart City Ltd. (CSCL), its employees or advisors to consider the investment objectives, financial situation and particular needs of each party who reads or uses this RFP. The assumptions, assessments, statements and information contained in the Bidding Documents may not be complete, accurate, adequate or correct. Each Bidder should, therefore, conduct its own investigations and analysis and should check the accuracy, adequacy, correctness, reliability and completeness of the assumptions, assessments, statements and information contained in this RFP and obtain independent advice from appropriate sources.

Information provided in this RFP to the Bidder(s) is on a wide range of matters, some of which may depend upon interpretation of law. The information given is not intended to be an exhaustive account of statutory requirements and should not be regarded as a complete or authoritative statement of law. The Chandigarh Smart City Ltd. (CSCL) accepts no responsibility for the accuracy or otherwise for any interpretation or opinion on law expressed herein.

The Chandigarh Smart City Ltd. (CSCL), its employees and advisors make no representation or warranty and shall have no liability to any person, including any Applicant or Bidder under any law, statute, rules or regulations or tort, principles of restitution or unjust enrichment or otherwise for any loss, damages, cost or expense which may arise from or be incurred or suffered on account of anything contained in this RFP or otherwise, including the accuracy, adequacy, correctness, completeness or reliability of the RFP and any assessment, assumption, statement or information contained therein or deemed to form part of this RFP or arising in any way for participation in this BID Stage.

The Chandigarh Smart City Ltd. (CSCL) also accepts no liability of any nature whether resulting from negligence or otherwise howsoever caused arising from reliance of any Bidder upon the statements contained in this RFP. The Chandigarh Smart City Ltd. (CSCL) may in its absolute discretion, but without being under any obligation to do so, update, amend or supplement the information, assessment or assumptions contained in this RFP.

The issue of this RFP does not imply that the Chandigarh Smart City Ltd. (CSCL) is bound to select a Bidder or to appoint the Selected Bidder or Concessionaire, as the case may be, for the Project and the Chandigarh Smart City Ltd. (CSCL) reserves the right to reject all or any of the Bidders or BIDs without assigning any reason whatsoever.

## Contents

# Part – A

# Form of Invitation for Bids

Chief Executive Officer,
Chandigarh Smart City Limited
New Bridge Building – 2, 2nd Floor, Near TDI Mall, Sector 17 – A, Chandigarh – 160017
Phone No.: +91 172 5043196; e-mail: smartcity.chd@nic.in

1. The Government of India (GoI) has funded the project under Smart City Project under Smart City Mission. It is intended that part of the proceeds of this fund will be applied to eligible payments under the contract for "Rehabilitation/Upgradation of 5 Nos. existing Sewage Treatment Plants (STPs) and Construction of 1 No. new STP on Design, Build and Operate (one year DLP plus 15 years O&M) basis at Chandigarh under Smart City Project". The funds for Operation and Maintenance shall be provided by the respective Depts. i.e. Chandigarh Administration/Municipal Corporation Chandigarh.

2. The Chandigarh Smart City Limited (CSCL) invites e-Bids from experienced and eligible Bidders. The STPs is to be designed with a proven technology having any Aerobic Biological Treatment Process for Liquid Stream preferably $A^2O$, SBR or MBR.

3. A Single-Stage, Two Folder, bidding procedure will be adopted. Bidders are to submit online simultaneously two folders, First containing the "Initial Filter" (Part A) for Pre-Qualification and Technical Proposal (Part B) and Second folder containing the price bid. First only Initial Filter (Part A) shall be opened & evaluated. The Technical Proposal (Part B) of only those bidders shall be opened who meet the eligibility criteria as annexed. The Price proposal of only those bidders shall be opened and evaluated who qualify the Technical Evaluation.

4. All prospective Bidders may write to smartcity.chd@nic.in to obtain further information and clarifications.

5. A complete set of Bidding Documents may be downloaded from e-tender website i.e. http://etenders.chd.nic.in. Interested Bidders shall pay document fee amounting to Rs. 50,000/- (Rupees Fifty Thousand Only) in form of Demand Draft (DD) or by Bank Transfer through RTGS in the A/c of CSCL (A/c No.: 50100074016350; A/c Name: Chandigarh Smart City Ltd.; Bank Name & Address: HDFC Bank, SCO 78-79, Sector 8-C, Chandigarh (UT), Chandigarh - 160018; IFSC: HDFC0000107).

| | | |
|---|---|---|
| Start Date/Time of purchase of bid documents and Publication of Bid Document on the e-tender website | 31.12.2018 | 15:00 Hrs. |
| Date/Time of Pre-Bid Meeting | 14.01.2019 | 11:00 Hrs. |
| Date/Time of submission of bid | 28.01.2019 | 15:00 Hrs. |
| Date/Time of opening of First Folder ( Initial Filter and Technical Bid) | 28.01.2019 | 16:00 Hrs. |
| Date/Time of opening of Second Folder (Price Bid) | To be informed later to Technically Qualified Bidders | |

| S.No. | Name of Work | Estimated Cost | Earnest Money (Rs.) | Completion Period |
|---|---|---|---|---|
| 1. | Rehabilitation/Upgradation of 5 Nos. existing Sewage Treatment Plants (STPs) and Construction of 1 No. new STP on Design, Build and Operate (one year DLP plus 15 years O&M) basis at Chandigarh under Smart City Project | (Rs. 511 Cr.) | Rs.5.11 Cr. (Bank Guarantee) | 24 Months + 6 months (trial run & commissioning) |

The bid shall remain valid for a period of 180 days after the last date of submission of bids. Further corrigendum/addendum/clarification, if any, will be uploaded on e-tender website i.e. http://etenders.chd.nic.in.

Sd-
Authorized Signatory
Chandigarh Smart City Limited

# Section - I: Instructions to Bidders

## A General

### 1 Scope of Bid

1.1 In connection with the Invitation for Bids specified in the Bid Data Sheet (BDS), the Employer, as specified in the BDS, issues these Bidding Documents (hereinafter referred to as "Bidding Documents") for the procurement of Electrical and Mechanical Plant, and for Building and Engineering Works, designed by the Contractor as specified in Section VI, Employer's Requirements.

1.2 Throughout these Bidding Documents:

a) the term "in writing" means communicated in written form and delivered against receipt;

b) except where the context requires otherwise, words indicating the singular also include the plural and words indicating the plural also include the singular; and

c) "day" means calendar day.

### 2 Source of Funds

2.1 The Employer specified in the BDS will receive or received funds under Smart City Mission, Government of India. The Funds for operation and maintenance shall be provided by respective department i.e. Chandigarh Administration/Municipal Corporation Chandigarh. The Employer intends to apply a portion of the proceeds of the above mentioned funds to eligible payments under the Contract(s) for which these Bidding Documents are issued.

2.2 No party other than the Employer (CSCL) shall derive any rights from the Smart City funds.

### 3 Corrupt and Fraudulent Practices

3.1 Bidders and Contractor as well as the Employers will observe the highest standard of ethics during the procurement and execution of such contracts. In pursuance of this, Employer/CSCL:

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

b. will recognize a Bidder or Contractor as ineligible, for a period determined by Employer, to be awarded a contract if it, at any time, determines that the Bidder or the Contractor has engaged in corrupt or fraudulent practices in competing for, or in executing, another contract of Employer and

c. will recognize a Contractor as ineligible to be awarded a contract if the Contractor or a Subcontractor, who has a direct contract with the Contractor, is debarred by any Government department/Public Sector Undertaking/Private Sector/or any other agency during the last 7 years ending last day of the month previous to the one in which Bids are invited.

d. will reject a proposal for award if it determines that the bidder recommended for award has been blacklisted/De-registered/debarred by any Government department/Public Sector Undertaking/Private Sector/or any other agency during the last 7 years ending last day of the month previous to the one in which Bids are invited.

# 4 Eligible Bidders

4.1 The tenders for this contract will be considered only from those bidders specified in the Bid Data Sheet (BDS) who meet requisite eligibility criteria.

4.2 Joint Venture shall not be allowed.

4.3 The bidder may rely on the experience of its Associate(s)/Parent Company or vice versa to qualify the Technical and Financial Experience requirements. A certificate as specified in the BDS shall be provided, if applicable. However, the experience as Sub- Contractor is not acceptable.

4.4 A Bidder shall not have a conflict of interest. A Bidder shall not be employed under any of the circumstances set forth below throughout the bidding/selection process and/or the execution of the Contract unless the conflict has been resolved in a manner acceptable to CSCL

(a) A firm shall be disqualified from providing goods or non-consulting services resulting from or directly related to consulting services for the preparation or implementation of a project that it provided or were provided by any affiliate that directly or indirectly controls, is controlled by, or is under common control with that firm. This provision does not apply to the various firms (consultants, contractors, or suppliers) only due to the reason that those firms together are performing the Contractor's obligations under a turnkey or design and build contract.

(b) A firm that has a close business relationship with the Borrower's professional personnel, who are directly or indirectly involved in any part of: (i) the preparation of the prequalification and Bidding Documents for the Contract, (ii) the prequalification and Bid evaluation, or (iii) the supervision of such Contract, shall be disqualified.

I Based on the "One Bid Per Bidder" principle, which is to ensure fair competition, a firm and any affiliate that directly or indirectly controls, is controlled by, or is under common control with that firm shall not be allowed to submit more than one Bid.

(d) A firm having any other form of conflict of interest other than (a) through (c) stated above shall also be disqualified.

4.5 A Bidder that has been determined to be ineligible by the Employer in accordance with ITB 3.1 shall not be eligible to be awarded a Contract.

4.6 A Bidder shall provide such evidence of its eligibility satisfactory to the Employer, as the Employer shall reasonably request. Also, an Undertaking shall be provided by the Bidder as specified in the BDS.

## 5 Eligible Plant, Material and Services

5.1 The Plant, Material and Services to be supplied under the Contract shall be as per the Technical Specifications.

# B Contents of Bidding Documents

## 6 Sections of Bidding Documents

6.1 The Bidding Documents consist of Parts 1, 2, and 3, which include all the Sections indicated below, and should be read in conjunction with any Addenda issued in accordance with ITB 8.

PART 1 Bidding Procedures

- Section I. Instructions to Bidders (ITB)
- Section II. Bid Data Sheet (BDS)
- Section III. Evaluation and Qualification Criteria (EQC)
- Section IV. Bidding Forms

PART 2 Employer's Requirements

- Section V. Employer's Requirements
- Section VI. Drawings

PART 3 Conditions of Contract and Contract Forms

- Section VII. General Conditions (GC)
- Section VIII. Particular Conditions (PC)
- Section IX. Annex to the Particular Conditions – Contract Forms

6.2 Unless obtained directly from the Employer, the Employer is not responsible for the completeness of the Bidding Documents, responses to requests for clarification, the minutes of the pre-bid meeting (if any), or Addenda to the Bidding Documents in accordance with ITB 8. In case of any contradiction, documents obtained directly from the Employer shall prevail.

6.3 The Bidder is expected to examine all instructions, forms, terms, and Employer's Requirement in the Bidding Documents, and to furnish with its Bid all information and documentation as is required by the Bidding Documents.

## 7 Clarification of Bidding Documents, Site Visit, Pre-Bid Meeting

7.1 A Bidder requiring any clarification of the Bidding Documents shall contact the Employer in writing at the Employer's address specified in the BDS or raise his enquiries during the pre-bid meeting if provided for in accordance with ITB 7.4. The Employer will respond in writing to any request for clarification, provided that such request is received no later than fifteen (15) days prior to the deadline for submission of Bids. The Employer shall forward copies of its response to all Bidders who have acquired the Bidding Documents in accordance with ITB 6.2, including a description of the inquiry but without identifying its source. If so specified in the BDS, the Employer shall also promptly publish its response at the web page identified in the BDS. Should the clarification result in changes to the essential elements of the Bidding Documents, the Employer shall amend the Bidding Documents following the procedure under ITB 8 and ITB 24.2.

7.2 The Bidder is advised to visit and examine the Site and its surroundings and obtain for itself on its own responsibility all information that may be necessary for preparing the Bid and entering into a contract for construction of the Works. The costs of visiting the site shall be at the Bidder's own expense.

7.3 The Bidder and any of its personnel or agents will be granted permission by the Employer to enter upon its premises and lands for the purpose of such visit, but only upon the express condition that the Bidder, its personnel, and agents will release and indemnify the Employer and its personnel and agents from and against all liability in respect thereof, and will be responsible for death or personal injury, loss of or damage to property, and any other loss, damage, costs, and expenses incurred as a result of the inspection.

7.4 The Bidder's designated representative is invited to attend a pre-bid meeting, if so specified in the BDS. The purpose of the meeting will be to clarify issues and to answer questions on any matter that may be raised at that stage. A site visit may be conducted by the Employer at the time of the pre-bid meeting, if so specified in the BDS.

7.5 The Bidder is requested to submit any questions in writing, to reach the Employer not later than one (1) day before the pre-bid meeting.

7.6 Minutes of the pre-bid meeting, if applicable, including the text of the questions asked by Bidders, without identifying the source, and the responses given, together with any responses prepared after the meeting, will be transmitted promptly to all Bidders who have acquired the Bidding Documents in accordance with ITB 6.2. Any modification to the Bidding Documents that may become necessary as a result of the pre- bid meeting shall be made by the Employer exclusively through the issue of an addendum pursuant to ITB 8 and not through the minutes of the pre-bid meeting. Non-attendance at the pre-bid meeting will not be a cause for disqualification of a Bidder.

## 8 Amendment of Bidding Documents

8.1 At any time prior to the deadline for submission of Bids, the Employer may amend the Bidding Documents by issuing addenda.

8.2 Any addendum issued shall be part of the Bidding Documents and shall be communicated in writing to all who have obtained the Bidding Documents from the Employer in accordance with ITB 6.2. If so specified in the BDS, the Employer shall also promptly publish the addendum on the Employer's web page in accordance with ITB 7.1

8.3 To give Bidders reasonable time in which to take an addendum into account in preparing their Bids, the Employer may extend the deadline for the submission of Bids, pursuant to ITB 24.2.

# C Preparation of Bids

## 9 Cost of Bidding

9.1 The Bidder shall bear all costs associated with the preparation and submission of its Bid, and the Employer shall not be responsible or liable for those costs, regardless of the conduct or outcome of the bidding process.

## 10 Language of Bid

10.1 The Bid, as well as all correspondence and documents relating to the Bid exchanged by the Bidder and the Employer, shall be written in the language specified in the BDS. Supporting documents and printed literature that are part of the Bid may be in another language provided they are accompanied by an accurate translation of the relevant passages in the language of Bid, in which case, for purposes of interpretation of the Bid, such translation shall govern.

## 11 Documents Comprising the Bid

11.1 The bid shall comprise Two Folders submitted simultaneously online. Folder 1 containing the IFQ and Technical Bid' comprising of the documents listed in ITB 11.2 and Folder 2 containing 'Price Bid' comprising of the documents listed in ITB 11.3.

11.2 The Initial Filter and Technical Bid submitted by the Bidder shall comprise the following:

i. Document Fee, in accordance with ITB 23;
ii. Bid Security, in accordance with ITB 21;
iii. written confirmation authorizing the signatory of the Bid to commit the Bidder, in accordance with ITB 22.2;
iv. documentary evidence in accordance with ITB 15 establishing the Bidder's eligibility and qualifications to perform the Contract if its Bid is accepted;
v. Letter of Technical Bid;
vi. Technical Proposal in accordance with ITB 17;
vii. documentary evidence establishing in accordance with ITB 16 that the Works offered by the Bidder conform to the Bidding Documents;
viii. any other document specified in the BDS.`

11.3 The Price Bid submitted by the Bidder shall comprise the following:

a. Letter of Price Bid;
b. Completed Price Schedules, in accordance with ITB 12 and 18;
c. any other document specified in the BDS.

## 12 Letters of Bid and Schedules

12.1 The Bidder shall complete the Letters of Technical Bid and Price Bid, including the appropriate Technical and Price Schedules, using the relevant forms furnished in Section IV, Bidding Forms – Volume 1. The forms must be completed without any alterations to the text, and no substitutes shall be accepted except as provided under ITB 22.2. All blank spaces shall be filled in with the information requested.

## 13 Alternative Bids

13.1 The BDS indicates whether alternative Bids are allowed. If they are allowed, the BDS will also indicate whether they are permitted in accordance with ITB 13.3, or invited in accordance with ITB 13.2 and/or ITB 13.4.

13.2 When alternatives to the Time for Completion of the whole of the Works or the sections are explicitly invited, a statement to that effect will be included in the BDS, and the method of evaluating different time schedules will be described in Section III, Evaluation and Qualification Criteria.

13.3 Except as provided under ITB 13.4 below, Bidders wishing to offer technical alternatives to the Employer's requirements as described in the Bidding Documents must also provide: (i) a price at which they are prepared to offer such alternative meeting the Employer's requirements; and (ii) all information necessary for a complete evaluation of the alternatives by the Employer, including drawings, design calculations, technical information (particulars), breakdown of prices, and proposed installation methodology and other relevant details. Only the technical alternatives, if any, of the lowest evaluated Bidder conforming to the basic technical requirements shall be considered by the Employer.

13.4 When Bidders are invited in the BDS to submit alternative technical solutions for specified parts of the Works, such parts shall be described in Section VI, Employer's Requirements. Technical alternatives that comply with the performance and technical criteria specified for the Works shall be considered by the Employer on their own merits, pursuant to ITB 35.2.

## 14 Documents Establishing the Eligibility of Plant, Materials and Services

14.1 To establish the eligibility Plant, Materials and Services in accordance with ITB 5, Bidders shall complete the country of origin declarations in the Price Schedule Forms, included in Section IV, Bidding Forms.

## 15 Documents Establishing the Eligibility and Qualifications of the Bidder

15.1 In accordance with Section III, Evaluation and Qualification Criteria, if the prequalification process was conducted prior to the bidding process, the Bidder shall provide in the corresponding information sheets included in Section IV, Bidding Forms, (i) updated information on any assessed aspect that changed from that time to establish that the Bidder continues to meet the criteria used at the time of prequalification and (ii) the requested information on the additional qualification criteria stated in Section III, Evaluation and Qualification Criteria, or if the assessment of qualification criteria was not conducted prior to the bidding process, the Bidder shall provide the information requested in the corresponding information sheets included in Section IV, Bidding Forms.

## 16 Documents establishing conformity of the Works

16.1 The documentary evidence of the conformity of the Works with the Bidding Documents may be in the form of literature, drawings and data, and shall include:

a. a detailed description of the essential technical and performance characteristics of the Plant, including the Schedule of Guarantees of the proposed Plant, in response to the Employer's Requirement. The Schedule of Guarantees of the proposed Plant shall be stated in the applicable form in Section IV, Bidding Forms;

b. a list giving full particulars, including available sources, of all spare parts, special tools, etc., necessary for the proper and continuing functioning of the Plant for the period specified in the BDS, following completion of the Works in accordance with the provisions of Contract; and

c. adequate evidence demonstrating the substantial responsiveness of the Works to those Employer's Requirements. Bidders shall note that standards for workmanship, materials and equipment designated by the Employer in the Bidding Documents are intended to be descriptive (establishing standards of quality and performance) only and not restrictive. The Bidder may substitute alternative standards, brand names and/or catalogue numbers in its Technical Proposal, provided that it demonstrates to the Employer's satisfaction that the alterations are substantially equivalent or superior to the standards designated in the Employer's Requirement.

## 17 Technical Proposal, Subcontractors

17.1 The Bidder shall furnish a Technical Proposal, including a statement of work methods, equipment, personnel, schedule, safety plan, and any other information as stipulated in Section IV, Bidding Forms in sufficient detail to demonstrate substantial responsiveness of the Bidder's proposal to the Employer's Requirements and the completion time.

17.2 For major items of the Works as listed by the Employer in Section III, Evaluation and Qualification Criteria, which the Bidder intends to purchase or subcontract, the Bidder shall give details of the name and nationality of the proposed Subcontractors, including manufacturers, for each of those items. In addition, the Bidder shall include in its Technical Proposals information establishing compliance with the requirements specified by the Employer for these items. Bidders are free to list more than one Subcontractor against each item of the Works. Quoted rates and prices will be deemed to apply to whichever Subcontractor is appointed, and no adjustment of the rates and prices will be permitted.

17.3 The Bidder shall be responsible for ensuring that any Subcontractor proposed complies with the requirements of ITB 4, and that any Works to be provided by the Subcontractor comply with the requirements of ITB 5 and ITB 16.1.

17.4 Unless otherwise stated in the BDS, the Employer does not intend to execute any specific elements of the Works by subcontractors selected in advance by the Employer (nominated subcontractors).

17.5 As Prequalification is being conducted prior to the bidding process, the Bidder's Bid shall name the same specialist subcontractor(s) whose experience in the key activities was evaluated in the Prequalification.

## 18 Bid Prices and Discounts

18.1 Unless otherwise specified in the BDS, Bidders shall quote for the Works such that the total Bid Price covers all the Contractor's obligations mentioned in or to be reasonably inferred from the Bidding Documents in respect of the design, manufacture, including procurement and subcontracting (if any), delivery, construction, installation and completion of the Works. This includes all requirements under the Contractor's responsibilities for testing, pre- commissioning and commissioning of the plant and, where so required by the Bidding Documents, the acquisition of all permits, approvals and licenses, etc.; the operation, maintenance and training services and such other items and services as may be specified in the Bidding Documents, all in accordance with the requirements of the General Conditions. Items in the Price Schedule against which no price is entered by the Bidder will not be paid for by the Employer when executed and shall be deemed to be covered by the prices for other items.

18.2 Bidders are required to quote the price for the commercial, contractual and technical obligations outlined in the Bidding Documents.

18.3 Bidders shall provide price in each item in the manner and detail called for in the Price Schedules included in Section IV, Bidding Forms. Further, Bidders may add breakdowns of items and provide the prices in each Price Schedule included in Section IV, Bidding Forms.

18.4 The price to be offered in the Letter of Bid, in accordance with ITB 12.1, shall be the total price of the Bid, excluding any discounts that may be offered.

18.5 Unless otherwise specified in the BDS and the Contract, the prices offered by the Bidder are subject to adjustment during the performance of the Contract in accordance with the provisions of the Conditions of Contract. In such a case, the Bidder shall furnish the indices and weightings for the price adjustment formulae in the Schedule of Adjustment Data and the Employer may require the Bidder to justify its proposed indices and weightings.

18.6 If so specified in BDS 1.1, Bids are being invited for individual lots (contracts) or for any combination of lots (packages). Bidders wishing to offer discounts for the award of more than one Contract shall specify in their Bid the price reductions applicable to each package, or alternatively, to individual Contracts within the package. Discounts shall be submitted in accordance with ITB 18.4, provided the Bids for all lots (contracts) are opened at the same time.

18.7 Unless otherwise provided in the BDS, all duties, taxes, and other levies payable by the Contractor under the Contract, or for any other cause, as of the date twenty-eight (28) days prior to the deadline for submission of Bids, shall be included in the rates and prices and the total Bid Price submitted by the Bidder.

18.8 Bidders wishing to offer any unconditional discount shall specify in their Letter of Price Bid the offered discounts and the manner in which price discounts will apply.

## 19 Currencies of Bid and Payment

19.1 The currency (ies) of the Bid shall be, as specified in the BDS.

## 20 Period of Validity of Bids

20.1 Bids shall remain valid for the period specified in the BDS after the Bid submission deadline date prescribed by the Employer pursuant to ITB 24.1. A Bid valid for a shorter period shall be rejected by the Employer as non-responsive.

20.2 In exceptional circumstances, prior to the expiration of the Bid validity period, the Employer may request Bidders to extend the period of validity of their Bids. The request and the responses shall be made in writing. The Bid Security shall also be extended for twenty-eight (28) days beyond the deadline of the extended validity period. A Bidder granting the request shall not be required or permitted to modify its Bid.

## 21 Bid Security

21.1 The Bidder shall furnish as part of its Bid a Bid Security in the amount specified in the BDS.

21.2 The Bid Security shall be an unconditional and irrevocable Bank guarantee issued by a Scheduled Bank payable at Chandigarh. The Bid Security shall be submitted using the Bid Security Form included in Section IV, Bidding Forms. The Bid Security shall be valid for twenty-eight (28) days beyond the original validity period of the Bid, or beyond any period of extension if requested under ITB 20.2. Employer reserves the right to verify the Bid Security submitted by the Bidder in the shape of Bank Guarantee. In case the verification reveals that the submitted Bank Guarantee is fraudulent, Employer reserves the right to reject the bid.

21.3 Any Bid not accompanied by a substantially responsive Bid Security shall be rejected by the Employer as non-responsive.

21.4 The Bid Security of unsuccessful Bidders without any interest shall be returned once the successful Bidder has signed the Contract.

21.5 The Bid Security of the Successful Bidder without any interest shall be returned as promptly as possible once the successful Bidder has signed the Contract and furnished the required Performance Security.

21.6 The Bid Security may be forfeited:

a. if a Bidder withdraws its Bid during the period of Bid validity specified by the Bidder on the Letters of Technical Bid and Price Bid, or any extension thereto provided by the Bidder; or

b. if the successful Bidder fails to:
   i. sign the Contract in accordance with ITB 43; or
   ii. furnish a Performance Security in accordance with ITB 44.

## 22 Format and Signing of Bid

22.1 The Bidder shall provide all the information sought under this document. The Authority will evaluate only those Bids that are received in the required formats and complete in all respects.

22.2 The Bid shall be typed or written in indelible ink and signed by the authorised signatory of the Bidder specified in the BDS, who shall also sign on each page, in blue ink and will upload the same on the e-tender website. All the alterations, omissions, additions or any other amendments made to the Bid shall be signed by the person(s) signing the Bid. The Employer may ask for the hard copies of the Bid as uploaded on the e-tender website from all the Bidders.

22.3 The Bid shall contain continuing page numbers as also the total number of pages must be mentioned on the first page of the Bid document.

22.4 Any interlineations, erasures, or overwriting shall be valid only if they are signed or initialled by the person signing the Bid.

# D Submission and Opening of Bids

## 23 Submission of Bids

23.1 The Bidder shall submit both Technical and Financial Proposal in the format specified in this RFP on the website i.e. http://etenders.chd.nic.in.

23.2 The documents of Technical Proposal shall have as prescribed hereunder –

**a. Folder 1: Initial Filter & Technical Proposal**

**Part A: Document Fee & Bid Security**

i. Document fee Rs. 50,000/- (Rupees Fifty Thousands only) in the form of crossed Bank Demand Draft in favour of Chandigarh Smart City Limited payable at Chandigarh or by Bank Transfer through RTGS in the A/c of CSCL. The Scanned copy of Demand Draft or proof of bank transfer of requisite amount of Bid document shall be submitted online. The Original Demand Draft shall be submitted at the office of CSCL i.e. New Bridge Building – 2, 2nd Floor, Near TDI Mall, Sector 17 – A, Chandigarh – 160017 on the date of opening of Technical Bid.

ii. Bid Security Rs 5.11 Cr. (Rupees Five Crore Eleven lakhs only. The Scanned copy of the Bank Guarantee submitted for the Bid Security amount shall be submitted online. The Original Bank Guarantee shall be submitted at the office of CSCL i.e. New Bridge Building – 2, 2nd Floor, Near TDI Mall, Sector 17 – A, Chandigarh – 160017 on the date of opening of Technical Bid.

iii. written confirmation authorizing the signatory of the Bid to commit the Bidder, in accordance with ITB 22.2;

iv. documentary evidence in accordance with ITB 15 establishing the Bidder's eligibility and qualifications to perform the Contract if its Bid is accepted;

v. Statement from the bidder in accordance with Clause 4, Section-I, ITB.

**Part B: Technical Proposal**

i. Technical Bid shall comprise of the relevant part of Volume 1, 2 & 4 of Bid Documents along with the following:
ii. Letter of Technical Bid;
iii. Technical Proposal in accordance with ITB 16;
iv. Duly completed Schedules in Section-IV, Bidding Forms, Volume 1 of the Bidding Documents.

**b. Folder 2: Financial Bid**

i. Financial Bid as per prescribed format on e-procurement website only i.e. http://etenders.chd.nic.in.

23.3 All submissions shall be addressed to the Employer as specified in the BDS.

23.4 Bids submitted by hard copy, fax, telex, telegram or e-mail shall not be entertained and shall be rejected.

## 24 Deadline for Submission of Bids

24.1 Bids must be received by the Employer no later than the date and time specified in the BDS.

24.2 The Employer may, at its discretion, extend the deadline for the submission of Bids by amending the Bidding Documents in accordance with ITB 8, in which case all rights and obligations of the Employer and Bidders previously subject to the deadline shall thereafter be subject to the deadline as extended.

## 25 Late Bids

25.1 Bids received by the Authority after the specified time on the Bid Due Date shall not be eligible for consideration and shall be summarily rejected.

## 26 Withdrawal, Substitution, and Modification of Bids

26.1 No Bid shall be modified, substituted or withdrawn by the Bidder on or after the Bid Due Date.

26.2 Any alteration/ modification in the Bid or additional information supplied subsequent to the Bid Due Date, unless the same has been expressly sought for by the Authority, shall be disregarded.

## 27 Bid Opening

27.1 Bids received shall be opened as specified in the BDS.

27.2 The Initial Filter and Technical Bids shall be opened as specified in the BDS in the presence of authorized representatives of the Bidders, who choose to attend. The names of authorized representatives of the Bidders will be announced at the Bid Opening and recorded.

27.3 After the Bid Opening, information relating to the examination, clarification and evaluation of Bids and recommendations concerning the Bid Award shall not be disclosed.

27.4 In the first step, the Employer will evaluate the Initial Filter submitted by the Bidders as per the eligibility criteria as specified in this RFP document. After completion of Initial Filter evaluation, Employer would prepare a list of qualified/eligible bidders. Thereafter, Technical Bids of only qualified/eligible bidders shall be evaluated to access the Technical competence of the Bidders. However, if required at any stage during the technical evaluation of bids, clarifications may be sought by the Bidders. Also, Bidders may be asked to make presentation on their technical competence, if required.

27.5 The Employer will notify, in writing, Bidders who have been rejected on the grounds of their Technical Bids being substantially non-responsive to the requirements of the Bidding Documents and return their Bid security.

27.6 The Employer shall conduct the opening of Price Bids of all Bidders who submitted substantially responsive Technical Bids, in the presence of Bidders' representatives who choose to attend at the address, date and time specified by the Employer specified in the BDS. The Bidder's' representatives who are present shall be requested to sign a register evidencing their attendance.

27.7 The Employer shall prepare a record of the opening of Price Bids that shall include, as a minimum: the name of the Bidder, the Bid Price,, including any discounts. The Bidders' representatives who are present shall be requested to sign the record. The omission of a Bidder's signature on the record shall not invalidate the contents and effect of the record.

# E Evaluation and Comparison of Bids

## 28 Confidentiality

28.1 Information relating to the evaluation of Bids and recommendation of Contract award, shall not be disclosed to Bidders or any other persons not officially concerned with such process until information on Contract award is communicated to all Bidders in accordance with ITB 42.

28.2 Any attempt by a Bidder to influence the Employer in the evaluation of the Bids or Contract award decisions may result in the rejection of its Bid.

28.3 Notwithstanding ITB 28.2, from the time of Bid opening to the time of Contract award, if any Bidder wishes to contact the Employer on any matter related to the bidding process, it shall do so in writing.

## 29 Clarification of Bids

29.1 To assist in the examination, evaluation, and comparison of the Initial Filter, Technical and Price Bids, and qualification of the Bidders, the Employer may, at its discretion, ask any Bidder for a clarification of its Bid, giving a reasonable time for a response. Any clarification submitted by a Bidder that is not in response to a request by the Employer shall not be considered. The Employer's request for clarification and the response shall be in writing. No change in the substance of the Technical Bid or prices in the Price Bid, including any voluntary increase or decrease in the prices, shall be sought, offered, or permitted, except to confirm the correction of arithmetic errors discovered by the Employer in the evaluation of the Bids, in accordance with ITB 36

29.2 If a Bidder does not provide clarifications of its Bid by the date and time set in the Employer's request for clarification, its Bid may be rejected.

## 30 Deviations, Reservations, and Omissions

30.1 During the evaluation of Bids, the following definitions apply:

a. "Deviation" is a departure from the requirements specified in the Bidding Documents;

b. "Reservation" is the setting of limiting conditions or withholding from complete acceptance of the requirements specified in the Bidding Documents; and

c. "Omission" is the failure to submit part or all of the information or documentation required in the Bidding Documents.

## 31 Preliminary Examination of Technical Bids

31.1 The Employer shall examine Initial Filter and Technical Bids to confirm that all documents requested in ITB 11.2 have been provided, and to determine the completeness of each document submitted.

31.2 The Employer shall confirm that all the requisite documents and information have been provided in the Technical Bid, if any of these documents or information is missing, the Bid shall be rejected.

## 32 Qualification of the Bidders

32.1 The Employer shall determine to its satisfaction whether Bidders meet the qualification criteria specified in Section III, Evaluation and Qualification Criteria, during the evaluation of Technical Bids. However, the Employer may again carry out the assessment of the qualification criteria specified in Section III, Evaluation and Qualification Criteria, for the Bidder who submitted the lowest evaluated and substantially responsive Bid only.

32.2 The determination shall be based upon an examination of the documentary evidence of the Bidder's qualifications submitted by the Bidder, pursuant to ITB 15.

32.3 An affirmative determination shall be a prerequisite for award of the Contract to the Bidder. A negative determination shall result in disqualification of the Bid, in which event the Employer shall return the unopened Price Bid to the Bidder.

If the assessment of the Bidder's qualification is conducted for the lowest evaluated Bidder only, in accordance with ITB 32.1, and the result of such assessment is negative, the Employer shall proceed to the next lowest evaluated Bid to make a similar determination.

## 33 Determination of Responsiveness of Technical Bids

33.1 The Employer's determination of a Technical Bid's responsiveness is to be based on the contents of the Bid itself, as defined in ITB 11.2.

33.2 A substantially responsive Technical Bid is one that meets the requirements of the Bidding Documents without material deviation, reservation, or omission. A material deviation, reservation, or omission is one that,

a. if accepted, would:

i. affect in any substantial way the scope, quality, or performance of the Works specified in the Contract; or

ii. limit in any substantial way, inconsistent with the Bidding Documents, the Employer's rights or the Bidder's obligations under the proposed Contract; or

b. if rectified, would unfairly affect the competitive position of other Bidders presenting substantially responsive Bids.

33.3 The Employer shall examine the technical aspects of the Technical Bid submitted in accordance with ITB 17, in particular, to confirm that all requirements of Section VI, Employer's Requirements have been met without any material deviation, reservation, or omission.

33.4 If a Technical Bid is not substantially responsive to the requirements of the Bidding Documents, it shall be rejected by the Employer and may not subsequently be made responsive by correction of the material deviation, reservation, or omission.

## 34 Nonmaterial Nonconformities

34.1 Provided that a Technical Bid is substantially responsive, the Employer may waive any nonconformity in the Technical Bid that does not constitute a material deviation, reservation or omission.

34.2 Provided that a Technical Bid is substantially responsive, the Employer may request that the Bidder submit the necessary information or documentation, within a reasonable period of time, to rectify nonmaterial nonconformities in the Technical Bid related to documentation requirements. Requesting information or documentation on such nonconformities shall not be related to any aspect of the price of the Price Bid. Failure of the Bidder to comply with the request may result in the rejection of its Bid.

34.3 Provided that a Technical Bid is substantially responsive, the Employer shall rectify quantifiable nonmaterial nonconformities related to the Bid Price. To this effect, the Bid Price shall be adjusted, for comparison purposes only, to reflect the price of a missing or non-conforming item or component. The adjustment shall be made using the method indicated in Section III, Evaluation and Qualification Criteria.

## 35 Detailed Evaluation of Technical Bids

35.1 The Employer shall carry out a detailed technical evaluation of the Bids not previously rejected as being substantially non- responsive, in order to determine whether the technical aspects are in compliance with the Bidding Documents. The Bid that does not meet minimum acceptable standards of completeness, consistency and detail, and the specified minimum (or maximum, as the case may be) requirements for specified Schedule of Guarantees, will be rejected for non-responsiveness. In order to reach such a determination, the Employer will examine and compare the technical aspects of the Bids on the basis of the information supplied by the Bidders, taking into account the following:

a. overall completeness and compliance with the Employer's Requirements; conformity of the Works offered with specified performance criteria, corresponding to each Schedule of Guarantees, as indicated in the Technical Requirements; suitability of the Works offered in relation to the environmental and climatic conditions prevailing at the site; and quality, function and operation of any process control concept included in the Bid;

b. other relevant factors, if any, listed in Section III, Evaluation and Qualification Criteria.

35.2 Where alternative technical solutions have been allowed in accordance with ITB 13.4, and offered by the Bidder, the Employer will make a similar evaluation of the alternatives. Where alternatives have not been allowed but have been offered, they shall be ignored.

## 36 Correction of Arithmetical Errors

36.1 During the evaluation of Price Bids, the Employer shall correct arithmetical errors on the following basis:

a. where there are errors between the total of the amounts given under the column for the price breakdown and the amount given under the Total Price, the former shall prevail and the latter will be corrected accordingly;
b. if there is an error in a total corresponding to the addition or subtraction of subtotals, the subtotals shall prevail and the total shall be corrected; and
c. if there is a discrepancy between words and figures, the amount in words shall prevail, unless the amount expressed in words is related to an arithmetic error, in which case the amount in figures shall prevail subject to (a) and (b) above.

36.2 Bidders shall be requested to accept correction of arithmetical errors. Failure to accept the correction, in accordance with ITB 36.1, shall result in the rejection of the Bid.

## 37 Currency for Evaluation

37.1 The Bids shall be in INR and as such evaluation shall be done accordingly.

## 38 Evaluation of Price Bids

38.1 The Employer shall use the criteria and methodologies indicated in this Clause. No other evaluation criteria or methodologies shall be permitted.

38.2 To evaluate a Price Bid, the Employer shall consider the following:
a. the Bid Price, excluding Provisional Sums in the Price Schedules, but including Day work items, where priced competitively;
b. price adjustment for correction of arithmetic errors in accordance with ITB 36.1;
c. price adjustment due to discounts offered in accordance with ITB 18.7 or ITB18.8;
d. price adjustment due to quantifiable nonmaterial nonconformities in accordance with ITB 34.3;
e. the evaluation factors indicated in Section III, Evaluation and Qualification Criteria.

38.3 If price adjustment is allowed in accordance with ITB 18.7& 18.8, the estimated effect of the price adjustment provisions of the Conditions of Contract, applied over the period of execution of the Contract, shall not be taken into account in Bid evaluation.

38.4 If these Bidding Documents allow Bidders to quote separate prices for different lots (contracts), and the award to a single Bidder of multiple lots (contracts), the methodology to determine the lowest evaluated price of the lot (contract) combinations, including any discounts offered in the Letter of Price Bid, is specified in Section III, Evaluation and Qualification Criteria.

38.5 If the Bid, which results in the lowest evaluated Bid Price, is seriously unbalanced or front loaded in the opinion of the Employer, the Employer may require the Bidder to produce detailed price analyses for any or all items of the Price Schedules, to demonstrate the internal consistency of those prices with the methods and the Price Schedules proposed. After evaluation of the price analyses, taking into consideration the Schedule of Payment, the Employer may require that the amount of the Performance Security be increased at the expense of the Bidder to a level sufficient to protect the Employer against financial loss in the event of default of the successful Bidder under the Contract.

## 39 Comparison of Bids

39.1 The Employer shall compare the evaluated prices of all substantially responsive Bids in accordance with ITB 38.2 to determine the lowest evaluated Bid.

### 40 Employer's Right to Accept Any Bid, and to reject any or All Bids

40.1 The Employer reserves the right to accept or reject any Bid, and to annul the bidding process and reject all Bids at any time prior to Contract award, without thereby incurring any liability to Bidders. In case of annulment, all Bids submitted and specifically, Bid Securities shall be promptly returned to the Bidders.

## F Award of Contract

### 41 Award Criteria

41.1 Subject to ITB 40.1, the Employer shall award the Contract to the Bidder whose offer has been determined to be the lowest evaluated Bid and is substantially responsive to the Bidding Documents, provided further that the Bidder is determined to be eligible and qualified to perform the Contract satisfactorily.

### 42 Notification of Award

42.1 Prior to the expiration of the period of Bid validity, the Employer shall notify the successful Bidder, in writing, that its Bid has been accepted. The notification letter (hereinafter and in the Conditions of Contract and Contract Forms called the "Letter of Acceptance") shall specify the sum that the Employer will pay the Contractor in consideration of the execution and completion of the Works (hereinafter and in the Conditions of Contract and Contract Forms called "the Accepted Contract Amount").

42.2 At the same time, the Employer reserves the right to notify all other Bidders of the results of the bidding.

42.3 Until a formal Contract is prepared and executed, the Letter of Acceptance shall constitute a binding Contract.

### 43 Signing of Contract

43.1 Within twenty-one (21) days of notification, the Successful Bidder shall sign the Contract Agreement.

### 44 Performance Security

44.1 Within twenty-one (21) days of the issue of the Letter of Acceptance from the Employer, the successful Bidder shall furnish the Performance Security in accordance with the General Conditions of Contract, subject to ITB 38.5, using for that purpose the Performance Security Form included in Section IX Contract Forms, or another form acceptable to the Employer.

44.2 Failure of the successful Bidder to submit the above- mentioned Performance Security or sign the Contract shall constitute sufficient grounds for the annulment of the award and forfeiture of the Bid Security. In that event the Employer may award the Contract to the next lowest evaluated Bidder whose Bid is substantially responsive and is determined by the Employer to be qualified to perform the Contract satisfactorily.

44.3 The Performance Security shall be valid at all times during the Contract Period (Works and Operation & Maintenance) and renew it 60 (sixty) days prior to the expiry of its validity, otherwise the payment of Bills shall be withheld till the renewal of Bank Guarantee. Moreover, the Bank Guarantee shall be encashable in Chandigarh.

## Section – II: Bid Data Sheet

| | |
|---|---|
| A. General | |
| ITB 1.1 | Invitation for Bids: Two Folder System –<br>Folder 1- Initial Filter and Technical &<br>Folder 2- Financial Bid submission. |
| ITB 1.1 | The Employer is: Chandigarh Smart City Limited |
| ITB 1.1 | The name of contract is: "Rehabilitation/Upgradation of 5 Nos. existing Sewage Treatment Plants (STPs) and Construction of 1 No. new STP on Design, Build and Operate (one year DLP plus 15 years O&M) basis at Chandigarh under Smart City Project" |
| ITB 3.1 | The Contractor shall furnish an Affidavit in this regard, using for that purpose, the Affidavit Form included in Section IX Contract Forms. |
| ITB 4.1 | The Bidder must be a company registered in India, under the companies Act 1956/2013. |
| ITB 4.3 | A certificate from the Statutory Auditor/Company Secretary regarding the Associates shall be provided. |
| ITB 4.6 | Bidder shall provide an undertaking duly attested by the Notary Public/First Class Magistrate on a Non Judicial Stamp Paper of requisite value declaring that the Statements made and the information being submitted is correct and true, and that any false information shall lead to disqualification any stage. |
| B. Bidding Documents | |
| ITB 6.1 | This is to be read as below: |
| | The Bidding Documents consist of Volume 1, 2, 3 and 4, which include all the Sections specified below, and which should be read in conjunction with any addenda issued in accordance with ITB-8. |
| | Volume 1<br>Part : A – Bidding Procedures<br>· Section I : Instructions to Bidders (ITB)<br>· Section II : Bid Data Sheet (BDS)<br>· Section III : Qualification Criteria<br>· Section IV : Bidding Forms and Technical Proposal<br>· Section V :Employers Requirements<br>· Section VI : Drawings<br>· Section VII : General Conditions (GC)<br>· Section VIII : Particular Conditions (PC) Part A – Contract Data<br>Particular Conditions (PC) Part B – Specific Provisions<br>· Section IX : Annex to the Particular Conditions – Contract Forms<br>Volume 1<br>Part : B – Initial Filter Qualification<br>· Section III A: Qualification Criteria<br>· Section III B : Bidding Forms (Initial Filter Qualification (IFQ))<br>· Section III C : Evaluation Criteria (Technical & Financial)<br>Volume 2 – Employer's Requirement- Works Requirements<br>· Section X. Technical Specifications<br>Volume 3 – Financial Proposals<br>· Section XI : Schedule of Payment and Prices<br>· Section XII : Service Level Agreement (O&M)<br>Volume 4 – Drawings<br>· Section XIII : Conceptual Drawings |

| | |
|---|---|
| | |
| ITB 7.1 | The Employer's address is: |
| | *Chief Executive Officer,*<br>*Chandigarh Smart City Limited,*<br>*New Bridge Building – 2, 2nd Floor, Near TDI Mall, Sector 17 – A, Chandigarh – 160017*,<br>*Phone: +91 172 5043196, e-mail: smartcity.chd@nic.in* |
| ITB 7.1 | *Date/Time of Pre-Bid Meeting: on 28th day of the publication of Bid Document on e-tendering website:* http://etenders.chd.nic.in |
| ITB 7.1 | "Response" to any request for clarification, if any, shall be published on e-procurement portal: http://etenders.chd.nic.in |
| ITB 7.4 | A Pre-bid meeting *will* take place at the following place: |
| | Place: Conference Room, New Bridge Building – 2, 2nd Floor, Near TDI Mall, Sector 17 – A, Chandigarh – 160017 |
| | |
| ITB 8.2 | "Addenda" if any, *shall* be published on e-procurement portal: http://etenders.chd.nic.in. |
| C. Preparation of Bids | |
| ITB 10.1 | The language of the Bid is: *English* |
| ITB 10.1 | An accurate translation as a True copy shall be duly attested by a Document Writer or an Advocate. |
| | i. Duly Completed Schedules in Section IV; Bidding Forms, Volume 1 of the Bid Document; including the required qualification information alongwith the requisite certificates, documentary evidence etc;<br>*ii.* The original Bid Document, and addendums, if any, issued by the Employer related to the Technical Proposal, duly stamped and signed by the authorized signatory. |
| ITB 11.3 | The Folder 2 as "Price Bid" comprising of Volume 3 of the Bid Documents along with the following:<br>The original Bid Document, and addendums, if any, issued by the Employer related to the Financial Proposal, duly stamped and signed by the authorized signatory. |
| ITB 13.1 | Alternative Bids shall not be permitted. |
| ITB 16.1(b) | 15 Years of Operation & Maintenance and one year of DLP". |
| ITB 17.2 | This is to be read as follows: Not Applicable |
| ITB 19.1 | Indian National Rupee ( INR) . |
| ITB 20.1 | The Bid validity period shall be *180* days. |
| ITB 21.1 | The amount of the Bid Security shall be INR 5.11 Cr. (Indian National Rupee Five Crore Eleven Lakhs Only). |
| ITB 22.2 | The written confirmation of authorization to sign on behalf of the Bidder shall consist of:<br>*Original Power of Attorney (legally valid) for authorized signatory of the Bid.* |
| ITB 23.1 | The Chief Executive Officer,<br>Chandigarh Smart City Limited,<br>New Bridge Building – 2, 2nd Floor, Near TDI Mall, Sector 17 – A, Chandigarh – 160017E-Mail: smartcity.chd@nic.in |
| D. Submission and Opening of Bids | |
| ITB 24.1 | 28.01.2019 at 15:00 Hrs. |
| ITB 27.1 | 28.01.2019 at 16:00 Hrs. |
| ITB 27.2 | The Chief Executive Officer, |

| | |
|---|---|
| | Chandigarh Smart City Limited,<br>New Bridge Building – 2, 2nd Floor, Near TDI Mall, Sector 17 – A, Chandigarh – 160017E-Mail: smartcity.chd@nic.in |
| ITB 27.6 | To be informed later to the Technically Qualified Bidders only. |
| E. Evaluation and Comparison of Bids | |
| ITB 34.3 | Quantifiable nonmaterial and nonconformities are not being considered. |

# Section - III: Qualification Criteria

For Initial Filter Qualification Criteria
Refer to "Section III-A & III-B" Part – B of Volume 1, &

For Evaluation Criteria (Technical & Financial)
Refer to "Section III-C" Part – B of Volume 1

# Section - IV: Bidding Forms for Technical Bid

## Letter of Technical Bid

Date: [insert date of Bid submission]

To,
Chief Executive Officer,
Chandigarh Smart City Limited,
New Bridge Building – 2, 2nd Floor, Near TDI Mall, Sector 17 – A, Chandigarh – 160017,
Phone: +91 172 5043196, e-mail: smartcity.chd@nic.in

I/We, the undersigned, declare that:

a. I/We, including subcontractors meet the eligibility requirements in accordance with ITB 4 and ITB 5;
b. I/We, including subcontractors have no conflict of interest in accordance with ITB 4;
c. I/We offer to execute in conformity with the Bidding Documents the following Works: "Rehabilitation/Upgradation of 5 Nos. existing Sewage Treatment Plants (STPs) and Construction of 1 No. new STP on Design, Build and Operate (one year DLP plus 15 years O&M) basis at Chandigarh under Smart City Project".
d. Our Bid shall be valid for a period of 180 days from the date fixed for the Bid submission deadline in accordance with the Bidding Documents, and it shall remain binding upon us and may be accepted at any time before the expiration of that period;
e. I/We are not participating, as a Bidder or as a subcontractor, in more than one Bid in this bidding process in accordance with ITB 4.4, other than alternative Bids submitted in accordance with ITB 13; and
f. I/We hereby certify that we have taken steps to ensure that no person acting for us or on our behalf will engage in any type of fraud and corruption.
g. I/We, the undersigned declare that the statements made and the information provided in the duly completed proposal is complete, correct and true in every detail.

Name of the Bidder[*] *[insert complete name of person signing the Bid]*

Name of the person duly authorized to sign the Bid on behalf of the Bidder[†] *[insert complete name of person duly authorized to sign the Bid]*

Title of the person signing the Bid *[insert complete title of the person signing the Bid]*

Signature of the person named above *[insert signature of person whose name and capacity are shown above]*

Date signed *[insert date of signing]* day of *[insert month], [insert year]*

[†]Person signing the Bid shall have the power of attorney given by the Bidder to be attached with the Bid.

## Technical Bid

The Technical Bid shall include the Following information

- Site Organization
- Method Statement: The bidder should submit adequate Executing Plans (Method Statement) with certain definite requirements described in Bidding Documents e.g. X number of tunnel boring machines; inadequate contents of such executing plans would result into disqualification at the Technical Evaluation."
- Plan for Rehabilitation/ Upgradation of 5 Nos. existing Sewage Treatment Plants (STPs) and Construction of 1 No. new STP at Chandigarh
- Technical Bid for achieving treated effluent quality as defined under clause no. 1.4.2, Part-1 General Requirement of Volume 2 with details of Process Design complete with supporting calculations.
- List of Electrical Drives in the format as given in attachment 1
- Mobilization Schedule
- Construction Schedule
- Safety Plan
- Personnel
- Equipment
- Others

Note:

The information requested in this Technical Schedules should be filled with clear responses, information like

- "DDE" (During Detailed Engineering), as per manufactures standard,
- "later on detailing" or other similar meaning works or phrases

would essentially be taken as a non-responsive bid. All queries requested for in the Technical schedules should be provided with clear responses and any responses with the above statement with above statements shall be considered as "Non-Responsive "

## Site Organization

The bidder shall submit a detailed plan of Site Organization, including as;

- Organization Chart (should include all key position).
- authorized person/responsibilities of Contract, financial and Technical Management / responsibility structure with staff positions
- Site Office
- Licenses / permissions for execution of the Works (issued by Authority of origin or equivalent i.e. issued for previous projects)
- Others

## Method Statement

The Bidder must demonstrate adequate execution plans (method statement) to achieve all scope of work with certain definite requirements described in the Bidding Documents, including as;

- During Design
- Construction method (including temporally and permanent); QA/QC;
- Contract management method
- Construction schedule control System and Software; and outputs information for control / management.
- Others

## Mobilization Schedule

The bidder shall write –up detailed Mobilization Schedule, including as; Design stage

- Deployment schedule of key staffs
- Employment schedule for Skilled and none- skilled labour Deployment schedule and list of plant, equipment and materials, Schedule of permissions/ applications required for the Works,
- Others

## Construction Schedule

[The Bidder must submit schedules to achieve all scope of work and breakdown work items as per requirements described in the Bidding Documents as;

- Detailed Construction schedule (Bar chart), including Design stage, procurement equipment & Plant and others.
- Table of Milestones (major items, quantities and completion dates)
- Schedule of submission for contractor's documents.

## Safety Plan

[The Bidder should demonstrate the proposed Safety and Environmental Management Plan that meets the requirements in the Section VI Works Requirements]

## Form PER-1: Proposed Personnel

[insert day, month, year]

Bidder's Legal Name: [insert full name]

IFB No.[insert number]

Page [insert page number] of [insert total number] page

[The Bidder shall provide the names of suitably qualified personnel to meet the specified requirements stated in Section III: Evaluation and Qualification Criteria, Clause 1.1.1.]

| | |
|---|---|
| 1. | Title of position* |
| | Name |
| 2. | Title of position* |
| | Name |
| 3. | Title of position* |
| | Name |
| 4. | Title of position* |
| | Name |

*As listed in Section III.

## Form PER-2: Resume of Proposed Personnel

[insert day, month, year]

Bidder's Legal Name: [insert full name]

IFB No.[insert number]

Page [insert page number] of [insert total number] page

[The Bidder shall provide the data on the experience of the personnel indicated in Form PER-1, in the form below:]

| | | |
|---|---|---|
| Name of Bidder | | |
| Position | | |
| Personnel information | Name | Date of birth |
| | Professional qualifications | |
| Present employment | Name of employer | |
| | Address of employer | |
| | Telephone | Contact (manager / personnel officer) |
| | Fax | E-mail |
| | Job title | Years with present employer |

[Summarize professional experience over the last 20 years, in reverse chronological order. Indicate particular technical and managerial experience relevant to the project.]

| From | To | Company / Project / Position / Relevant technical and management experience |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |

## Form EQU: Equipment

[insert day, month, year]

Bidder's Legal Name: [insert full name]

IFB No. [insert number]

Page [insert page number] of [insert total number] page

[The Bidder shall provide adequate information to demonstrate clearly that it has the capability to meet the requirements for the key equipment listed in Section III: Evaluation and Qualification Criteria, Clause 1.1.2. A separate Form shall be prepared for each item of equipment listed, or for alternative equipment proposed by the Bidder.]

| Item of equipment | | |
|---|---|---|
| Equipment information | Name of manufacturer | Model and power rating |
| | Capacity | Year of manufacture |
| Current status | Current location | |
| | Details of current commitments | |
| Source | Indicate source of the equipment<br>• Owned • Rented • Leased • Specially manufactured | |

Omit the following information for equipment owned by the Bidder.

| Owner | Name of owner | |
|---|---|---|
| | Address of owner | |
| | Telephone | Contact name and title |
| | Fax | Telex |
| Agreements | Details of rental / lease / manufacture agreements specific to the project | |

## Bidders Technical Bid

The Following details shall be provided for each STP as applicable on the basis of proposed technology

| Particular | Unit | Proposed STPs | | | | | |
|---|---|---|---|---|---|---|---|
| | | 30 MGD Diggian | 5 MGD Raipur Kalan | 2 MGD Raipur Khurd | 2 MLD Shukhna Lake | 11 MGD 3 BRD | 1.65 MGD Dhanas |
| **Inlet Chamber** | | | | | | | |
| Design peak flow | | | | | | | |
| No. of units | | | | | | | |
| Size of the Unit (m x m x m) | | | | | | | |
| Free Board (m) | | | | | | | |
| Hydraulic Retention Time (Sec) | | | | | | | |
| Maximum , Average, Minimum water levels (m) | | | | | | | |
| Type & Nos. of Flow Control Gate | | | | | | | |
| Size of Flow Control Gate (m x m) | | | | | | | |
| **Screen Influent Channel** | | | | | | | |
| Design peak flow through each channel | | | | | | | |
| No. of units | | | | | | | |
| MOC | | | | | | | |
| Length of Channel (m) | | | | | | | |
| Width of Channel (m) | | | | | | | |
| Side water depth (m) | | | | | | | |
| Free Board (m) | | | | | | | |
| Hydraulic Retention Time (Sec) | | | | | | | |
| Maximum , Average, Minimum water levels (m) | | | | | | | |
| Type & Nos. of Flow Control Gate | | | | | | | |
| Size of Flow Control Gate (m x m) | | | | | | | |
| **Medium and Fine Screen Channel** | | | | | | | |
| Design peak flow through each channel | | | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| No. of units | | | | | | | |
| MOC | | | | | | | |
| Length of Channel (m) | | | | | | | |
| Width of Channel (m) | | | | | | | |
| Side water depth (m) | | | | | | | |
| Free Board (m) | | | | | | | |
| Clear spacing of bars<br>▪ Medium Screen<br>▪ Fine Screen | | | | | | | |
| Velocity through Screen opening | | | | | | | |
| Length of channel at the upstream of the screen mechanism | | | | | | | |
| Angle of Inclination of screen to horizontal | | | | | | | |
| Maximum , Average, Minimum water levels (m) | | | | | | | |
| Type & Nos. of Flow Control Gate | | | | | | | |
| Size of Flow Control Gate (m x m) | | | | | | | |
| **Equalization Tank, (applicable to 11 MGD 3 BRD and 1.65 MGD Dhanas)** | | | | | | | |
| Design Flow | | | | | | | |
| No. of units | | | | | | | |
| Size of the Unit (m x m x m) | | | | | | | |
| Free Board (m) | | | | | | | |
| Hydraulic Retention Time (Hours) | | | | | | | |
| Maximum , Average, Minimum water levels (m) | | | | | | | |
| Type & Nos. of Flow Control Gate | | | | | | | |
| Size of Flow Control Gate (m x m) | | | | | | | |
| | | | | | | | |
| **Grit Chambers** | | | | | | | |
| Design peak flow through each channel | | | | | | | |
| No. of units | | | | | | | |
| Type / Shape | | | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| MOC | | | | | | | |
| Diameter (m) | | | | | | | |
| Side water depth (m) | | | | | | | |
| Free Board (m) | | | | | | | |
| Hydraulic Retention Time (Sec) at peak flow | | | | | | | |
| Maximum , Average, Minimum water levels (m) | | | | | | | |
| Size of Gate (m x m) | | | | | | | |
| Nos. of Gate (m x m) | | | | | | | |
| Specific gravity of grit | | | | | | | |
| Grit Particle size removal % | | | | | | | |
| Efficiency of Grit removal greater than 150 microns, % | | | | | | | |
| Efficiency of Grit removal greater than 100 but less than 150 microns,% | | | | | | | |
| **Flow Measurement Channel** | | | | | | | |
| Design peak flow | | | | | | | |
| No. of units | | | | | | | |
| MOC | | | | | | | |
| Width (m) | | | | | | | |
| Length (m) | | | | | | | |
| Side water depth (m) | | | | | | | |
| Free Board (m) | | | | | | | |
| Type of flow meter | | | | | | | |
| Maximum , Average, Minimum water levels (m) | | | | | | | |
| **Primary Sedimentation Tank Distribution Chamber** | | | | | | | |
| Design peak flow | | | | | | | |
| No. of unit | | | | | | | |
| Size of the Unit (m x m x m) | | | | | | | |
| Free Board (m) | | | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Hydraulic Retention Time (Sec) | | | | | | | |
| Maximum , Average, Minimum water levels (m) | | | | | | | |
| Type & Nos. of Flow Control Gate | | | | | | | |
| Size of Flow Control Gate (m x m) | | | | | | | |
| **Primary Sedimentation Unit** | | | | | | | |
| No. of primary clarifiers/clariflocculator | | | | | | | |
| Size of Primary Clarifier/clariflocculator | | | | | | | |
| V notch weir plates | | | | | | | |
| Scraper bridge arrangement (Centrally driven, Col supported drive) | | | | | | | |
| MOC for bridge | | | | | | | |
| MOC for under water structure and submerged nuts bolts | | | | | | | |
| Rack Tip Speed | | | | | | | |
| Scrapper sludge loading | | | | | | | |
| Accessories (Torque switch for tripping at overload) | | | | | | | |
| Design flow to each New Primary Clarifier | | | | | | | |
| Surface loading rate at 15° C (at ave) ($m^3/m^2$-day) | | | | | | | |
| Overall weir Loading rate (m3/d/m) | | | | | | | |
| Diameter (m) | | | | | | | |
| Side water depth (m) | | | | | | | |
| Free Board (m) | | | | | | | |
| Hydraulic Retention Time (hr.) | | | | | | | |
| Maximum, Average, Minimum water levels (m) | | | | | | | |
| Inlet Pipe Diameter (From distribution structure to Centre column) (mm) | | | | | | | |
| Centre column diameter (mm) | | | | | | | |
| Bottom floor slope | | | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Raw Sludge Sump & Pump House** | | | | | | | |
| Nos. of Building | | | | | | | |
| Length (m) | | | | | | | |
| Width (m) | | | | | | | |
| Clear height (m) | | | | | | | |
| **Primary Scum Pit & Sump, if applicable** | | | | | | | |
| Scum pit Size (m x m x m) | | | | | | | |
| No. of Scum Pit units | | | | | | | |
| Scum Sump Volume (m3) | | | | | | | |
| Size of Scum Sump (m x m x m) | | | | | | | |
| **Biological Reactor** | | | | | | | |
| Type and nos of Zones (if applicable) | | | | | | | |
| Total Design Flow | | | | | | | |
| Nos. of Stream/Tank | | | | | | | |
| No of sub zones in each stream/ tank | | | | | | | |
| Hydraulic Retention Time (hr) | | | | | | | |
| Length of each Tank (m) | | | | | | | |
| Width of each Tank (m) | | | | | | | |
| Side water depth (m) | | | | | | | |
| Free Board (m) | | | | | | | |
| Maximum , Average, Minimum water levels (m) | | | | | | | |
| Nos. & Size Isolation gates U/s of Bio Reactor (m x m) | | | | | | | |
| **Anoxic Tank, if applicable** | | | | | | | |
| Total Design Flow | | | | | | | |
| Nos. of Stream/Tank | | | | | | | |
| No of sub zones in each stream/ tank | | | | | | | |
| Hydraulic Retention Time (hr) | | | | | | | |
| Length of each Tank (m) | | | | | | | |
| Width of each Tank (m) | | | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Side water depth (m) | | | | | | | |
| Free Board (m) | | | | | | | |
| Maximum , Average, Minimum water levels (m) | | | | | | | |
| Nos. & Size Isolation gates U/s of Anoxic tank (m x m) | | | | | | | |
| | | | | | | | |
| **Anaerobic Tank, if applicable** | | | | | | | |
| Total Design Flow | | | | | | | |
| Nos. of Stream/Tank | | | | | | | |
| No of sub zones in each stream/ tank | | | | | | | |
| Hydraulic Retention Time (hr) | | | | | | | |
| Length of each Tank (m) | | | | | | | |
| Width of each Tank (m) | | | | | | | |
| Side water depth (m) | | | | | | | |
| Free Board (m) | | | | | | | |
| Maximum , Average, Minimum water levels (m) | | | | | | | |
| Nos. & Size Isolation gates U/s of Anaerobic tank (m x m) | | | | | | | |
| **Process Air Blower Building** | | | | | | | |
| Nos. of Building | | | | | | | |
| Length (m) | | | | | | | |
| Width (m) | | | | | | | |
| Clear height (m) | | | | | | | |
| **Final Sedimentation Tank Distribution Chamber, if applicable** | | | | | | | |
| Quantity | | | | | | | |
| Size of Distribution Chamber (m x m x m) | | | | | | | |
| Nos. & Size of Flow regulating Weir Gate | | | | | | | |
| Maximum, Average, Minimum water levels (m) | | | | | | | |
| **Final Sedimentation Tank, if applicable** | | | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Total Design Flow for all Secondary Clarifiers | | | | | | | |
| No. of Secondary Clarifiers | | | | | | | |
| Design flow to each New Secondary Clarifiers | | | | | | | |
| Surface loading rate at 15° C (at ave) ($m^3/m^2$-day) | | | | | | | |
| Overall weir Loading rate (m3/d/m) | | | | | | | |
| Diameter (m) | | | | | | | |
| Side water depth (m) | | | | | | | |
| Free Board (m) | | | | | | | |
| Hydraulic Retention Time (hr.) | | | | | | | |
| Maximum, Average, Minimum water levels (m) | | | | | | | |
| Bottom floor slope | | | | | | | |
| Inlet Pipe Diameter (From distribution structure to Centre column) (mm) | | | | | | | |
| Centre column diameter (mm) | | | | | | | |
| Nos. & Size Isolation gates U/s of Secondary Clarifier (m x m) | | | | | | | |
| **Return Activated Sludge (RAS) Sump and Pump House, if applicable** | | | | | | | |
| Nos. of Building | | | | | | | |
| Length (m) | | | | | | | |
| Width (m) | | | | | | | |
| Clear height (m) | | | | | | | |
| **Secondary Scum Pit & Sump, if applicable** | | | | | | | |
| Scum pit Size (m x m x m) | | | | | | | |
| No. of Scum Pit units | | | | | | | |
| Scum Sump Volume (m3) | | | | | | | |
| Size of Scum Sump (m x m x m) | | | | | | | |
| **Filtration Building** | | | | | | | |
| Nos. of Building | | | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Length (m) | | | | | | | |
| Width (m) | | | | | | | |
| Clear height (m) | | | | | | | |
| **Travelling Bridge Filters, if applicable** | | | | | | | |
| Total Design Flow at Peak | | | | | | | |
| Total Design Flow at Average | | | | | | | |
| Nos. of Filters | | | | | | | |
| Average Filtration Rate L/m2/min (max) | | | | | | | |
| Total Backwash water required(max) | | | | | | | |
| **Cloth Media Disc Filters, if applicable** | | | | | | | |
| Total Design Flow at Peak | | | | | | | |
| Total Design Flow at Average | | | | | | | |
| Nos. of Filters | | | | | | | |
| Average Filtration Rate m3/m3/hr (max) | | | | | | | |
| Peak Filtration Rate m3/m3/hr (max) | | | | | | | |
| Total Backwash water required (max) | | | | | | | |
| **Membrane Filtration, if applicable** | | | | | | | |
| Total Design Flow at Peak | | | | | | | |
| Total Design Flow at Average | | | | | | | |
| Nos. of Units | | | | | | | |
| Flux Rate (Max) LMH | | | | | | | |
| Total Backwash water required (max) | | | | | | | |
| Interval between backwash | | | | | | | |
| Maximum Spare Space in each unit | | | | | | | |
| **Disinfection System** | | | | | | | |
| Total Design Flow | | | | | | | |
| Nos. of Stream/Tank | | | | | | | |
| Hydraulic Retention Time (Minutes) | | | | | | | |
| Length of each Tank (m) | | | | | | | |
| Width of each Tank (m) | | | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Side water depth (m) | | | | | | | |
| Free Board (m) | | | | | | | |
| Maximum , Average, Minimum water levels (m) | | | | | | | |
| Nos. & Size of Isolation gates | | | | | | | |
| **Disinfection System Building** | | | | | | | |
| Nos. of Building | | | | | | | |
| Length (m) | | | | | | | |
| Width (m) | | | | | | | |
| Clear height (m) | | | | | | | |
| **Treated Effluent Reuse Pump Station** | | | | | | | |
| Nos. of Building | | | | | | | |
| Total Design flow at Peak | | | | | | | |
| Total Design flow at Average | | | | | | | |
| Sump Size | | | | | | | |
| Hydraulic Retention Time, min | | | | | | | |
| Length (m) | | | | | | | |
| Width (m) | | | | | | | |
| Clear height (m) | | | | | | | |
| | | | | | | | |
| **Permeate Tank for MBR, if applicable** | | | | | | | |
| Total Design Flow | | | | | | | |
| Nos. of Tank | | | | | | | |
| Hydraulic Retention Time (Minutes) | | | | | | | |
| Length of each Tank (m) | | | | | | | |
| Width of each Tank (m) | | | | | | | |
| Side water depth (m) | | | | | | | |
| Free Board (m) | | | | | | | |
| Maximum , Average, Minimum water levels (m) | | | | | | | |
| Nos. & Size of Isolation gates | | | | | | | |
| | | | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Sludge Thickening sump and Pump House, if applicable** | | | | | | | |
| Nos of Building | | | | | | | |
| No of Floors | | | | | | | |
| Length (m) | | | | | | | |
| Width (m) | | | | | | | |
| Clear height (m) | | | | | | | |
| **Sludge Thickener** | | | | | | | |
| Total Design Flow | | | | | | | |
| Nos. of Thickener | | | | | | | |
| Design flow to each Thickener | | | | | | | |
| Type of Thickener | | | | | | | |
| MOC | | | | | | | |
| Solids concentration | | | | | | | |
| Solids Recover | | | | | | | |
| **Thickened Sludge sump** | | | | | | | |
| Total Design Flow | | | | | | | |
| No. of units | | | | | | | |
| Size of Tank (m x m x m) | | | | | | | |
| MOC | | | | | | | |
| Hydraulic Retention Time (hr) | | | | | | | |
| Free Board (m) | | | | | | | |
| **Sludge Pump/ Centrifuge Feed Pump House** | | | | | | | |
| Nos. of Building | | | | | | | |
| Length (m) | | | | | | | |
| Width (m) | | | | | | | |
| Clear height (m) | | | | | | | |
| **Dewatering Centrifuge Building and Control** | | | | | | | |
| Quantity | | | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Length (m) | | | | | | | |
| Width (m) | | | | | | | |
| Clear height (m) | | | | | | | |
| **Electrical Main Sub Station Building** | | | | | | | |
| Quantity | | | | | | | |
| Length (m) | | | | | | | |
| Width (m) | | | | | | | |
| Clear height (m) | | | | | | | |
| **Electrical Sub Station Building** | | | | | | | |
| Quantity | | | | | | | |
| Length (m) | | | | | | | |
| Width (m) | | | | | | | |
| Clear height (m) | | | | | | | |
| **Fire Fighting Pump House** | | | | | | | |
| No. of units | | | | | | | |
| Size of Tank (m x m x m) | | | | | | | |
| Hydraulic Retention Time (hr) | | | | | | | |
| Free Board (m) | | | | | | | |

Mechanical Data Sheet

| | | | |
|---|---|---|---|
| Mechanical Medium and Fine Screen | | | |
| Make | | | |
| Model | | | |
| Quantity (W+S) | | | |
| Type | | | |
| Velocity (m/s) Lean flow Avg.flow Peak flow | | | |
| Water level (m) Lean flow Avg. flow Peak flow | | | |
| Screen | | | |
| Capacity peak flow (mld) | | | |
| Clear Spacing (mm) | | | |
| Width (mm) | | | |
| Height (mm) | | | |
| Side water depth (mm) | | | |
| Angle of inclination (deg.) | | | |
| Cross section of the bars (8mm and depth 50mm) | | | |
| Raking speed (m/min) | | | |
| Motor rating (kw) | | | |
| Materials of Construction | | | |
| Frame, Rake carriage, Screen bars, Fasteners. Canopy etc. | | | |
| Screw Conveyor System | | | |
| Type | | | |
| Make | | | |
| MOC | | | |
| Speed (rpm) | | | |
| Motor rating (kw) | | | |
| Size of screw (mm) | | | |
| Angle of screw (deg.) | | | |
| Wash System | | | |
| Operating Pressure (bar) | | | |
| Flow Rate (ltrs./sec) | | | |
| Source for Back Wash | | | |
| Compaction and Dewatering | | | |
| Type | | | |
| Make | | | |
| MOC | | | |
| Speed (rpm) | | | |
| Motor rating (kw) | | | |
| Control Panel | | | |
| Make | | | |
| Over all dimensions (mm x mm x mm) | | | |
| Degree of protection | | | |
| Grit Removal System | | | |
| Make | | | |

| | | | |
|---|---|---|---|
| Model | | | |
| Quantity (W+S) | | | |
| Type | | | |
| Design peak flow through each grit chamber | | | |
| Size each Grit Basins L*B*D (m) | | | |
| Degree of vortex rotation ( 270 / 360 deg ) | | | |
| MOC of axial flow propeller, All wetted parts | | | |
| Reduction Gear | | | |
| Make | | | |
| Type | | | |
| Drive Motor | | | |
| Make | | | |
| Speed | | | |
| Rating | | | |
| Efficiency of removal | | | |
| Grit greater than 150 microns in size, (%) | | | |
| Grit greater than 100 but less than 150 microns in size (%) | | | |
| Grit Classifier / Washer | | | |
| Type | | | |
| Width/diameter of Screw (mm) | | | |
| Speed of Screw (m/Sec) | | | |
| Motor rating (kw) | | | |
| MOC of Screw | | | |
| Air Lift pump / Turbo Grit Pump, as applicable | | | |
| Impellers, volute, shaft, Seal | | | |
| Motor Rating (kw) | | | |
| | Primary Sedimentation Unit | | |
| No. of primary clarifier tanks | | | |
| Size of Clarifier | | | |
| Bridge Type | | | |
| Rack Tip Speed (cm/sec) | | | |
| Scrapper sludge loading (kN/m) | | | |
| Material of construction: | | | |
| Feed Well | | | |
| Bridge Superstructure and Walkway | | | |
| Rake Arm | | | |
| Centre Cage | | | |
| Rake Blades | | | |
| V-notch weir | | | |
| Squeegees | | | |
| Scum skimmer assembly | | | |
| Scum Box | | | |
| Scum Baffle | | | |

| | | | |
|---|---|---|---|
| Fasteners - Under Water & Above Water | | | |
| Accessories (Torque switch for tripping at overload) | | | |
| Constant bleed arrangement | | | |
| Electrically operated gate valve with head stock at sludge outlet line timer operated. | | | |
| | Primary Scum Pump | | |
| Make | | | |
| Type | | | |
| Quantity | | | |
| Capacity | | | |
| Head | | | |
| Speed | | | |
| Pump Efficiency % | | | |
| Motor Efficiency % | | | |
| Overall efficiency (pump+ Motor) % | | | |
| Absorbed power (Bkw) | | | |
| Motor Rating (Kw) | | | |
| Materials of Construction | | | |
| Casing | | | |
| Impeller | | | |
| Shaft | | | |
| Mechanical Seal | | | |
| | Mixers in Raw Sludge Sump | | |
| Size of Sump | | | |
| Volume m3 | | | |
| Mixers Nos | | | |
| Type | | | |
| Impeller diameter (mm) | | | |
| Speed (RPM) | | | |
| KW Rating Drive | | | |
| BKW transferred to Fluid | | | |
| BKW transferred to Fluid in Watt / M3 | | | |
| MOC of Lifting arrangement with Guide rail, lifting Chain | | | |
| | Raw Sludge Pump | | |
| Make | | | |
| Type | | | |
| Quantity | | | |
| Capacity | | | |
| Head | | | |
| Speed | | | |
| Pump Efficiency % | | | |
| Motor Efficiency % | | | |
| Overall efficiency (pump+ Motor) % | | | |
| Absorbed power (BKW) | | | |
| Motor Rating (Kw) | | | |
| Materials of Construction | | | |

| | | | |
|---|---|---|---|
| Casing | | | |
| Impeller | | | |
| Wearing rings | | | |
| Casing rings | | | |
| Shaft | | | |
| Shaft sleeves | | | |
| Shaft Seal | | | |
| Base plate | | | |
| | Biological Reactor | | |
| | Submersible Mixers (for each type zone as applicable) | | |
| No of Reactor | | | |
| Reactor Volume m3 | | | |
| Nos of Mixers per reactor | | | |
| Type | | | |
| Impeller diameter (mm) | | | |
| Speed (RPM) | | | |
| KW Rating Drive | | | |
| BKW transferred to Fluid | | | |
| BKW transferred to Fluid in Watt / M3 | | | |
| MOC of Lifting arrangement with Guide rail, lifting Chain | | | |
| | Mixers in Anoxic Zone, if applicable | | |
| No of Reactor | | | |
| Reactor Volume m3 | | | |
| Nos of Mixers per reactor | | | |
| Type | | | |
| Impeller diameter (mm) | | | |
| Speed (RPM) | | | |
| KW Rating Drive | | | |
| BKW transferred to Fluid | | | |
| BKW transferred to Fluid in Watt / M3 | | | |
| MOC of Lifting arrangement with Guide rail, lifting Chain | | | |
| | Diffuser | | |
| Make | | | |
| Model | | | |
| Type | | | |
| Diffuser OD x Length | | | |
| Design Air-Flow per Aeration (Maximum/Average) | | | |
| Quantity per Aeration Basin | | | |
| Total Quantity in Aeration Basin | | | |
| Weight per Diffuser | | | |
| Design air flow per diffuser | | | |
| Efficiency per diffuser | | | |
| Oxygenation capacity | | | |
| Diffuser Membrane | | | |
| Type-self-cleaning (Yes/No) | | | |

| | | | |
|---|---|---|---|
| Membrane Material | | | |
| Means of attachment | | | |
| Membrane OD X Length (mm x mm) | | | |
| Pore size (Average) mm | | | |
| No. of Pores per length of Diffuser (Nos./m) | | | |
| Bubble size (Avg) (mm) | | | |
| Materials of Construction | | | |
| Diffuser Tube | | | |
| Membrane | | | |
| Pipe clamps & Hardware | | | |
| Air grid pipe line & Size | | | |
| Coupling Type | | | |
| Performance | | | |
| SOTE Oxygen transfer rate Clear water Field | | | |
| Zone of influence (m) | | | |
| Zone of oxygenation (m) | | | |
| Depth of mixing (m) | | | |
| Velocity thro' the Diffuser (m/Sec) | | | |
| Diffuser Head loss & Efficiency V/s Submergence Curve attached | | | |
| Diffuser Grid Drawing arrangement details attached | | | |
| | Alum Dosing System, if applicable | | |
| Pumps | | | |
| Make | | | |
| Type | | | |
| Quantity (W+S) | | | |
| Model | | | |
| Capacity max/min | | | |
| Head | | | |
| Stroke adjustment | | | |
| Stroking speed max/min | | | |
| Casing material | | | |
| Diaphragm material | | | |
| Shaft material | | | |
| Motor rating | | | |
| Motor Make | | | |
| | Process Air Blowers | | |
| Make | | | |
| Type | | | |
| Quantity (W+S) | | | |
| Average Air Requirement $Nm^3/Hr$ | | | |
| Peak Air Requirement $Nm^3/Hr$ | | | |
| Capacity of each blower Provided Nm3/Hr | | | |
| Design maximum discharge pressure (mlc) | | | |

| | | | |
|---|---|---|---|
| Efficiency (%) | | | |
| Blower Speed (RPM) | | | |
| Absorbed power | | | |
| Motor rating | | | |
| Motor Speed (RPM) | | | |
| Type of bearing | | | |
| Noise level at Duty Point in dB(A) at 1.86 m from the unit dB(A) | | | |
| Vibration (mm/sec) | | | |
| With Acoustic Hood, dB(A) | | | |
| Without Acoustic Hood, dB(A) | | | |
| Weight – Blower (Kg) | | | |
| Maximum lifting weight (Kg) | | | |
| Dimensions ( L x W x H) (mm x mm x mm) | | | |
| Coupling Type, Make | | | |
| Coupling Make | | | |
| Cooling System | | | |
| Material of construction: | | | |
| Casing | | | |
| Impeller | | | |
| Shaft | | | |
| Common Base frame | | | |
| Acoustic Hood: | | | |
| Type | | | |
| Material of Construction | | | |
| Inlet/Outlet silencer | | | |
| Type | | | |
| Make | | | |
| Filter media | | | |
| Mean air velocity (m/s) | | | |
| MLR Pumps | | | |
| Make | | | |
| Type | | | |
| Quantity | | | |
| Capacity | | | |
| Head | | | |
| Speed | | | |
| Pump Efficiency % | | | |
| Motor Efficiency % | | | |
| Overall efficiency (pump+ Motor) % | | | |
| Absorbed power (BKW) | | | |
| Motor Rating (Kw) | | | |
| VFD operation | | | |
| Materials of Construction | | | |
| Pump casing, Connection chamber, Diffuser / Inlet Diffuser | | | |
| Propeller hub | | | |
| Propeller Blades | | | |

| | | | |
|---|---|---|---|
| Shaft | | | |
| Impeller key & bolt | | | |
| Wearing ring | | | |
| Chain | | | |
| Lifting Hoop | | | |
| Bearing Bracket | | | |
| Motor casing | | | |
| O-ring | | | |
| Coupling ring | | | |
| Bolts, nuts | | | |
| Shaft seal | | | |
| Type of seal | | | |
| Monitoring | | | |
| Thermal winding protection | | | |
| Motor housing monitoring | | | |
| Mechanical seal leakage detection | | | |
| Bearing temp monitoring | | | |
| Motor | | | |
| Type | | | |
| Nominal speed | | | |
| Motor efficiency | | | |
| Degree of protection | | | |
| Insulation class | | | |
| Coolant temp | | | |
| inal Sedimentation Tank, if applicable | | | |
| Bridge Type | | | |
| Rack Tip Speed (cm/sec) | | | |
| Scrapper sludge loading (kN/m) | | | |
| Material of construction: | | | |
| Feed Well | | | |
| Bridge Superstructure and Walkway | | | |
| Rake Arm | | | |
| Centre Cage | | | |
| Rake Blades | | | |
| V-notch weir | | | |
| Squeegees | | | |
| Scum skimmer assembly | | | |
| Scum Box | | | |
| Scum Baffle | | | |
| Fasteners - Under Water & Above Water | | | |
| Accessories (Torque switch for tripping at overload) | | | |
| Constant bleed arrangement | | | |
| Electrically operated gate valve with head stock at sludge outlet line timer operated. | | | |
| Mixers in Return Activated Sludge (RAS) Sump | | | |
| Size of Sump | | | |
| Mixers Nos | | | |

| | | | |
|---|---|---|---|
| Type | | | |
| Impeller diameter (mm) | | | |
| Speed (RPM) | | | |
| KW Rating Drive | | | |
| BKW transferred to Fluid | | | |
| BKW transferred to Fluid in Watt / M3 | | | |
| MOC of Lifting arrangement with Guide rail, lifting Chain | | | |
| | Return Sludge Pump | | |
| Make | | | |
| Type | | | |
| Quantity | | | |
| Capacity | | | |
| Head | | | |
| Speed | | | |
| Pump Efficiency % | | | |
| Motor Efficiency % | | | |
| Overall efficiency (pump+ Motor) % | | | |
| Absorbed power (BKW) | | | |
| Motor Rating (Kw) | | | |
| Materials of Construction | | | |
| Casing | | | |
| Impeller | | | |
| Wearing rings | | | |
| Casing rings | | | |
| Shaft | | | |
| Shaft sleeves | | | |
| Shaft Seal | | | |
| Base plate | | | |
| | Secondary Scum Pump, if applicable | | |
| Make | | | |
| Type | | | |
| Quantity | | | |
| Capacity | | | |
| Head | | | |
| Speed | | | |
| Pump Efficiency % | | | |
| Motor Efficiency % | | | |
| Overall efficiency (pump+ Motor) % | | | |
| Absorbed power (Bkw) | | | |
| Motor Rating (Kw) | | | |
| Materials of Construction | | | |
| Casing | | | |
| Impeller | | | |
| Shaft | | | |
| Mechanical Seal | | | |
| | Tertiary Filtration System | | |
| Type | | | |

| | | | |
|---|---|---|---|
| Quantity | | | |
| Capacity | | | |
| MOC of Filtration Media | | | |
| Dimension of Filters | | | |
| Cleaning / Backwashing of Filters | | | |
| (Describe cleaning / backwashing System) | | | |
| Filter Drive KW | | | |
| | UV Disinfection System | | |
| Make | | | |
| Type | | | |
| Quantity (W+S) | | | |
| Dosing Rate | | | |
| Other necessary details | | | |
| | Sludge Thickener, if applicable | | |
| Make | | | |
| Type | | | |
| Quantity (W+S) | | | |
| Capacity | | | |
| MOC | | | |
| | Mixers in Thickened Sludge Sump, if applicable | | |
| Size of Sump | | | |
| Volume m3 | | | |
| Numbers (W) | | | |
| Type | | | |
| MOC | | | |
| | Thickened Sludge Pump, if applicable | | |
| Make | | | |
| Type | | | |
| Model | | | |
| Quantity (W+S) | | | |
| Capacity (cum/hr) | | | |
| Head (mlc) | | | |
| Efficiency (%) | | | |
| Max. solid size (mm) | | | |
| Speed (RPM) | | | |
| Absorbed power (BKW) | | | |
| Motor rating (Kw) | | | |
| Material of construction | | | |
| Casing | | | |
| Rotor | | | |
| Stator | | | |
| Line shaft | | | |
| Sealing | | | |
| Base Plate | | | |
| Centrifuge Feed Pump | | | |
| Make | | | |
| Type | | | |
| Model | | | |

| | | | |
|---|---|---|---|
| Quantity (W+S) | | | |
| Capacity (cum/hr) | | | |
| Head (mlc) | | | |
| Efficiency (%) | | | |
| Max. solid size (mm) | | | |
| Speed (RPM) | | | |
| Absorbed power (BKW) | | | |
| Motor rating (Kw) | | | |
| Material of construction | | | |
| Casing | | | |
| Rotor | | | |
| Stator | | | |
| Line shaft | | | |
| Sealing | | | |
| Base Plate | | | |
| Centrifuge | | | |
| Make | | | |
| Type | | | |
| Model | | | |
| Quantity (W+S) (nos.) | | | |
| Feed rate per centrifuge (cum/hr) | | | |
| Mass feed rate | | | |
| % dried solids | | | |
| Noise level (dBA) at 1m distance from the machine, dB(A) | | | |
| Vibration level | | | |
| Bowl Diameter (mm) | | | |
| Bowl length (mm) | | | |
| Taper Angle (degree) | | | |
| Bowl speed (RPM) | | | |
| Centrifugal force (kgf) | | | |
| Gear Box ratio | | | |
| Overall Dimension (mm) | | | |
| Weight (Centrifuge + Motor) (Kgs) | | | |
| Protection of centrifuge | | | |
| Material of Construction: | | | |
| Bowl | | | |
| Scroll | | | |
| Blade | | | |
| Scroll lead face protection | | | |
| Casing-Upper & Lower | | | |
| Wear protection | | | |
| Motor :- Main Drive | | | |
| Motor rating (Main Drive) | | | |
| Absorbed power (BKW) | | | |
| Motor speed | | | |
| Motor -Back drive | | | |
| Motor rating | | | |

| | | | |
|---|---|---|---|
| Motor speed | | | |
| Make of Motor | | | |
| Polymer Dosing System | | | |
| Pumps | | | |
| Make | | | |
| Type | | | |
| Quantity (W+S) | | | |
| Model | | | |
| Capacity max/min | | | |
| Head | | | |
| Stroke adjustment | | | |
| Stroking speed max/min | | | |
| Casing material | | | |
| Diaphragm material | | | |
| Shaft material | | | |
| Motor rating | | | |
| Motor Make | | | |
| Polyelectrolyte preparation Tank: | | | |
| Make | | | |
| Model | | | |
| Quantity (W+S) | | | |
| Size (Diameter x Height) | | | |
| Material of construction | | | |
| Agitator Type | | | |
| Motor rating | | | |
| Motor speed | | | |
| Impeller material | | | |
| Shaft material | | | |
| For Alternate proposal (Continuous Polymer Solution preparation) of Polymer Dosing System please furnish the details. | | | |
| Plant DrainPumps | | | |
| Make | | | |
| Type | | | |
| Quantity | | | |
| Capacity | | | |
| Head | | | |
| Speed | | | |
| Pump Efficiency % | | | |
| Motor Efficiency % | | | |
| Overall efficiency (pump+ Motor) % | | | |
| Absorbed power (Bkw) | | | |
| Motor Rating (Kw) | | | |
| Materials of Construction | | | |
| Casing | | | |
| Impeller | | | |
| Shaft | | | |

| | | | |
|---|---|---|---|
| Mechanical Seal | | | |
| Fire Fighting Pumps | | | |
| No. of pumps | | | |
| Capacity | | | |
| Type | | | |
| Head | | | |
| MOC | | | |
| Motor Rating (Kw) | | | |
| Details of Fire Fighting system shall be enclosed along with the offer | | | |
| S/G/D/G HOT , EOT at following location of suitable Capacity | | | |
| EOT for Raw sludge pumping station | | | |
| EOT for wastewater pumping station for equalization tank | | | |
| EOT for Process Air Blower Building | | | |
| EOT for Return Sludge pumping station | | | |
| | | | |
| EOT for Centrifuge feed pump house | | | |
| EOT for Centrifuge building | | | |
| EOT for Fire Fighting Pump House | | | |
| Gates | | | |
| Make | | | |
| Model | | | |
| Quantity (W+S) | | | |
| Service | | | |
| Type | | | |
| Spindle Type | | | |
| Size | | | |
| Weight | | | |
| Seating Head | | | |
| Unseating Head | | | |
| Material of construction: | | | |
| Wall Thimble | | | |
| Gate | | | |
| Frame | | | |
| Spindle | | | |
| Stem coupling | | | |
| Seating face | | | |
| Wedge | | | |
| Headstock | | | |
| Gear House cover & stem guide | | | |
| Lift Nut | | | |
| Fasteners & Anchors | | | |
| Lifting mechanism, Gear House & stem guide | | | |
| Gate Actuators | | | |
| Make | | | |
| Type | | | |

| | | | |
|---|---|---|---|
| Model | | | |
| Service | | | |
| Number | | | |
| Motor Rating (Kw) | | | |
| Motor speed (RPM) | | | |
| Protection | | | |
| Butterfly valves | | | |
| Make | | | |
| Type | | | |
| Model | | | |
| Service | | | |
| Quantity (W+S) | | | |
| Size | | | |
| Rating | | | |
| Test pressure | | | |
| Material of construction: | | | |
| Body | | | |
| Disc | | | |
| Sealing face | | | |
| Shaft | | | |
| Gear Reducers | | | |
| Make | | | |
| Material | | | |
| Flange Drilling standard | | | |
| Actuators | | | |
| Make | | | |
| Type | | | |
| Model | | | |
| Service | | | |
| Number | | | |
| Motor Rating (Kw) | | | |
| Motor speed (RPM) | | | |
| Protection | | | |
| Sluice valves | | | |
| Make | | | |
| Type | | | |
| Model | | | |
| Service | | | |
| Number | | | |
| Size | | | |
| Rating | | | |
| Test pressure | | | |
| Material of construction: | | | |
| Body | | | |
| Gate | | | |
| Sealing face | | | |
| Shaft | | | |
| Gear Reducers | | | |

| | | | |
|---|---|---|---|
| Make | | | |
| Material | | | |
| Flange Drilling standard | | | |
| Sluice Valve Actuators | | | |
| Make | | | |
| Type | | | |
| Number | | | |
| Motor rating | | | |
| Design Torque | | | |
| Time for full open to full close | | | |
| Knife Gate valves | | | |
| Make | | | |
| Type | | | |
| Model | | | |
| Service | | | |
| Number | | | |
| Size | | | |
| Rating | | | |
| Test pressure | | | |
| Body material | | | |
| gate material | | | |
| Sealing face material | | | |
| Shaft material | | | |
| Gear Reducers : | | | |
| Make | | | |
| Material | | | |
| Flange Drilling standard | | | |
| Knife Gate Valve Actuators | | | |
| Make | | | |
| Type | | | |
| Number | | | |
| Motor rating | | | |
| Design Torque | | | |
| Time for full open to full close | | | |
| Non Return valves | | | |
| Make | | | |
| Type | | | |
| Model | | | |
| Service | | | |
| Quantity (W+S) | | | |
| Size | | | |
| Rating | | | |
| Test Pressure | | | |
| Design standard | | | |
| Flange drilling standard | | | |
| Material of construction: | | | |
| Body | | | |
| Disc/plates | | | |

| | | | |
|---|---|---|---|
| Spring | | | |
| Shaft | | | |
| Plug valves | | | |
| Make | | | |
| Type | | | |
| Model | | | |
| Service | | | |
| Quantity (W+S) | | | |
| Size | | | |
| Rating | | | |
| Test pressure | | | |
| Body material | | | |
| Pipes & Specials | | Detailed List Required | |
| **Wastewater lifting Pump in Equalization Tank, if applicable** | | | |
| Make | | | |
| Type | | | |
| Quantity | | | |
| Capacity | | | |
| Head | | | |
| Speed | | | |
| Pump Efficiency % | | | |
| Motor Efficiency % | | | |
| Overall efficiency (pump+ Motor) % | | | |
| Absorbed power (Bkw) | | | |
| Motor Rating (Kw) | | | |
| Materials of Construction | | | |
| Casing | | | |
| Impeller | | | |
| Shaft | | | |
| Mechanical Seal | | | |

Note: Pump data sheet & performance curve should be enclosed along with the offer.

| | | |
|---|---|---|
| Mechanical Decanter for SBR | | |
| Make | | |
| Model | | |
| Quantity (W+S) | | |
| Type | | |
| Capacity peak flow (mld) | | |
| Diameter of pipe (mm) | | |
| Height of Decanter (mm) | | |
| Angle of inclination (deg.) | | |
| Decanter speed (m/min) | | |
| Motor rating (kw) | | |
| Materials of Construction | | |

Note:

A full set of performance (certificate of performance) shall be provided. The performance curves shall include gas flow and pressure, cooling water, flow, pressure and temperature rise and guaranteed power curves.

Electrical Data Sheets

| S. No. | Description | Unit | Particulars |
|---|---|---|---|
| A. | HV SWITCGEAR | | |
| 1 | General | | |
| i | Type | | |
| ii | Rated voltage, no. of phases and rated frequency | kV / - / Hz | |
| iii | System neutral earthing | | |
| 2 | Rated Insulation Levels | | |
| i | - Rated short duration power frequency withstand voltage | kV (rms) | |
| ii | - Rated lightning impulse withstand voltage | kV (peak) | |
| iii | Rated normal current of bus bars under design ambient temperature of $50^0$C and material of bulbar | A / - | |
| iv | Rated short-time withstand current and time | kA (rms) / sec | |
| v | Dynamic rating | kA (peak) | |
| 3 | Constructional Requirements | | |
| i | Minimum thickness of sheet steel in mm Cold rolled (Frame/Enclosure/Covers) | mm | |
| ii | Degree of protection of enclosure | | |
| iii | Color finish shade | | |
| iv | - Interior | | |
| v | - Exterior | | |
| vi | Cable connection | | |
| 4 | Circuit Breakers | | |
| i | Type | | |
| ii | Rated current inside the cubicle under design ambient temperature at 50°C | A | |
| iii | Rated operating sequence | | |
| iv | Rated short time breaking current | kA (rms) | |
| v | Rated short time making current | kA (peak) | |
| vi | Rated short-time withstand current and time | kA (rms) / sec | |
| vii | Rated peak withstand current | kA (peak) | |
| viii | Min. no. of auxiliary contacts | | |
| ix | Type of operating mechanism | | |
| x | - Normal | | |
| xi | - Emergency | | |
| xii | Auxiliary control voltage | | |
| xiii | - Closing coil / Tripping coil | V | |
| xiv | - Spring charging motor | V | |
| xv | - Space heater and lighting | V | |
| xvi | Earthing switch | | |
| 5 | Current and Voltage Transformers | | |
| | Details of ratio, taps, burden, accuracy | | |
| 6 | Protective Relays | | |
| i | Type | | |
| ii | Auxiliary supply | V | |
| iii | Details of protective relays | | |
| 7 | Switch-Disconnector | | |

| | | | |
|---|---|---|---|
| i | Rated current under design ambient temperature of 50°C | A | |
| ii | Rated making current | kA (peak) | |
| iii | Rated peak withstand capacity | kA (peak) | |
| iv | Rated short-time withstand current and time | kA (rms) / sec | |
| 8 | Insulation levels | | |
| i | Rated lightning impulse withstand voltage | | |
| ii | - Across the isolating distance | kV (peak) | |
| iii | - Phase to phase, between phases and across open switching devices | kV (peak) | |
| iv | Rated short duration power frequency withstand voltage | | |
| v | - Across the isolating distance | kV(rms) | |
| vi | - Phase to phase, between phases and across open switching devices | kV(rms) | |
| vii | Operating mechanism | | |
| viii | - Closing and opening | | |
| ix | - Control voltage | V | |
| x | Earthing switch | | |
| 9 | HV Fuses | | |
| i | Application | | |
| ii | Type | | |
| iii | Rated current | A | |
| iv | Rated voltage | kV | |
| v | Rated breaking capacity | kA (rms) | |
| B. | TRANSFORMER | | |
| 1 | General | | |
| i | Quantity required | Nos. | |
| ii | Installation (Indoor / Outdoor) | | |
| 2 | Ratings | | |
| i | Rated power | | |
| ii | (*) Contractor shall submit their design calculation for rating of each equipment for CSCL or their representative for approval. | kVA | |
| iii | No load voltage Primary | kV | |
| iv | Secondary | kV | |
| v | Number of phases | | |
| vi | Rated frequency | Hz | |
| vii | Impedance Voltage | % | |
| viii | Vector group | | |
| ix | Winding material | | |
| x | Type of cooling | | |
| 3 | System Voltage | | |
| i | Nominal system voltage Primary | kV | |
| ii | Secondary | kV | |
| iii | Highest system voltage - Primary | kV | |
| | - Secondary | kV | |
| 4 | Transformer Secondary Neutral Earthing | | |

| | | | |
|---|---|---|---|
| 5 | Insulation Withstand | | |
| i | Rated lightning impulse withstand voltage | kV (peak) | |
| ii | - Secondary | kV (rms) | |
| 6 | Temperature Rise | | |
| i | Reference design ambient | $^0$C | |
| ii | Temperature rise over design ambient temperature of 50$^0$C | | |
| iii | - Average winding temperature rise (by resistance measurement) | $^0$C | |
| iv | - Top oil temperature rise (by thermometer) | $^0$C | |
| 7 | Tap Changing Gear | | |
| i | Type of tap changer | | OLTC |
| ii | Tapping range | % | |
| iii | Tapping steps | % | |
| 8 | Bushings | | |
| i | Rated voltage – Primary | kV | |
| ii | – Secondary | kV | |
| iii | One minute power frequency withstand voltage (dry and wet) – Primary | kV (rms) | |
| iv | - Secondary (Line and Neutral) | kV (rms) | |
| v | Rated lightning impulse withstand voltage | kV (peak) | |
| vi | Nominal creepage distance | mm/kV | |
| 9 | Guaranteed Losses | | |
| i | No Load losses at 75 degree C, rated frequency at rated voltage | Kw | |
| ii | Full Load losses at 75 degree C, rated frequency at rated voltage | Kw | |
| iii | Total Losses | Kw | |
| iv | Tolerances on Losses | | |
| 10 | Terminal Connections | | |
| i | Primary line end | | |
| ii | Secondary line end | | |
| iii | Secondary neutral end | | |
| iv | Type of wheels | | |
| C. | MOTORS | | |
| 1 | Type | | |
| 2 | Rating | kW | |
| 3 | Rated voltage | kV | |
| 4 | Type of mounting | | |
| 5 | Duty type | S1 | |
| 6 | Method of starting | | |
| 7 | Type of system earthing | | |
| 8 | Class of insulation | | |
| 9 | Design ambient temperature | °C | |
| i | Limits of temperature rise of winding | | |
| ii | - Determination by resistance method | °C | |
| iii | - Determination by ETD method | °C | |
| 10 | Location | | |

| | | | |
|---|---|---|---|
| 11 | Degree of Protection | | |
| 12 | Cooling designation | | |
| 13 | External cable details | | |
| 14 | Space heater for motor | | |
| D. | CAPACITORS & APFC PANELS | | |
| 1 | Capacitor Bank | | |
| 2 | Application | | |
| 3 | Arrangement | | |
| 4 | Type of insulation | | |
| 5 | Rated output | kVAR | |
| 6 | Rated voltage | V | |
| 7 | Rated frequency and no. of phases | Hz / - | |
| 8 | Capacitor bank connection | | |
| 9 | Type of mounting and location | | |
| 10 | Design ambient temperature | °C | |
| 11 | Type of switching | | |
| 12 | Control supply | | |
| 13 | No. of steps for control | Nos. | |
| 14 | Degree of protection of enclosure | | |
| 15 | Colour finish shade | | |
| E | MV & LV CABLE | | |
| 1 | MV XLPE Power Cables | | |
| i | Rated voltage U / Uo (Um) | kV | |
| ii | Material of conductor | | |
| iii | Cross-sectional area | | |
| iv | Type of insulation | | |
| v | Inner sheath | | |
| vi | Outer sheath | | |
| vii | Conductor and insulation screening | | |
| viii | Material of armour | | |
| 2 | LV Power, Control and Lighting Cables | | |
| i | Rated voltage U / Uo (Um) | kV | |
| ii | Material of conductor | | |
| iii | Cross-sectional area | | |
| iv | Type of insulation | | |
| v | Inner sheath | | |
| vi | Outer sheath | | |
| vii | Material of armour | | |
| viii | Cable Protection | | |
| ix | Rated voltage, no. of phases and rated frequency | V / - / Hz | |
| x | System neutral earthing | | |
| xi | Rated short duration power frequency withstand voltage | | |
| xii | - Power circuit | kV (rms) | |
| xiii | - Control circuit | kV (rms) | |
| xiv | Rated normal current of bus bars under design ambient temperature of 50°C and material of bulbar | A / - | |

| | | | |
|---|---|---|---|
| xv | Rated short-time withstand current and time | kA (rms) / sec | |
| F. | L.V. SWITCHGEAR | | |
| 1 | Constructional Requirements | | |
| i | Thickness of sheet steel in mm Cold rolled (Frame/Enclosure/Covers) | mm | |
| ii | Degree of protection of enclosure | | |
| iii | Colour finish shade | | |
| iiia | - Interior | | |
| iiib | - Exterior | | |
| iv | Cable connection | | |
| 2 | Circuit Breakers | | |
| i | Type | | |
| ii | Rated current inside the cubicle under design ambient temperature at 50°C | A | |
| iii | Rated operating sequence | | |
| iv | Rated short-time withstand current and time | kA (rms)/ sec | |
| v | Min. no. of auxiliary contacts | | |
| vi | Type of operating mechanism | | |
| via | - Normal | | |
| vib | - Emergency | | |
| vii | Auxiliary control voltage | | |
| viia | - Closing coil / Tripping coil | V | |
| viib | - Spring charging motor | V | |
| viic | - Space heater and lighting | V | |
| viid | Earthing switch | | |
| 3 | Current and Voltage Transformers | | |
| i | Details of ratio, taps, burden, accuracy | | |
| 4 | Protective Relays | | |
| i | Type | | |
| ii | Auxiliary supply | V | |
| iii | Details of protective relays | | |
| 5 | Moulded Case Circuit Breakers | | |
| i | Type | | |
| ii | Rated current when installed within cubicle under design ambient temperature of$50^0$C | A | |
| iii | Rated short-time withstand current | kA (rms) | |
| 6 | Miniature Circuit Breakers | | |
| i | Type | | |
| ii | Rated current when installed within cubicle under design ambient temperature of$50^0$C | A | |
| iii | Rated short-time withstand current | kA (rms) | |
| 7 | Motor Starters and Contactors | | |
| i | Type | | |
| ii | Rated current | A | |
| iii | Rated voltage of coil | V | |
| iv | Utilization category | | |
| G. | BUS DUCT | | |
| 1 | Make | - | |

| | | | |
|---|---|---|---|
| 2 | Type Designation | - | |
| 3 | Degree of protection | - | |
| 4 | Maximum weight of each section | - | |
| 5 | Over all dimensions | - | |
| i | Length | mm | |
| ii | Width | mm | |
| iii | Height | mm | |
| 6 | Clearance in air | | |
| i | Phase to Phase | mm | |
| ii | Phase to earth | mm | |
| 7 | Bus bar Current Rating | Amp | |
| 8 | Bus bar Size | $mm^2$ | |
| 9 | Main Bus bar | $mm^2$ | |
| 10 | Earth Bus bar | $mm^2$ | |
| 11 | Minimum size of S.C. withstand | $mm^2$ | |
| 12 | Bus bar Materials | Al/Cu | |
| i | Main Bus bar | | |
| ii | Earth Bus bar | | |
| 13 | Insulating Material | | |
| i | Type | | |
| ii | Tracking Index | | |
| 14 | Voltage withstand | | |
| i | 1 minute power frequency | KV | |
| ii | Impulse(1.2/50µS) | KV | |
| iii | 1 minute short circuit withstand capacity | KA | |
| 15 | Safety Features | Provided/ Not Provided | |
| 16 | Earth Jumpers for each bus duct section enclosure | Provided/ Not Provided | |
| 17 | Slope at bottom with drain plug | Provided/ Not Provided | |
| 18 | Space Heater | Provided/ Not Provided | |
| H. | SOFT STARTER | | |
| 1 | Type, Application and criteria for sizing | | |
| 2 | Connection | | |
| 3 | Rating | Kw | |
| 4 | Quantity | Nos. | |
| 5 | Rated voltage | V | |
| 6 | Insulation levels | | |
| 7 | Rated lightning impulse withstand voltage | KV | |
| i | - Across the isolating distance | | |
| ii | - Phase to phase, between phases and across open switchingdevices | | |
| iii | Rated short duration power frequency withstand voltage | | |
| iv | - Across the isolating distance | | |

| | | | |
|---|---|---|---|
| v | - Phase to phase, between phases and across open switchingdevices | | |
| 8 | Installation | | |
| 9 | Enclosure | | |
| i | - Sheet steel thickness | mm | |
| ii | - Degree of protection | | |
| iii | - Color finish shade | | |
| 10 | External cable details | | |
| 11 | Type of cooling | | |
| 12 | Bypass arrangement | Reqd. | |
| 13 | Control supply | V | |
| I | VARIABLE FREQUENCY DRIVES | | |
| 1 | General | | |
| i | Make | | Approved Vendor List |
| ii | Type | | Inverter Controlled AC Drives |
| iii | Applicable Standard | | IEC-1800-2 |
| 2 | Drive Application | | Blowers, Pumps |
| 3 | Quantity | Nos | |
| 4 | Type of converters | | |
| 5 | Inverter capacity at specified pf | | |
| 6 | Rated Current | | |
| 7 | Load power factor | | |
| 8 | Max. continuous current | | |
| 9 | Rated voltage with number of phases | | |
| 10 | Rated frequency | | |
| 11 | Converter Bridge | | |
| 12 | Single Quadrant/Two quadrant/ Four Quadrant | | |
| 13 | Control Characteristics | | |
| i | Speed Control | | |
| ii | Rated speed | rpm | |
| iii | Speed ratio | | |
| iv | Constant torque/constant power | | |
| v | Speed accuracy | | |
| vi | Closed loop/open loop | | |
| vii | Accel. /Deccel. time | | |
| viii | Possibility of Remote Operation | Yes / No | |
| ix | Overall Harmonic Limitation | % | |
| 14 | Braking | | |
| i | Type of braking | | |
| ii | Braking Torque | | |
| 15 | Miscellaneous | | |
| i | Soft-start | Yes/No | Yes |
| ii | Flying restart | Yes/No | |
| iii | Auto restart | Yes/No | |
| iv | Kinetic Buffering | Yes/No | |

| | | | |
|---|---|---|---|
| v | Confirm whether following minimum Indications on Drive Panel are Provided | Yes/No | |
| vi | Motor running | | |
| vii | Motor stopped / trip | | |
| viii | AC mains 'ON' | | |
| ix | System Ready to start | | |
| x | VFD system fault | | |
| 16 | Confirm whether Digital Display of following Minimum parameters on the Drive Panels:- | Yes/No | |
| i | Input AC Voltage | | |
| ii | Input AC Frequency | | |
| iii | Input AC Current | | |
| iv | Output Voltage | | |
| v | Output Current VFD/Bypass | | |
| vi | Output Frequency | | |
| vii | Motor speed | | |
| viii | Whether Necessary transducers provided for indicating motor speed & current inPLC/DCS. | Yes/No | |
| | | | |
| J | BATTERY | | |
| 1 | Make | | |
| 2 | Type of battery | | |
| 3 | Applicable Standards | IS/BS | |
| 4 | Number of battery banks required | Nos. | 1 |
| 5 | Ambient conditions | ºC | Min.-25 ºC, Max-45ºC, |
| 6 | Description | Unit | Technical Particulars |
| i | D.C. system voltage | V | 30 |
| ii | Ampere hour capacity of battery at 27 Deg. C at 5 hour rate to give final cell voltage of 1.16volts/cell | Ah | As per requirement |
| iii | Momentary load/duration | A | |
| iv | Emergency load/duration | A | |
| v | Continuous load/duration | A | |
| vi | Nominal voltage | V | |
| vii | Cell voltage - initial/final | V | |
| viii | Number of cells per bank required to give rated voltage | Nos | |
| ix | Number of spare cells per bank | Nos | |
| x | Overall dimensions | | |
| xi | Each Cell (L x W x H) | mm x mm x mm | |
| xii | Complete battery in the rack | mm x mm x mm | |
| xii | Mounting arrangement | | |
| xiii | Charging method | | |
| K | BATTERY CHARGER | | |
| 1 | General | | |
| i | Make | | Approved Vendor List |

| | | | |
|---|---|---|---|
| ii | Applicable Standards | | IS-4540 |
| iii | Number required<br><br>(i) Battery charger | <br><br>Nos | |
| iv | Rated Output voltage (DC) | V | 110 |
| v | Rated Output | kW | Suitable for Load Cycles |
| vi | DC System Earthing | | Unearthed |
| 2 | Description | Unit | Technical Particulars |
| i | Voltage regulation from no load to rated load | % | 1 |
| ii | Ambient Design Temperature | Deg. C | 45°C |
| iii | Busbar material & size | - | Al |
| iv | Overall dimensions | Mm x mm x mm | |
| 3 | Battery Details | | |
| i | Float/Trickle charging current of battery | mA | |
| ii | Boost Charging Current of Battery (Maximum) | A | |
| iii | Boost Charging Voltage of Battery (maximum) | V | |
| iv | Maximum Time for Boost charging of Battery | hr | |
| v | Battery capacity & no. of cells | Ah | |
| vi | | Nos. | |
| 4 | AC System Data | | |
| i | Supply | Voltage V | |
| ii | | Phase | |
| iii | (i) Variation in supply Voltage | % | |
| iv | (ii) Variation in supply frequency | % | |
| v | Short Circuit level | kA | |
| 5 | Type of earthing | | |
| 6 | Performance | | |
| 7 | DC voltage setting adjustment for float charger | | |
| 8 | Voltage stabilization for constant voltage regulator | | |
| 9 | Maximum permissible variation in DC voltage (no load to fullload) | | |
| i | D.C. current adjustment for boost Charging | | 30% to 100% of max boost charging current |
| ii | Current stabilization for constant current regulator for boost charger | | 2% |
| iii | Minimum permissible power factor to rated continuousload | | 0.8 |
| iv | Permissible ripple content at rated continuous load | | 3% max |
| v | Relay for auto changeover from Float to boost mode to be provided (in case of float-cum-boostcharger) | | Yes |
| 10 | Constructional Features | | |
| i | Thickness of sheet steel Frame, Frame enclosures, doors, covers andpartition | mm | 2 |
| ii | Degree of protection | | IP-54 |
| iii | Colour finish shade | | Light smoke Grey |

| | | | | |
|---|---|---|---|---|
| iv | Earthing bus | Material | | |
| v | | Size | mmx mm | |
| vi | Earthing conductor | Material | | |
| vii | | Size | mmx mm | |
| 11 | Cable entry | | | |
| 12 | Cable Sizes<br>(i) Battery | sq.mm | | |
| 13 | (ii) DC output | sq.mm | | |
| 14 | (iii) AC input (iv) | sq.mm | | |
| L. | DC DISTRIBUTION BOARD | | | |
| 1 | General | | | |
| i | Make | | | |
| ii | Applicable standards | | | As per Specification |
| iii | DC System voltage (Nominal) | V | | 110 |
| iv | DC System Earthing | | | Unearthed |
| v | Ambient Design Temperature | Deg. C | | 45ºC |
| vi | Bus bar material , rating and size | | | |
| vii | DC Bus Load | | | |
| viii | Total continuous DC load | A | | |
| ix | Short time loads (Additional to continuous loads) | | | |
| x | (i) DC lights/Facia lamps | A | | |
| xi | (ii) Starting current and duration of Largest Connected DC Motor | A | | |
| 2 | Constructional Features | | | |
| i | Thickness of sheet steel Frame, Frame enclosures, doors,<br>covers and partition | mm | | 2 |
| ii | Degree of protection | | | IP-54 |
| iii | Colour finish shade | | | Light smoke Grey |
| iv | Earthing bus | Material | | |
| v | | Size | Mm x mm | |
| 3 | Earthing conductor | Material | | |
| i | | Size | Mm x mm | |
| 4 | Cable entry | | | |
| i | Cable Sizes<br>DC Input from Battery | sq.mm | | |
| ii | DC output to Load | sq.mm | | |
| M. | UPS SYSTEM | | | |

| | | | |
|---|---|---|---|
| 1 | UPS | | |
| i | Make | | |
| ii | Type designation | | |
| iii | Rating (KVA at 0.8 p.f) | | |
| iv | Mode of operation | | |
| v | Dynamic Response under following conditions | | |
| vi | For 50% step load | | |
| vii | For 100% step load and unload | | |
| viii | Power supply interruption and restoration | | |
| ix | Load Transferred to bypass line | | |
| x | When one inverter gets faulty and load transferred to healthyinverter | | |
| xi | Maximum recovery time to reach steady state after above disturbance | | |
| xii | Type of cooling/ Redundancy in cooling system | | |
| xiii | Degree ingress protection of panels | | |
| xiv | Noise Level | | |
| xv | Colour shade | | |
| xvi | Overall efficiency of UPS system (Ratio of output load to input power drawn from mains when all chargers and inverters are ON and synchronized with bypass | | |
| xvi-i | At 100% Load | | |
| xvi-ii | At 75 % Load | | |
| xv-iii | At 50% load | | |
| xvii | Guaranteed dimensions (L x D x H) of UPS system except ACDB andbattery | | |
| xviii | Heat loss of the total system (KW) | | |
| xix | Cable entry | | |
| 2 | INVERTOR | | |
| i | Rating (at specified ambient)/ No. of phases | | |
| ii | Steady state output voltage (Nominal/ Variation) | | |
| iii | Steady state output frequency (Nominal/ Variation) | | |
| iv | Output voltage adjustment range at rated load | | |
| v | Input voltage DC (Nominal/Range) | | |
| vi | Frequency variation limit for inverter phase locked with mains | | |
| vii | Allowable unbalance between phases (for 3 only) | | |
| viii | Harmonic distortion at inverter output at rated load | | |
| ix | For liner load | | |
| x | For nonlinear load | | |
| xi | Overloading capacity and duration | | |
| xii | Short circuit capacity and duration | | |
| xiii | Efficiency at 100% / 75%/ 50% load | | |
| xiv | Output voltage and phase angles (for 3-ph. Only) | | |
| | For 30% unbalance load | | |
| | For 40% unbalance load | | |
| | For 50% unbalance load | | |

| | | | |
|---|---|---|---|
| | For 100% unbalance load | | |
| xv | Type of control circuit | | |
| xvi | Load crest factor (for which UPS is designed) | | |
| xvii | Max. allowed rating of outgoing feeders for fault clearance of feeder fault by UPS with and without mains bypass supply back up (as percentage of UPS rating | | |
| | With fast acting semi-conducting fuse | | |
| | With normal HRC fuse | | |
| 3 | STATIC SWITCH | | |
| i | No. of static switches in each UPS system | | |
| ii | Current rating at specified ambient (continuous / short time) | | |
| iii | Type of static switch | | |
| iv | Transfer time | | |
| v | Synchronized mode | | |
| vi | Unsynchronized mode | | |
| 4 | BATTERY CHARGER | | |
| i | Current Rating | | |
| ii | Type of Charger | | |
| iii | Output voltage under float/ rapid charging condition | | |
| iv | Output voltage accuracy under specified input | | |
| v | Maximum ripple content on DC side with battery connected/ disconnected | | |
| vi | Maximum harmonic content in input current | | |
| vii | Efficiency at 100%/ 75 % 50% of load | | |
| viii | Input transformer rating | | |
| 5 | MANUAL TRANSFER DEVICES | | |
| i | Make/ Type designation | | |
| ii | Rating Continuous/ short time | | |
| 6 | 6. BATTERY | | |
| i | Make | | |
| ii | Type designation | | |
| iii | Type | | |
| iv | AH rating | | |
| v | End cell voltage | | |
| vi | Nominal voltage | | |
| vii | No. of cells in each bank | | |
| viii | No. of battery banks | | |
| ix | | | |
| x | Nominal Volts/ Cell | | |
| xi | Float Voltage/ Cell | | |
| xii | Rapid charging Voltage/ cell | | |
| xiii | Rapid charging time | | |
| xiv | Overall rack dimensions, no. of racks and tiers with clearances | | |
| xv | Container type | | |

| | | | |
|---|---|---|---|
| xvi | No. of recommended air charges/ hour for battery room | | |
| 7 | STEPDOWN BYPASS TRANSFORMER WITH SOLID STATE VOLTAGESTABLIZER | | |
| i | Make/ Type designation | | |
| ii | Rating and voltage ratio | | |
| iii | Accuracy of stabilizer | | |
| iv | Type of control | | |
| v | Type of cooling | | |
| vi | Type of stabilizer | | |
| 8 | AC DISTRIBUTION BOARD | | |
| i | Make/ Type designation | | |
| ii | Rating of board | | |
| iii | No. of outgoing feeders/ rating of each | | |
| iv | Overall dimension (L x D x H) | | |
| v | Maximum and minimum operating height | | |
| 9 | CELL BOOSTER | | |
| i | Make/ Type designation | | |
| ii | Voltage range | | |
| iii | Current range | | |
| 10 | RELIABILITY | | |
| i | Safety factor used for selecting the components | | |
| ii | Electronic devices | | |
| iii | Electric devices | | |
| iv | MTBF/ MTTR | | |
| v | Availability factor | | |
| N. | LIGHTING FIXTURES & ACCESSORIES | | |
| 1 | General | | |
| i | Illumination levels at various premises whether considered as per Specification | Yes /No | |
| ii | Normal supply voltage, phase and frequency | AC | 240,1 Phase, 50Hz |
| iii | Normal supply voltage, phase and Earth | DC | 110 |
| iv | frequency | Hz | |
| v | Variation in supply: | | |
| | (i) Voltage (AC & DC) | % | +/-10 |
| | (ii) Frequency | % | +/-5 |
| | (iii) Combined voltage & frequency | % | +/-10 |
| vi | Design ambient air temperature | 0C | 45ºC |
| vii | Luminaries terminal suitable for | | |
| viii | Indoor area | | |
| | (i) Conductor material | | Copper |
| | (ii) Cable size | Coresxmm | 2Core-1.5 |
| ix | Outdoor area | | |
| | (i) Conductor material | | copper |
| | (ii) Cable size | Cores xmm | |
| x | Luminaries earthing terminal suitable for | | |
| | (i) Conductor material | | |
| | (ii) Conductor size | SWG | |

| | | | |
|---|---|---|---|
| xi | Luminaries | | |
| xii | Fluorescent Luminaries | | |
| | Make | | |
| | Type | | |
| | Rating | | |
| xiii | HPSV / HPMV Luminaries | | |
| | Make | | |
| | Type | | |
| | Rating | | |
| xiv | Flood Light Luminaries | | |
| | Make | | |
| | Type | | |
| | Rating | | |
| xv | LED Luminaries | | |
| | Make | | |
| | Type | | |
| | Rating | | |
| O. | LIGHTING SYSTEM AND EQUIPMENT | | |
| 1 | System Particular | | |
| i | Voltage | | |
| ii | (i) 3 Phase, 4 wire 50 Hz system | | |
| iii | Rated | V | 415 |
| iv | Maximum | V | |
| v | One minute withstand voltage | | |
| vi | D.C. system | | |
| vii | Rated | V | |
| viii | System short-circuit level | | |
| ix | At 415 V, A.C. | kA (rms) | |
| x | At 110 V.D.C. | kA (D.C.) | |
| xi | Reference ambient temperature | °C | |
| 2 | Distribution Board/Panels | | |
| | Main, floor mounted distribution boards | | |
| | Main Lighting distribution board(A.C.) | | |
| i | Make | | |
| ii | Type | | |
| iii | Degree of protection | | |
| iv | Bus bar material | | |
| v | Bus bar current rating | A | |
| vi | Short circuit current rating | kA | |
| vii | Details of Incoming and Outgoing feeders | | |
| viii | Cable entry | | |
| ix | Location | | |
| 3 | Emergency lighting panel (D.C.) | | |
| i | Make | | |
| ii | Type | | |
| iii | Degree of protection | | |
| iv | Bus bar material | | |
| v | Bus bar current rating | A | |

| | | | | |
|---|---|---|---|---|
| vi | Short circuit current rating | kA | | |
| vii | Details of Incoming and Outgoing feeders | | | |
| viii | Cable entry | | | |
| ix | Location | | | |
| x | Single phase DBs, wall/structure mounting | | | |
| 4 | SLDB for indoor area | | | |
| i | Make | | | |
| ii | Type | | | |
| iii | Details of Incoming and Outgoing feeders | | | |
| iv | Degree of Protection | | | |
| 5 | SLDB for outdoor area | | | |
| i | Make | | | |
| ii | Type | | | |
| iii | Details of Incoming and Outgoing feeders | | | |
| iv | Degree of Protection | | | |
| v | Paint Finish | | | |
| vi | (i) Colour shade: | | | |
| 6 | Street Light Poles And Flood Light Poles | | | |
| a | Street Light Pole | | | |
| i | Type | | | |
| ii | Total Height: | m | | |
| iii | Quantity: | Nos. | | |
| b | Floodlight Light Pole | | | |
| i | Type | | | |
| ii | Total height : | m | | |
| iii | Quantity: | Nos. | | |
| iv | No. Of floodlights to be fixed per Pole | No. | | |
| P. | EARTHING AND LIGHTNING PROTECTION SYSTEM | | | |
| | | Size | Material | No. of Leads & Quantity |
| 1 | Main Earthing Grid<br>Buried in earth | | | |
| 2 | Buried in floor slabs in buildings | | | |
| 3 | Conductor Leads To Equipment (above ground) | | | |
| 4 | Transformers | | | |
| i | Transformer neutral to bottom of tank | | Copper | |
| ii | From bottom of tank to earth grid | | GS | |
| iii | Transformer tanks and radiator bank | | GS | |
| iv | Fence posts and gates (Flex. braid) | | GS | |

Instrumentation Data Sheets

| | | | |
|---|---|---|---|
| A | PRESSURE GAUGE | | |
| 1 | GENERAL | | |
| a. | Tag No. | | |
| b. | Quantity | Nos. | |
| c. | Service | Sewage water &Gas | |
| d. | Type | | |
| e. | Range | | |
| f. | Pressure (Nor./ Max.) | Kg/cm2g | |
| g. | Temperature (Nor./ Max.) | OC | |
| h. | Case Mat'l | | |
| i. | Bezel Gasket | | |
| j. | Zero Adjustment | | |
| l. | Window Mat'l | | |
| m. | Accuracy | | |
| n. | Below Out Protection | | |
| o. | Over Range Protection | | |
| ii. | DIAL | | |
| a. | Size | | |
| b. | Color | | |
| iii. | ELEMENT | | |
| a. | Sensor | | |
| b. | Sensor Mat'L | | |
| c. | Movement Mat'L | | |
| iv. | CONNECTION | | |
| a. | Gauge End Connection | | |
| b. | Connection Location | | |
| c. | Process Connection | | |
| d. | Rating Connection | | |
| v. | ACCESSORIES | | |
| a. | Snubber/ Syphon | | |
| b. | Snubber/ Syphon Conn. | | |
| c. | Snubber/ Syphon Mat'L | | |
| vi. | DIAPHRAGM SEAL | | |
| a. | Primary Element | | |
| b. | Primary Element Material | | |
| c. | Other Wetted part | | |
| d. | Upper Body Mat'L | | |
| e. | Lower Body Mat'L | | |
| f. | Seal Fluid | | |
| vii. | REMARKS | | |
| a. | Enclosure Protection | | |
| b. | Mounting | | |
| c. | Area Classification | | |
| d. | Ambient Temp. | | |
| B. | PRESSURE SWITCH | | |

| | | | |
|---|---|---|---|
| 1 | GENERAL | | |
| a. | Tag No. | | |
| b. | Quantity | No. | |
| c. | Service | | |
| d. | Measuring Range | | |
| e. | Accuracy | | |
| f. | Set Pressure | Kg/cm2g | |
| g. | Diff. Pressure | Kg/cm2g | |
| h. | Over Range Protection | | |
| i. | Switch Action On | | |
| j. | Access to setting | | |
| 2 | DESIGN DATA | | |
| a. | Fluid | | |
| b. | Press. (Nor./ Max) | Kg/cm2g | |
| c. | Temp. (Nor/ Max) | OC | |
| 3 | SENSOR | | |
| a. | Type | | |
| b. | End Connection | | |
| 4 | DIAPHRAGM SEAL | | |
| a. | Type | | |
| b. | Process Connection | | |
| c. | Size and Rating | | |
| d. | Rating | | |
| 5 | MATERIALS | | |
| a. | Sensor | | |
| b. | Wetted Parts | | |
| c. | Case | | |
| d. | Finish | | |
| 6 | MICRO-SWITCH | | |
| a. | Type | | |
| b. | Contact Form & Rating | | |
| c. | No. of Switches | | |
| d. | Local Display Indicator | | |
| 7 | ACCESSORIES | | |
| a. | Syphon/ Snubber | | |
| b. | Syphon/ Snubber Conn. | | |
| c. | Syphon/ Snubber Mat'L | | |
| 8. | REMARK | | |
| C. | PRESSURE TRANSMITTER | | |
| 1 | Tag No. | | |
| 2 | Qty | No | |
| 3 | Type | | |
| 4 | Service/ Fluid | | |
| 5 | Element | | |
| 6 | Element Material | | |
| 7 | Case Material | | |
| 8 | Cover Flange Material | | |
| 9 | Other Wetted Parts Mat'L | | |

| | | | |
|---|---|---|---|
| 10 | Output | | |
| 11 | Power Supply | | |
| 12 | Local Display Indicator | | |
| 13 | Enclosure Protection | | |
| 14. | Flange Rating | | |
| 15 | Accuracy | | |
| 16 | Flange Rating | | |
| 17 | Flange Mat'L | | |
| 18 | Capillary Length | | |
| 19 | Capillary mat'L | | |
| 20 | Armour Flexible Mat'L | | |
| 21 | Temp (Nor./ Max.) | $^{O}C$ | |
| 22 | Press. (No./ max.) | Kg/ $Cm^2$ | |
| 23 | Range Span/ Set | | |
| 24 | Seal Fluid | | |
| 25 | Cable Entry | | |
| 26 | Mounting | | |
| 27 | Mounting Access/ Clamps | | |
| 28 | Ambient Temp. | | |
| 29 | Area Classification | | |
| D. | DIFFERENTIAL PRESSURE TRANSMITTER | | |
| 1 | GENERAL | | |
| a. | Tag No. | | |
| b. | Quantity | | |
| c. | Service | | |
| d. | Type | | |
| e. | Case Mat'L | | |
| f. | Enclosure Protection | | |
| g. | Power Supply | | |
| h. | Accuracy | | |
| i. | Output | | |
| j. | Element | | |
| k. | Element Material | | |
| l. | Cover Flange Material | | |
| m. | Process Connection | | |
| n. | Range Span/ Set | | |
| o. | Zero Elevation $mmH_2O$ | | |
| p. | Zero Suppress. Mm $H_2O$ | | |
| 2 | DESIGN DATA | | |
| a. | Press. (Nor./ Max) | Kg/ $Cm^2g$ | |
| b. | Temp. (Nor/ Max) | $^{O}C$ | |
| 3 | DIAPHRAGM SEAL | | |
| a. | Process Connection | | |
| b. | Flange Rating | | |
| c. | Flange mat'L | | |
| d. | Capillary mat'L | | |
| e. | Armour Flexible Mat'L | | |

| | | | |
|---|---|---|---|
| f. | Capillary Length | | |
| g. | Seal Fluid | | |
| 4 | REMARK | | |
| a. | 3- valve Manifold | | |
| b. | Cable Entry | | |
| c. | Local Display Indocator | | |
| d. | Mounting | | |
| e. | Mounting Access./ Clamps | | |
| f. | Area Classification | | |
| g. | Ambient Temp. | | |
| E. | LEVEL INDICATOR (MAGNETIC TYPE) | | |
| 1 | GENERAL | | |
| i | Tag No. | | |
| ii | Quantity | | |
| iv | Service | | |
| v | Type | | |
| 2 | PROCESS | | |
| i | Pressure (Minimum -- Normal--- Maximum) | Kg/ $Cm^2g$ | |
| ii | Temperature (Minimum -- Normal--- Maximum) | $^OC$ | |
| iv | Specific Gravity | | |
| 3 | MOUNTING | | |
| 4 | FLANGE RATING | | |
| 5 | PROCESS CONNECTION SIZE | | |
| 6 | VENT | | |
| i | Type | | |
| ii | Size | | |
| 7 | DRAIN | | |
| i | Type | | |
| ii | Size | | |
| 8 | INDICATOR | | |
| i | Flag with Scale | | |
| ii | Follower with Scale | | |
| iii | None | | |
| 9 | UNIT OF MEASUREMENT | | |
| i | Metric (5 cm increments) | | |
| 10 | OPTIONAL ACCESSORIES | | |
| i | | | |
| 11 | TESTS &INSPECTION | | |
| i | Hydrostatic Test | | |
| 12 | CERTIFICATION | | |
| i | Calibration Certificate | | |
| ii | Certificate of conformance | | |
| F. | LEVEL SWITCH (CAPACITANCE TYPE) | | |
| 1 | GENERAL | | |
| a. | Tag No. | | |
| b. | Quantity | | |

| | | | |
|---|---|---|---|
| c. | Service | | |
| d. | Measuring Range | | |
| e. | Mounting | | |
| 2 | ENCLOSURE PROTECTION | | |
| a. | Enclosure Protection | | |
| b. | Enclosure Protection Mat'L | | |
| c. | Conn. Size | | |
| d. | Flange Mat'L | | |
| e. | Flange Rating | | |
| f. | Power Supply | | |
| g. | Switch Relay type | | |
| h. | Qty | No. | |
| i. | Contact Rating | | |
| j. | Cable Entry Single/ Double | | |
| k. | Time Delay On & Off | | |
| l. | Fail Safe Setting | | |
| m. | Probe/ Electrode mat'L | | |
| n. | Ref. Electrode mat'L | | |
| 3 | DESIGN DATA | | |
| a. | Fluid | | |
| b. | Press. (Nor./ Max) | Kg/ $Cm^2g$ | |
| c. | Temp. (Nor/ Max) | $^OC$ | |
| d. | SP. Gravity | | |
| e. | Probe Length | | |
| f. | Ref. Electrode Mat'L | | |
| 4 | SERVICE CONDITION | | |
| A | Ambient Temp. | | |
| G. | LEVEL SWITCH (CONDUCTIVITY TYPE) | | |
| 1 | GENERAL | | |
| i | Tag No. | | |
| ii | Area Classification | | |
| 2 | PROCESS CONDITION | | |
| i | Fluid | | |
| ii | Specific Gravity | Kg/ $Cm^2g$ | |
| iii | Pressure (Min./Nor./Max.) | $^OC$ | |
| iv | Temperature (Min./Nor./Max.) | | |
| 3 | TANK DETAILS | | |
| i | Type | | |
| ii | MOC | | |
| iii | Height | Mtr. | |
| iv | Diameter | Mtr | |
| v | Max. Fluid Level | Mtr | |
| 4 | PROBE& PREAMPLIFIER | | |
| i | Reference Probe Length | Mtr | |
| ii | Electrode Material & Insulation | | |
| iii | Cable Entry | | |

| | | | |
|---|---|---|---|
| iv | Power Supply | | |
| 5 | SWITCH UNIT | | |
| i | Type, Qty. & Form | | |
| ii | Rating | | |
| iii | On level decreasing contacts | | |
| iv | Set point Adjustment | | |
| v | Cable Entry | | |
| vi | Mounting | | |
| vii | Enclosure Class | | |
| viii | Enclosure Material | | |
| ix | Set Point-Low from Tank Top | | |
| x | Set Point-Low Low from Tank Top | | |
| 6 | OPTIONS | | |
| i | Mounting Accessories | | |
| ii | SS Tag Plate | | |
| 7 | PURCHASE | | |
| i | Model | | |
| ii | Make | | |
| iii | Qty. | | |
| H. | LEVEL TRANSMITTER | | |
| 1 | GENERAL | | |
| i | Tag No. | | |
| ii | Area Classification | | |
| 2 | PROCESS CONDITION | | |
| i | Fluid | | |
| ii | Specific Gravity | | |
| iii | Pressure (Min./Nor./Max.) | Kg/ $Cm^2g$ | |
| iv | Temperature (Min./Nor./Max.) | $^OC$ | |
| 3 | TANK DETAILS | | |
| i | Type | | |
| ii | MOC | | |
| iii | Height | | |
| iv | Diameter | | |
| v | Max. Fluid Level | | |
| 4 | SENSOR | | |
| i | Sensor Type | | Non-contact Ultrasonic |
| ii | Frequency range | Hz | |
| iii | Beam Angle | | |
| iv | Blocking Distance | Mtr | |
| v | MOC Housing | | |
| vi | MOC Wetted Parts | | |
| vii | Enclosure Class | | |
| viii | Temperature Compensation | | |
| ix | Process Connection Flange Size | | |
| x | Mounting Position | Mtr | |
| xi | Cable length from Sensor to Transmitter | Mtr | |
| 5 | TRANSMITTER | | |

| | | | |
|---|---|---|---|
| i | Type | | |
| ii | Power Supply | | |
| iii | Output | | |
| iv | Accuracy | | |
| v | Repeatability | | |
| vi | Instrument Range | | |
| vii | Calibration Range | | |
| viii | Enclosure Protection Class | | |
| ix | Cable Entry | | |
| x | Enclosure | | |
| xi | Display | | |
| 6 | OPTIONS | | |
| i | Mounting Accessories | | |
| ii | SS Tag Plate | | |
| 7 | CERTIFICATION | | |
| i | Area Certification | | |
| ii | Calibration Certificate | | |
| 8 | PURCHASE | | |
| i | Make | | |
| ii | Model | | |
| iii | Qty. | | |
| I. | DIFFERENTIAL LEVEL TRANSMITTER | | |
| 1 | GENERAL | | |
| i | Tag No. | | |
| ii | Equipment No. | | |
| iii | Location | | |
| iv | Area Classification | | |
| 2 | SITE CONDITION | | |
| i | Ambient Temperature (Max./Min.) | | |
| ii | Relative Humidity | | |
| iii | General Climate | | |
| 3 | PROCESS CONDITIONS | | |
| i | Fluid | | |
| ii | Max. Pressure / Operating Pressure | | |
| iii | Max. Temp. / Operating Temp. | | |
| iv | Channel /Sump/Tank/Depth | Mtr | |
| v | Specific Gravity | | |
| vi | MOC of Channel/Sump/Tank | | |
| 4 | SENSOR | | |
| i | Type | | Ultrasonic |
| ii | Principle | | |
| iii | Material | | |
| iv | Process Connection | | |
| v | Sensor Maximum measuring range | Mtr | |
| vi | Frequency | | |
| vii | Beam Angle | | |
| viii | Blocking Distance | Mtr | |
| ix | Cable Length | Mtr | |

| | | | |
|---|---|---|---|
| x | Mounting Location | | |
| xi | Integral Temperature Sensor | | |
| xii | Enclosure Class | | |
| 5 | TRANSMITTER | | |
| i | Type | | |
| ii | Power Supply | | |
| iii | Output | | 4-20mA (Isolated) HART with 3 nos. SPSDT |
| iv | Differential Instrument Range | | |
| v | Differential Level Calibration Range | | |
| vi | Accuracy | | |
| vii | Repeatability | | |
| viii | Enclosure Material | | |
| ix | Enclosure Class | | |
| x | Zero and Span Adjustment | | |
| xi | Electrical Connection | | |
| xii | Integral Temperature Compensation | | |
| xiii | False Echo Detection | | |
| xiv | Display | | |
| 6 | ACCESSORIES | | |
| i | SS Tag Plate | | |
| 7 | CERTIFICATION | | |
| i | Calibration Certificate | | |
| 8 | PURCHASE | | |
| i | Make | | |
| ii | Model-Sensor & Qty | | |
| iii | Model-Transmitter & qty | | |
| J. | TEMPERATURE GAUGE | | |
| 1 | GENERAL | | |
| i | Tag No. | | |
| ii | Quantity | No. | |
| iii | Service | | |
| iv | Range | | |
| v | Press. (Nor./ Max.) | Kg/ $Cm^2g$ | |
| vi | Temp. (Nor/ Max) | $^OC$ | |
| vii | Case Mat'L | | |
| viii | Zero Adjustment | | |
| ix | Stem Type | | |
| x | Stem/ Bulb Material | | |
| xi | Stem Bulb Dia | | |
| xii | Stem Length (I.L) | | |
| xiii | Movement mat'L | | |
| xiv | Accuracy | | |
| xv | Over Range Protection | | |
| 2 | DIAL | | |
| i | Size | | |
| ii | Colour | | |

| | | | |
|---|---|---|---|
| 3 | CONNECTION | | |
| i | Gauge End Connection | | |
| ii | Connection Location | | |
| 4 | THERMOWELL | | |
| i | Material | | |
| ii | Constriction | | |
| iii | Process Connection | | |
| iv | Rating (Flange) | | |
| | Flange Mat'L | | |
| v | I.D mm | | |
| vi | O.D mm | | |
| vii | Length "U" mm | | |
| viii | Extension Length mm | | |
| 5 | REMARK | | |
| i | Enclosure Protection | | |
| ii | Mounting | | |
| iii | Area Classification. | | |
| iv | Ambient Temp. | | |
| K. | TEMPERATURE TRANSMITTER | | |
| 1 | GENERAL | | |
| i | Tag No. | | |
| ii | Location | | |
| iii | Area Classification | | |
| 2 | PROCESS CONDITION | | |
| i | Fluid | | |
| ii | Temperature (Min.,Normal, Max.) | $^{O}C$ | |
| 3 | TRANSMITTER | | |
| i | Type | | |
| ii | RTD Type Supported | | |
| iii | Power Supply | | |
| iv | Output | | 4-20mA, Isolated |
| v | Accuracy | | |
| vi | Instrument Range | | |
| vii | Calibration Range | | |
| viii | Mounting | | |
| ix | RTD Cable Connection | | |
| x | Enclosure Material | | Aluminium Polyester Powder Coated |
| xi | Enclosure Class | | IP-66 |
| xii | Electrical Connection | | ½" NPTF |
| xiii | Display | | LCD, Local Indicator |
| 4 | OPTIONS | | |
| i | SS Tag Plate | | |
| ii | Certification | | |
| 5 | PURCHASE | | |
| i | Make | | |
| ii | Model | | |
| iii | Qty. | | |

| | | | |
|---|---|---|---|
| L. | RESITANCE TEMPERATURE DETECTOR | | |
| 1 | GENERAL | | |
| i | Tag No. | | |
| ii | Quantity | | |
| iii | Service | | |
| iv | Pressure | Kg/ $Cm^2g$ | |
| v | Temperature | $^OC$ | |
| 2 | ELEMENT | | |
| i | Type | | |
| ii | No. of Elements | | |
| iii | Calibration | | |
| iv | No. of wires | | |
| v | Sheath O.D | | |
| vi | Sheath Material | | |
| vii | Nipple-Union-Nipple Mat. | | |
| viii | Nipple-Union-Nipple Con. To T/W | | |
| ix | Inser. Length (I.L) mm | | |
| x | Exten. Length (E.L) mm | | |
| 3 | HEAD | | |
| i | Material | | |
| ii | Cover Type | | |
| iii | Cable Entry | | |
| iv | No. of Entries | | |
| v | Enclosure Protection | | |
| vi | Gasket Between Case & Cover | | |
| 4 | TERMINAL BLOCK | | |
| i | Material | | |
| ii | I/O Terminals | | |
| 5 | THERMOWELL | | |
| i | Material | | |
| ii | Construction | | |
| iii | Process Connection | | |
| iv | Flange Rating | | |
| v | Flange Mat'l | | |
| vi | O.D mm | | |
| vii | I.D mm | | |
| viii | Length "U" mm | | |
| 6 | REMARK | | |
| i | Total length Below Head (I.L+EL) mm | | |
| ii | Area Classification | | |
| iii | Ambient Temp. | | |
| M. | ROTAMETER | | |
| 1 | GENERAL | | |
| i | Tag No. | | |
| ii | Quantity | | |
| iii | Service | | |
| iv | Type | | |

| | | | |
|---|---|---|---|
| v | Mounting | | |
| vi | Accuracy | | |
| 2 | DESIGN DATA | | |
| i | Pressure | Kg/ $Cm^2g$ | |
| ii | Temperature | $^OC$ | |
| iii | Flow Rate (Nor) | $m^3$/ hr | |
| iv | Scale/ Range | $m^3$/ hr | |
| v | SP. GR. | | |
| f. | Viscosity | CP | |
| vi. | Allow D/P | mm $H_2O$ | |
| 3 | CONNECTION | | |
| i | Size (Piping) | | |
| ii | Rating | | |
| iii | Location In/Out | | |
| 4 | MATERIAL | | |
| i | Float | | |
| ii | Float Shaft | | |
| iii | Metering Tube | | |
| iv | End Fitting and Body | | |
| v | Packing Retainers | | |
| vi | Other Wetting Parts | | |
| 5 | REMARK | | |
| i | Area Classification | | |
| ii | Enclosure Protection | | |
| iii | Scale Length | | |
| iv | Ambient Temp. | | |
| v | Relative Humidity | | |
| vi | Flange To Flange Distance | | |
| vii | Mounting Hardware for Flange | | |
| g. | Mounting Hardware for Flange | | |
| N. | ELECTROMAGNETIC FLOWMETER | | |
| 1 | GENERAL | | |
| i | Tag No. | | |
| ii | Quantity | | |
| iii | Meter Size | | |
| iv | Accuracy | | |
| 2 | DESIGN DATA | | |
| i | Fluid | | |
| ii | Press. (Nor./ Max) | Kg/ $Cm^2g$ | |
| iii | Temp. (Nor/ Max) | $^OC$ | |
| iv | Flow Rate (Nor/ Max) | $m^3$/ hr | |
| v | Velocity | m/sec | |
| vi | Range | $m^3$/ hr | |
| vii | SP. GR. | | |
| viii | Viscosity | CP | |
| ix | Min. Conductivity | S/Cm | |

| | | | |
|---|---|---|---|
| 3 | CONNECTION | | |
| i | Size (Piping) | | |
| ii | Rating | | |
| iii | Flange Material | | |
| 4 | MATERIAL | | |
| i | Body | | |
| ii | Tube | | |
| iii | Electrode | | |
| iv | Liner | | |
| v | Grounding Ring | | |
| 5 | FLOW TRANSMITTER | | |
| i | Output Isolated | | |
| ii | Local Display Indicator | | |
| iii | Power Supply | | |
| iv | Cable Entry | | |
| v | Location | | |
| vi | Cable (In case of Remote) | | |
| vii | Mounting | | |
| 6 | REMARK | | |
| i | Area Classification | | |
| ii | Enclosure Protection | | |
| iii | Liner Heating System | | |
| iv. | Ambient Temp. | | |
| v | Relative Humidity | | |
| O. | ULTRASONIC FLOWMETER | | |
| 1 | GENERAL | | |
| i | Tag No. | | |
| ii | Location | | |
| iii | Area Classification | | |
| iv | Channel Material | | |
| 2 | PROCESS CONDITION | | |
| i | Fluid | | |
| ii | Specific Gravity | | |
| iii | Viscosity | (cP) | |
| iv | Flow ( Min. Normal Maximum) | $M^3$/Hr | |
| v | Pressure ( Min. Normal Maximum) | Kg/ $Cm^2g$ | |
| vi | Temperature ( Min. Normal Maximum) | $^OC$ | |
| vii | Throat width (mm) | | |
| 3 | SENSOR | | |
| i | Sensor Type | | Non-contact ultrasonic type |
| ii | Sensor Material | | |
| iii | Blocking Distance | | |
| iv | Process Connection | | |
| v | Cable Length | | |
| vi | Mounting Location | | |
| 4 | TRANSMITTER | | |
| i | Type | | |

| | | | |
|---|---|---|---|
| ii | Power Supply | | |
| iii | Output | | |
| v | Accuracy | | |
| v | Instrumentation Range | | |
| vi | Calibration Range | | |
| vii | Mounting | | |
| viii | Enclosure Material | | |
| ix | Enclosure Protection Class | | |
| x | Cable Entry | | |
| xi | Display | | |
| 5 | OPTIONS | | |
| i | Mounting Accessories | | |
| ii | SS Tag | | |
| 6 | CERTIFICATION | | |
| i | Area Classification | | |
| 7 | PURCHASE | | |
| i | Make | | |
| ii | Model | | |
| iii | Qty | No. | |
| P. | pH ANALYZER | | |
| 1 | GENERAL | | |
| i. | Tag No. | | |
| ii | Quantity | | |
| iii | Service | | |
| iv | Range | pH | |
| v | Type | | |
| vi | Accuracy | | |
| vii | Power Supply | | |
| viii | Output Signal | | |
| ix | Auto Temp. Compensation | | |
| x | Mounting | | |
| 2 | DESIGN DATA | | |
| i | Press. (Nor./ Max) | Kg/ $Cm^2g$ | |
| ii | Temp. (Nor/ Max) | $^OC$ | |
| iii | Flow Rate | | |
| 3 | CONNECTION | | |
| i | Size (Piping) | | |
| ii. | Rating (Flange) | | |
| iii | Electrical Connection | | |
| 4 | CHAMBER | | |
| i | Flow Through | | |
| 5 | MATERIAL | | |
| i. | Flow Through | | |
| ii | Electrode | | |
| iii | Gasket | | |
| 6 | ACCESSORY | | |
| i | Electrode (With 3 Mtr. Cable) | | |

| | | | |
|---|---|---|---|
| ii | Electrode Size/ Conn. | | |
| iii | Local Display Indicator | | |
| 7 | SERVICE CONDITIONS | | |
| i | Ambient Temp | | |
| ii | Area Classification | | |
| iii | Relative Humidity | | |
| Q. | ORP ANALYZER | | |
| 1 | GENERAL | | |
| i | Tag No. | | |
| ii | Quantity | | |
| iii | Service | | |
| iv | Range mV | | |
| v | Accuracy | | |
| vi | Auto Temp. Compensation | | |
| vii | Enclosure Protection | | |
| viii | Measurement Location | | |
| 2 | DESIGN DATA | | |
| i | Sample Temp. (Nor./ Max) | $^{O}C$ | |
| ii | Sample Pressure. (Nor/ Max) | Kg/ $Cm^2g$ | |
| iii | Flow Rate | | |
| iv | Constituent | | |
| v | Line Size | | |
| 3 | TRANSMITTER | | |
| i | Type | | |
| ii | Output Signal | | |
| iii | Power Supply | | |
| iv | Transmitter Mounting | | |
| v | Auto Temp/ Compensation | | |
| vi | Temperature Sensor | | |
| vii | Local Display Indicator | | |
| viii. | Cable Entry | | |
| ix | Interconnection Cable | | |
| 4 | CHAMBER | | |
| i | Type | | |
| ii. | Material | | |
| iii | End Conn. | | |
| iv | Wetted part | | |
| 5 | REMARK | | |
| i | Ambient Temperature | | |
| ii | Area Classification | | |
| R. | DO ANALYZER | | |
| 1 | GENERAL | | |
| i | Tag No. | | |
| ii | Location | | |
| iii | Area Classification | | |
| 2 | PROCESS CONDITIONS | | |
| i | Fluid | | |

| | | | |
|---|---|---|---|
| ii | Pressure(Min.----Nor Max.) | Kg/ $Cm^2g$ | |
| iii | Temperature(Min.----Nor Max.) | $^OC$ | |
| iv | DOValue(Min.----Nor Max.) | | |
| 3 | SENSOR DETAILS | | |
| i | Measuring Principle | | Luminescent |
| ii | Measuring Range | Mg/l | |
| iii | Wetted Parts ---- Sensor Cap/Body | | |
| iv | Accuracy | % | |
| v | Sensor Cable Type | | |
| vi | Sensor Cable Length | Mtr | |
| vii | Process Connection | | |
| viii | Mounting Arrangement | | |
| ix | Calibration | | |
| x | Recommended Flow Velocity to Sensor | | |
| 4 | TRANSMITTER | | |
| i | Type | | |
| ii | Power Supply | | |
| iii | Output | | |
| iv | Accuracy | | |
| v | Repeatability | | |
| vi | Calibration Range | | |
| vii | Temperature Compensation | | |
| viii | Mounting | | |
| ix | Enclosure Protection | | |
| x | Enclosure Material | | |
| xi | Electrical Connection | | |
| xii | Display | | |
| 5 | OPTIONS | | |
| i | SS Tag | | |
| ii | Mounting Accessories | | |
| iii | Auto Cleaning Facility | | |
| 6 | CERTIFICATION | | |
| i | Area Certification | | |
| 7 | PURCHASE | | |
| i | Manufacturer | | |
| ii | Model | | |
| iii | Qty. | | |
| iv | Spare Qty. | | |
| S. | BOD ANALYZER | | |
| i. | Detection Limit | | |
| ii. | Range | | |
| iii. | Range | | |
| iv. | T 90 time | | |
| v. | Main Power | | |
| vi. | Trrage current usage | | |
| vii. | Maximum current Usage | | |
| viii. | Enclosure | | |

| | | | |
|---|---|---|---|
| ix. | Protection Class | | |
| x. | EMC Imission | | |
| xi. | Certification | | |
| xii. | Test Method | | |
| xiii. | Display | | |
| xiv. | Key Pad | | |
| xv. | Data preselection | | |
| xvi. | Data Storage | | |
| xvii. | Monitoring | | |
| xviii. | Analog Outputs | | |
| xix. | Diskette Drive | | |
| xx. | Computer Interface | | |
| xxi. | Dimensions (W x H x D) | | |
| xxii. | Weight | | |
| T. | CONTROL VALVE | | |
| 1 | GENERAL | | |
| i | Tag No. | | |
| ii | Quantity | | |
| iii | Name | | |
| iv | Line Size | | |
| 2 | BODY | | |
| i | Body/ Port Size | | |
| ii | No Port | | |
| iii | Port Style | | |
| iv | Port Form | | |
| v | Guiding | | |
| vi | End Connection | | |
| vii | Flange Rating | | |
| viii | Body Material | | |
| ix | Bonnet Type | | |
| x | Packing Material | | |
| xi | Trim Form | | |
| xii | Trim Mat'l (Plug/ Seat/ Seat Ring) | | |
| 3 | DESIGN DATA | | |
| i | Fluid | | |
| ii | Flow rate (Nor./Max) | $Nm^3$/ hr | |
| iii | Inlet Pr. | Kg/ $Cm^2g$ | |
| iv | Closed Pr. | Kg/ $Cm^2g$ | |
| v | Diff. Pr. | Kg/ $Cm^2g$ | |
| vi | Cv Reqd./ Set | | |
| vii | Temp. (Nor. Max.) | $^OC$ | |
| viii | SP. Gravity | | |
| ix | Viscosity | C P | |
| x | Velocity | m/sec | |
| 4 | ACTUATOR | | |

| | | | |
|---|---|---|---|
| i | Type | | |
| ii | Spring Range | | |
| iii | Air Failure Valve To | | |
| 5 | POSITIONER | | |
| i | Air Supply Press. | | |
| ii | Input | | |
| ii | Output | | |
| 6 | ACCESSORY | | |
| i | I/P Converter Or E/P Positioner | | |
| ii | Sol. Valve | | |
| iii | Sol. Valve Supply | | |
| iv | Air Filter Regulator | | |
| v | Limit Filter Regulator | | |
| vi | Limit Switch | | |
| 7 | REMARKS | | |
| i | Ansi Leakage Class | | |
| ii | Cable Entry | | |
| iii | Travel Length | | |
| iv | Max. Allowable Sound Lvel | | |
| v | Enclosure Protection | | |
| vi | Mounting Bracket & Hardware (S.S) | | |
| 8 | SERVICE CONDITIONS | | |
| i | Ambient Temp. | | |
| ii | Relative Humidity | | |
| iii | Area Classification | | |
| U. | TSS ANALYZER | | |
| 1 | GENERAL | | |
| i | Tag No. | | |
| ii | Location | | |
| iii | Area Classification | | |
| 2 | PROCESS CONDITIONS | | |
| i | Fluid | | |
| ii | Pressure(Min.----Nor Max.) | Kg/ $Cm^2g$ | |
| iii | Temperature(Min.----Nor Max.) | $^OC$ | |
| iv | TSSValue(Min.----Nor Max.) | | |
| 3 | SENSOR DETAILS | | |
| i | Measuring Principle | | |
| ii | Measuring Range | Mg/l | |
| iii | Wetted Parts ---- Sensor Cap/Body | | |
| iv | Accuracy | % | |
| v | Sensor Cable Type | | |
| vi | Sensor Cable Length | Mtr | |
| vii | Process Connection | | |
| viii | Mounting Arrangement | | |
| ix | Calibration | | |
| x | Recommended Flow Velocity to Sensor | | |
| 4 | TRANSMITTER | | |

| | | | |
|---|---|---|---|
| i | Type | | |
| ii | Power Supply | | |
| iii | Output | | |
| iv | Accuracy | | |
| v | Repeatability | | |
| vi | Calibration Range | | |
| vii | Temperature Compensation | | |
| viii | Mounting | | |
| ix | Enclosure Protection | | |
| x | Enclosure Material | | |
| xi | Electrical Connection | | |
| xii | Display | | |
| xiii | Communication Protocol | | |
| 5 | OPTIONS | | |
| i | SS Tag | | |
| ii | Mounting Accessories | | |
| iii | Auto Cleaning Facility | | |
| 6 | CERTIFICATION | | |
| i | Area Certification | | |
| 7 | PURCHASE | | |
| i | Manufacturer | | |
| ii | Model | | |
| iii | Qty. | | |
| iv | Spare Qty. | | |

CONTROL AUTOMATION

| | | | |
|---|---|---|---|
| A | PLC SYSTEM | | |
| 1 | Type | | |
| 2 | Make | | |
| 3 | Display | | |
| 4 | Digit Height | | |
| 5 | Battery backup for integrator provided? Y/N | | |
| 6 | Output Card Density | | |
| 7 | Input Card Density | | |
| 8 | PID Control Capability | | |
| 9 | Maximum Scan Time | | |
| 10 | Power Supply | | |
| 11 | Output on Process Failure | | |
| 12 | System Architecture | | |
| 13 | Logic Description in word format | | |
| 14 | UPS with SMF Batteries, charging facilities, auto change over panel | | |
| 15 | Portable programming terminal hardware/software | | |
| 16 | Desktop Programming Software and cable | | |
| B | ALARM ANNUNCIATOR | | |
| 1 | GENERAL | | |
| i | Make | | |
| ii | Model No. | | |

| | | | |
|---|---|---|---|
| iii | Model Description | | |
| iv | Nos. of windows | | |
| v | Window Dimension | | |
| 2 | TECHNICAL SPECIFICATION | | |
| i | OperatingTemperatureMin Max. | $^{O}C$ | |
| ii | Supply Voltage | | |
| iii | Field Initiation Contact | | |
| iv | Response Time | | |
| v | Input Isolation | | |
| vi | Field Contact Voltage | | |
| vii | Flash Rate | CPM | |
| viii | Nos. of Input/output | | |
| ix | Audible Alarm | | |
| x | Audible Device | | |
| xi | Nos. of Lamps per Channel | | |
| xii | Power Consumption | | |
| xiii | Display Device | | |
| xiv | Facia Type | | |
| xv | Catalogue Enclosed? Y/N | | |
| 3 | SCADA SYSTEM | | |
| 1 | SCADA Server Manufacturer | | |
| 2 | SCADA Software Provider | | |
| 3 | Alarm Outputs | | |
| 4 | Catalogue Enclosed? Y/N | | |
| 4 | INSTRUMENT CABLE | | |
| 1 | Manufacturer | | |
| 2 | Type of cable | | |
| 3 | Applicable Standard | | |
| 4 | Voltage Grade | V | |
| 5 | Frequency | Hz | |
| 6 | Permissible Voltage/Frequency Variation | % | |
| 7 | Nos. of Pairs | Nos. | |
| 8 | Conductor | | |
| i | Material | | |
| ii | Nominal Cross sectional area | Sq.mm | |
| iii | Nos. of wire | Nos. | |
| iv | Nominal Dia. of wire | mm | |
| v | Shape of Conductor | | |
| 9 | Insulation | | |
| i | Material | | |
| ii | Nominal thickness of insulation | mm | |
| ii | Minimum thickness at any point | mm | |
| iv | Specific Insulation Resistance | 'Ω.cm | |
| v | Pair Identification | | |
| 10 | Individual Shielded Pair | | |
| i | Material | | |
| ii | Nominal thickness of tape | mm | |
| iii | Overlap of tap | % | |

| | | | |
|---|---|---|---|
| 11 | Drain Wire Details | | |
| i | Material | | |
| ii | Nos. of wire | Nos. | |
| iii | Nominal Dia. Of wire | mm | |
| 12 | Pair Screening | | |
| i | Material | | |
| ii | Nominal thickness of tape | mm | |
| iii | Overlap of tap | % | |
| 13 | Laid up and Over all shielded | | |
| i | Material | | |
| ii | Nominal thickness of tape | mm | |
| iii | Overlap of tap | % | |
| 14 | Over all Screening | | |
| i | Material | | |
| ii | Nominal thickness of tape | mm | |
| iii | Overlap of tap | % | |
| 15 | Over all sheath | | |
| i | Material | | |
| ii | Nominal thickness of outer sheath | mm | |
| iii | Colour of outer sheath | | |
| iv | Approximate overall Diameter | mm | |
| v | Approximate overall weight of cable | Kg/Km | |
| 16 | Electrical Parameters | | |
| i | Maximum DC Resistance at 20 $^{O}$C | ’Ω/Km | |
| ii | Maximum AC Resistance at 90 $^{O}$C | ’Ω/km | |
| iii | LR Ratio (Maximum) | µ H / ’Ω | |
| iv | Mutual Capacitance at 1 KHz between core & Screen | µf / ’Ω | |
| v | IR at 500V (Core to Core) | M’Ω/Km | |
| vi | High Voltage Test for 1 Minute | Kv | |
| vii | Maximum operating Temperature | $^{O}$C | |
| viii | Drum Length with tolerances | mtr | |
| ix | Recommended Bending Radius | 6D | |
| 17 | FRLS Properties | | |
| i | Oxygen Index Test | | |
| ii | Temperature Index Test | | |
| iii | Acid Gas Generation Test | | |
| iv | Smoke Density Test | | |
| v | Flammability Test | | |

## Functional Guarantees of the Plant

This schedule sets out the functional guarantees required for the calculation of Liquidated Damages for failing O&M performance guarantees.

The bidder shall provide values of electrical energy and chemical usage for the quantity and quality of raw sewage given in the technical specifications.

The contractor's guarantee for the performance in the DLP and O&M period to be as follows:

### A. Treated Effluent and Sludge Quality Guarantee

The quality of treated effluent shall be as follows: for 30 MGD Diggian, 5 MGD Raipur Kalan, 2 MGD Raipur Khurd, 11 MGD 3 BRD & 1.65 MGD Dhanas

| S No | Parameters | To be Guaranteed by Bidder |
|---|---|---|
| 1 | pH | 6.5-9.0 |
| 2 | TSS | ≤ 5 mg/l |
| 3 | Total Nitrogen | ≤ 5 mg/l |
| 4 | Ammonical Nitrogen (NH4-N) | ≤ 5 mg/l |
| 5 | $BOD_5$ | ≤ 5 mg/l |
| 6 | COD | ≤ 50 mg/l |
| 7 | $PO_4$– P (TP) | ≤ 1 mg/lf |
| 8 | Faecal Coliform | <100 MPN/100 ml |

**TREATED EFFLUENT CHARACTERISTICS FOR 2 MLD Sukhna Lake (MBR)**

| SNO. | CONSTITUENTS | UNITS | VALUE |
|---|---|---|---|
| 1 | PH | - | 7.0-8.0 |
| 2 | $BOD_5$ | mg/l | <1 |
| 3 | COD | mg/l | <10 |
| 4 | TSS | mg/l | <1 |
| 5 | TN | mg/l | <2 |
| 6 | TP | mg/l | 0.1 (Target)<br>Guarantee 0.5 |
| 7 | Coliform | MPN/100ml | 100 |

### B. Chemical Usage for each plant separately

The average annual usage of chemical during the 15 Years of Operation & Maintenance and one year of DLP" is to be guaranteed. Figures to be given separately for each type of chemical used in each plant:

| Sl. No | Description | Qty ( Ton/year) |
|---|---|---|
| 1 | *Chemical-1 | |
| 2 | *Chemical-2 | |
| 3 | *Chemical-3 | |

*Bidder to name the chemical

## C. Power Guarantee

| 1. Total Power Consumption (KWHr.) | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S. No | Month | DLP | 1st year | 2nd year | 3rd year | 4th year | 5th year | 6th year | 7th year | 8th year | 9th year | 10th year | 11th year | 12th year | 13th year | 14th year | 15th year |
| 1 | Jan | | | | | | | | | | | | | | | | |
| 2 | Feb | | | | | | | | | | | | | | | | |
| 3 | March | | | | | | | | | | | | | | | | |
| 4 | April | | | | | | | | | | | | | | | | |
| 5 | May | | | | | | | | | | | | | | | | |
| 6 | June | | | | | | | | | | | | | | | | |
| 7 | July | | | | | | | | | | | | | | | | |
| 8 | Aug. | | | | | | | | | | | | | | | | |
| 9 | Sept. | | | | | | | | | | | | | | | | |
| 10 | Oct. | | | | | | | | | | | | | | | | |
| 11 | Nov. | | | | | | | | | | | | | | | | |
| 12 | Dec. | | | | | | | | | | | | | | | | |
| | **Total** | | | | | | | | | | | | | | | | |

Note:

1. The Bidder will provide the total power consumption (Kwhr) for each plant separately in the above format.
2. The power required towards lighting of plants, campus and buildings etc. Shall be indicated separately and this shall not be accounted for evaluation.

| 2. Total Power Generation (KWHr.), if proposed by the Bidder | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S. No | Month | DLP | 1st year | 2nd year | 3rd year | 4th year | 5th year | 6th year | 7th year | 8th year | 9th year | 10th year | 11th year | 12th year | 13th year | 14th year | 15th year |
| 1 | Jan | | | | | | | | | | | | | | | | |
| 2 | Feb | | | | | | | | | | | | | | | | |
| 3 | March | | | | | | | | | | | | | | | | |
| 4 | April | | | | | | | | | | | | | | | | |
| 5 | May | | | | | | | | | | | | | | | | |
| 6 | June | | | | | | | | | | | | | | | | |
| 7 | July | | | | | | | | | | | | | | | | |
| 8 | Aug. | | | | | | | | | | | | | | | | |
| 9 | Sept. | | | | | | | | | | | | | | | | |
| 10 | Oct. | | | | | | | | | | | | | | | | |
| 11 | Nov. | | | | | | | | | | | | | | | | |
| 12 | Dec. | | | | | | | | | | | | | | | | |
| | **Total** | | | | | | | | | | | | | | | | |

Note:

The Bidder will provide the total power consumption (Kwhr) for each plant separately in the above format.

| 3. Net Power Consumption (KWHr.) | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S. No | Month | DLP | 1st year | 2nd year | 3rd year | 4th year | 5th year | 6th year | 7th year | 8th year | 9th year | 10th year | 11th year | 12th year | 13th year | 14th year | 15th year |
| 1 | Jan | | | | | | | | | | | | | | | | |
| 2 | Feb | | | | | | | | | | | | | | | | |
| 3 | March | | | | | | | | | | | | | | | | |
| 4 | April | | | | | | | | | | | | | | | | |
| 5 | May | | | | | | | | | | | | | | | | |
| 6 | June | | | | | | | | | | | | | | | | |
| 7 | July | | | | | | | | | | | | | | | | |
| 8 | Aug. | | | | | | | | | | | | | | | | |
| 9 | Sept. | | | | | | | | | | | | | | | | |
| 10 | Oct. | | | | | | | | | | | | | | | | |
| 11 | Nov. | | | | | | | | | | | | | | | | |
| 12 | Dec. | | | | | | | | | | | | | | | | |
| | **Total** | | | | | | | | | | | | | | | | |

Note:

The Bidder will provide the total power consumption (Kwhr) for each plant separately in the above format.

**Also,** the Bidder shall guarantee the Total Electric Power Consumed based on the following Nominal Design loads:

| S No | Parameter | Nomenclature | Units | Nominal Numbers | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Diggian | Raipur Kalan | Raipur Khurd | 3 BRD | Dhanas | Sukhna |
| 1 | Nominal Design Flow | Qd | M3/day | 1,36,000 | 22,000 | 9,000 | 50,000 | 7,500 | 2,000 |
| 2 | Total Suspended Solids | TSSd | mg/l | 273 | 305 | 308 | 236 | 276 | 305 |
| 3 | Volatile Suspended Solids / Suspended Solids Ratio | (VSS/ TSS)d | % | 60% | 60% | 60% | 60% | 60% | 60% |
| 4 | BOD | (BOD)d | mg/l | 315 | 310 | 370 | 285 | 411 | 310 |
| 5 | TKN | (TN)d | mg/l | 12.2 | 9.1 | 7.8 | 10.3 | 6.9 | 9.1 |

a. Guaranteed Power (to be provided separately for each plant)

| **Description** | **Provide Guaranteed Net Power consumption at the nominal flow and polluted load in KwHr / day Power Guarantee ((PG)d)** | | | | | |
|---|---|---|---|---|---|---|
| | Diggian | Raipur Kalan | Raipur Khurd | 3 BRD | Dhanas | Sukhna |
| Fixed Part (PG-F) | | | | | | |
| Variable Part (PG-V) d | | | | | | |
| Total (PG-F) + (PG-V)d | | | | | | |

b. Guaranteed Net Power Adjustment for Variable Part(PG-V)d from Normal Flow & Pollutant Load

In case of variance of flow or pollutant load the guaranteed power shall be evaluated as per the following formula where Power Consumed at reduced load (PG)a will be

(PG)a = [{Qa/Qd} x {(TSS)a x (VSS/ TSS)a} / ((TSS)d x (VSS/ TSS)d}X F1+ {Qa/Qd} x {(BOD)a } / { (BOD)d} X F2+ {Qa/Qd} x {(TKN)a } /{ (TKN)d} X F3] x (PG-V)d

Where
Qa = Actual Wastewater Flow (average over immediate past 5 days)
TSS a = Actual Total Suspended Solids (average over immediate past 5 days)
(VSS/TSS)a = Actual Volatile Suspended Solids to Total Suspended Solids (average over immediate past 5 days)
BOD a = Actual BOD Concentration (average over immediate past 5 days)

TKN a = Actual TKN Concentration (average over immediate past 5 days)

The Pollutant Factors are:

| | | |
|---|---|---|
| F1 | = | Factor for TSS Pollutant Loading and VSS/ TSS ratio |
| F2 | = | Factor for BOD Pollutant Loading |
| F3 | = | Factor for TKN Pollutant Loading |

The factors applicable shall be as given below:

| S No | Parameter | Units | | Values of Pollutant Load Factor |
|---|---|---|---|---|
| 1 | Nominal Design Flow | M3/day | | |
| 2 | Total Suspended Solids | mg/l | F1 | 0.45 |
| 3 | Volatile Suspended Solids / Total Suspended Solids Ratio | % | | |
| 4 | BOD $_5$ Day | mg/l | F2 | 0.3 |
| 5 | TKN | mg/l | F3 | 0.25 |

The Bidder's offer shall be evaluated on Net Guaranteed Power only, however during actual operation the Power consumed by bidders shall be calculated according to the above indicated formula and penalties shall be enforceable as per "Section XII – Service Level Agreement, Volume - 3 of Bid Document.

**Annexure-1 : List of Electrical Drives**

**Note : <u>This information requested is to consider the Bidders load calculations for Transformer and Emergency power Calculation of Transformer and for communication to the Electricity Board and for assessment of Emergency Load requirement</u>**
**<u>(This table shall not be used for evaluating the bidders offer for guaranteed load which shall be as per schedule and numbers given under Functional Guarantees of the Plant)</u>**
**Margin Should be considered as 0-8 kW = 25%, 9kW=20%, 37 kW-75%, 90 kW onwards 10%**

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *S.no* | *Drive For* | *Total Nos.* | *Working Nos.* | *Stand By* | *BKW of Motor* | *Margin (10% to 25%)* | *Rating (KW)* | *Efficiency of Motor* | *Operating KW* | *Operating Hrs. / Day* | *Energy Consumption per day in KWH* | *System Power Loss 3%* | *Total Energy Consumption Per day in KWH* | *Emergency Load LW* | *Remarks* |
| ( a ) | ( b ) | ( c ) | ( d ) | ( e ) | ( f ) | 10% - 25% | ( g ) | ( h ) | ( i ) = ( d ) X (f) / (h) | ( j ) | ( k ) = ( i ) X ( j ) | ( l ) | ( k ) + ( l ) | ( m ) | ( n ) |
| | | | | | | | | | | | | | | | |
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| | | | | | | | | | | | | | | | |
| | | | **Total Operating Load** | | | | | | | | | | | | |

## Section - V: Employers Requirements

Refer Volume – 2: Technical Requirements of the Bid Document

## Section - VI: Drawings

Refer Volume – 4: Drawings of the Bid Document

### Scope of Works

Refer Volume – 2: Technical Requirements of the Bid Document

### Specification

Refer Volume – 2: Technical Requirements of the Bid Document

### Drawings

Refer Volume – 4: Drawings of the Bid Document

### Supplementary Information

Refer Annexure attached to the Bid Document

## Section - VII: General Conditions (GC)

The General Conditions governing this Contract shall be the "Conditions of Contract for Design, Build and Operate Projects First Edition 2008, published by the International Federation of Consulting Engineers (FIDIC), commonly referred to as "the FIDIC Gold book",

Only those pages contained within that section of the above document entitled 'General Conditions' shall constitute the General Conditions of Contract. All other pages of the document shall have no contractual effect except as for guidance.

# Section - VIII: Particular Conditions (PC)

## Particular Conditions (PC)

The following Particular Conditions shall supplement the GC. Whenever there is a conflict, the provisions herein shall prevail over those in the GC:

### Part A - Contract Data

Appendix to Technical Bid

### Part A - Contract Data

Appendix to Technical Bid

| **FIDIC Gold Book (General Conditions) Provision.** | **Item** | **Contract Data** |
|---|---|---|
| 1.1.24 | Where the Contract allows for Cost Plus Profit, percentage profit to be added to the Cost: | Not Applicable |
| 1.1.26 | Cut-Off Date (number of days after the Time for Completion of Design-Build): | 30 days |
| 1.1.32 & 1.3 | Employer's name and address: Address of Employer for Communications: | Chief Executive Officer,<br>Chandigarh Smart City Limited,<br>New Bridge Building – 2, 2nd Floor, Near TDI Mall, Sector 17 – A, Chandigarh – 160017,<br>Phone: +91 172 5043196,<br>e-mail: smartcity.chd@nic.in |
| 1.1.35 & 1.3 | Employer's Representative Name and Address | General Manager (Engineering & Technical)<br>New Bridge Building – 2, 2nd Floor, Near TDI Mall, Sector 17 – A, Chandigarh – 160017 |
| 1.1.70 | Parts of the Works that shall be designated a Section for the purposes of the Contract | Not Applicable |
| 1.1.78, 8.2 & 9.2 | Time for Completion of Works / Design Build | Section A "Works Contract" – 30 Months (24 months of construction work including Detailed Design Engineering and 6 months of trial run and commissioning)<br>Section B "O&M Contract" – 15 Years of Operation & Maintenance and one year of DLP (from taking over of Section A) |
| 1.4 | Contract shall be govern by the law of | Republic of India |
| 1.4 | Ruling Language | English |
| 1.4 | Language of Communications | English |
| 2.1 | After receiving the Letter of Acceptance, the Contractor shall be given right of access to all or part of the Site within: | 14 Days |

| **FIDIC Gold Book (General Conditions) Provision.** | **Item** | **Contract Data** |
|---|---|---|
| 4.2 | Performance Security<br>(as percentages of the Accepted Contract Amount in Currencies): | Amount:<br>Section A - Five (5) percent of Works Contract Price.<br>Section B - Five (5) percent of O&M Contract Price<br>The amount of performance security will be in INR<br>Time of Submission:<br>Section A – within 21 days of issue of Letter of Acceptance.<br>Section B - To be submitted within 28 days of receiving Works Contract completion certificate for Section A.<br>Return:<br>Section A – The Performance Security shall be released to the Contractor after issuance of Works Contract Completion Certificate and the receipt of Performance Security of Section B.<br>Section B – Performance Security shall be reduced annually after adjusting the cost of accepted O&M Contract Price for previous year. |
| 5.1 | Period for notification of errors, faults and other defects is: | 28 days |
| 5.2 | Contractor's Documents requiring approval: | All project related submission which include Drawings, Designs, Reports etc. |
| 6.5 | Normal Working hours on the Site: | Section A – Normal hours during which work will be permitted to be carried out at the Site shall be between 08:00 hrs to 18:00 hrs, Monday to Saturday, excluding gazetted and national holidays. The Contractor shall be responsible to obtain the written consent of the Employer's Representative if he desires to work outside these times during the execution of work till wet run test.<br>Section B- Operation and Maintenance shall be carried out 24 hours a day, 7 days a week for all days of the year including national holidays. |
| 8.2 | Period of Operations Service: | 15 Years of Operation & Maintenance and one year of DLP. |
| 9.2 | Time for Completion of Design-Build: | Section A "Works Contract" – 30 Months (24 months of construction work including Detailed Design Engineering and 6 months of trial run and commissioning). |
| 9.6 | Delay damages (amount per day of delay): | 0.07% of accepted Works Contract Price on per day Basis. |
| 9.6 | Maximum amount of delay damages (percent of final Contract Price): | 10% of accepted Works Contract Price |

| **FIDIC Gold Book (General Conditions) Provision.** | **Item** | **Contract Data** |
|---|---|---|
| 10.6 (a) | Maximum compensation payable by Contractor: | 5% of the Contract price. |
| 10.6 (b) | Maximum compensation payable by Employer: | 5% of the Contract Price. |
| 10.7 (a) | Performance damages: Failure lies with the Employer | 5% of the Contract Price. |
| 10.7 (b) | Performance damages: Failure lies with the Contractor | 5% of the Contract Price. |
| 10.7 | Minimum production outputs required (give details): | 80% of measured flow at the inlet of each STP. |
| 13.5 | Percentage to be applied to Provisional Sums: | Cost + 15% |
| 14.2 | Amount advance payment (percent of Accepted Contract Amount): | Ten (10%), Percentage of the Accepted Works Contract Amount. |
| 14.2 | Percentage deductions for the repayment of the Advance Payment: | 25% of each Interim Payment Certificate during Section A. |
| 14.3 | Percentage of Retention: | 10% of interim payment certificate |
| 14.3 (c) | Limit of retention money: | 5 % of Accepted Works Contract Amount |
| 14.7 (a)&(b) | Amount to be withheld of Interim Payment Certificate: | Minimum 0.5% of the accepted contract amount of Section A. |
| 14.9 | delayed payment: | Financing Charges shall be 2%. |
| 14.17 | Currencies for payment of Contract Price: | "*The Contract Price shall be paid in Indian National Rupee (INR).* |
| 14.17 | Proportions of Local and Foreign Currencies are: | Not Applicable |
| 14.17 | Rate of Exchange: | Not Applicable |
| 14.19 | Amount of Maintenance Retention Fund: | Not Applicable. |
| 17.1 | Operation of forces of nature allocated to the Contractor: | None |
| 17.8 | Total Liability of the Contractor shall not exceed: | As per the (GC) 17.8 |
| 19.2(a(i) | Permitted deductible limits: | Ten (10%), Percentage of the Accepted Works Contract. |
| 19.2(a((ii)) | Additional sum to be insured: | None |
| 19.2(a)4 | Additional sum to be insured: | None |
| 19.2(a)5 | Employer's Risks to be insured if different to Sub-Clause 17.1 | None |
| 19.2(b) | Exceptional Risks to be insured if different to Sub-Clause 18.1 | None |
| 19.2(c) | Insurance of Contractor's Equipment (amount required) | Minimum INR 20 CR. for the entire project duration. |

| **FIDIC Gold Book (General Conditions) Provision.** | **Item** | **Contract Data** |
|---|---|---|
| 19.2(c) | Amount of professional liability Insurance required: | 10% of works contract price (for works contract duration) and 10% of O&M price (for entire O&M period. |
| 19.2(c) | Period for which professional liability Insurance required: | For the entire contract duration works as well as O&M period. |
| 19.2(d) | Amount of Insurance required for injury to persons and damage to property: | Rs. 10 Crore |
| 19.3(a) | Amount of fire extended cover insurance required: | Rs. 10 Crore |
| 19.3(d) | Other insurances required by law from the Contractor (give details): | Professional indemnity Insurance. |
| 19.3(e) | Other optional insurance required from the Contractor (give details): | None |
| 20.3 | Date for appointment of DAB: | Within 21 days from the date of commencement. |
| 20.4 | The DAB shall comprise: | Three (3) Members. |
| 20.8 | Appointing entity (official) for DAB members | If not agreed, shall be Jointly by Employer & Contractor President of FIDIC or a person appointed by him. |

## Particular Conditions Part B – Specific Provisions

The provisions to be found in the Particular Conditions Part B – Special Provisions will always overrule and supersede the equivalent provisions in the General Conditions of Contract, and it is important that the changes are easily identifiable by using the same clause numbers and titles as appear in the General Conditions. Furthermore, it is necessary to add a statement in the tender document and Contract Document that:

References to Clauses and Sub-Clauses herein refer to the Clauses or Sub-Clauses of the General Conditions or such additional clauses as may be included in these Particular Conditions. Sub-Clauses of the General Conditions not amended herein remain as stated in the General Conditions.

**Sub Clause 1.1 Definitions**

i. **Replace Sub-Clause 1.1.10 with:**
1.1.10 (a) "Contract" means these Conditions of Contract (Section VII and Section VIII of Volume – 1 of Bid Document), the Employer's Requirements, the Letter of the Bid, the Contractor's Proposal, the Schedules, the Letter of Acceptance, the Contract Agreement (if completed) and such further documents as may be expressly incorporated in the Letter of Acceptance or Contract Agreement (if completed).

For the purposes of defining the different activities and obligations under the Contract, the Contract will be comprised of a "Works Contract" and an "O&M Contract", as defined in the following Sub-paragraphs 1.1.10 (b) and (c), respectively; such definitions are for convenience only and shall not affect the rights or obligations of the Employer or the Contractor under the Contract.

1.1.10 (b) "Works Contract" means that portion of the Contract that relates to the design, submittals, procurement, Construction, fabrication, installation, testing, trial run and commissioning of the Works or components of the Works, demolition of existing structures (as required), but excluding remedying any defects, and excluding Operation and Maintenance, in accordance with the provisions of the Contract.

Works Contract Completion Certificate means that the Certificate issued by the employer after Completion of Works Contract as define above.

1.1.10 (c) "O & M Contract" means that portion of the Contract that relates to the Operation and Maintenance of the Works for the Operation and Maintenance Period, as defined in the "Part A – Contract Data Appendix to Technical Bid", but excluding the Works Contract, in accordance with the provisions of the Contract.

ii. **Add to the end of Sub-Clause 1.1.49, the following:**
"The word 'Letter of Tender' is synonymous with the word 'Letter to Bid'

iii. **Add to the end of Sub-Clause 1.1.36, the following:**
"Employer's Requirements shall be read in conjunction with Scope of Work vide Part 1 Section X: Technical Requirements, Volume 2 of the Bid Document".

iv. **Replace Sub-Clause 1.1.20 with:**
"Contractor's Proposal" means the documents entitled Technical Bid and price proposal, which the Contractor submitted with the Letter of Bid (in separate envelopes), as included in the

Contract. Such document may include the Contractor's preliminary design and any other relevant data submitted by the Contractor.

**v. Add to the end of Sub-Clause 1.1.75, the following:**

**vi. Replace Sub-Clause 1.1.14 with:**

The word "Contract Data" is synonymous with "Contract Data Appendix to Technical Bid"

**vii. Replace Sub-Clause 1.1.78 with:**

1.1.78 (i) "Time for Completion of Works" means the time period, starting from the Commencement Date, within which Contractor is required by Contract to complete the whole of the Works. The numerical value for Time for Completion of Works is specified in "Contract Data Appendix to Technical Bid".

1.1.78 (ii) "Operation and Maintenance Period" means the time period during which the Contractor shall be fully responsible for operation and maintenance of the entire Works, starting from the date of taking over of Section A and initiating Retention Period of the Works as certified by the Employer & Employer Representative. The numerical value for Operation and Maintenance Period is specified in "Contract Data Appendix to Technical Bid"

**viii. Replace Sub-Clause 1.1.16 with:**

1.1.16 (a) "Contract Price" means the price as defined in Sub Clause 14.1[The Contract Price], and includes the adjustments in accordance with the Contract.

For the purposes of determining payments under the Contract and, where applicable, other obligations, the Contract Price shall be subdivided into a "Works Contract Price" and "O &M Contract Price", as defined in the following Sub paragraphs 1.1.16 (b) and (c), respectively.

The total "Contract Price" will be the sum of the Works Contract Price and the O&M Contract Price.

1.1.16 (b) "Works Contract Price" means that portion of the Contract Price payable to the Contractor for performance of the Works Contract in accordance with the provisions of the Contract. The Works Contract Price will be the total of the amounts for carrying out the Works, as set out in Volume 3, Section XI, Schedule of Payment and Prices.

1.1.16 (c) "O&M Contract Price" means that portion of the Contract Price payable to the Contractor for performance of the O&M Contract in accordance with the provisions of the Contract. The O&M Contract Price

will be the total amount for operation and maintenance during the 15 Years of Operation & Maintenance and one year of DLP as set out in Volume 3, Section XII-, Schedule of Payment and Prices.

**ix. Add to the end of Sub-Clause 1.1.50 the following:**

"Currency of the Country is Indian National Rupee (INR)."

**x. Replace Sub-Clause 1.1.66 with:**

"Retention period" means "Defect Liability Period" of one year after issuance of commissioning certificate. During this period Contractor shall be responsible for the rectification of any defects without any cost implication and also operate and maintain the STP as per the requirement of O&M contract.

**Sub-Clause 1.2 Interpretation**

Add sub-paragraphs (f) to Sub-Clause 1.2, as follows:

"(g) Words importing persons or parties shall include firms and corporations and any organization having legal capacity. "

**Sub-Clause 1.5 Priority of Documents**

Add sub-paragraphs (j) to Sub-Clause 1.5 as follows:

(j) Corrigendum & Addendum and Reply to Pre-Bid Queries issued

**Sub-Clause 1.9 Care and Supply of Documents**

Add to the end of Sub-Clause 1.9 the following:

"Failure to issue such notice by the Employer or to the Contractor in respect of any error in the Contractor's Documents shall not in any manner relieve the Contractor of its obligation to ensure the correctness and accuracy of the Contractor's Documents, and their compliance with the requirements of the Contract."

**Sub-Clause 1.14 Compliance with Laws**

Replace of Sub-Clause 1.14(b) with:

"The Contractor shall, in all matters arising in the performance of the Contract, comply with, give all notices under, and pay all fees required by the provisions of any national or state statute, ordinance or other law, or any regulation of any legally constituted public authority having jurisdiction over the works. The Contractor shall obtain all permits, licenses or approvals required for any part of the Works, in reasonable time taking account of the times for delivery of the Plant and Materials and for completion of the Works. The Employer shall facilitate in getting necessary approvals, permissions by the Contractor. The Employer and the Contractor shall comply with the laws of each country where their activities in relation to the Contract are performed."

**Sub-Clause 1.16 Audit and Inspection by the Employer/GOI/any other Authorized Agency.**

Add new Sub-Clause 1.16 as follows:

"The Contractor shall permit Employer/GOI/any other Authorized Agency to inspect the Contractor's accounts and records related to the performance of the Contract and to have the same audited if so required. The Contractor shall have to remove all defects/deficiencies pointed out by Employer and recoveries if any proposed will be enforceable from the Contractor's payment."

**Sub-Clause 4.2 Performance Security**

**Replace the first three paragraphs of Sub-Clause 4.2 with:**

"The Contractor shall submit an irrevocable Performance Security applicable to Section A as specified in "Part A Contract Data" (Appendix to Technical Bid) for his proper performance of Section A of the Contract, in the amount and at the time stated in the "Part A Contract Data" (Appendix to Technical Bid). This period can be further extended by Employer up to a maximum period of 5 working days on written request of the Contractor stating the reason for delays in procuring the Guarantee to the satisfaction of Employer."

The Contractor shall submit an irrevocable Performance Security applicable to Section B as specified in "Part A Contract Data" (Appendix to Technical Bid) for his proper performance of Section B of the Contract, in the amount and at the time stated in the "Part A Contract Data" (Appendix to Technical Bid).

The Performance Securities shall be in the form of Bank Guarantees from a scheduled list of banks approved by Reserve Bank of India as per the format provided in Sample Forms. The currency of Performance Securities shall be as stated in "Part A Contract Data" (Appendix to Technical Bid).

A Letter of Acceptance shall be issued in the first instance informing the Contractor of the decision of the Employer to accept his Bid and the Work Order shall be issued only after the Performance Guarantee applicable to Section A in prescribed form is received.

Without limitation to the provisions of the preceding paragraph, whenever the Employer determines a cumulative addition to the Contract Price as a result of a change in cost and/or legislation or as a result of a variation more than the Accepted Contract Amount for that Section of the Works, the Contractor, at the written request of the Employer, shall promptly increase the value of the Performance Security applicable to that Section of the Works by an equivalent amount.

If the terms of a Performance Security specify its expiry date, and the Contractor has not become entitled to receive certification of the end of Defect Liability Period or the Final Contract Completion Certificate following completion of Section B, as applicable, by the date 28-days prior to the expiry date, the Contractor shall extend the validity of the Performance Security until the relevant Section of the Works has been completed and any defects remedied. Prior to making a claim under a Performance Security, the Employer shall, in every case, notify the Contractor stating the nature of the default for which the claim is to be made."

*Replace the final paragraph of Sub-Clause 4.2 with:*

"The Employer shall return the Performance Security for Section A to the Contractor after the issue of Woks Contract Completion Certificate by the Employer and the receipt of Performance Security of Section B, as stated in "Part A Contract Data" (Appendix to Technical Bid). The Performance Security for Section B shall be reduced annually after adjusting the cost of O&M Works for previous year, as stated in "Part A Contract Data" (Appendix to Technical Bid)."

**Sub-Clause 4.3 Contractor's Representative**

Add to the end of Sub-Clause 4.3 the following:

The Contractor's Representative shall be fluent in the language for communications defined in Sub-Clause 1.4 [Law and Language]. If the Contractor's Representative's delegates are not fluent in the said language, the Contractor shall make competent interpreters available during all working hours in a number deemed sufficient by the Employer.

**Sub-Clause 4.8 Safety Procedures**

Replace the first sentence of Sub-Clause 4.8 with:

"The Contractor shall, comply with all applicable safety regulations during construction, Retention Period& O&M period:"

**Sub-Clause 4.9 Quality Assurance**

Add the following paragraph at the end of Sub-Clause 4.9:

"The Contractor shall, prior to commencement of Permanent Works on Site, establish his own laboratory on the Site, with prior notification to the Employer & Employer Representative. Calibration of the laboratory equipment and instruments shall be certified by agencies approved by the Employer. Laboratory equipment shall be properly maintained and calibrated throughout the period of the Contract by the Contractor at his own expense. The Contractor shall give the Employer & Employer Representative.at least 24-hours' advance notice prior to conducting any tests on Materials and work. The Employer & Employer Representative. shall also inspect the laboratory if deemed necessary and the Contractor shall provide adequate facilities for their independent verification of the accuracy and adequacy of the facilities. The list of mandatory laboratory equipment to be provided at Site by the Contractor shall be as indicated in the Employer's Requirements."

**Sub-Clause 4.17 Contractor's Equipment**

Add before the first sentence of Sub-Clause 4.17 with the following:

"Unless otherwise stated in the Employer's Requirements, the Contractor shall provide all Contractors' Equipment necessary to fully and satisfactorily complete the Works Contract and the O&M Contract of the facilities."

**Sub-Clause 4.19 Electricity, Water and Gas**

Replace the Sub-Clause 4.19 with the following:

**Electricity**

a. The Contractor shall arrange and provide at his own cost electric connection of suitable load from Electricity Supply Agency. All electricity charges during construction period shall be borne by the Contractor. The Contractor will also keep ready Generators of adequate capacity as standby arrangement in case of electric failure during construction for running of pump sets, vibrators, mixer, needle sets and electric set and other electrically operated construction equipment etc. at his own cost. However, the Employer will issue essentially certificate in favor of the Contractor for obtaining a temporary electric connection from Electricity Supply Agency. The cabling for electric connection shall be arranged by the Contractor himself at his own cost. The non- availability /sanction of electric connection shall be no excuse for delay in completion of work.
b. For O&M period, permanent power connection shall be obtained by the Contractor as per the requirement from Electric Supply Agency. For permanent connection all the statutory deposits/fees as required by the Electric Supply Agency shall be paid by the Employer directly. However, follow up and liaison with statutory authorities and all other expenses are in the Contractor's scope. For approval of entire electrical installation including gas engines, H.T. side shall be obtained by the Contractor at his own cost from electrical inspector and no cost will be reimbursed by the Employer on this account.

   The electrical connection shall be in the name of the Employer. The electric supply shall be provided at one point to the Contractor for usage for project works. Rate of power per unit will be worked out on the basis of demand charges, equipment charges, misuse charges, if any, and any other charges/penalty levied by electric supply authority. If needed, approval of entire electrical installation shall be obtained by the Contractor at his own cost from concerned electrical inspector and no cost will be reimbursed by the Employer on this account. All electricity charges during construction period shall be borne by the Contractor.

*During Trial Run and Commissioning*

No payment on account of manpower, consumables & preventive maintenance /replacement is admissible to the Contractor during Trial run & commissioning period of the STP.

The cost of electricity / power supplies shall be paid directly by CSCL to electricity supply company as per the similar provision of O&M period. i.e., minimum of the power consumption guaranteed by the contractor or actual consumed at site. However any excess power consumed than the guaranteed power during six months trial run period then the power charges shall be borne by the Contractor.

Further during extended period of Trial run of the Plant the Electricity charges will have be borne by the contractor

*During Defect Liability Period and Operation & Maintenance*

During the 15 Years of Operation & Maintenance and one year of Retention Period, CSCL shall pay the electricity charges to the Electricity Supply Agency directly but this shall be lesser of the following:

a. the actual power consumed during the period
b. the power charges calculated on the basis of net power consumption guaranteed by the Contractor. The net power consumption shall be adjusted for the quantity and quality of the raw sewage treated at the STP, as per Technical Schedule, Volume – 1, Part – A, Section - IV of the Bid documents.

   Any additional electricity charges on account of the actual power consumption exceeding the net power consumption guaranteed shall be borne by the Contractor and the Employer shall recover such additional amount from Contractor.

   "No payment is admissible to contractor for rendering O & M services during Defect Liability Period inclusive of manpower, consumables & preventive maintenance /replacement.

   Further during extended period of Retention Period of the Plant all costs of operation & maintenance including electricity charges shall be borne by the Contractor.

   The Employer shall not pay any penalties due to late payment, excess power consumption etc. imposed by the Electricity Supply Agency.

Water

a. The Water required for construction purpose shall be arranged by Contractor at his cost. The Employer will not be responsible for any water supply and no time extension will be granted on account of non-availability of water. Water required for testing of pipe line and liquid retaining structures/tanks shall also be arranged by the Contractor at his cost. Wherever the Employer's water is made available to the contractor for construction and drinking purpose recovery @ 1% of the gross amount of civil works done shall be made. The ferrule connection with the Employer's main and the pipeline upto the site shall be provided by the contractor at his own cost.
b. If the quality of ground water is as per standards and contractor makes his own arrangement for construction and drinking purposes. The quality of water shall be got tested as per BIS by the Contractor at his own cost at the Employer's own laboratory. Permission for extracting ground water shall be obtained from concerned authority by the Contractor.
c. During the O&M period, permanent water connection shall be provided by the Employer. Deposit/fees, if any, required by the Employer shall be paid by Contractor and reimbursed by the

Employer. All other works/expenses etc. are in the Contractor's scope. All maintenance and running expenses shall be borne by the Contractor.

**Sub-Clause 4.20 Employer's Equipment and Free-Issue Material**

Replace the Sub-Clause 4.20 with the following:

"Employer does not have provision for any equipment or Free Issue material."

**Sub-Clause 4.24 Fossils**

Replace the first sentence of Sub-Clause 4.24 with:

"All gold, silver, coins, oil and other minerals of any description, and all precious stones of all kinds, treasures, antiques, fossils and other similar things, which shall be found in or at site, shall be the property of the Employer, and the Contractor shall duly preserve the same to the satisfaction of the Employer, and shall from time to time deliver the same to such person or persons, as the Employer may appoint to receive the same."

**Sub-Clause 5.1 General Design Obligations**

Replace the first sentence of Sub-Clause 5.1 with:

"The Contractor shall carry out, and be responsible for, the design of the Works, including any site surveys, subsoil investigations and all other things necessary for proper planning and design."

Add to the end of first paragraph of Sub-Clause 5.1 the following:

"Employer's requirements include an outline design necessary to establish the feasibility of the project. Bidders are advised that the Employer's outline design is to be considered as an enforceable guideline."

"The Contractor shall be responsible to get all the designs vetted from IIT as approved by the Employer, at his own cost."

**Sub-Clause 5.2 Contractor's Documents**

Replace the first sentence of the third paragraph of Sub-Clause 5.2 with:

"Each of the Construction Documents shall be submitted to the Employer & Employer Representative for review prior to the commencement of construction of the works described in the Construction Documents."

**Sub-Clause 5.4 Technical Standards and Regulations**

Add to the end of Sub-Clause 5.4 the following:

"With respect to technical standards, National or International Standards other than those specified may be acceptable, subject solely to the Employer's approval."

**Sub-Clause 6.7 Health and Safety**

Add to the end of first paragraph of Sub-Clause 6.7, the following:

"In the event of any outbreak of illness of an epidemic nature, the Contractor shall comply with and/or carry out all such regulations, orders, and/or requirements as may be applicable, including those imposed by various governments and the local medical or sanitary authorities."

Replace the last sentence of second paragraph of Sub-Clause 6.7, with the following:

"Throughout the execution of the Works and the Operation and Maintenance Period, the Contractor shall provide whatever is required by this person to exercise this responsibility and authority."

**Add to the end of Sub-Clause 6.7, the following:**

HIV-AIDS Prevention. The Contractor shall conduct an HIV-AIDS awareness programme via an approved service provider, and shall undertake such other measures as are specified in this Contract to reduce the risk of the transfer of the HIV virus between and among the Contractor's Personnel and the local community, to promote early diagnosis and to assist affected individuals.

The Contractor shall throughout the contract (including the Defects Notification Period): (i) conduct Information, Education and Communication (IEC) campaigns, at least every other month, addressed to all the Site staff and labour (including all the Contractor's employees, all Subcontractors and any other Contractor's or Employer's personnel, and all truck drivers and crew making deliveries to Site for construction activities) and to the immediate local communities, concerning the risks, dangers and impact, and appropriate avoidance behavior with respect to, of Sexually Transmitted Diseases (STD) - or Sexually Transmitted Infections (STI) in general and HIV/AIDS in particular; (ii) provide male or female condoms for all Site staff and labour as appropriate; and (iii) provide for STI and HIV/AIDS screening, diagnosis, counseling and referral to a dedicated national STI and HIV/AIDS programme, (unless otherwise agreed) of all Site staff and labour.

The Contractor shall include in the programme to be submitted for the execution of the Works under Sub- Clause 8.3 an alleviation programme for Site staff and labour and their families in respect of Sexually Transmitted Infections (STI) and Sexually Transmitted Diseases (STD) including HIV/AIDS. The STI, STD and HIV/AIDS alleviation programme shall indicate when, how and at what cost the Contractor plans to satisfy the requirements of this Sub-Clause and the related specification. For each component, the programme shall detail the resources to be provided or utilised and any related sub-contracting proposed. The programme shall also include provision of a detailed cost estimate with supporting documentation. Payment to the Contractor for preparation and implementation this programme shall not exceed the Provisional Sum dedicated for this purpose.

"The Contractor is required to follow the Employer's Safety Code and guidelines published by National Human Rights Commission (N.H.R.C).

**Sub-Clause 6.8 Contractor's Superintendence**

**Add to the end of Sub-Clause 6.8, the following:**

"The Contractor shall submit, within 14 days of signing the Contract Agreement, the proposed Deployment Program for all key personnel for superintendence of construction activities for approval by the Employer & Employer Representative. Such Deployment Program shall show details of qualifications and experience of key personnel which is essential for proper superintendence and systematic and professional management of all construction works. The Employer & Employer Representative. will either approve the submittal or provide comments thereon to the Contractor within 14 days of submission by the Contractor.

None of the Contractor's key personnel shall be withdrawn from the Works without due notice being given to the Employer & Employer Representative. Further, no such withdrawals shall be made if in the

sole opinion of Engineer, such withdrawals will jeopardize the progress and timely, successful completion of the Works.

Contractor shall appoint a Planning Engineer at Project Site with computer having MS Project/Primevera and CAD facility. The role and purpose of the Planning Engineer shall be mainly to maintain weekly reporting to the Employer (besides Monthly Progress Reports) on an approved format of the Employer through e-mail facility kept by the Contractor at site. Also CAD drafting facility is required to incorporate necessary details/variation on drawings or the As-Built Drawings time-to-time during construction process and to avoid any discrepancies therein."

**Sub-Clause 6.10 Records of Contractor's Personnel and Equipment**

**Add to the end of Sub-Clause 6.10, the following:**

The Contractor shall submit by the 4$^{th}$and 19$^{th}$of every month, to the Employer or Its Representative, a true statement showing in respect of the second half of the preceding month and the first half of the current month respectively:

i. The number of labourers employed by him on the work,
ii. Their working hours,
iii. The wages paid to them,
iv. The accidents that occurred during the said fortnight showing the circumstances under which they happened and the extent of damage and injury caused by them, and
v. The number of female workers who have been allowed maternity benefit and the amount paid to them."

**Sub-Clause 6.11 Disorderly Conduct**

**Add to the end Sub-Clause 6.11, the following:**

The Contractor shall at all the times during the progress of Works take all requisite precautions and use his best endeavors for preventing any riotous or unlawful behavior by or among the workers and other employees at work and shall preserve peace and protection of the inhabitants and the security of property in the neighborhood of the Works.

In case of any disputes with labourer (skilled or unskilled) and charges are claimed against the Contractor, the Employer shall have the full authority to deduct the same from the bill of the Contractor, so as to enable him to settle the disputes."

**Add new Sub-Clause 6.12 as follows:**

**Sub-Clause 6.12 Foreign Personnel**

The Contractor may bring in to the Country any foreign personnel who are necessary for the execution of the Works to the extent allowed by the applicable Laws. The Contractor shall ensure that these personnel are provided with the required residence visas and work permits. The Employer will, if requested by the Contractor, use his best endeavors in a timely and expeditious manner to assist the Contractor in obtaining any local, state, national, or government permission required for bringing in the Contractor's personnel.

The Contractor shall be responsible for the return of these personnel to the place where they were recruited or to their domicile. In the event of the death in the Country of any of these personnel or

members of their families, the Contractor shall similarly be responsible for making the appropriate arrangements for their return or burial.

**Add new Sub-Clause 6.13 as follows:**

**Sub-Clause 6.13 Suitable Feed**

The Contractor shall arrange for the provision of a sufficient supply of suitable food as may be stated in the Employer's Requirements at reasonable prices for the Contractor's Personnel for the purpose of or in connection with the Contract.

**Add new Sub-Clause 6.14 as follows:**

**Sub-Clause 6.14 Supply of Water**

The Contractor shall, having regard to local conditions, provide on the Site an adequate supply of drinking and other water for the use of the Contractor's Personnel.

**Add new Sub-Clause 6.15 as follows:**

**Sub-Clause 6.15 Measures against Insect and Pest Nuisance**

The Contractor shall at all times take the necessary precautions to protect the Contractor's Personnel employed on the Site from insect and pest nuisance, and to reduce their danger to health. The Contractor shall employ with all the regulations of the local health authorities, including use of appropriate insecticides.

**Add new Sub-Clause 6.16 as follows:**

**Sub-Clause 6.16 Alcoholic Liquor or Drugs**

The Contractor shall not, otherwise than in accordance with the Laws of the Country, import, sell, give, barter or otherwise dispose of any alcoholic liquor or drugs, or permit or allow importation, sale, gift, barter or disposal thereto by Contractor's Personnel.

**Add new Sub-Clause 6.17 as follows:**

**Sub-Clause 6.17 Arms and Ammunition**

The Contractor shall not give, barter, or otherwise dispose of, to any person, any arms, or ammunition of any kind, or allow Contractor's Personnel to do so.

**Add new Sub-Clause 6.18 as follows:**

**Sub-Clause 6.18 Festivals and Religious Customs**

The Contractor shall respect the Country's recognized festivals, days, of rest and religious or other customs.

**Add new Sub-Clause 6.19 as follows:**

**Sub-Clause 6.19 Funeral Arrangements**

The Contractor shall be responsible, to the extent required by local regulations, for making any funeral arrangements for any of his local employees who may die while engaged upon the Work.

**Add new Sub-Clause 6.20 as follows:**

**Sub-Clause 6.20 Forced Labour**

The Contractor shall not employ "forced or compulsory labour" in any form. "Forced or compulsory labour" consists of all work or service, not voluntarily performed, that is extracted from an individual under threat of force or penalty.

**Add new Sub-Clause 6.21 as follows:**

**Sub-Clause 6.21 Child Labour**

The Contractor shall not employ any child to perform any work that is economically exploitative, or is likely to be hazardous to, or to interfere with, the child's education, or to be harmful to the child's health or physical, mental, spiritual, moral, or social development. The Contractor shall follow all applicable Child Labour Laws in India.

**Add new Sub-Clause 6.22 as follows:**

**Sub-Clause 6.22 Employment Records of Workers**

The Contractor shall keep complete and accurate records of the employment of labour at the Site. The records shall include the names, ages, genders, hours worked and wages paid to all workers. These records shall be summarized on a monthly basis and submitted to the Employer, and these records shall be available for inspection by Auditors during normal working hours. These records shall be included in the details to be submitted by the Contractor under Sub-Clause 6.10 [Records of Contractor's Personnel and Equipment].

**Add new Sub-Clause 6.23 as follows:**

**Sub-Clause 6. 23 Worker's Organizations**

In countries where the relevant labour laws recognize worker's rights to form and to join workers' organizations of their choosing without interference and to bargain collectively, the Contractor shall comply with such laws. Where the relevant labour laws substantially restrict workers' organizations, the Contractor shall enable alternative means for the Contractor's Personnel to express their grievances and protect their rights regarding working conditions and terms of employment. In either case described above, and where the relevant labour laws are silent, the Contractor shall not discourage the Contractor's Personnel from forming or joining workers' organizations of their choosing or from bargaining collectively, and shall not discriminate or retaliate against the Contractor's Personnel who participate, or seek to participate, in such organizations and bargain collectively. The Contractor shall engage with such workers' representatives. Workers' organizations are expected to fairly represent the workers in the workforce.

**Add new Sub-Clause 6.24 as follows:**

**Sub-Clause 6. 24 Non-Discrimination and Equal Opportunity**

The Contractor shall not make employment decisions on the basis of personal characteristics unrelated to inherent job requirements. The Contractor shall base the employment relationship on the principle of equal opportunity and fair treatment, and shall not discriminate with respect to aspects of the employment relationship, including recruitment and hiring, compensation (including wages and benefits), working conditions and terms of employment, access to training, promotion, termination of

employment or retirement, and discipline. In countries where the relevant labour laws provide for non-discrimination in employment, the Contractor shall comply with such laws. When the relevant labour laws are silent on non- discrimination in employment, the Contractor shall meet this Sub- Clause's requirements. Special measures of protection or assistance to remedy past discrimination or selection for a particular job based on the inherent requirements of the job shall not be deemed discrimination.

**Replace the last sentence of the Sub-Clause 8.1, the following:**

**Sub-Clause 8.1 Commencement of Work**

The commencement date shall be within 28 days after the Contractor receives the Letter of Acceptance.

**Replace Sub-Clause 10.4, with the following:**

**Sub-Clause 10.4 Delivery of Raw Materials**

"The Contractor shall be responsible for the supply and delivery to the Site (or other designated place) of the chemicals, fuels, consumables and other such items specified in the Employer's Requirements. The Contractor shall be responsible that all such items are fit for purpose and comply with the requirements of the Contract in respect of quality, purpose and function. The Employer shall facilitate the Contractor in getting necessary permissions and approvals for supplying the material at designated site.

In the event that any such item or product is not delivered in accordance with the agreed delivery program or deviates from the specified quality, and such delay or deviation causes the Contractor to suffer additional cost, the Contractor shall not be entitled for any extra costs which he has incurred."

**Add to the end of Sub-Clause 10.8 the following:**

**Sub-Clause 10.8 Completion of Operations Services**

All work shall be executed by the Contractor at his own cost before handing over the Works. In the event that the Contractor fails to carry out the necessary remedial works, the Employer shall notify the Contractor, and proceed in accordance with the provisions of Sub-Clause 12.3 (a) and (b). Any costs incurred by the Employer in so doing shall be recoverable from the Contractor and will become a debt due and payable by the Contractor to the Employer and the Employer may, at his sole discretion, recover such amount by invoking the Contractor's bank guarantee provided as Performance Security.

**Add new Sub-Clause 10.10 the following:**

**Sub-Clause 10.10 Non-Availability of Raw Sewage**

"Throughout the Term of these Conditions of Contract for Operation and Maintenance, the Employer shall be supplying Raw Sewage.

In the event of non-availability of Raw Sewage to the Facility beyond a continuous period of 56 working days, after the start of the Operation Period the responsibilities of the Contractor shall stand suspended.

During such period of suspension,

i. the Employer shall be liable to pay to the Contractor the Fixed Operation & Maintenance Charges as specified by the bidder at the time of bidding in 'Schedule A-9, Section XIV, Volume 3 of Bid documents'

ii. in the event of sustained inability to supply Raw Sewage to the facility for a period greater than 56 days, the Employer shall be liable to pay inventory holding charges for chemicals and consumables that may have been stored by contractor for the purpose of treatment of sewage, that may otherwise have been required, as per the consumption norms specified at the time of bidding.

Such charges shall be payable for each day beyond the period of eight weeks mentioned hereinabove, till such time as the Employer resumes the Facility.

**Add new Sub-Clause 10.11 the following:**

**Sub-Clause 10.11 Adverse Operating Conditions**

"In the event the raw sewage quality deteriorates beyond the specifications provided, the following provision will be applicable:

If the raw sewage can still be treated to meet the Output Standards, the Contractor shall comply with such specifications.

a) In the event it is not possible to meet the Output Standards, the Contractor shall, as soon as practically possible, inform the Employer. The Parties shall consult in good faith to arrive at mutually acceptable Alternative Output Standards, which shall be complied with by the Contractor till the time the raw sewage quality is restored.

b) In the event the change in characteristics is for a period of more than 30 days and it is possible to meet the Output Standards, the Contractor till the time the raw sewage quality is restored.

c) The Liquated Damages as specified in 'Annexure – Service Level Agreement, Volume 3 of Bid Document' then shall be applicable on the agreed Alternative Output Standards."

In such a case, the Contractor shall be suitably compensated with reasonable profit for any additional cost incurred."

**Sub-Clause 13.3 Variation Procedure**

**Add the following in the end of Sub-Clause 13.3:**

All the items are covered in the price schedule. However for any unforeseen items which is not covered in price schedule shall be paid as per the latest schedule of rates (SOR) or on the basis of market rate + 15% over head & profit if not covered in SOR. However no escalation shall be paid on such items. Also, for any deviation/extra item, prior approval of employer shall be required.

**Sub- Clause 13.5 Provisional Sums**

**Add the following in the end of Sub-Clause 13.5 -:**

As an exception to the above, the Provisional Sum for the cost of the DAB shall be used for payments to the Contractor of the Employer's share (one-half) of the invoices of the DAB for its fees and expenses, in accordance with GC20.3. No prior instruction of the Employer's Representative shall be required with respect to the work of the DAB. The Contractor shall produce the DB invoices and satisfactory evidence of having paid 100% of such invoices as part of the substantiation of those Statements submitted under Sub-Clause 14.3, which contain requests for payment under the Provisional Sum toward the cost of the DAB. The Employer's Representative's certification of such Statements shall be based upon such invoices

and such evidence of payment by the Contractor. Contractor's overhead, profit, etc., shall not be included in the provisional sums for the cost of the DAB,

**Sub-Clause 13.8 Adjustment for Changes in Cost**

Replace Sub-Clause 13.8 with:

Price Variation shall be applicable for Works Contract and Operation and Maintenance Contract. This shall also include extension in the Stipulated Date of completion on account of reasons other than those attributable to the Contractor. No price variation will be made where the extension in Stipulated Date of Completion is because of default of Contractor. The decision of Employer shall be final and binding on the Contractor.

In case of extension in the date of completion of Works Contract, the compensation under price variation shall be limited to indices prevailing at the time of Stipulated period of Completion or as prevailing for the period under consideration, whichever is less, provided that, if an extension of time is granted in accordance with Sub-Clause 9.3 [Extension of Time for Completion], the above provision shall apply to the extended Time for Completion.

The amount payable to the Contractor and valued at base prices in accordance with the payment Schedule shall be adjusted for rise or fall in the cost of labor and material by the addition or deduction of the amounts determined by the formulae given in this Sub-Clause and shall be based on Reserve Bank of India (RBI) indices for material and labour. In cases where the "currency of index" is not the relevant currency of payment, each index shall be converted into the relevant currency of payment at the selling rate, established by the central bank of the Country, of this relevant currency on the above date for which the index is required to be applicable. This clause is operative both ways, i.e. if the price variation as calculated is on the plus side, payments on account of the price variations shall be allowed to the contractor and if it is on the negative side, the Employer shall be entitled to recover the same from the Contractor and the amount shall be deductible from any amounts due and payable under the Contract. To the extent that full compensation for any rise or fall in costs to the Contractor is not covered by the provision of this or any other clause in the Contract, the Contract Price shall be deemed to include amounts to cover the contingency of such other rise or fall in costs.

The amount to be added to or deducted from Interim Payment Certificates for changes in cost and legislation shall be determined from formulae for the currency in which the Contract Price is payable and for each of the civil works, electrical and mechanical works, installation, testing and commissioning work and Operation and Maintenance Contract as priced in the Schedule.

Adjustment Formula-The Price Adjustment factor shall be determined in general by the following formula.

Increase or decrease in the cost of labor and material shall be calculated quarterly. The first statement of price adjustment shall be prepared at the end of three months from the month in which the work was deemed to be started and the work done from the date of start to the end of this period shall be taken into account. For subsequent statements, the cost of work done during every quarter shall be taken into account. At the completion of work, the work done during the last quarter or portion thereof shall be taken into account.

For the purposes of reckoning the work done during any period, the bills prepared during the period shall be considered. The dates of recording measurements in the measurement book by the Employer

shall be the guiding factor to decide the bills relevant to any period. The date of completion, as finally recorded by the Employer in the measurement book, shall be the criterion.

For working out the percentages of the values of labor and material components in the work, the total of these two components should be taken as 100.The base date shall be taken as 28 days before the last date of submission of final bid by the pre-qualified bidders.

(A) LABOUR

$$V_L = 0.85 * W * \frac{K_1}{100} * \frac{(L_1 - L_0)}{L_0}$$

where;

$V_L$ = Amount (in INR) of price variation for the labour component W = Cost of Work done during the quarter under consideration.

K1 =Percentage of labour component as 25% for civil works and 15% for E&M works during Works Contract Period and 60% for O&M Works during O&M Period.

L0 = Higher of the "Minimum wage of an unskilled male mazdoor" notified by the ministry of labour and that notified by the UT Administration, twenty eight (28) days prior to the last date of submission of final bid.

L1 = Minimum wage of an unskilled adult male mazdoor, applicable on the last date of the quarter previous to the one under consideration. (In respect of the justified period extended under the provisions of clause 5 of the contract without any action under clause 2, the minimum wage prevailing on the last date of quarter previous to the quarter pertaining to stipulated date of Completion or the minimum wage prevailing on the last date of the quarter previous to the one under consideration, whichever is less, shall be considered.)

MATERIAL:

$$V_M = 0.85 * W * \frac{K_2}{100} * \frac{(M_1 - M_0)}{M_0}$$

where;

$V_M$ = Amount (in INR) of price variation for the material component W = Cost of Work done during the quarter under consideration.

$K_2$ = Percentage of material component as 75% for civil works and 85% for E&M works during Works Contract period and 40% for O&M Works during O&M Period.

M0 =All India Wholesale Price Index for as worked out on the basis of All India Wholesale Price Index for Individual Commodities/Group Items valid twenty eight

(28) days prior to the last date of submission of final bid, as published by the Economic Advisor to Govt. of India, Ministry of Industry & Commerce and applying weightages to the Individual Commodities/Group items.

M1=All India Wholesale Price Index for as worked out on the basis of All India Wholesale Price Index for Individual Commodities/ Group Items for the period under consideration as published by Economic Advisor to Govt. Of India, Ministry of Industry & Commerce and applying weightages to the Individual

Commodities/Group Items. (In respect of the justified period extended under the provisions of clause 5 of the contract without any action under clause2, the index prevailing at the time of stipulated date of completion or the prevailing index of the period under consideration, whichever is less, shall be considered.)

**Sub-Clause 13.9 Taxation**

*Add new Sub-Clause 13.9, as follows:*

"The Accepted Contract Amount shall be deemed to include all taxes, duties, levies, cess, GST and other charges imposed on the production, manufacture, sale and transport of the Contractor's Equipment, Plant, Materials and supplies to be used on or furnished under the Contract and on the services performed under the Contract.

Unless explicitly mentioned in the Contract, Employer doesn't ensure any tax benefits (reduced tax rate/ tax waivers) under Custom Duty, GST, any Cess, etc. during the time of submission of bids. Bidders are advised to consider the actual tax rates (without considering any waiver) while estimating the Contract Price. Any benefits received during the currency of Contract or later shall be passed on to the Employer by the Contractor. The amount due under the clause shall be recovered from Contractor's running account bill, final payment or any other payments due to the Contractor under this Contract. Employer shall also have the right to liquidate the Performance Security available with it to the extent required to recover such amount due.

Recognition of invoice against the material and supplies at the time of their receipt at the project site should not be understood in any case, that the contractor can procure any quantity of material which is way beyond the quantity to be consumed (estimated using the common business prudence) and the shelf life of the material expires before it being used. Accordingly, material and supplies should be procured based on the progressive use of material and supplies/equipments and the same shall correspond with the approved/ released design & drawing, and BOQ.

Further, Employer shall not be responsible in any manner to recognize the billing for any excess consumption of material and supplies/ equipment's by the Contractor beyond the quantities worked out, subject to permissible variation allowed.

**Sub-Clause 14.1 The Contract Price**

*Replace Sub-Clause 14.1 with:*

Payment for the Works shall be made on a lump sum basis according to four major work categories as follows:

Design and documentation, including all necessary designs and documentation required for the Works;

Civil works, installation, testing, commissioning and other services required for the different plant components in accordance with the payment units as set out in the Schedule of Prices and/or as proposed by the Contractor and approved by the Employer;

Plant and equipment, whether manufactured or fabricated outside or within the Employer's country, including supply of all electro-mechanical, electrical and instrumentation equipment, etc., for the different plant components according to the payment units as set out in the Schedule of Prices and/or as proposed by the Contractor and approved by the Employer; and

Operation and maintenance of the constructed facilities after completion and acceptance of Section A of the Works.

The Contract Price shall be adjusted for changes in the cost of labour and materials in accordance with the provisions of Sub-Clause 13.8 [Adjustments for Changes in Cost];

The Contractor shall pay all the duties, fees and taxes in consequence of his obligations under the Contract, and the Contract Price shall not be adjusted for such costs, except as stated in Sub-Clause 13.7 [*Adjustments for Changes in Legislation*];

any quantities, which may be set out in a Schedule are estimated quantities and are not to be taken as the actual and correct quantities of the Works to be executed by the Contractor in ful fillment of his obligations under the Contract;

Bidders are required to submit detailed price break-ups including quantities, unit rates and other pricing information which may be useful for the assessment and subsequent detailing for interim payments.

The Employer shall be authorized to inspect the statements of account as and when it so desires. It may be noted that the project has first right to the funds released by the Employer."

**Sub-Clause 14.3 Application for Advance & Interim Payment Certificates**

*Replace Sub-Clause 14.3 with:*

"**Sub Clause 14.3.1 Application for Advance & Interim Payment Certificates for Works**

The Contractor shall submit a statement in two copies to the Employer after the end of each month in a form approved by the Employer, showing the amounts to which the Contractor considers himself to be entitled together with supporting documents which shall include the detailed report of progress during the month in accordance with Sub-Clause 4.21 [ *Progress Reports*]. ***In case of supplied plant and equipment, inspection and testing clearance certificates shall also be enclosed as support documents***. The statement shall include the following items, as applicable, which shall be expressed in the various currencies in which the Contract Price is payable, in the sequence listed:

the estimated contract value, at base rates and prices, of the Construction Documents produced and the Works (including variations) executed up to the end of the month.

any amounts to be added and deducted for changes in legislation and Adjustments in cost in accordance with Sub-Clauses 13.6 [*Adjustments for Changes in Legislation*] and 13.8 [*Adjustments for Changes in Cost*];

any amount to be deducted for retention, calculated by applying the percentage of retention stated in the **"Part A Contract Data"** (Appendix to Technical Bid) to the total of the above amounts, until the amount so retained by the Employer reaches the limit of Retention Money (if any) stated in the **"Part A Contract Data"** (Appendix to Technical Bid).

any amounts to be added and deducted for the advance payments and repayments in accordance with Sub-Clause 14.2 [*Advance Payment*];

any amounts to be added or deducted for Plant and Materials in accordance with Sub-Clause 14.6 [*Payment for Plants and Materials intended for the Works*];

any other additions or deductions which may have become due in accordance with the Contract (including those under Clause 20 –Claims, Disputes and Arbitration), other than under Sub-Clause 8.5 [*Delay Damages*]; and the deduction of the amounts certified in all previous Interim Payment Certificates.

**14.3.2 Application for Interim Payment Certificates for Operation and Maintenance**

The Contractor shall submit a statement in two copies to the Employer after the end of each month, in a form approved by the Employer, showing the amounts to which the Contractor considers himself to be entitled together with supporting documents. The Statement shall include the following items as applicable:

the estimated contract value of the operation and maintenance services of the facilities up to the end of the month;

i. any amount to be added or deducted for changes in legislation and cost in accordance with Sub clause 13.6 and13.8;
ii. any other additions or deductions which may have become due in accordance with the Contract (including those under Clause 20–Claims, Disputes and Arbitration), other than underSub-Clause8.7 [*Delay Damages*]; and the deduction of the amounts certified in all previous Interim Payment Certificates."

**Sub-Clause 14.4 Schedule of Payments**

*Add the following at the end of Sub-Clause 14.4:*

"Payment Schedule shall be regulated as under:

The designation "P" means progressive monthly payments up to the limits indicated, based on progress made by the Contractor. The designation "LS" means that lump sum payment is made upon completion of the activity described.

| **Payment Schedule (Reference to Sub-Clause 14.4 of the Particular Conditions of Contract)** | | | | |
|---|---|---|---|---|
| **Major Work Category** | **Type of Payment** | **Payment (in % of Total Price)** | **Amount** | **Cumulative %** |
| Design and Documentation | LS | 100 % | | |
| Civil Works | | | | |
| Water Retaining Structures (e.g. Pre Treatment, Biological Reactor, Clarifiers, Digesters, Thickeners etc) | P | 90 % | | |
| Water Retaining Structures after Hydraulic Testing | P | 5% | | |
| Water Retaining Structures after successful completion of testing, trial run, and performance guarantee test | LS | 5% | | |
| Non Water Retaining Structures , ( like Pump House Electrical Panel Room Blower Room , Laboratory roads , drains pathways , stairs etc ). | P | 95% | | |

| **Payment Schedule (Reference to Sub-Clause 14.4 of the Particular Conditions of Contract)** | | | | |
|---|---|---|---|---|
| **Major Work Category** | **Type of Payment** | **Payment (in % of Total Price)** | **Amount** | **Cumulative %** |
| Non Water Retaining Structures, On completion of work & putting the plant/unit in to full service. | LS | 5% | | |
| Mechanical & Electrical, Instrumentation Plant and Equipment for Incorporation in the Permanent Works ( including trial run ) | | | | |
| Mechanical and Electrical Equipment, Instrumentation, Automation etc. supply on site. | P | 70 % | | |
| Payment on completion of installation. | P | 20 % | | |
| Payment on successful completion of testing, trial run, commissioning and performance guarantee test | LS | 10 % | | |
| Operation and Maintenance during Defect Liability Period | | | | |
| Monthly O&M Services (On completion of each month's operations and maintenance) inclusive of man power and consumables. | P | 100 % | | |
| Operation and Maintenance during Ten (10) Years Period | | | | |
| Monthly O&M Services (On completion of each month's operations and maintenance.) inclusive of man power, consumables & preventive maintenance/replacement. | P | 100 % | | |

**Sub-Clause 14.6 Payment for Plant and Material intended for the Works**

**Replace Sub-Clause 14.6 with:**

"If this Sub-Clause applies, Interim Payment Certificates shall include (i) an additional amount for Plant and Materials which have been brought to the Site for incorporation in the Permanent Works, and (ii) a deduction when they have been incorporated in the Permanent Works. The Employer shall determine each addition and deduction in accordance with the following provisions:

a. no addition shall be included in the Interim Payment Certificate unless, in the opinion of the Employer:
   i. the Plant and Materials are considered to be in accordance with the Contract;
   ii. the Plant and Materials have been delivered to the Site and are properly stored on Site and protected against loss, damage or deterioration;
   iii. the Contractor's records of the requirements, orders, receipts and use of Plant and Materials are kept in a form approved by the Employer, and such records are available for inspection by the Employer;

iv. the Contractor has submitted a statement of the cost of acquiring and delivering the Plant and Materials to the Site, together with such documents as may be required for the purpose of evidencing such Cost; and

v. the Plant and Materials are those listed in the "Part A Contract Data" (Appendix to Technical Bid).

b. the additional amount to be certified shall be the equivalent of 70% (seventy percent) of the cost of the Plant and Materials delivered to the Site, as determined by the Employer & Employer Representative after review of the documents mentioned in sub-paragraph (a) above, taking account of the contract value of such Plant and Materials as determined and considered appropriate by the Employer & Employer Representative;

c. the amount of deduction for any Plant and Materials incorporated in the Permanent Works shall be equivalent to the addition previously certified by the Employer & Employer Representative for such Plant and Materials under sub-paragraph (b) above, and

d. the currencies for such addition and deductions shall be determined by the Employer as follows:

i. In the case of each addition, the currencies shall be those in which the payment will eventually become due for the relevant item of Plant or Materials, upon their incorporation in the Permanent Works; and

ii. In the case of a deduction, the currencies shall be those in which the addition for the respective item of Plant or Materials had been certified."

**Sub-Clause 14.13 Application for Final Payment Certificate Operations Services**

**Add to the end of Sub-Clause 14.13, the following:**

If the Employer disagrees with or cannot verify any part of the draft final statement, the Contractor shall submit such further information as the Employer may reasonably require and shall make such changes in the draft as may be agreed between them. The Contractor shall then prepare and submit to the Employer the final statement on Operation and Maintenance as agreed. This agreed statement on Operation and Maintenance is referred to in these Conditions as the "Final Statement on Operation and Maintenance".

However, if following discussions between the Employer and the Contractor and any changes to the draft final statement on Operation and Maintenance which are agreed, it becomes evident that a dispute exists, the Employer shall deliver the Final Payment Certificate for the amount which he considers to be due to the Contractor. Thereafter, if the dispute is finally resolved under Sub-Clause 20.6 [Obtaining Dispute Adjudication Board's Decision] or Clause 20.7 [Amicable Settlement], the Contractor shall then prepare and submit to the Employer (with a copy to the Employer) a Final Statement."

**Sub-Clause 14.18 Asset Replacement Fund**

**Replace Sub-Clause 14.18 with**

Asset replacement fund is not applicable.

**Sub-Clause 14.19 Maintenance Retention Fund**

**Replace Sub-Clause 14.19 with**

Maintenance retention fund is not applicable

**Add New Sub-Clause 15.8 Corrupt or Fraudulent Practice**

If the Employer determines, based on reasonable evidence, that the Contractor has engaged in corrupt, fraudulent, collusive or coercive practices, in competing for or in executing the Contract, then the Employer may, after giving 14 days' notice to the Contractor, terminate the Contract and expel him from the Site, and the provisions of Clause 15 shall apply as if such termination had been made under Sub-Clause 15.2 [Termination by Employer]. Should any employee of the Contractor be determined, based on reasonable evidence, to have engaged in corrupt, fraudulent or coercive practice during the execution of the work then that employee shall be removed in accordance with Sub-Clause 6.9 [Contractor's Personnel]

**Sub-Clause 16.1 Contractor's Entitlement to Suspend Work**

**Replace Sub-Clause 16.1 with:**

"If the Employer fails to pay the Contractor an amount due under any Payment Certificate, and fails to explain why the Contractor is not entitled to such amount within 21 days after the expiry of the time stated in Sub-Clause 14.8 [Payment] within which payment is to be made, except for any deduction that the Employer is entitled to make under the Contract, the Contractor may suspend work or reduce the rate of work after giving not less than 7 days prior notice to the Employer (with a copy to the Employer's Representative). Such action shall not prejudice the Contractor's entitlements to payment under Sub-Clause 14.9 [Delayed Payment] or to terminate under Sub-Clause 16.2 [Termination by Contractor].

Notwithstanding the above, if the Bank has suspended disbursements under the loan or credit from which payments to the Contractor are being made, in whole or in part, for the execution of the Works, and no alternative funds are available as provided for in Sub-Clause 2.4 [Employer's Financial Arrangements], the Contractor may by notice suspend work or reduce the rate of work at any time, but not less than 7 days after the Borrower having received the suspension notification from the Bank.

If the Contractor suspends work or reduces the rate of work, and the Employer subsequently pays the amount due (including payment in accordance with Sub-Clause 14.9 [Delayed Payment]), the Contractor's entitlement under Sub-Clause 16.2 [Termination by Contractor] shall lapse in respect of such delayed payment, unless notice of termination has already been given, and the Contractor shall resume normal working as soon as it is reasonably practicable.

If the Contractor suffers delay and/or incurs cost as a result of suspending work or reducing the rate of work in accordance with this Sub-Clause, the Contractor shall give notice of such cost to the Employer. After receipt of such notice, the Employer shall proceed in accordance with Sub-Clause 3.5 [Determinations] to agree or determine:

a. any extension of the Time for Completion to which the Contractor is entitled under Sub-Clause 9.3 [Extension of Time for Completion of Design Build], and
b. the amount of such Cost plus reasonable profit, which shall be added to the Contract Price, and shall notify the Contractor accordingly."

**Sub-Clause 16.2 Termination by Contractor**

**Add the following at the end second last paragraph of Sub-Clause 16.2:**

In the event the Bank suspends the loan or credit from which part or whole of the payments to the Contractor are being made, if the Contractor has not received the sums due to him upon expiration of

the 14 days referred to in Sub-Clause 14.7 [Payment] for payments under Interim Payment Certificates, the Contractor may, without prejudice to the Contractor's entitlement to financing charges under Sub-Clause 14.8 [Delayed Payment], take one of the following actions, namely (i) suspend work or reduce the rate of work, and (ii) terminate his employment under the Contract by giving notice to the Employer, with a copy to the Employer's Representative, such termination to take effect 14 days after the giving of the notice.

**Sub-Clause 20.8**

**Replace Sub Clause 20.8 with:**

Unless settled amicably under Sub-Clause 20.7 [Amicable Settlement], and subject to Sub-Clause 20.9 [Failure to Comply with Dispute Adjudication Board's Decision], any Dispute in respect of which the DAB's decision (if any) has not become final and binding shall be settled by Arbitration in accordance with the Chandigarh Arbitration Centre (CAC) Rules, 2018 and shall be subject to provisions of the Arbitration & Conciliation Act, 1996 or any statutory amendment thereof.
The appointment of Arbitrator(s) shall be made in accordance with the provisions of the Chandigarh Arbitration Centre (CAC) Rules, 2018 by the parties. In case of disagreement on the appointment of Sole Arbitrator by the parties, there shall be a Board of Three (3) Arbitrators of whom one shall be appointed by the Authority, one shall be appointed by the Concessionaire, and the third shall be appointed by the two arbitrators appointed as aforesaid.
The arbitration proceedings shall be conducted in Chandigarh and the venue of the Arbitration proceedings shall be the Chandigarh Arbitration Centre. The arbitration proceedings shall be conducted in the English language.
The arbitrators shall make a reasoned award (the "Award"). The Parties agree that the decision or award resulting from arbitration shall be final and binding upon the Parties and shall be enforceable in accordance with the provisions of the Arbitration Act subject to the rights of the aggrieved parties to secure relief from any higher forum.
The Contractor and the Employer agree that an Award may be enforced against the Contractor and/or the Employer, as the case may be, and their respective assets wherever situated.
The cost incurred on the process of arbitration including inter alia the fees of the arbitral tribunal and the cost of the proceedings shall be borne by the Parties in equal proportions. Each Party shall be bear its own legal fees incurred as a result of any Dispute under this Clause.

Pending the submission of and/or decision on a Dispute and until the arbitral award is published; the Parties shall continue to perform their respective obligations under this Agreement.

# Section - IX: Annex to the Particular Conditions - Contract Forms

## Letter of Acceptance

[Insert letterhead paper of the Employer]

[Insert date]

To: [Insert name and address of the Contractor]

This is to notify you that your Bid dated [insert date] for execution of the [insert name of the Contract and identification number, as given in the Contract Data] for the Accepted Contract Amount of the equivalent of [insert amount in words and figures] [insert name of currency], as corrected and modified in accordance with the Instructions to Bidders, is hereby accepted by our Agency.

You are requested to furnish the Performance Security within 21 days of issue of this Letter of Acceptance in accordance with the Conditions of Contract, using for that purpose one of the Performance Security Forms included in Section IX, Annex to the Particular Conditions - Contract Forms, of the Bidding Documents

Authorized Signature: Name and Title of Signatory:

## Form of Bid Security (Bank Guarantee)

[Guarantor letterhead or SWIFT identifier code] Beneficiary: [Employer to insert its name and address] IFB No.:[Employer to insert number of Invitation for Bids] Date: [Insert date of issue]

BID GUARANTEE No.: [*Insert guarantee reference number*]

Guarantor: [*Insert name and address of place of issue, unless indicated in the letterhead*]

We have been informed that [*insert name of the Applicant(s)]*, has submitted or will submit to the Beneficiary its Bid (hereinafter called "the Bid") for the execution of [*insert description of contract*].

Furthermore, we understand that, according to the Beneficiary's conditions, Bids must be supported by a bid guarantee.

At the request of the Applicant, we, as Guarantor, hereby irrevocably undertake to pay the Beneficiary any sum or sums not exceeding in total an amount of [*insert amount in words*]([*insert amount in figures*]) upon receipt by us of the Beneficiary's complying demand, supported by the Beneficiary's statement, whether in the demand itself or a separate signed document accompanying or identifying the demand, stating that either the Applicant:

a. has withdrawn its Bid during the period of bid validity set forth in the Applicant's Letter of Bid ("the Bid Validity Period"), or any extension thereto provided by the Applicant; or
b. having been notified of the acceptance of its Bid by the Beneficiary during the Bid Validity Period or any extension thereto provided by the Applicant, (i) has failed to execute the contract agreement, or (ii) has failed to furnish the Performance Security, in accordance with the Instructions to Bidders of the Beneficiary's bidding documents.

This guarantee will expire and shall be returned: (a) if the Applicant is the successful Bidder, upon our receipt of copies of the contract agreement signed by the Applicant and the Performance Security issued to the Beneficiary in relation to such contract agreement; or (b) if the Applicant is not the successful Bidder, upon the earlier of (i) our receipt of a copy of the contract agreement signed by the Successful bidder; or (ii)twenty-eight days after the end of the Bid Validity Period.

Consequently, any demand for payment under this guarantee must be received by us at the office indicated above on or before that date.

**The Guarantee shall be encashable at Chandigarh.**

[signature (s)]

[Note: All italicized text is for use in preparing this form and shall be deleted from the final product.]

## Performance Security for Works Contract Period

Bank Guarantee [Insert Guarantor letterhead or SWIFT identifier code]

Beneficiary:[Insert name and Address of the Employer] Date:[*Insert date of issue*]

PERFORMANCE GUARANTEE No.: [*Insert guarantee reference number*]

Guarantor: [*Insert name and address of place of issue, unless indicated in the letterhead*]

We have been informed that [insert name of the Applicant, (hereinafter called "the Applicant") has submitted or will submit to the Beneficiary its Bid (hereinafter called "the Bid") for the execution of [*insert description of contract]*.

Furthermore, we understand that, according to the conditions of the Contract, a performance guarantee is required.

At the request of the Applicant, we as Guarantor, hereby irrevocably undertake to pay the Beneficiary any sum or sums not exceeding in total an amount of [*insert amount in figures*]([*insert amount in words*])[‡], upon receipt by us of the Beneficiary's complying demand supported by the Beneficiary's statement, whether in the demand itself or in a separate signed document accompanying or identifying the demand, stating that the Applicant is in breach of its obligation(s) under the Contract, without the Beneficiary needing to prove or to show grounds for its demand or the sum specified therein.

This guarantee shall be valid until the date of issue of the Works Contract Completion Certificate or the receipt of O & M Performance Security.

**The Guarantee shall be encashable at Chandigarh.**

[signature(s)]

[Note: All italicized text (including footnotes) is for use in preparing this form and shall be deleted from the final product.]

[‡]The Guarantor shall insert an amount representing the percentage of the Accepted Contract Amount specified in the Letter of Acceptance, less provisional sums, if any.

## Performance Security for O&M Contract Period

Bank Guarantee

[Insert Guarantor letterhead or SWIFT identifier code]

Beneficiary:[Insert name and Address of the Employer] Date:[*Insert date of issue*]

PERFORMANCE GUARANTEE No.: [*Insert guarantee reference number*]

Guarantor: [*Insert name and address of place of issue, unless indicated in the letterhead*]

We have been informed that [insert name of the Applicant (hereinafter called "the Applicant") has submitted or will submit to the Beneficiary its Bid (hereinafter called "the Bid") for the execution of [*insert description of contract*].

Furthermore, we understand that, according to the conditions of the Contract, a performance guarantee is required.

At the request of the Applicant, we as Guarantor, hereby irrevocably undertake to pay the Beneficiary any sum or sums not exceeding in total an amount of [*insert amount in figures*]([*insert amount in words*]), upon receipt by us of the Beneficiary's complying demand supported by the Beneficiary's statement, whether in the demand itself or in a separate signed document accompanying or identifying the demand, stating that the Applicant is in breach of its obligation(s) under the Contract, without the Beneficiary needing to prove or to show grounds for its demand or the sum specified therein.

This guarantee shall be valid until the date of issue of the Contract Completion Certificate.

**The Guarantee shall be encashable at Chandigarh.**

[signature(s)]

[Note: All italicized text (including footnotes) is for use in preparing this form and shall be deleted from the final product]

## Advance Payment Security Bank Guarantee

[Insert Guarantor letterhead or SWIFT identifier code] Beneficiary: [*Insert name and address of the Employer*] Date: [*Insert date of issue*]

ADVANCE PAYMENT GUARANTEE No.: [*Insert guarantee reference number*]

Guarantor: [*Insert name and address of place of issue, unless indicated in the letterhead*]

We have been informed that [*insert name of the Applicant* (hereinafter called "the Applicant") has submitted or will submit to the Beneficiary its Bid (hereinafter called "the Bid") for the execution of [*insert description of contract*].

Furthermore, we understand that, according to the conditions of the Contract, an advance payment in the sum [insert amount in figures] ([insert amount in words])1 is to be made against an advance payment guarantee.

At the request of the Applicant, we as Guarantor, hereby irrevocably undertake to pay the Beneficiary any sum or sums not exceeding in total an amount of [insert amount in figures] ([insert amount in words] upon receipt by us of the Beneficiary's complying demand supported by the Beneficiary's statement, whether in the demand itself or in a separate signed document accompanying or identifying the demand, stating either that the Applicant:

(a) has used the advance payment for purposes other than the costs of mobilization in respect of the Works; or

(b) has failed to repay the advance payment in accordance with the Contract conditions, specifying the amount which the Applicant has failed to repay.

A demand under this guarantee may be presented as from the presentation to the Guarantor of a certificate from the Beneficiary's bank stating that the advance payment referred to above has been credited to the Applicant on its account number[insert number]at[insert name and address of Applicant's bank].

The maximum amount of this guarantee shall be progressively reduced by the amount of the advance payment repaid by the Applicant as specified in copies of interim statements or payment certificates which shall be presented to us. This guarantee shall expire, at the latest, upon our receipt of a copy of the interim payment certificate indicating that ninety (90) percent of the Accepted Contract Amount, less provisional sums, has been certified for payment, or on the[insert day] day of[insert month], [insert year], whichever is earlier. Consequently, any demand for payment under this guarantee must be received by us at this office on or before that date..

**The Guarantee shall be encashable at Chandigarh.**

[signature(s)]

1. The Guarantor shall insert an amount representing the amount of the advance payment as specified in the Contract.

# Affidavit/Undertaking

(duly attested by Notary Public/First Class Magistrate on stamp paper of Rs. 50/-.)

I, _____ authorized signatory of M/s._____sole proprietorship/partnership firm/public/private limited company, having its principal place of business/ registered office at.....(Full Address) do hereby solemnly affirm and declare as under:-

a) That I/We do hereby undertake that I/We have not been black listed / Debarred / suspended by any Govt. or Semi Govt. or Corporation or Private Organization during the last seven years ending last day of the month previous to the one in which Bids are invited.

b) That I/We do hereby undertake and confirm that eligible similar works has / have not been executed though another contractor on back to back basis.

c) That I/We do hereby undertake that no complaint / FIR has been registered / no criminal proceedings against the firm / partners of the firm or its director are pending / ongoing in any court of law regarding any offence punishable under IPC / any other law of the land applicable. If any such fact comes to the notice of the CSCL, the CSCL shall reject the tender / bid straightway without assigning any reason.

d) That I/We do hereby undertake that he / she / Director / Partner of the firm / company / agency have never been convicted of any criminal offence.

e) That I/ We do hereby undertake that the particulars given by me are true and correct to the best of my knowledge and belief and nothing has been concealed thereof. I am aware that in case of any discrepancy/ false statement found, it will lead to rejection of my bid / tender and CSCL will debar / blacklist the firm / agency as per policy of blacklisting issued by Chandigarh Administration vide notification dated 27-02-2009.

f) That I/We do hereby undertake that there are no pending dues to be deposited by the agency with any Government Department / Govt. Undertaking or Board or Organization / Public Sector Undertaking anywhere in the country.

g) That I/We do hereby undertake that in case any such violation comes to the notice of Department before the date of start of work or during the execution of work, CSCL shall be free to forfeit the entire amount of earnest money and / or performance guarantee deposited by me.

Signed by an authorized Officer of the Entity

Date:

# Affidavit / Indemnity (Post Completion Date)

Name of the Work:

W.O. No. Dt. against C.A Employer

I, _____ authorized signatory of M/s._____sole proprietorship/partnership firm/public/private limited company, having its principal place of business/ registered office at……(Full Address) do hereby solemnly affirm and declare that the contents given below from S. No. I to VI are correct and nothing has been concealed:

I. That the above supply / work order was awarded to us through …… Bid on the basis of …… (registered contractor / manufacturer / sole distributor dealer/ authorized dealer / petty contractor).

II. That there is no abnormality in the rate quoted / offered for award of this work.

III. That the purchase of entire quantity of materials supplied / utilized during execution of work has been done from the ……(Manufacturer / authorized dealer / open market / local fabricator) as a …… …… (Contractor / manufacturer / sole distributor or dealer / authorized dealer / petty contractor) which meets the department's specifications in all respect.

IV. That the purchase vouchers submitted along with our bills are genuine.

V. That we have paid all taxes, duties claimed to the appropriate authorities as per norms.

VI. That we executed the work/ supply order strictly as per specifications of work/ supply order issued to us.

Any evidence which proves false declaration at any stage, our firm shall be liable for suitable action as per government laws and rules / regulations.

# Contract Agreement

THIS AGREEMENT made the [insert day] day of [insert month], [insert year], between [insert name of the Employer] (hereinafter "the Employer"), of the one part, and [insert name of the Contractor] (hereinafter "the Contractor"), of the other part:

WHEREAS the Employer desires that the Works known as [name of the Contract] should be executed by the Contractor, and has accepted a Bid by the Contractor for the execution and completion of these Works and the remedying of any defects therein,

The Employer and the Contractor agree as follows:

1. In this Agreement words and expressions shall have the same meanings as are respectively assigned to them in the Contract documents referred to.

2. The following documents shall be deemed to form and be read and construed as part of this Agreement:

(a) The Letter of Acceptance;
(b) The Letter of Technical Bid;
(c) The letter of Price Bid;;
(d) The Particular Conditions (Part A Contract data and Part B Specific Provisions);
(e) The General Conditions of Contract;
(f) The Employer's Requirement;
(g) Contractor's Proposal and post-bid opening correspondences;
(h) The Schedules (if any);
(i) Corrigendum & Addendum and Reply to Pre-Bid Queries issued; and

For the purpose of interpretation, the priority of the listed documents shall be in accordance with the above listed order. This Agreement shall prevail over all other Contract documents.

3. In consideration of the payments to be made by the Employer to the Contractor as specified in this Agreement, the Contractor hereby covenants with the Employer to execute the Works and to remedy defects therein 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 and completion of the Works and the remedying of defects therein, the Contract Price or such other sum as may become payable under the provisions of the Contract at the times and in the manner prescribed by the Contract.

IN WITNESS whereof the parties hereto have caused this Agreement to be executed in accordance with the laws of India on the day, month and year specified above.

| | |
|---|---|
| Signed by | Signed by |
| for and on behalf of the Employer | for and on behalf the Contractor |
| in the presence of | in the presence of |
| Witness, Name, Signature, Address, Date | Witness, Name, Signature, Address, Date |

# Part – B

## Section - III A: Qualification Criteria

Bidder shall provide a comprehensive table indicating on what page number the Qualification Criteria/Projects are being met in the submitted Bid Document.

| Sr. No. | Criteria No. | Criteria Description | Page No. in the Submitted Bid Document that is meeting the intended Criteria |
|---|---|---|---|
| | 1.1 | Bidders Information | |
| | 1.2 | Conflict of Interest | |
| | 1.3 | Ineligibility | |
| | 2.1 | History of Non-Performing Contracts | |
| | 2.2 | Pending Litigation | |
| | 2.3 | Litigation History | |
| | 3.1 | Financial Performance | |
| | 3.2 | Average Annual Construction Turnover | |
| | 3.3 | Financial Resources | |
| | 3.4 | Financial Performance | |
| | 4.1 | General Construction Experience | |
| | 4.2(a) | Specific Construction Experience | |
| | 4.2 (b) | Specific Construction Experience | |
| | 4.2 (c) | Specific Construction Experience | |
| | 4.2 (d) | Specific Construction Experience | |
| | 4.2 (e) | Specific Construction Experience | |
| | 4.2 (f) | Specific Construction Experience | |

Section III A: Qualification Criteria

1. Eligibility and Qualification Criteria

| Eligibility and Qualification Criteria | | | Documentation |
|---|---|---|---|
| **No.** | **Subject** | **Requirement** | **Submission Requirements** |
| 1.1 | Bidder's Information | General Information of the Bidders | Forms EL1-1 with attachments. |
| 1.2 | Conflict of Interest | No conflicts of interest as per ITB 4.4 | Application Submission Form<br>Letter of Technical Bid |
| 1.3 | Ineligibility | Not having been declared ineligible by Employer, as per ITB 4.5 | Letter of Technical Bid and Affidavit/Undertaking (Section IX – Volume 1) |
| 2.1 | History of Non-Performing Contracts | Non-performance of a contract did not occur within the last five (5*)* years prior to the deadline for bid submission based on all information on fully settled disputes or litigation.<br><br>A fully settled dispute or litigation is one that has been resolved in accordance with the Dispute Resolution Mechanism under the respective contract and where all appeal instances available to the Bidder have been exhausted. | Form CON-1 |
| 2.2 | Pending Litigation | The Bidder shall submit along with, the bid details of all pending litigation. The maximum possible legal liability arising out of all the pending litigation should not exceed 50% of net worth of the Bidder | Form CON – 2 |
| 2.3 | Litigation History | The Bidder shall submit along with, the bid details that No consistent history of Court/ arbitral award decisions against the bidder since 1st January 2012 | Form CON – 3 |

| Eligibility and Qualification Criteria | | | Documentation |
|---|---|---|---|
| **No.** | **Subject** | **Requirement** | **Submission Requirements** |
| 3.1 | Financial Experience | The Bidder should have satisfactory completed and commissioned in the last Seven (7) Years ending last day of the month previous to the one in which bids are invited;<br>i. **One similar work** of value **not less than 80%** of the estimated cost of the work, or<br>ii. **Two similar works** each of the value **not less than 60%** of the estimated cost of the work, or<br>iii. **Three similar works** each of the value **not less than 40%** of the estimated cost of the work. | Requisite Certificates |
| 3.2 | Financial Performance | Submission of audited balance sheets, for the last three (3) financial years to demonstrate the current soundness of the Bidder's financial position and its prospective long term profitability.<br>As the minimum requirement, Bidder's net worth calculated as the difference between total assets and total liabilities should be positive. | Form FIN – 1 with attachments |
| 3.3 | Average Annual Construction Turnover | Minimum Average Annual Construction turnover of Rs. 316.43 Cr. in three preceding Financial Years i.e. 2015-16, 2016-17 and 2017-18.<br>*Note: Complete Financial Details required shall be certified by its Charted Accountant/ Statutory Auditor. Information provided/submitted without certification as stated will not be considered for evaluation.* | Form FIN – 2 |
| 3.4 | Financial Resources | (i) The Bidder shall demonstrate that it has access to, or has available, liquid assets, unencumbered real assets, line of credit, and other financial means (independent of any contractual advance payment) sufficient to meet the construction cash flow requirements for a period of twelve (12) months during duration of the contract, for the subject contract(s) net of the Bidder's other commitments. | Form FIR – 1 |

| Eligibility and Qualification Criteria | | | Documentation |
|---|---|---|---|
| **No.** | **Subject** | **Requirement** | **Submission Requirements** |
| | | (ii) The bidder shall also demonstrate, to the satisfaction of the Employer, that it has adequate sources of finance to meet the cash flow requirements on works currently in progress and for future contract commitments | Form FIR – 1 and 2 |
| | | (iii) The Bidder should have a minimum available bid capacity of Rs. 316.43 Cr.<br><br>Bidding capacity = [AXNX2.5] – B where,<br>A= maximum value of works executed in any one year during last five financial years [The Value of Works shall be brought to current costing level by enhancing the actual value of Work at simple rate of 7% per annum; calculated from the date of completion to last date of receipt of application for tenders] taking into account the completed as well as work in progress and<br><br>N = Number of years prescribed for completion of the works for which these bids are being invited and<br><br>B = value of the existing commitments [The Value of Works shall be brought to current costing level by enhancing the actual value of Work at simple rate of 7% per annum; calculated from the date of completion to last date of receipt of application for tenders] and ongoing works to be completed during the period of completion of work for which bids have been invited. | Form FIR – 1 and 2 |
| 3.5 | Financial Performance | The applicant should not be currently in the process of financial restructuring under Corporate Debt Restructuring Act. | Form FIN-3 |
| 4.1 | General Construction Experience | The bidder should have experience under Contract at least for last 7 years as on date of submission of bids. | Form EXP – 4.1 |

| Eligibility and Qualification Criteria | | | Documentation |
|---|---|---|---|
| **No.** | **Subject** | **Requirement** | **Submission Requirements** |
| 4.2(a) | Specific Construction Experience | The Bidder should have experience for Design, Construction, Supply, Installation, Testing & Commissioning of:<br>At least 1 (One) Wastewater Treatment Plant (STP) of 109 MLD<br>OR<br>At least 2 (Two) Waste Water Treatment plant (STP) of 82 MLD each<br>OR<br>At least 3 (Three) Waste Water Treatment plant (STP) of 55 MLD each<br><br>The above projects should have been completed and commissioned (in India) during last Seven (7) years as on date of submission of Bid. | Form EXP – 4.2 (a) |
| 4.2 (b) | Specific Construction Experience | The Bidder should have experience for Design, Construction, Supply, Installation, Testing & Commissioning of:<br>At least 1 (one) 55 MLD capacity Waste Water Treatment plant (STP) with Tertiary Treatment/Filtration Process designed to meet effluent standards as BOD ≤ 10 mg/l, TSS ≤ 10 mg/l.<br><br>The above project should have been completed and commissioned (in India) during last Seven (7) years as on date of submission of Bid. | Form EXP – 4.2 (b) |
| 4.2 (c) | Specific Construction Experience | The Bidder should have experience of installation of PLC & SCADA fully automated in at least one Waste Water Treatment Plant (STP) or Water Treatment Plant (WTP) of minimum 55 MLD capacity.<br><br>The above project should have been completed and commissioned (in India) during last Seven (7) years as on date of submission of Bid. | Form EXP – 4.2 (c) |

| Eligibility and Qualification Criteria | | | Documentation |
|---|---|---|---|
| **No.** | **Subject** | **Requirement** | **Submission Requirements** |
| 4.2 (d) | Specific Construction Experience | The Bidder should have experience for Design, Construction, Erection and successful Commissioning of at least one Waste Water Treatment plant (STP) with minimum 1.0 megawatt power generation from biogas produced at the plant using only biogas engines"<br><br>The above project should have been completed and commissioned (in India) during last Seven (7) years as on date of submission of Bid. | Form EXP – 4.2 (d) |
| 4.2 (e) | Specific Construction Experience | The Bidder should have done successfully Operation & Maintenance for at least 2 years in the last Seven (7) years of one Waste Water Treatment plant (STP) of minimum 55 MLD capacity.<br><br>The above project should have been completed and commissioned (in India) during last Seven (7) years as on date of submission of Bid. | Form EXP – 4.2 (e) |
| 4.2 (f) | Specific Construction Experience | The Bidder should have experience for Design, Construction, Testing & Commissioning of a minimum 55 MLD capacity Waste Water Treatment Plant (STP) having Sludge Digestion and Mechanical Dewatering.<br><br>The above project should have been completed and commissioned (in India) during last Seven (7) years as on date of submission of Bid. | Form EXP – 4.2 (f) |

# Section - III B: Bidding Forms (Initial Filter Qualification)

## Form ELI -1: Bidder Information Form

IFB No.: [insert number]

Page [insert page number] of [insert total number] pages [Bidders shall provide the following information:]

Date: [insert day, month, year]

Page [insert page number] of [insert total number] pages

[Bidders shall provide the following information:]

| |
|---|
| Bidder's legal name<br>*[insert full name]* |
| Bidder's actual or intended country of registration:<br>*[insert country of registration]* |
| Bidder's actual or intended year of incorporation:<br>*[insert year of incorporation]* |
| Bidder's legal address in country of registration:<br>*[insert street/ number/ town or city/ country]* |
| Bidder's authorized representative information Name: *[insert full name]*<br>Address: *[inset street/ number/ town or city/ country]*<br>Telephone/Fax numbers: *[insert telephone/fax numbers, including country and city codes]*<br>E-mail address: *[insert E-mail address]* |
| 1. Attached are copies of original documents of Articles of Incorporation (or equivalent documents of constitution or association), and/or documents of registration of the legal entity named above.<br>2. Included are the organizational chart, a list of Board of Directors, and the beneficial ownership. |

## Form CON-1: History of Non-Performing Contracts

Date: [insert day, month, year] Bidder's Legal Name: [insert full name] Bidder's Partner Legal Name: [insert full name]

IFB No.[insert number]

Page [insert page number] of [insert total number] pages

[The following table shall be filled in for the Bidder]

1. History of Non-Performing Contracts

| **Non-Performing Contracts** | | | |
|---|---|---|---|
| Contract non-performance did not occur since [*insert Date & Year*], as appropriate.<br>Contract(s) not performed since *[insert Date & Year]*, as appropriate, is(are) indicated below: | | | |
| Year | Non- performed portion of contract | Contract Identification | Total Contract Amount (current value, currency, exchange rate and INR) |
| *[insert year]* | *[insert amount and percentage]* | Contract Identification: *[insert complete contract name, number, and any other identification]*<br>Name of Employer: *[insert full name]*<br>Address of Employer: *[insert street/city/country]*<br>Reason(s) for non-performance: *[indicate main reason(s)]* | *[insert amount]* |

## Form CON-2: Pending Litigation

| **Pending Litigation** | | | | |
|---|---|---|---|---|
| | | | | |
| Pending litigation, is indicated below: | | | | |
| Year of dispute | Amount in dispute (currency) | Outcome as Percentage of Net Worth | Contract Identification | Total Contract Amount (current value, currency, exchange rate and INR) |
| *[insert year]* | *[insert amount]* | *[insert percentage]* | Contract Identification: *[indicate complete contract name, number, and any other identification]*<br>Name of Employer: *[insert full name]*<br>Address of Employer: *[insert street/city/country]*<br>Matter in dispute: *[indicate main issues in dispute]*<br>Status of dispute: *[Indicate if it is being treated by the Adjudicator, under*<br>*Arbitration or being dealt with by the Judiciary]* | *[insert amount]* |

## Form CON-3: Litigation History

| **Litigation History** | | |
|---|---|---|
| Court/ Arbitral Award decisions against the Bidder since 1st January *[2012]*, are indicated below: | | |
| Year of award | Contract Identification | Total Contract Amount (current value, currency, exchange rate and INR) |
| *[insert year]* | Contract Identification: *[indicate complete contract name, number, and any other identification]*<br><br>Name of Employer: *[insert full name]*<br><br>Address of Employer: *[insert street/city/country]*<br><br>Matter in dispute: *[indicate main issues in dispute]*<br><br>Partner who initiated the dispute: *[indicate "Employer" or "Contractor"]*<br><br>Status of dispute: *[Indicate if it is being treated by the Adjudicator, under Arbitration or being dealt with by the Judiciary]* | *[insert amount]* |

## Form FIN -1: Financial Performance

[The following table shall be filled in for the Bidder]

Date: [insert day, month, year]

Bidder's Legal Name: [insert full name]

Bidder's Party Legal Name: [insert full name]

IFB No. [insert number]

Page [insert page number] of [insert total number] page

### Financial data

| **Type of Financial information in** | **Historic information for previous *[insert number]*years (amount in INR)** | | | | |
|---|---|---|---|---|---|
| | **2015-16** | **2016-17** | **2017-18** | | |
| Statement of Financial Position (Information from Balance Sheet) | | | | | |
| Total Assets (TA) | | | | | |
| Total Liabilities (TL) | | | | | |
| Net Worth (NW) | | | | | |
| Current Assets (CA) | | | | | |
| Current Liabilities (CL) | | | | | |
| Information from Income Statement | | | | | |
| Total Revenue (TR) | | | | | |
| Profits Before Taxes (PBT) | | | | | |
| Profits After Taxes (PAT) | | | | | |

## Financial Documents

The Bidder and its parties shall provide copies of the financial statements duly certified from audited balance sheets by Chartered Accountant for [number of years] years, as appropriate. The financial statements shall:

a. Reflect the financial situation of the Bidder and not of an affiliated entity (such as parent company or group member).
b. Be independently audited or certified in accordance with local legislation.
c. Be complete, including all notes to the financial statements.
d. Correspond to accounting periods already completed and audited.

Attached are copies of financial statements* for the [number of years] years required above; and complying with the requirements.

* If the most recent set of financial statements is for a period earlier than 12 months from the date of bid, the reason for this should be justified.

## Form FIN - 2: Average Annual Construction Turnover

[The following table shall be filled in for the Bidder]

Date: [insert day, month, year]

Bidder's Legal Name: [insert full name]

Bidder's Party Legal Name:[insert full name]

IFB No. [insert number]

Page [insert page number] of [insert total number] page

| **Annual Turnover Data (Construction only)** | | | |
|---|---|---|---|
| **Year** | **Amount and Currency** | **Exchange rate** | **INR equivalent** |
| ***[indicate year]*** | ***[insert amount and indicate currency]*** | ***[insert applicable exchange rate]*** | ***[insert amount in INR equivalent]*** |
| | | | |
| | | | |
| | | | |
| **Average Annual Construction Turnover** | | | |

## Form FIR – 1: Financial Resources

[The following table shall be filled in for the Bidder]

Date: [insert day, month, year]

Bidder's Legal Name: [insert full name]

Bidder's Partner Legal Name:[insert full name]

IFB No.[insert number]

Page [insert page number] of [insert total number] page

[Specify proposed sources of financing, such as liquid assets, unencumbered real assets, lines of credit, and other financial means, net of current commitments, available to meet the total construction cash flow demands of the subject contract or contracts as specified in Section III : Qualification Criteria, Criteria 3.4]

| **Financial Resources** | | |
|---|---|---|
| **No.** | **Source of financing** | **Amount (INR)** |
| 1 | | |
| 2 | | |
| 3 | | |
| | | |

## Form FIR – 2: Current Contract Commitment

[The following table shall be filled in for the Bidder]

Date: [insert day, month, year]

Bidder's Legal Name: [insert full name]

Bidder's Partner Legal Name:[insert full name]

IFB No. [insert number]

Page [insert page number] of [insert total number] page

[Bidders should provide information on their current commitments on all Contracts that have been awarded, or for which a letter of intent or acceptance has been received, or for Contracts approaching completion, but for which an unqualified, full completion certificate has yet to be issued, in accordance with Section III, Qualification Criteria, Clause 3.4]

| **Current Contract Commitments** | | | | | |
|---|---|---|---|---|---|
| **No.** | **Name of Contract** | **Employer's Contact Address, Tel, Fax** | **Value of Outstanding Work [INR Equivalent]** | **Estimated Completion Date** | **Average Monthly Invoicing Over Last Six Months [INR EQVT/month)]** |
| 1 | | | | | |
| 2 | | | | | |
| 3 | | | | | |
| 4 | | | | | |
| 5 | | | | | |
| | | | | | |

## Form FIN-3: Financial Performance

[The following table shall be filled in for the Bidder]

Date: [insert day, month, year]

Bidder's Legal Name: [insert full name]

Bidder's Party Legal Name:[insert full name]

IFB No.[insert number]

Page [insert page number] of [insert total number] page

To Whom So Ever It may Concern

This is to Certify that our Firm (name of the Bidder) has not currently in the process of Financial Restructuring under the Corporate Debt Restructuring Act as on the date of Submission of the Bid Document.

Duly Signed by the Company Secretary as well as the Authorized Signatory.

## Form EXP – 4.1 - General Construction Experience

[The following table shall be filled in for the Applicant]

Date: [insert day, month, year]

Applicant's Legal Name: [insert full name]

Applicant's Party Legal Name: [insert full name]

Reference ID No.: [insert number, if any]

Page [insert page number] of [insert total number] pages

[Identify contracts that demonstrate continuous construction work over the past [number] years pursuant to Section III A, Qualification Criteria and Requirements, Criteria 4.1. List contracts chronologically, according to their commencement (starting) dates.]

| **General Construction Experience** | | | |
|---|---|---|---|
| **Starting Month / Year** | **Ending Month / Year** | **Contract Identification** | **Role of Applicant** |
| ***[indicate month/ year]*** | ***[indicate month/ year]*** | **Contract name:** ***[insert full name]*** **Brief description of the Works performed by the Applicant:** ***[describe Works performed briefly]*** **Name of Employer:** ***[indicate full name]*** **Address:** ***[indicate street/number/town or city/country]*** | ***[insert "Contractor" or "Subcontractor" or "Management Contractor"]*** |
| | | | |
| | | | |
| | | | |

## Form EXP – 4.2(a) - Specific Construction Experience

[The following table shall be filled in for contracts performed by the Applicant]

Date: [insert day, month, year]

Applicant's Legal Name: [insert full name]

Applicant's Party Legal Name: [insert full name]

Reference ID No.: [insert number, if any]

Page [insert page number] of [insert total number] pages

Fill up one (1) form per contract.

| **Contract of Similar Size and Nature** | | |
|---|---|---|
| Similar Contract No. *[insert number]* of *[insert number of similar contracts required]* | Information | |
| Contract Identification | *[insert contract name and Reference ID number, if* | |
| Award Date | *[insert day, month, year]* | |
| Completion Date | *[insert day, month, year]* | |
| Role in Contract | Prime Contractor Only | |
| Total Contract Amount | *[insert total contract amount in INR]* | |
| If partner in a JV, specify participation in total contract amount | *[insert a percentage amount]* | *[insert total contract amount in INR]* |
| Employer's Name: | *[insert full name]* | |
| Address: Telephone/Fax Number:<br><br>E-mail: | *[indicate street / number / town or city / country]*<br><br>*[insert telephone/fax numbers, including country and city area codes]*<br><br>*[insert E-mail address, if available]* | |

Note:

1. Details of Experience mentioned in above Form, without Certificate from Respective Employer (i.e. officer not below the rank of Executive Engineer) shall not be considered.
2. Use separate Forms, to fill the details of contract(s) of similar works for each Contract/Work.
3. The Experience of Contract/Work, completed and commissioned (in India) during the last Seven (7) Years ending last Day of the Month previous to the one in which bids are invited shall be considered.
4. Incomplete Form shall be summarily rejected.

## Form EXP – 4.2(b) - Specific Construction Experience

Date: [insert day, month, year]

Applicant's Legal Name: [insert full name]

Applicant's Party Legal Name: [insert full name]

Subcontractor's Legal Name (as per ITA 23.1) [insert full name]

Reference ID No.: [insert number, if any]

Page [insert page number] of [insert total number] pages

Fill up one (1) form per contract.

1 [insert brief description of the Activity, emphasizing its specificity]

| **Contract with Similar Key Activities** | | | |
|---|---|---|---|
| Item | Information | | |
| Contract Identification | *[insert contract name and number, if applicable]* | | |
| Award Date | *[insert day, month, year]* | | |
| Completion Date | *[insert day, month, year]* | | |
| Role in Contract<br>*[check the appropriate box]* | Prime Contractor<br>☐ | Management Contractor<br>☐ | Subcontractor<br>☐ |
| Total Contract Amount | *[insert total contract amount in INR]* | | |
| If partner in a JV or subcontractor, specify participation of total contract amount | *[insert a percentage amount* | *[insert total contract amount in INR]* | |
| Employer's Name: | *[insert full name]* | | |
| Address: Telephone/Fax Number: E-mail: | *[indicate street / number / town or city / country]*<br><br>*[insert telephone/fax numbers, including country and city area codes]*<br>*[insert E-mail address, if available]* | | |

1. Activity No. (2)
2. Activity No. (3)

Note:

1. Details of Experience mentioned in above Form, without Certificate from Respective Employer (i.e. officer not below the rank of Executive Engineer) shall not be considered.
2. Use separate Forms, to fill the details of contract(s) of similar works for each Contract/Work.
3. The Experience of Contract/Work, completed and commissioned (in India) during the last Seven (7) Years ending last Day of the Month previous to the one in which bids are invited shall be considered.
4. Incomplete Form shall be summarily rejected.

## Form EXP – 4.2(c) - Specific Construction Experience

Date: [insert day, month, year]

Bidder's Legal Name: [insert full name]

Bidder's Party Legal Name: [insert full name]

Subcontractor's Legal Name (as per ITA 23.1) [insert full name]

1.): [insert brief description of the Activity, emphasizing its specificity]

| **Contract with Similar Key Activities** | | | |
|---|---|---|---|
| Item | Information | | |
| Contract Identification | *[insert contract name and number, if applicable]* | | |
| Award Date | *[insert day, month, year]* | | |
| Completion Date | *[insert day, month, year]* | | |
| Role in Contract<br>*[check the appropriate box]* | Prime Contractor<br>☐ | Management Contractor<br>☐ | Subcontractor<br>☐ |
| Total Contract Amount | *[insert total contract amount in INR]* | | |
| If partner in a JV or subcontractor, specify participation of total contract amount | *[insert a percentage amount* | *[insert total contract amount in INR]* | |
| Employer's Name: | *[insert full name]* | | |
| Address: Telephone/Fax Number: E-mail: | *[indicate street / number / town or city / country]*<br><br>*[insert telephone/fax numbers, including country and city area codes]*<br>*[insert E-mail address, if available]* | | |

1. Activity No. (2)
2. Activity No. (3)

Note:

1. Details of Experience mentioned in above Form, without Certificate from Respective Employer (i.e. officer not below the rank of Executive Engineer) shall not be considered.
2. Use separate Forms, to fill the details of contract(s) of similar works for each Contract/Work.
3. The Experience of Contract/Work, completed and commissioned (in India) during the last Seven (7) Years ending last Day of the Month previous to the one in which bids are invited shall be considered.
4. Incomplete Form shall be summarily rejected.

## Form EXP – 4.2(d) - Specific Construction Experience

Date: [insert day, month, year]

Bidder's Legal Name: [insert full name]

Bidder's Party Legal Name: [insert full name]

Subcontractor's Legal Name (as per ITA 23.1) [insert full name]

Reference ID No.: [insert number, if any]

Page [insert page number] of [insert total number] pages

Fill up one (1) form per contract.

1. [insert brief description of the Activity, emphasizing its specificity]

| **Contract with Similar Key Activities** | | | |
|---|---|---|---|
| Item | Information | | |
| Contract Identification | *[insert contract name and number, if applicable]* | | |
| Award Date | *[insert day, month, year]* | | |
| Completion Date | *[insert day, month, year]* | | |
| Role in Contract<br>*[check the appropriate box]* | Prime Contractor<br>☐ | Management Contractor<br>☐ | Subcontractor<br>☐ |
| Total Contract Amount | *[insert total contract amount in INR]* | | |
| If partner in a JV or subcontractor, specify participation of total contract amount | *[insert a percentage amount* | *[insert total contract amount in INR]* | |
| Employer's Name: | *[insert full name]* | | |
| Address: Telephone/Fax Number: E-mail: | *[indicate street / number / town or city / country]*<br><br>*[insert telephone/fax numbers, including country and city area codes]*<br>*[insert E-mail address, if available]* | | |

1. Activity No. (2)
2. Activity No. (3)

1. Details of Experience mentioned in above Form, without Certificate from Respective Employer (i.e. officer not below the rank of Executive Engineer) shall not be considered.
2. Use separate Forms, to fill the details of contract(s) of similar works for each Contract/Work.
3. The Experience of Contract/Work, completed and commissioned (in India) during the last Seven (7) Years ending last Day of the Month previous to the one in which bids are invited shall be considered.
4. Incomplete Form shall be summarily rejected.

## Form EXP – 4.2(e) - Specific Construction Experience

Date: [insert day, month, year]

Bidder's Legal Name: [insert full name]

Bidder's Party Legal Name: [insert full name]

Subcontractor's Legal Name (as per ITA 23.1) [insert full name]

Reference ID No.: [insert number, if any]

Page [insert page number] of [insert total number] pages

Fill up one (1) form per contract.

1 [insert brief description of the Activity, emphasizing its specificity]

| **Contract with Similar Key Activities** | | | |
|---|---|---|---|
| Item | Information | | |
| Contract Identification | *[insert contract name and number, if applicable]* | | |
| Award Date | *[insert day, month, year]* | | |
| Completion Date | *[insert day, month, year]* | | |
| Role in Contract<br>*[check the appropriate box]* | Prime Contractor<br>☐ | Management Contractor<br>☐ | Subcontractor<br>☐ |
| Total Contract Amount | *[insert total contract amount in INR]* | | |
| If partner in a JV or subcontractor, specify participation of total contract amount | *[insert a percentage amount* | *[insert total contract amount in INR]* | |
| Employer's Name: | *[insert full name]* | | |
| Address: Telephone/Fax Number: E-mail: | *[indicate street / number / town or city / country]*<br><br>*[insert telephone/fax numbers, including country and city area codes]*<br>*[insert E-mail address, if available]* | | |

1. Activity No. (2)
2. Activity No. (3)

1. Details of Experience mentioned in above Form, without Certificate from Respective Employer (i.e. officer not below the rank of Executive Engineer) shall not be considered.
2. Use separate Forms, to fill the details of contract(s) of similar works for each Contract/Work.
3. The Experience of Contract/Work, completed and commissioned (in India) during the last Seven (7) Years ending last Day of the Month previous to the one in which bids are invited shall be considered.
4. Incomplete Form shall be summarily rejected.

Form EXP – 4.2(f) - Specific Construction Experience

Date: [insert day, month, year]

Bidder's Legal Name: [insert full name]

Bidder's Party Legal Name: [insert full name]

Subcontractor's Legal Name (as per ITA 23.1) [insert full name]

Reference ID No.: [insert number, if any]

Page [insert page number] of [insert total number] pages

Fill up one (1) form per contract.

1 [insert brief description of the Activity, emphasizing its specificity]

| **Contract with Similar Key Activities** | | | |
|---|---|---|---|
| Item | Information | | |
| Contract Identification | *[insert contract name and number, if applicable]* | | |
| Award Date | *[insert day, month, year]* | | |
| Completion Date | *[insert day, month, year]* | | |
| Role in Contract<br>*[check the appropriate box]* | Prime Contractor<br>☐ | Management Contractor<br>☐ | Subcontractor<br>☐ |
| Total Contract Amount | *[insert total contract amount in INR]* | | |
| If partner in a JV or subcontractor, specify participation of total contract amount | *[insert a percentage amount* | *[insert total contract amount in INR]* | |
| Employer's Name: | *[insert full name]* | | |
| Address: Telephone/Fax Number: E-mail: | *[indicate street / number / town or city / country]*<br><br>*[insert telephone/fax numbers, including country and city area codes]*<br>*[insert E-mail address, if available]* | | |

1. Activity No. (2)
2. Activity No. (3)

1. Details of Experience mentioned in above Form, without Certificate from Respective Employer (i.e. officer not below the rank of Executive Engineer) shall not be considered.
2. Use separate Forms, to fill the details of contract(s) of similar works for each Contract/Work.
3. The Experience of Contract/Work, completed and commissioned (in India) during the last Seven (7) Years ending last Day of the Month previous to the one in which bids are invited shall be considered.
4. Incomplete Form shall be summarily rejected.

# Section - III C: Evaluation Criteria (Technical & Financial)

## 1 Evaluation of Technical Bids

### 1.1 Assessment of Adequacy of Technical Proposal with Requirements

#### 1.1.1 Personnel

The Bidder demonstrates that it has the personnel for the key positions to be posted at site that meet the requirements in the Table: List of Key Personnel.

The Bidder shall provide details of the proposed personnel and their experience records in the relevant Information Forms included in Section IV, Bidding Forms.

**Table : List of Key Personnel Required**

| S. No. | Position | Desirable Qualification | Total Experience (Years) | Experience in Similar Works (years) | Minimum number Required |
|---|---|---|---|---|---|
| CONSTRUCTION & PROJECT MANAGEMENT | | | | | |
| 1 | Construction Project Manager | Graduate in Civil Engineering | 15 | 5 | 1 |
| 2 | Construction Project Engineer (Civil) | Graduate in Civil Engineering | 8 | 4 | 3 |
| 3 | Construction Project Engineer (Mechanical) | Graduate in Mechanical Engineering | 8 | 4 | 2 |
| 4 | Construction Project Engineer (Electrical) | Graduate in Electrical Engineering | 8 | 4 | 1 |
| 5 | Quality Assurance / Quality Control Engineer | Accredited / Certified | 8 | 4 | 3 |
| 6 | Site Engineer (Civil) | Diploma in Civil Engineering | 8 | 4 | 4 |
| 7 | Site Engineer (E&M) | Diploma in Electrical / Mechanical Engineering | 8 | 4 | 4 |
| 8 | Safety Engineer | Accredited / Certified | 5 | 2 | 3 |

Note:

1. The above staff and number are the minimum to be available during execution of contract. However the successful bidder shall deploy additional staff of required qualification in sufficient numbers, as required at site for successful completion of the contract.
2. The Project Manager should be responsible for timely execution of work and he should have an authority of work in administrative and financial deals / decisions for the project.
3. The proposed Project Manager, QA/QC Engineer and Safety Engineer should have been a full time employee of the applicant firm.

The Bidder shall provide details of the proposed personnel and their experience records in Form PER- 1 and Form PER-2 in Section IV: Bidding Forms.

#### 1.1.2 Equipment

a. The Bidder demonstrates that it has all the key construction equipment and specifically the equipment listed below:

**Table-Key Items of Equipment**

| S. No. | Equipment Type and Characteristics |
|---|---|
| 1 | Excavators |

| | |
|---|---|
| 2 | Bar bending and cutting machines |
| 3 | Concrete pump |
| 4 | Concrete Batch Mixing Plant |
| 5 | Concrete mixers Machines(Electrical/Diesel) |
| 6 | Concrete vibrator of various types |
| 7 | Dewatering pump sets |
| 8 | Cube testing machines |
| 9 | Water Tankers |

b. The above is a partial list and number of equipment/machinery/plant specified is the minimum number required for prequalification.
c. All equipment/machinery/plant are to be in good working condition.
d. The Bidder shall provide further details of proposed items of equipment using Form EQU in Section IV: Bidding Forms.
e. The bidder shall arrange and provide at site all machinery, tools, plants, equipment's, etc during construction as per the site requirements.
f. The number and capacity of the equipment/machinery/plant to be engaged in the work are to be compatible with nature and magnitude of works so as to complete the work on schedule.
g. All the equipment/machinery/plant operators shall be skilled and experienced in using the equipment /machinery/plant to deliver the necessary output.

## 2 Evaluation of Price Bids

In addition to the criteria listed in ITB 38.2 (a) – (d) the following criteria shall apply:

For plant and equipment, the comparison shall be for price of plant and equipment offered from within the Employer's country, (such price to include all costs as well as duties and taxes paid or payable on components and raw material incorporated or to be incorporated in the plant and equipment) and of the CIF-named port of destination price offered from outside the Employer's country; plus the cost of local transportation, civil works, installation and other services required under the contract.

The following evaluation methods for bid evaluated the "Lowest Evaluated Substantially Responsive Bid" shall be followed:

a) **Time Schedule**:

The plant and equipment covered by this bidding process are required to be shipped, installed and the facilities completed within the period specified. Bidders submitting bids that deviate from the specified time schedule will be rejected.

b) **Operating & Maintenance Costs**:

I. Since the full-operation and maintenance costs (i.e., once all the facility construction is complete and the entire plant is brought under operation to achieve the desired effluent quality) of the facilities being procured form a major part of the life cycle cost of the facilities, these costs will be evaluated for 15 years and based on the performance characteristics of the plant and equipment proposed to be furnished by the Bidder as well as on past experience of the Employer or other employers similarly placed. Such costs shall be added to the bid price for evaluation.

Factors which will be used in calculating include:

i. Cost of Operation & Maintenance of WWTP and facilities during 15 Years of Operation & Maintenance and one year of DLP at its rated capacity/output following completion of commissioning and the trial operation period;

ii. The estimated total cost of the electricity required at and consumed by the Plant and equipment during the 15 Years of Operation & Maintenance and one year of DLP including:
    a. The power consumed by the equipment supplied as a part of the facilities, based on calculations of the operating efficiencies and power consumption of all electrically-operated Plant and equipment under working condition.
    b. The guaranteed power generated.

iii. The Evaluation shall further be considered as:
Based on the equipment selected, the bidder shall provide net guaranteed power consumption (Total power requirement – Power generated) during operation and maintenance. This net guaranteed power consumption shall be multiplied by the current rate of electricity charges of Rs. 6.05 per KWh and shall be added to the overall operation and maintenance cost provided by the bidder; which then will be used to determine Present Value (PV) (O&M) for each year and for the total duration of O&M including DLP period.

iv. The rate at ten (10) percent per annum will be used to discount the present value of all annual future costs calculated under (ii) above for the period specified in (i).

v. Land cost shall not be accounted for evaluation.

The O&M NPV cost inclusive of power cost calculated as per the procedure stipulated above will be added to the Bid Price (capital costs) to obtain the Evaluated Bid Price upon which the decision for award of contract will be based.

The life cycle cost as calculated in the procedure stipulated above will be added to the Bid Price (capital costs) to obtain the Evaluated Bid Price upon which the decision for award of contract will be based.

The Bidders' attention is directed to the fact that the operating costs for low efficiency Plant and equipment will be substantially higher than the operating costs for high efficiency Plant and equipment, and that the cost differential over the project period used in this calculation will, in all probability, greatly exceed any incremental capital cost savings which may be realised by offering lower efficiency Plant. Bidders are encouraged to offer Plant and equipment which has high efficiencies at the specified operating conditions.

**c) Functional Guarantee of the facilities:**

Bidders shall state the functional guarantees (e.g. performance, efficiency, consumption) of the proposed facilities in response to the Technical Requirements. Plant and equipment offered shall have a minimum (or a maximum, as the case may be) level of functional guarantees specified in the Technical Requirements to be considered responsive. Bids offering plant and equipment with functional guarantees less (or more) than the minimum (or maximum) specified will be rejected.

d) **Work, Services, Facilities etc., to be provided by the Employer:**

Where bids include for the undertaking of work or the provision of services or facilities by the Employer in excess of the provisions allowed for in the Bid Document, the Employer shall assess the costs of such additional work, services and/or facilities during the duration of the contract. Such costs shall be added to the bid price for the purposes of evaluation; and

i. Any adjustments in price which result from the above procedures will be added, for the purposes of comparative evaluation only, to arrive at an "Evaluated Bid Price." Bid prices quoted by Bidders will remain unaltered.

ii. The Employer reserves the right to accept or reject any variation or deviation. Variations, deviations, and other factors which are in excess of the requirements of the Bid Document or otherwise result in the accrual of unsolicited benefits to the Employer will not be taken into account in bid evaluation.

iii. The estimated effect of the price adjustment provisions of the Particular Conditions, applied over the period of execution of the Contract, will not be taken into account in bid evaluation.

iv. If the bid of the successful Bidder is substantially below the Employer's estimate for the contract, the Employer may require the Bidder to produce detailed price analyses to demonstrate the internal consistency of those prices. After evaluation of the price analysis, the Employer may require that the amount of the performance security be increased at the expense of the successful Bidder to a level sufficient to protect the Employer against financial loss in the event of default of the successful Bidder under the Contract.

# REHABILITATION/UPGRADATION OF 5 NOS. EXISTING SEWAGE TREATMENT PLANTS (STPS) AND CONSTRUCTION OF 1 NO. NEW STP ON DESIGN, BUILD AND OPERATE (ONE YEAR DLP PLUS 15 YEARS O&M) BASIS AT CHANDIGARH UNDER SMART CITY MISSION

## REQUEST FOR PROPOSAL

**26-12-2018**

*Chandigarh Smart City Lmited*

**New Bridge Building - 2, 2nd Floor, Near TDI Mall, Sector 17 – A, Chandigarh – 160017**

# VOLUME 2 - SECTION X
## Technical Specifications

**Part 1: - General Requirements and Scope of Work**

**Part 2: - Plant and Process Requirement**

**Part 3: - Civil Specification**

**Part 4: - Technical Specifications General and Particular – Mechanical**

**Part 5: - Electrical System General and Particular Specification**

**Part 6: - Instrumentation and Specification**

**Part 7: - Inspection, Testing, Erection and Commissioning**

**Part 8: - Scope of Works**

**List of Approved Makes**

# Contents

# SECTION X - VOLUME II: Part 1: General Requirements and Scope of Works

**Part - 1: General Requirements& Scope of Works**

# 1 Project description

## 1.1 Location and Access to the Site

There are 5 STP sites which are located within the existing Chandigarh Wastewater Treatment Plant premises situated in: -

1. STP Sector 66 Diggian, adjoining to Bestech Square Mall, Mohali
2. STP 3 BRD Air Force area, near Ram-Darbar
3. STP Raipur Kalan
4. STP Raipur Khurd
5. STP Dhanas

The requirements specified in the Section-XI -Part-I General Requirements & Scope of Work here under, shall be read in conjunction with addition requirements specified in: -

- Section-X -Part-2 Plant & Process Requirements
- Section-X -Part-3 Civil Specifications
- Section-X -Part-4 Mechanical Specifications
- Section-X -Part-5 Electrical Specifications
- Section-X -Part-6 Instrumentation and Automation Specifications
- Section-X -Part-7 Inspection, Testing, Erection & Commissioning
- Section-X -Part-8 Operation & Maintenance
- Section-X -Part-9 List of Approved Makes

## 1.2 Project Background

The Phase I (Sector 1 to 30) of Chandigarh's sewerage system was laid during 1952 to 1965, Phase II (Sector 31 to 47) was laid during 1965 to 1976, and Phase III was laid 1976 onwards. There are separate sewer and storm water drainage systems in Chandigarh. The sewage and storm water is discharged by gravity flow due to good natural slope from north-east to south-west.

The natural slope facilitates easy disposal of storm water through Sukhna Choe, N-Choe, and Patiala-Ki- Rao Choe. Also, due to provision of proper road gullies and good slope of pipes, the storm water drainage of the city is in very good condition. Similarly, well organized sewerage system serves its purpose of carrying sewage to treatment plant(s), as the natural slope also helps the sewers to be naturally cleaned by attaining the good self-cleansing velocities. Google earth image show the elevation drop/variance of 366 m to 311 m from north-east to south-west by covering approx. 11.40 Km. As per data available approx. 1039 Km storm water drainage exists in the city which generally consists of diameter ranges between minimum 10" to 120" maximum.

Approx. 1138 Km sewerage system exists in the city which generally consists of 778 Km (laterals) and 360 Km (trunk/interceptors). Moreover, details of Circular and Egg-Shaped Brick Sewers as available w.r.t. Phase I, II and III.

At present, approx. 56 MGD of sewage is being generated and collected. Out of which approx. 54 MGD of sewage is being treated by Six (6) number of Sewage Treatment Plant(s), which is

approximately 93% of the quantity of the sewage generated in the city. The capacities and the order in which these WWTP's were constructed are as given below:

| | | | |
|---|---|---|---|
| (i) | 30 MGD | : | STP at Diggian |
| (ii) | 11 MGD | : | STP at 3 BRD |
| (iii) | 5 MGD | : | STP at 3 BRD |
| (iv) | 5 MGD | : | STP at Raipur Kalan |
| (v) | 1.25 MGD | : | STP at Raipur Khurd |
| (vi) | 1.65 MGD | : | STP at Dhanas |

## 1.3 Project Objective

Smart Cities is an urban renewal and retrofitting program by the Government of India with a mission to develop 100 cities all over the country making them citizen friendly and sustainable. The Union Ministry of Urban Development is responsible for implementing the mission in collaboration with the state governments of the respective cities.

With increasing pressure on water as a result of limited availability, increasing urbanization and deterioration of water quality of surface as well as ground water, primarily due to pollution of sources of supplies, water recycling is becoming an established way of moving towards sustainable management of our water resources and environment. As, water is the precious commodity of the day and its judicious use is the basic need of present times, therefore, the main objective of use of TT water is to save the potable drinking water, which is presently being used for the purpose of gardening and irrigation of green spaces in various sectors of the city. Further Tertiary Treatment of sewage will improve the environment of city as the effluent of Tertiary Treatment is rich in nitrogen/manure and plants/grass will flourish by its use.

The overall objective of this package is augmentation (Design, Build and Operate) of existing STPs in place of existing WWTPs. Once the augmentation of WWTP is commissioned and put into service, the old plants will be demolished and the site / area will be developed. The nomenclature of this package is as below:

***Construction of 30 MGD STP at Diggian, 5 MGD STP at Raipur Kalan, 2 MGD STP at Raipur Khurd , Primary Treatment Units (Equalization Tank and Clari-flocculator) of Existing 1.65 MGD at Dhanas , Primary Treatment Units (Equalization Tank and Clari-flocculator) of Existing 11 MGD at 3 BRD with effluent standards of BOD – 5 mg/l, TSS – 5 mg/l, and 2 MLD STP at Sukhna Lake with effluent standards of BOD – 1 mg/l, TSS – 1 mg/l and one year DLP plus 15 years O&M) basis including demolition of existing WWTPs wherever required***

## 1.4 Performance Guarantee – a Statutory Requirement

The waste water treatment facilities to be designed for the flow mentioned below:

| S. No. | Location of WWTP | Average Design Flow | Peak Design Flow |
|---|---|---|---|
| 1 | STP Sector 66 Diggian | 30 MGD | |
| 2 | STP 3 BRD Air Force area, near Ram-Darbar | 11 MGD | |
| 3 | STP Raipur Kalan | 5 MGD | |
| 4 | STP Raipur Khurd | 2 MGD | |
| 5 | STP Dhanas | 1.65 MGD | |
| 6 | STP at Sukhna Lake | 2 MLD | |

| S. No | Parameter | Diggian STP | 3 BRD | Raipur Kalan | Raipur Khurd | Dhanas |
|---|---|---|---|---|---|---|
| 1 | pH | 6.80 | 6.20 | 7.30 | 7.80 | 7.70 |
| 2 | COD | 521 | 541 | 542 | 580 | 736 |
| 3 | BOD | 315.00 | 285.00 | 310.00 | 370.00 | 411.00 |
| 4 | NO3-N | 3.4 | 3.1 | 4 | 3.2 | 0.7 |
| 5 | NH3-N | 36.83 | 36.97 | 37.49 | 42.46 | 52.10 |
| 6 | Phosphate | 4.26 | 4 | 3.17 | 3.19 | 5.43 |
| 7 | TSS | 273.00 | 236.00 | 305.00 | 308.00 | 276.00 |
| 8 | TDS | 482.00 | 475.00 | 512.00 | 663.00 | 724.00 |
| 9 | Turbidity | 230 | 250 | 600 | 620 | 425 |
| 10 | TKN | 12.20 | 10.30 | 9.10 | 7.80 | 6.90 |
| 11 | Fecal Coliform | $1.4x10^5$ | $1.8x10^5$ | $7.6x10^3$ | $5.4x10^3$ | $1.5x10^5$ |
| 12 | Oil & Grease | 8 | 10 | 14 | 18 | 7 |
| 13 | Total Nitrogen | 17.2 | 17.1 | 12 | 17 | 11 |
| 14 | Min. Sewage Temperature (Tmin) | 18 $^OC$ | 18 $^OC$ | 18 $^OC$ | 18 $^OC$ | 18 $^OC$ |
| 15 | Max. Sewage Temperature (Tmax) | 27 $^OC$ | 27 $^OC$ | 27 $^OC$ | 27 $^OC$ | 27 $^OC$ |

### 1.4.1 Incoming Wastewater Quality & Design Parameter

For design purposes, the characteristics of raw sewage are to be taken as follows, considering the fact the Municipal Corporation Chandigarh is implementing various initiatives to channelize the sewage to the treatment plants and the design parameters adopted: –

The above data is based on wastewater quality analyzed by Municipal Corporation Chandigarh. However, the contractor may conduct the sampling and tests of raw sewage by himself to ascertain the raw sewage quality for treatment process. Contractor can also verify the operating data of existing plants. For design purposes values lower than the basic design shall not be permitted.

### 1.4.2 Treated Effluent & Sludge Guarantees

The contractor shall design the process in such a way that the treated effluent quality (at plant outlet) meets the following standards or better:

| S No | Particulars | To be Guaranteed by Bidder |
|---|---|---|
| 1 | pH | 7.5 |
| 2 | TSS | ≤ 5 mg/lt |
| 3 | Total Nitrogen | ≤ 5 mg/l |
| 4 | Ammonical Nitrogen (NH4-N) | ≤ 5 mg/lt |
| 5 | $BOD_5$ | ≤ 5 mg/lt |
| 6 | COD | ≤ 50 mg/lt |
| 7 | $PO_4$-P (TP) | ≤ 1 mg/lt |
| 8 | Fecal Coliform | <230 MPN/100ml |

Sampling, analyzing in laboratory and liquidated damages/Penalty for non-conformance etc. has been mentioned in Volume 3; Section XII- Service Level Agreements.

## 1.5 Brief Scope of Work

It will be essentially a Design, Build & Operate (DBO) contract. The brief scope of work comprises of the following major heads:

1) Construction of following capacities of WWTP along with appropriate sludge treatment and its ultimate reuse.

    1) 30 MGD STP at Diggian,
    2) 5 MGD STP at Raipur Kalan,
    3) 2 MGD STP at Raipur Khurd ,
    4) Primary Treatment Units (Equalization Tank and Clari-flocculator) of Existing 1.65 MGD at Dhanas ,
    5) Primary Treatment Units (Equalization Tank and Clari-flocculator) of Existing 11 MGD at 3 BRD and
    6) MLD STP at Sukhna Lake

Necessary connections for the inflow of raw sewage and treated waste water to make this system functional is responsibility of contractor

2) Trial Run of the Plant.
3) Operation and Maintenance of Plant during Defect Liability Period of one year.
4) Operation & Maintenance of the plant for a period of 15 years after DLP.
5) Demolition of structures of existing abandoned WWTPs wherever required

The duration of period shall be as follows:

| | | |
|---|---|---|
| Construction period | | 24 months |
| Trial run | : | 6 months |
| Commissioning of Plant | : | After completion of successful trial run and all civil works including appropriate sludge treatment and reuse system |
| Defect Liability Period (DLP) | : | 12 months after successful completion of trial run |
| O&M period | : | 180 months |

## PROPOSED TREATMENT SCHEMES

Following treatment scheme proposed for planning and costing purposes to meet the desired treated water quality parameters.

| S. No. | Location of WWTP | Average Design Flow | Major Scope of Work | Preferable Technology for Treatment Process/Scheme |
|---|---|---|---|---|
| 1 | STP Sector 66 Diggian | 30 MGD | Construction of New STP Excluding MPS & Lab Building | A2O Process |
| 2 | STP 3 BRD Air Force area, near Ram-Darbar | 11 MGD | Rehabilitation/Upgradation of Existing STP | Addition of Primary + Tertiary Treatment |
| 3 | STP Raipur Kalan | 5 MGD | Construction of New STP | SBR Process |
| 4 | STP Raipur Khurd | 2 MGD | Construction of New STP | SBR Process |
| 5 | STP Dhanas | 1.65 MGD | Rehabilitation/Upgradation of Existing STP | Addition of Primary + Tertiary Treatment |
| 6 | STP at Sukhna Lake | 2 MLD | Construction of New STP | MBR Process |

Tender is invited for Proven technology however above mentioned technology would be preferable to meet the desired treated parameters for proposed treatment plants

The treatment scheme proposed is split into four distinct parts:

**Pre-treatment:** this comprises of coarse, fine screening and grit removal tank. After pretreatment the sewage shall be taken to biological treatment plant at the uniform rate.

**Biological treatment:** comprising anaerobic tank, anoxic tank and aeration tank. The sludge from the secondary clarifier will be recycled back to anoxic tank for denitrification.

**Tertiary treatment:** comprising filtration unit i.e., disc filter, effluent will be discharged to waterbodies /reuse.

**Sludge Handling and disposal:** Excess sludge produced in biological treatment process shall be collected in sludge tank and digested aerobically. The Excess sludge dewatered in centrifuge and finally disposed or used as organic manure.

Domestic sewage will flow through Bar Screen and collected in raw sewage sump. Large floating particles will be removed by the coarse bar screen. The raw sewage from the raw sewage sump shall be pump to the stilling chamber to pass through the fine screen and followed by grit removal. After grit removal the sewage will be taken to anoxic tank followed by aeration. From anoxic tank denitrified sewage overflow into aeration tank for the removal of BOD and nitrification. The air in the aeration tank shall be provided through an air diffused aeration system of SS-316. The sewage from aeration tank overflows into the Secondary Clarifier. The sludge from Secondary Clarifier shall be recycled back to anoxic tank for denitrification. The sewage from Secondary clarifier shall be filtered through gravity filter to meet the disposal standards. Depending on the MLSS to be retained in the Biological reactor the excess is collected in sludge sump equipped with the mixer and then sludge shall be fed to centrifuge where sludge shall be collected in the form of cake for manure use & permeate shall be send back to raw sewage sump to be recycled.

## PROCESS UNITS FOR 30 MGD STP AT DIGGIAN

### Main Pumping Station

The existing building and pumping station would be utilized as such with minor modification if required. The necessary connections including automation from the existing MPS to inlet chamber would be within the scope of the tender.

### Inlet Chamber

The Inlet chamber will be constructed in RCC that receives flow from the raw sewage from raw sewage pumping station via raw sewage transfer pumps. From inlet chamber by gravity it will be conveyed to course screen through an RCC channel.

### Medium Screen Channels

The flow of Sewage from the inlet chambers shall then enter the 3 nos. of mechanical medium course screens with 2 nos.of manual screen for the removal of floating and oversize materials coming with raw Sewage. The screen channels shall be designed for peak flow. Gates shall be provided at the upstream and downstream ends of the channel to regulate the flow. The conveyor belt and chute arrangement shall be provided to take the screenings from chute in to the wheel burrow container. The mechanical screen shall be operated with level transmitter.

### Fine Screen Distribution Chamber

The distribution chamber will be constructed in RCC that receives flow from the raw sewage from medium screen chamber. From distribution chamber by gravity it will be conveyed to fine screen through an RCC channel.

### Fine Screen Channels

The flow of Sewage from the distribution chamber shall then enter the 3 nos. of mechanical fine screens with 2 nos. manual screen for the removal of floating and oversize materials coming with raw Sewage. The screen channels shall be designed for peak flow. Gates shall be provided at the upstream and downstream ends of the channel to regulate the flow. The conveyor belt and chute arrangement shall be provided to take the screenings from chute in to the wheel burrow container. The mechanical screen shall be operated with level transmitter.

### Aerated Grit Distribution Chamber

The grit distribution chamber will be constructed in RCC that receives flow from the raw sewage from fine screen chamber. From grit distribution chamber by gravity it will be conveyed to aerated grit chamber through an RCC channel.

### Aerated Grit Chamber

Grit chambers shall be provided to remove the grit from the raw sewage. The sewage after the screen shall be received in to the grit chamber. The grit shall be settled in to the grit chamber and withdrawn with the help of grit pump and organic return pump.

### Parshall Flume

The parshall flume is the most widely used flume and has been the standard for flume measurements since designed in the 1930s. The main advantage of the Parshall Flume is its relatively low loss of head. The head loss is only about a fourth of that needed to operate a weir having the same crest length. This allows a wide operating range for a given size flume. The tapered approach section followed by the downward sloping floor of the throat gives the Parshall flume its ability to withstand relatively high degrees of submergence without affecting the flow rate. Another advantage of the flume is its self-cleansing capacity.

**Primary Clarifier Distribution Chamber**

The distribution chamber will be constructed in RCC that receives flow from the raw sewage from parshall flume channel. From clarifier distribution chamber by gravity it will be conveyed to primary clarifier tank through a RCC channel.

**Primary Clarifier**

The purpose of the primary sedimentation is to remove settleable organic solids. The settleable solids are collected by mechanical scrapper into a hopper, from which they are pumped into sludge handling units. It receives flow from parshall flume by gravity method. The design of circular primary sedimentation tank has been based on the average design flow and checked for peak design flow. The tank is design in a such fashion that the weir loading should be less than 120 m3/d.m.

**Biological Treatment Unit**

The biological treatment units shall have the anaerobic tank for phosphorus removal, anoxic tank for denitrification, aeration tank for BOD removal and nitrification. The sludge from Secondary Clarifier shall continuously pumped to biological unit through RAS pumps in to the anaerobic tank.

**Anaerobic Tank**

There shall be two numbers of anaerobic tanks shall be provided. The anaerobic tank shall be equipped with the submersible mixer to keep the suspended solids in suspension. The raw sewage after primary clarifier removal shall be received in the anaerobic tank and mixed with the return sludge from secondary clarifier.

**Anoxic Tank**

There shall be two numbers of anoxic tanks shall be provided. The anoxic tank shall be equipped with the submersible mixer to keep the suspended solids in suspension. The raw sewage after primary clarification removal shall be received in the anoxic tank and mixed with the internal recycle sludge from secondary clarifier.

**Aeration Tank**

There shall be two numbers of aeration tanks. The sewage from the anoxic tank shall be overflow to the aeration tank where it will be treated in the present of microbes for BOD removal and Nitrification. The aeration tank shall be equipped with fine bubble diffusers for the diffused aeration. The air will supplied by twin lobe air blower. The overflow of aeration tank shall be received in to the Secondary Clarifier. The process employs low organic loading, long aeration time, high MLSS concentration and low F/M. The BOD removal efficiency is high. Because of long detention in the aeration tank, the mixed liquor solids undergo considerable endogenous respiration and remain well stabilized. The excess sludge does not require separate digestion and can dewatered directly.

**Secondary Clarifier**

The floor bottom of the clarifiers is scraped by mechanical scrapers in order to divert the sludge to the central sludge pit. These scraper arms and the squeegees are constantly immersed in sewage and are not subjected to severe corrosion because they are not exposed to the air.

**Tertiary Treatment**

Treated water after biological would influent for tertiary treatment. Disk Filter is proposed as filtration mechanism to achieve the desired parameters

**Chlorine Contact Tank and Chlorination System**

The objective of chlorination of water is to reduce organic matter, algae growth etc. One no. chlorine contact tank shall be provided for the disinfection treated sewage. The water from the filtered water sump shall be transfer in to the chlorine contact tank via gravity. The chlorine shall be dose in the chlorine contact tank.

2 Nos (1W+1S) each of chlorinators will be provided. All the chlorinators are installed in the chlorination building. Chlorinators consist of tonner manifold automatic gas feeder, vacuum regulator, pressure reducing valve, vacuum relief valve, controller and ejector. Liquid chlorine is withdrawn from the tonners and is conveyed to vacuum regulator. Thereafter chlorine is conveyed to chlorinator. The required vacuum is created by pumping water under pressure to the injector assembly with the help of 2 Nos. (1W+1S) booster pumps for each chlorinator. The chlorine gas is then mixed with water in the injector and the chlorine solution thus formed is dosed to respective dosing point. Adjacent to the chlorine contact tanks a pump house shall be provided to house the service water pumps, filter backwash pump and air scoring blowers. Pump house shall be provided material handling equipment like EOT/HOT etc.

**Effluent Parshall Flume**

Parshall flume is provided after CCT through gravity. The head loss is only about a fourth of that needed to operate a weir having the same crest length. This allows a wide operating range for a given size flume. The tapered approach section followed by the downward sloping floor of the throat gives the Parshall flume its ability to withstand relatively high degrees of submergence without affecting the flow rate. Another advantage of the flume is its self-cleansing capacity.

**Primary Sludge Sump and Pumps**

The sludge sump shall be provided to receive the surplus sludge from the clarifier via RAS pump. From here, the sludge shall be pumped to the primary thickeners with the help of two nos. of sludge pumps (one working + one standby).

**Primary Sludge Thickener**

Thickening of sludge is used to concentrate solids and reduce the volume and requires less tank capacity. Gravity thickening is accompanied in circular in circular sedimentation tank similar to primary and secondary clarifier. Top layer has relatively clear liquid. The next layer is sedimentation zone and bottom zone is thickening zone. From here, the thickened sludge shall be pumped to the centrifuges with the help of two nos. of centrifuge feed pumps (one working + one standby).

**Primary Dilution Sump and Pumps**

The sludge dilution sump shall be provided to dilute the sludge via dilution pump. From here, the water shall be pumped to the primary thickeners with the help of two nos. of dilution pumps (one working + one standby).

**Secondary Sludge Sump and Pumps**

The sludge sump shall be provided to receive the surplus sludge from the secondary clarifier via RAS pump. From here, the sludge shall be pumped to the primary thickeners with the help of two nos. of sludge pumps (one working + one standby).

**Secondary Sludge Thickener**

Thickening of sludge is used to concentrate solids and reduce the volume and requires less tank capacity. Gravity thickening is accompanied in circular in circular sedimentation tank similar to primary and secondary clarifier. Top layer has relatively clear liquid. The next layer is sedimentation zone and bottom zone is thickening zone. From here, the thickened sludge shall be pumped to the centrifuges with the help of two nos. of centrifuge feed pumps (one working + one standby).

**Secondary Dilution Sump and Pumps**

The sludge dilution sump shall be provided to dilute the sludge via dilution pump. From here, the water shall be pumped to the primary thickeners with the help of two nos. of dilution pumps (one working + one standby).

**Centrifuges**

The solid bowl type centrifuge machine will be to dewater the thickened sludge into sludge cakes for final disposal. The polyelectrolyte dose at the inlet of centrifuge is to increase the efficiency of dewatering. The dewatered sludge as cakes from the centrifuge is collected in a dumper and disposed off elsewhere. The centrate from the centrifuges is conveyed to the raw sewage sump.

**Poly-Electrolyte Dosing System**

Two numbers of polyelectrolyte solution preparation tanks shall be provided for preparation and dosing of polyelectrolyte solution. Each tank will provide with feed water lines, over flow drain and outlet lines. The Polyelectrolyte tank is provided with level transmitter and level indicator with low and high alarm for sensing in the level in the tank. All the running pumps are tripped automatically at low level.

Each tank is also equipped with agitator for dissolving poly electrolyte. The polyelectrolyte solution from the solution preparation tanks shall be dosed to Centrifuge with the help of dosing Pumps. All PE Metering pumps shall be equipped with Electric operated diaphragm valve in suction and discharge line for operation at auto mode.

**Centrifuge Feed Sump and Pumps**

The thickened sludge from primary and secondary thickener shall be collected in the sump through pumping system. From here, the sludge shall be pumped to the centrifuge with the help of two nos. of feed pumps (one working + one standby).

**Centrate & Supernatant Sump and Pumps**

The supernatant and centrate from sludge thickener and centrifuge shall be collected in the sump through gravity. From here, the water shall be pumped to the primary clarifier inlet with the help of two nos. of pumps (one working + one standby).

**Treated Water Disposal**

Treated water after tertiary treatment and disinfection shall be connected with the existing pumping arrangements of the treated waste water

**Laboratory and SCADA building**

The Laboratory SCADA building shall be located at a suitable place. However, existing structure with renovation will be used. The building shall be R.C.C. framed structure. It shall bear a good architectural look. The quality of raw water, clarified Water and filtered water will be monitoring in the laboratory. The laboratory shall be well equipped to analyses of water parameters.

**Building in the STP premises**

Following existing structures shall be used with required renovation/augmentation if any and connected to the proposed treatment system.

- 66/11 kV switchyard

Following existing buildings shall be used with required renovation/augmentation if any

- Switchgear Building
- CSCL Building
- D G Room
- Electric Panel Room
- 11 kV Emergency Panel Building
- Process Air Blower Building
- Chemical Building
- Chemical Building (Lower Level)
- Chemical Building (Upper Level)
- Chlorine Building
- Chlorine Scrubber Foundation
- Administration, Laboratory, and SCADA Building
- Maintenance Workshop
- Guard Room (Security Room)

## PROCESS UNITS FOR 5.0 MGD STP AT RAIPUR KALAN

### Receiving Chamber

The receiving chamber shall receive the sewage from deep gravity out fall sewers. The chamber shall consist of sluice gates on downstream for the flow regulation.

### Coarse Screen Channels

The flow of Sewage from the receiving chambers shall then enter the one mechanical coarse screens with one manual screen for the removal of floating and oversize materials coming with raw Sewage. The screen channels shall be designed for peak flow. Gates shall be provided at the upstream and downstream ends of the channel to regulate the flow. The conveyor belt and chute arrangement shall be provided to take the screenings from chute in to the wheel burrow container. The mechanical screen shall be operated with level transmitter.

### Wet well and Sewage Transfer Pump House

After removal of floating materials through the screens, the flow of Sewage shall enter into the wet well of the pumping station. The capacity of sump shall be for detention of Minimum 10 minutes at peak flow. The pumps shall be the non-clog submersible type. The pumped flow from the pumping station shall be taken to the Stilling chamber of the sewage treatment plant through a pipe line.

### Inlet Chamber

The Inlet chamber will be constructed in RCC that receives flow from the raw sewage from raw sewage pumping station via raw sewage transfer pumps. From inlet chamber by gravity it will be conveyed to course screen through an RCC channel.

### Medium Screen Channels

The flow of Sewage from the inlet chambers shall then enter the one mechanical medium course screens with one manual screen for the removal of floating and oversize materials coming with raw Sewage. The screen channels shall be designed for peak flow. Gates shall be provided at the upstream and downstream ends of the channel to regulate the flow. The conveyor belt and chute arrangement shall be provided to take the screenings from chute in to the wheel burrow container. The mechanical screen shall be operated with level transmitter.

### Fine Screen Distribution Chamber

The distribution chamber will be constructed in RCC that receives flow from the raw sewage from medium screen chamber. From distribution chamber by gravity it will be conveyed to fine screen through an RCC channel.

### Fine Screen Channels

The flow of Sewage from the distribution chamber shall then enter the one mechanical fine screens with one manual screen for the removal of floating and oversize materials coming with raw Sewage. The screen channels shall be designed for peak flow. Gates shall be provided at the upstream and downstream ends of the channel to regulate the flow. The conveyor belt and chute arrangement shall be provided to take the screenings from chute in to the wheel burrow container. The mechanical screen shall be operated with level transmitter.

**Grit Distribution Chamber**

The grit distribution chamber will be constructed in RCC that receives flow from the raw sewage from fine screen chamber. From grit distribution chamber by gravity it will be conveyed to grit chamber through an RCC channel.

**Mechanical Grit Chamber**

Grit chambers shall be provided to remove the grit from the raw sewage. The sewage after the screen shall be received in to the grit chamber. The grit shall be settled in to the grit chamber and withdrawn with the help of grit pump and organic return pump.

**Parshall Flume**

The main advantage of the Parshall Flume is its relatively low loss of head. The head loss is only about a fourth of that needed to operate a weir having the same crest length. This allows a wide operating range for a given size flume. The tapered approach section followed by the downward sloping floor of the throat gives the Parshall flume its ability to withstand relatively high degrees of submergence without affecting the flow rate. Another advantage of the flume is its self-cleansing capacity.

**Biological Treatment Unit**

The biological treatment units shall have the anoxic tank for denitrification and aeration tank for BOD removal and nitrification. The sludge from Secondary Clarifier shall continuously pumped to biological unit through RAS pumps in to the anaerobic tank. There shall be two numbers of pre-anoxic zones shall be provided. The anoxic zone shall be equipped with the submersible mixer to keep the suspended solids in suspension. There shall be two numbers of aeration tanks. The sewage from the anoxic tank shall be overflow to the aeration tank where it will be treated in the present of microbes for BOD removal and Nitrification. The aeration tank shall be equipped with fine bubble diffusers for the diffused aeration. The air will supplied by twin lobe air blower. The overflow of aeration tank shall be received in to the Secondary Clarifier. The process employs low organic loading, long aeration time, high MLSS concentration and low F/M. The BOD removal efficiency is high. Because of long detention in the aeration tank, the mixed liquor solids undergo considerable endogenous respiration and remain well stabilized. The excess sludge does not require separate digestion and can dewatered directly.

**Tertiary Treatment**

Treated water after biological would influent for tertiary treatment. Disk Filter is proposed as filtration mechanism to achieve the desired parameters

**Poly-Electrolyte Dosing System**

Two numbers of polyelectrolyte solution preparation tanks shall be provided for preparation and dosing of polyelectrolyte solution. Each tank will provide with feed water lines, over flow drain and outlet lines. The Polyelectrolyte tank is provided with level transmitter and level indicator with low and high alarm for sensing in the level in the tank. All the running pumps are tripped automatically at low level.

Each tank is also equipped with agitator for dissolving poly electrolyte. The polyelectrolyte solution from the solution preparation tanks shall be dosed to Centrifuge with the help of dosing Pumps. All PE Metering

pumps shall be equipped with Electric operated diaphragm valve in suction and discharge line for operation at auto mode.

**Effluent Parshall Flume**

Parshall flume is provided after CCT through gravity. The head loss is only about a fourth of that needed to operate a weir having the same crest length. This allows a wide operating range for a given size flume. The tapered approach section followed by the downward sloping floor of the throat gives the Parshall flume its ability to withstand relatively high degrees of submergence without affecting the flow rate. Another advantage of the flume is its self-cleansing capacity.

**Sludge Sump and Pumps**

The sludge sump shall be provided to receive the surplus sludge from the reactor via RAS pump. From here, the sludge shall be pumped to the thickener with the help of two nos. of sludge pumps (one working + one standby).

**Sludge Thickener**

Thickening of sludge is used to concentrate solids and reduce the volume and requires less tank capacity. Gravity thickening is accompanied in circular in circular sedimentation tank similar to primary and secondary clarifier. Top layer has relatively clear liquid. The next layer is sedimentation zone and bottom zone is thickening zone. From here, the thickened sludge shall be pumped to the centrifuges with the help of two nos. of centrifuge feed pumps (one working + one standby).

**Centrifuges**

The solid bowl type centrifuge machine will be to dewater the thickened sludge into sludge cakes for final disposal. The polyelectrolyte dose at the inlet of centrifuge is to increase the efficiency of dewatering. The dewatered sludge as cakes from the centrifuge is collected in a dumper and disposed off elsewhere. The centrate from the centrifuges is conveyed to the raw sewage sump.

**Poly-Electrolyte Dosing System**

Two numbers of polyelectrolyte solution preparation tanks shall be provided for preparation and dosing of polyelectrolyte solution. Each tank will provide with feed water lines, over flow drain and outlet lines. The Polyelectrolyte tank is provided with level transmitter and level indicator with low and high alarm for sensing in the level in the tank. All the running pumps are tripped automatically at low level.

Each tank is also equipped with agitator for dissolving poly electrolyte. The polyelectrolyte solution from the solution preparation tanks shall be dosed to Centrifuge with the help of dosing Pumps. All PE Metering pumps shall be equipped with Electric operated diaphragm valve in suction and discharge line for operation at auto mode.

**Centrifuge Feed Sump and Pumps**

The thickened sludge from thickener shall be collected in the sump through pumping system. From here, the sludge shall be pumped to the centrifuge with the help of two nos. of feed pumps (one working + one standby).

**Centrate & Supernatant Sump and Pumps**

The supernatant and centrate from sludge thickener and centrifuge shall be collected in the sump through gravity. From here, the water shall be pumped to the primary clarifier inlet with the help of two nos. of pumps (one working + one standby).

**Treated Water Disposal**

Treated water after tertiary treatment and disinfection shall be connected to the existing disposal or pumping arrangements if any created by the employer within execution period/extended execution period

**Laboratory and SCADA building**

The Laboratory SCADA building shall be located at a suitable place. The building shall be R.C.C. framed structure. It shall bear a good architectural look. The quality of raw water, clarified Water and filtered water will be monitoring in the laboratory. The laboratory shall be well equipped to analyses of water parameters.

**Building in the STP premises**

Following Existing building may be used with required repairs/augmentation/upgradation.

- Centrifuge Building
- CSCL & Electrical Panel Room
- Chlorination cum Chlorine Tonner House
- Admin Building
- Guard Room (Security Room)

## PROCESS UNITS FOR 2.0 MGD STP AT RAIPUR KHURD

**Receiving Chamber**

The receiving chamber shall receive the sewage from deep gravity out fall sewers. The chamber shall consist of sluice gates on downstream for the flow regulation.

**Coarse Screen Channels**

The flow of Sewage from the receiving chambers shall then enter the one mechanical coarse screens with one manual screen for the removal of floating and oversize materials coming with raw Sewage. The screen channels shall be designed for peak flow. Gates shall be provided at the upstream and downstream ends of the channel to regulate the flow. The conveyor belt and chute arrangement shall be provided to take the screenings from chute in to the wheel burrow container. The mechanical screen shall be operated with level transmitter.

**Wet well and Sewage Transfer Pump House**

After removal of floating materials through the screens, the flow of Sewage shall enter into the wet well of the pumping station. The capacity of sump shall be for detention of Minimum 10 minutes at peak flow. The

pumps shall be the non-clog submersible type. The pumped flow from the pumping station shall be taken to the Stilling chamber of the sewage treatment plant through a pipe line.

**Inlet Chamber**

The Inlet chamber will be constructed in RCC that receives flow from the raw sewage from raw sewage pumping station via raw sewage transfer pumps. From inlet chamber by gravity it will be conveyed to course screen through an RCC channel.

**Medium Screen Channels**

The flow of Sewage from the inlet chambers shall then enter the one mechanical medium course screens with one manual screen for the removal of floating and oversize materials coming with raw Sewage. The screen channels shall be designed for peak flow. Gates shall be provided at the upstream and downstream ends of the channel to regulate the flow. The conveyor belt and chute arrangement shall be provided to take the screenings from chute in to the wheel burrow container. The mechanical screen shall be operated with level transmitter.

**Fine Screen Distribution Chamber**

The distribution chamber will be constructed in RCC that receives flow from the raw sewage from medium screen chamber. From distribution chamber by gravity it will be conveyed to fine screen through an RCC channel.

**Fine Screen Channels**

The flow of Sewage from the distribution chamber shall then enter the one mechanical fine screens with one manual screen for the removal of floating and oversize materials coming with raw Sewage. The screen channels shall be designed for peak flow. Gates shall be provided at the upstream and downstream ends of the channel to regulate the flow. The conveyor belt and chute arrangement shall be provided to take the screenings from chute in to the wheel burrow container. The mechanical screen shall be operated with level transmitter.

**Grit Distribution Chamber**

The grit distribution chamber will be constructed in RCC that receives flow from the raw sewage from fine screen chamber. From grit distribution chamber by gravity it will be conveyed to grit chamber through an RCC channel.

**Mechanical Grit Chamber**

Grit chambers shall be provided to remove the grit from the raw sewage. The sewage after the screen shall be received in to the grit chamber. The grit shall be settled in to the grit chamber and withdrawn with the help of grit pump and organic return pump.

**Parshall Flume**

The main advantage of the Parshall Flume is its relatively low loss of head. The head loss is only about a fourth of that needed to operate a weir having the same crest length. This allows a wide operating range for a given size flume. The tapered approach section followed by the downward sloping floor of the throat

gives the Parshall flume its ability to withstand relatively high degrees of submergence without affecting the flow rate. Another advantage of the flume is its self-cleansing capacity.

**Biological Treatment Unit**

The biological treatment units shall have the anoxic tank for denitrification and aeration tank for BOD removal and nitrification. The sludge from Secondary Clarifier shall continuously pumped to biological unit through RAS pumps in to the anaerobic tank. There shall be two numbers of pre-anoxic zones shall be provided.

The anoxic zone shall be equipped with the submersible mixer to keep the suspended solids in suspension. There shall be two numbers of aeration tanks. The sewage from the anoxic tank shall be overflow to the aeration tank where it will be treated in the present of microbes for BOD removal and Nitrification.

The aeration tank shall be equipped with fine bubble diffusers for the diffused aeration. The air will supplied by twin lobe air blower. The overflow of aeration tank shall be received in to the Secondary Clarifier. The process employs low organic loading, long aeration time, high MLSS concentration and low F/M. The BOD removal efficiency is high. Because of long detention in the aeration tank, the mixed liquor solids undergo considerable endogenous respiration and remain well stabilized. The excess sludge does not require separate digestion and can dewatered directly.

**Tertiary Treatment**

Treated water after biological would influent for tertiary treatment. Disk Filter is proposed as filtration mechanism to achieve the desired parameters

**Poly-Electrolyte Dosing System**

Two numbers of polyelectrolyte solution preparation tanks shall be provided for preparation and dosing of polyelectrolyte solution. Each tank will provide with feed water lines, over flow drain and outlet lines. The Polyelectrolyte tank is provided with level transmitter and level indicator with low and high alarm for sensing in the level in the tank. All the running pumps are tripped automatically at low level.

Each tank is also equipped with agitator for dissolving poly electrolyte. The polyelectrolyte solution from the solution preparation tanks shall be dosed to Centrifuge with the help of dosing Pumps. All PE Metering pumps shall be equipped with Electric operated diaphragm valve in suction and discharge line for operation at auto mode.

**Effluent Parshall Flume**

Parshall flume is provided after CCT through gravity. The head loss is only about a fourth of that needed to operate a weir having the same crest length. This allows a wide operating range for a given size flume. The tapered approach section followed by the downward sloping floor of the throat gives the Parshall flume its ability to withstand relatively high degrees of submergence without affecting the flow rate. Another advantage of the flume is its self-cleansing capacity.

**Sludge Sump and Pumps**

The sludge sump shall be provided to receive the surplus sludge from the SBR via RAS pump. From here, the sludge shall be pumped to the thickener with the help of two nos. of sludge pumps (one working + one standby).

**Sludge Thickener**

Thickening of sludge is used to concentrate solids and reduce the volume and requires less tank capacity. Gravity thickening is accompanied in circular in circular sedimentation tank similar to primary and secondary clarifier. Top layer has relatively clear liquid. The next layer is sedimentation zone and bottom zone is thickening zone. From here, the thickened sludge shall be pumped to the centrifuges with the help of two nos. of centrifuge feed pumps (one working + one standby).

**Centrifuges**

The solid bowl type centrifuge machine will be to dewater the thickened sludge into sludge cakes for final disposal. The polyelectrolyte dose at the inlet of centrifuge is to increase the efficiency of dewatering. The dewatered sludge as cakes from the centrifuge is collected in a dumper and disposed off elsewhere. The centrate from the centrifuges is conveyed to the raw sewage sump.

**Centrifuge Feed Sump and Pumps**

The thickened sludge from thickener shall be collected in the sump through pumping system. From here, the sludge shall be pumped to the centrifuge with the help of two nos. of feed pumps (one working + one standby).

**Centrate & Supernatant Sump and Pumps**

The supernatant and centrate from sludge thickener and centrifuge shall be collected in the sump through gravity. From here, the water shall be pumped to the primary clarifier inlet with the help of two nos. of pumps (one working + one standby).

**Treated Water Disposal**

Treated water after tertiary treatment and disinfection shall be connected to the existing disposal or pumping arrangements if any created by the employer within execution period/extended execution period

**Laboratory and SCADA building**

The Laboratory SCADA building shall be located at a suitable place. The building shall be R.C.C. framed structure. It shall bear a good architectural look. The quality of raw water, clarified Water and filtered water will be monitoring in the laboratory. The laboratory shall be well equipped to analyses of water parameters.

**Building in the STP premises**

Following Existing building may be used with required repairs/augmentation/upgradation.

- Centrifuge Building
- CSCL & Electrical Panel Room
- Admin Building

- Guard Room

## PROCESS UNITS BASED ON MBR FOR 2.0 MLD STP AT SUKHNA LAKE

The proposed option should compact and provides treated effluent of a quality which can be reused for top up of lake as per water quality standard given below

Sukhna Lake Chandigarh is used for water sports like rowing, yachting, water surfing and water skiing. It is proposed that treated wastewater from 2 MLD Sewage Treatment plant shall be used to charge the lake. It is very important that treated wastewater should be of highest quality and treatment system should be designed not only for BOD, COD, TSS reduction but also to reduce nitrogen and phosphorous to low levels.

The system proposed is biological plus chemical nutrient removal and ozone treatment for further COD reduction and disinfection.

### RAW SEWAGE CHARACTERISTICS

The characteristics of raw sewage as provided are follows:

Raw sewage Characteristics

| SNO. | CONSTITUENTS | UNITS | VALUE |
|---|---|---|---|
| 1 | Flow | MLD | 2 |
| 2 | Peak Factor | | 2.2 |
| 3 | PH | - | 7.0-8.0 |
| 4 | $BOD_5$ | mg/l | 250-300 |
| 5 | COD | mg/l | 350-450 |
| 6 | TSS | mg/l | 280-320 |
| 7 | TN | mg/l | 30-40 |
| 8 | TP | mg/l | 10-12 |
| 9 | Faecal Coliform | MPN/100 ml | $2.4 \times 10^5$ |

### TREATED EFFLUENT CHARACTERISTICS

Treated effluent Characteristics

| SNO. | CONSTITUENTS | UNITS | VALUE |
|---|---|---|---|
| 1 | PH | - | 7.0-8.0 |
| 2 | $BOD_5$ | mg/l | <1 |
| 3 | COD | mg/l | <10 |
| 4 | TSS | mg/l | <1 |

| | | | |
|---|---|---|---|
| 5 | TN | mg/l | <2 |
| 6 | TP | mg/l | 0.1 (Target) Guarantee 0.5 |
| 7 | Coliform | MPN/100ml | 100 |

Scope of work under this consists of complete Design, supply, installing, testing & commissioning of Civil and Electro mechanical works including campus/site development boundary wall and connection of inlet from existing sewers and connections of treated waste water for Sukhna lake Chandigarh of 2 MLD capacity at the site to be identified by Chandigarh Administration.

The treatment process shall include civil works and compact process can efficiently achieve better outlet effluent quality.

The treatment scheme as proposed for the sewage treatment plant includes the following main treatment steps: -

- *Sewage Pumping Station*
  - *Receiving Chamber*
  - *Course Screening (20 mm)*
  - *Wet Well (With Submersible Pumps)*
- *Pre-treatment*
  - *Mechanical Fine Screen (6mm)*
  - *Grit Chamber*
  - *Fine screen (1 mm – 2 mm before biological treatment)*
- *Biological Treatment*
  - *Anaerobic Tank*
  - *Pre Anoxic Tank*
  - *Pre Aeration Tank*
  - *MBR Tank*
  - *MBR Permeate tank*
- *Disinfection and Removal of organics*
  - *Ozonation.*
  - *Treated water tank and pumping arrangement for discharge into lake*
- *Sludge Handling*
  - *Sludge Holding Tank*
  - *Volute Sludge Press*

**DESCRIPTION**

Proposed sewage treatment plant of 2 MLD based on MBR technology. A membrane bioreactor system eliminates the need for a secondary clarification tank. It allows operation of the biological process at high

mixed liquor suspended solids (MLSS) levels and thus reduces the size of the aeration tank. The elimination of clarification steps and reduction of the aeration tank size offers significant reductions in the footprint of the facility. The high MLSS in an MBR combined with the membrane as an absolute barrier provides better effluent quality compared to conventional treatment. The higher sludge age reduces sludge bulking and also reduces the amount of sludge produced, thus alleviating sludge disposal issues.

The membrane used in MBRs plays a crucial role in the treatment process. It is required to proposes a robust membrane with high chemical tolerance that can be operated at high MLSS concentrations (~10000 mg/L) encountered in MBRs and that can withstand mechanical stresses associated with aeration is required. The backwash shall be done at low flux rates only during maintenance cleanings. This reduces the volume of water used for backwashing and thus reduces the net flux for the system.

The detailed schemes of process units proposed in the STP are as follows:

**RECEIVING CHAMBER**

One number receiving chamber to be provided. Raw sewage will be received by gravity mains, which will discharge the raw sewage into a receiving chamber from where it will be taken into downstream screens / units. The function of the receiving chamber is to reduce the incoming velocity. Receiving chamber shall be of adequate size to meet the requirements of workability inside it. This shall be providing with an HRT of 60 seconds.

**COARSE SCREEN CHAMBER**

One Mechanical (1 Working) and one Manual (1 Standby) screens stainless steel- 304 corrugated bar screen shall be provided in fine screens channels at upstream of grit removal unit. The clear opening shall be 6 mm. The screens shall consist of flats 4 mm, Conveyor Belt and Chute arrangement shall be provided to take the screenings.

Isolation gates shall be provided at inlet and outlet of each screen channel to isolate each screen channel for maintenance purpose. The flow from fine screens is further sent to grit chamber

Screens are provided so as to remove large floating objects from the raw sewage & thereby preventing any kind of damage and obstruction to pumps and equipment's or structures in the subsequent stages of treatment.

**GRIT CHAMBER**

The sewage from the screen chamber flows into 1 no. grit chambers, to remove grit, consisting of sand, gravel, cinders or other heavy solid materials that have specific gravities substantially greater than those of the organic putrescible solids in wastewater.

Grit removal is necessary to protect the moving mechanical equipment and pump elements from abrasion and accompanying abnormal wear and tear. Also, removal of grit reduces the frequency of cleaning of settling tanks. De-gritted sewage shall exit the Grit Basins over the outlet weir. Liquid streams from grit washers and classifiers shall be returned to the degritted sewage stream or to the plant drain pump station.

Grit removal system with detritus mechanism is being proposed. The solids are removed by a rotating scrapper mechanism to a sump at the side of the tank. The solids settled are sent for disposal.

**FINE SCREEN**

1 No. Stainless Steel- 304 Mechanical and 1 No. manual Fine Screen with 1 /2 mm punched hole configuration -self-cleaning type, electric driven shall be provided to protect the MBR membranes from being damaged from large coarse objects.

## MEMBRANE BIO REACTOR

## ANAEROBIC TANK

Anaerobic tank is designed for biological removal of phosphorous, the phosphorous in the influent wastewater is incorporated into cell biomass, which is subsequently removed from the process as a result of sludge wasting. The reactor configuration provides the P accumulating organisms (PAO) with a competitive advantage over other bacteria. So PAO are encouraged to grow and consume phosphorous. The reactor configuration is comprised of an anaerobic tank and an activated sludge tank. In the anaerobic tank, its contents are mixed to provide contact with the return activated sludge and influent wastewater.

In the anaerobic zone, under anaerobic conditions, PAO assimilate fermentation products (i.e. volatile fatty acids) into storage products within the cells with the concomitant release of phosphorous from stored polyphosphates. Acetate is produced by fermentation of COD, which is dissolved degradable organic material that can be easily assimilated by the biomass. Using energy available from stored polyphosphates, the PAO assimilate acetate and produce intracellular polyhydroxybutyrate (PHB) storage products. Concurrent with the acetate uptake is the release of orthophosphates, as well as magnesium, potassium, calcium cations. The PHB content in the PAO increases as the polyphosphate decreases. Each anaerobic tank has 2 zones.

In the aerobic zone, energy is produced by the oxidation of storage products and polyphosphate storage within the cell increases. Stored PHB is metabolized, providing energy from oxidation and carbon for new cell growth. Some glycogen is produced from PHB metabolism. The energy released from PHB oxidation is used to form polyphosphate bonds in cell storage. The soluble orthophosphate is removed from solution and incorporated into polyphosphates within the bacterial cell. PHB utilization also enhances cell growth and this new biomass with high polyphosphate storage accounts for phosphorous removal. As a portion of the biomass is wasted, the stored phosphorous is removed from the bio- treatment reactor for ultimate disposal with the waste sludge.

## ANOXIC TANK

Anoxic processes are typically used for the removal of nitrogen from wastewater. The process of biological nitrogen removal is known as denitrification. Denitrification requires that nitrogen be first converted to nitrate, which typically occurs in an aerobic treatment process, which then is converted (reduced) into Nitrogen gas (N2). In the pre aeration tank and the MBR tank, the nitrogen present is first converted to nitrates and nitrites and then nitrified water shall be recycled back into the anoxic tank where the nitrified water then shall be exposed to an environment without free oxygen in anoxic tank. Organisms in this anoxic system use the nitrate as an electron acceptor and release nitrogen in the form of nitrogen gas. Internal recirculation pumps are provided to re-circulate the flow from MBR tanks to the anoxic tank.

## PRE-AERATION TANK

The denitrified mixed effluent from the anoxic tank, deficient in dissolved oxygen will be directed to pre-aeration tank. Intensive aeration shall be done using fine bubble disc type EPDM membrane air bubble diffusers to further oxidize the organic matter in the presence of microorganisms and reduce the BOD/COD

levels in the combined stream. Compressed air system shall be provided by air blowers located outside the tank. The blowers are sized to ensure dissolved oxygen level of approximately 1.5-2.0 mg/l in the Aeration Tank. The mixed liquor from the aeration tank shall flow by gravity into the adjacent MBR tank.

**MEMBRANE TANKS**

The mixed liquor from the pre-aeration tank shall flow into the membrane tanks. The membrane bioreactor combines conventional biological treatment processes with membrane filtration to provide an advanced level of organic and suspended solids removal, eliminating the need for secondary clarifier.

MBR membrane used is out/in configuration. Following the aeration tank, combined effluent will pass through hollow fiber or flat sheet membranes. In the process, this level of filtration provides high quality effluent, low in biochemical oxygen demand (BOD) content, total and Kjeldahl nitrogen, suspended solids and E. coli. In addition, the high biomass concentrations (8-12 kg/m³) allow the bioreactor volume to be reduced to as low as 25% of the size of a conventional aeration tank. Excess bio solids will be wasted from the bioreactor. Blowers will be used for air scouring of the MBR membranes to prevent excessive concentration polarization on the surface of the membranes and avoid membrane fouling. The membrane flux rate slowly decreases due to fouling, which is recovered back by periodic chemical cleaning of the membranes.

The operating sequence for MBR membranes are as follows:

a) Filtration (with continuous aeration)

b) Soak (with continuous aeration)

The cleaning modes shall be as below:

1. Chemically Enhanced Backwash (CEB) (Low concentration Chemical Cleaning)
2. Clean-In-Place (CIP) Cleanings (High Concentration chemical cleaning)

**Filtration**

In the filtration step, suction is applied to the fibre lumen by a vacuum pump which allows filtrate to flow through the fibre walls into the lumen (outside-infiltration). The microbes, colloidal particles and turbidity in the feed shall be removed by the micro porous fibre walls. The filtrate produced shall be collected in the filtrate tank. As the filtration cycle progresses, foulants are deposited onto the membrane surface and increase the trans-membrane pressure (TMP). Air shall be applied underneath the module and create a two-phase flow that will scour the membrane surface and continuously removes particles.

**Soak**

Every tfilt seconds, the filtration cycle shall be stopped and the membranes will be allowed to soak in the membrane tank for soak seconds while being continuously aerated. This relaxation cycle will help in the removal of foulants that have accumulated on the membrane surface during the filtration cycle by agitating the fibres and essentially shaking off surface particles.

**CEB**

Even though aeration and relaxation are quite effective in cleaning the membranes, a CEB, or maintenance cleaning, needs to conducted, typically at a frequency of once a week, to keep the membrane fouling to a minimum. The maintenance cleaning shall be conducted by backwashing with a solution made from sodium hypochlorite (NaOCl). During the CEB, the solution shall flow in the reverse direction; from inside the membrane lumens out into the membrane tank. The CEB shall typically be followed by a soak period

without aeration to allow the chemicals to react with particles on the surface and inside the pores to further help removal of bio fouling.

**CIP cleaning**

A CIP is another intensive method of cleaning with a chemical solution, either with sodium hypochlorite or citric acid. The most common type of CIP occurs at least once every three months and employs a high concentration chlorine solution made from sodium hypochlorite for injection into the membranes. A sodium hypochlorite CIP shall also be performed if the TMP reaches a pre-set value above the initial pressure experienced by the membranes during filtration at the same flux. A sodium hypochlorite CIP shall be done at whichever point occurs first, three months or when the pressure increases by the pre-set amount.

During a CIP, the membranes shall be backwashed with a chemical solution, a soak period shall occur for an extended time, and then the membranes shall be aerated. The concentrations and types of chemicals used and the soak time shall depend on the extent of fouling and the nature of the feed water. Chlorine aids in removal of biological fouling and citric acid shall remove inorganic scaling in the case of high alkalinity feed.

**ALUM DOSING**

Alum dosing is proposed at the inlet of MBR tank for the precipitation of Phosphorus. One alum dosing system is proposed for this purpose

**OZONATION**

The secondary biologically treated wastewater from the MBR tanks shall be fed to the disinfection units based on Ozonation.The treated wastewater from the MBR tank will enter Ozone contact tank where the same will be disinfected. Ozonation will also decompose organic compound left in the treatment process. Ozone is very useful for waste water treatment. Because of its oxidative power, ozone can easily decompose odor and color material and organic and inorganic compounds, and disinfect water.

**Treated Water Disposal**

Treated water after tertiary treatment and disinfection shall be discharged into Sukhna Lake through pipeline and pumping arrangements.

**SLUDGE DEWATERING SYSTEM**

The excess sludge generated from each unit shall be transferred to sludge dewatering facility through a trucking facility or piping network. The sludge dewatering facility shall be comprised of one number volute sludge press for sludge dewatering. The dewatered sludge obtained from these volute sludge press is of approx. 20% consistency. The sludge disposal is the responsibility of contractor

**ADDITION OF PRIMARY TREATMENT UNITS FOR 1.65 MGD STP AT DHANAS**

Dhanas STP - Existing SBR STP for Dhanas site will be used along with primary treatment unit + equalization tank + tertiary treatment (disc filter) for better treatment. Unit sizing is proposed as under.

**EQUALIZATION TANK**

| Design Parameter | Description | Units |
|---|---|---|
| Peak flow | 1.65 | MGD |

| | | |
|---|---|---|
| | 7501 | cum/day |
| Peak factor | 2.50 | |
| Average Flow | 1.65 | MGD |
| | 7501 | cum/Day |
| Number of Unit | 1.00 | Nos |
| Flow through Each Equalization Tank | 7501.05 | cum/Day |
| | 312.54 | cum/hr |
| HRT | 6.00 | Hours |

**FLASH MIXER**

| **Design Parameter** | **Description** | **Units** |
|---|---|---|
| Peak flow | 1.65 | MGD |
| | 7501 | cum/day |
| Peak factor | 2.50 | |
| Average Flow | 1.65 | MGD |
| | 7501 | cum/Day |
| Number of Unit | 1 | Nos |
| Flow through Each Equalization Tank | 7501 | cum/Day |
| | 312.54 | cum/hr |
| | 5.21 | cum/min |
| HRT | 1.5 | min |
| say | 2 | m |
| Free Board | 0.5 | m |
| Dimension = 2 m x 2 m x 2.50 m + F.B. – 0.5 m | | |

**CLARIFLOCCULATOR**

| **Design Parameter** | **Description** | **Units** |
|---|---|---|
| Peak flow | 1.65 | MGD |
| | 7501 | cum/day |
| Peak factor | 2.50 | |
| Average Flow | 1.65 | MGD |
| | 7501 | cum/day |
| No. of Unit | 1.00 | |

**Tertiary Treatment**

Treated water after biological would influent for tertiary treatment. Disk Filter is proposed as filtration mechanism to achieve the desired parameters

**Treated Water Disposal**

Treated water after tertiary treatment and disinfection shall be connected to the existing disposal or pumping arrangements if any created by the employer within execution period/extended execution period

## ADDITION OF PRIMARY TREATMENT UNITS FOR 11.0 MGD STP AT 3 BRD

3 BRD STP - Existing STP based on SBR at 3 BRD site will be used along with primary treatment unit + equalization tank + tertiary treatment (disc filter) for better treatment and improvement of treated water quality to the desired level. Unit sizing is proposed as under.

**EQUALIZATION TANK**

| Design Parameter | Description | Units |
|---|---|---|
| Peak flow | 11.00 | MGD |
| | 50007 | cum/day |
| Peak factor | 2.25 | |
| Average Flow | 11.00 | MGD |
| | 50007 | cum/Day |
| Number of Unit | 2.00 | Nos |
| Flow through Each Equalization Tank | 25003.50 | cum/Day |
| | 1041.81 | cum/hr |
| HRT | 6.00 | Hours |

**FLASH MIXER TANK**

| Design Parameter | Description | Units |
|---|---|---|
| Peak flow | 11.00 | MGD |
| | 50007 | cum/day |
| Peak factor | 2.25 | |
| Average Flow | 11.00 | MGD |
| | 50007 | cum/Day |
| Number of Unit | 1 | Nos |
| Flow through Each Equalization Tank | 50006.99 | cum/Day |
| | 2083.62 | cum/hr |
| | 34.73 | cum/min |
| HRT | 1.5 | min |

**CLARIFLOCCULATOR TANK**

| Design Parameter | Description | Units |
|---|---|---|
| Peak flow | 11.00 | MGD |
| | 50007 | cum/day |
| Peak factor | 2.25 | |
| Average Flow | 11.00 | MGD |
| | 50007 | cum/day |
| No. of Unit | 2.00 | |

**Tertiary Treatment**

Treated water after biological would influent for tertiary treatment. Disk Filter is proposed as filtration mechanisms to achieve the desired parameters

**Treated Water Disposal**

Treated water after tertiary treatment and disinfection shall be connected to the existing disposal pumping arrangements

### 1.5.1 Construction of WWTP

The construction of WWTPs that the site development, site grading, by cutting and filling to formation level including construction of required retaining walls will be responsibility of the contractor.

The scope of work under this heading broadly comprises but not limited to the following:

1. Clearing of shrubs & debris, cutting and filling to formation level, site grading, demolition of the abandoned plant if required for location of new STP by retaining the existing functional STP as such. If any tree(s) is required to be cut, then permission to do so will be obtained by the contractor from Forest Department. Only after getting written permission the contractor will proceed with cutting of trees.
2. Carrying out necessary site surveys and soil investigations for the purpose of design of various units. The worst case criteria for soil bearing capacity and other design criteria shall be used from the site surveys and soil investigations.
3. Testing of raw wastewater, analytical wastewater characterization process layout and hydraulic design calculations and hydraulic flow diagram, architectural drawings, general arrangement drawings, detailed Engineering, structural design calculations and construction drawings etc. However, the desired parameters for treated wastewater shall be the acceptance criteria.
4. Based on detailed process design, development & preparation of all electrical, mechanical and instrumentation equipment, including flow meters at various installations, on line monitoring instruments for monitoring process parameters, complete automation using PLC / SCADA, piping work, lifting, handling and ventilation equipment, electrical equipment, instrumentation, control, lighting systems, earthing and lightening protection system, materials, articles, fittings and accessories, ancillaries, taking power feeders (if not existing) of suitable capacity from Electricity Authority, electrical switchyard, ancillary works, cabling works of all kind and nature required for installations of the highest possible operative standards and for compliance with the standards prescribed in the specification and with the particulars and guarantees entered by the Contractor in the schedules at the time of bidding.
5. Development and preparation of detailed layout working drawings for process layout plan, General arrangement drawings, civil and structural drawings, electrical, mechanical, instrumentation system, automation, diagrams and cable schedules and detailed structural steel fabrication drawings, preparation of design basis report.
6. Procurement, manufacture, testing of electrical, mechanical and instrumentation equipment at place of manufacture, supply after painting, including packing, transport, delivery, supply and proper storage and maintaining equipment in safe custody.
7. Civil works construction, erection, setting to work, commissioning of mechanical, electrical, instrumentation and automation system, allied works, commissioning of treatment plant including power generation and all associated works, testing, painting, lining and finishing after erection of all plant required for the Waste Water Treatment Work, including all the necessary plants, equipment, piping, piping specials, valves, & penstock gates etc., spares, tools,

as required. All Gates and valves except valves in suction of pumps shall be electrically operated unless specified otherwise

8. Site development, landscaping, arboriculture and horticulture at the plant site by providing earth filling, greenery, plantation, rain water harvesting system, etc.
9. Liaison with various authorities including Government organization/ statutory bodies including Pollution Control Board, Electricity Authority, Fire Fighting Authority, Traffic Police, Forest Department, Labour Department for obtaining various clearances related to implementation of works including decommissioning, diversion of sewage, de-sludging, obtaining power supply, statutory inspection and approval of electrical inspector, etc. shall be in the Contractor's scope.
10. Sludge treatment for Class A Bio solids for land application or incineration as per USEPA 40 CFR Part 503 regulations.
11. Implementation of appropriate sludge handling system including safe disposal as designated site

Other contingent works:

1. Connection arrangements including chambers etc. with the existing gravity influent channels to the inlet chamber of new WWTP through RCC NP4 pipeline/channel.
2. Treated Effluent Tanker Filling Station.
3. Restoration of damaged road portion for laying of pipeline/channel.
4. Construction of treated effluent pipe/channel up to the existing final treated effluent channel.
5. Temporary site office along with necessary facilities for engineer and other staff.
6. Internal Roads, pathways / walkways, RCC platforms and connecting staircases along with railings.
7. All process units from inlet chamber to the end shall be connected by walkways / pathways / Platforms.
8. Storm water disposal system for disposal of storm water from the WWTP site to the adjacent treated effluent channel either by gravity or pumping system as per site requirement.
9. Sewerage and drinking water supply facilities in the buildings, for firefighting services and water supply network for horticulture.
10. Improvement/Upgradation of Fencing, Boundary wall, Gates & security room of the existing plants and creation of new Fencing, Boundary wall, Gates & security room for 2 MLD STP at Sukhna at the site to be identified by the employer.
11. Equipment for removal and transportation of screening, grit, sludge & solid waste.
12. All inter-connecting plant pipelines, channels and cable trenches.
13. Adequate indoor and plant lighting in all units including street lighting.
14. Safety and Firefighting equipment as per the approved specification of Chandigarh Fire Services.
15. Display boards near all units and buildings.
16. Model of plant
    i. **Soft Three Dimensional Model: Contractor** shall provide three dimensional graphical

working model of each plant with the help of standard software such as Bentley/plant 3D or any other suitable model which will be viewable on the screen of not less than of 80 cm (32inches). The model shall be rendered to allow outlook of the plant from various viewpoints to show all structures, interconnecting pipe work and equipment. The contractor shall also provide an HD LED TV of 40" size of reputed make such as Sony, Samsung etc. as approved by the Engineer

ii. **Hard Table Top Model:** Contractor shall also provide three dimensional physical model of each plant of scale such that the size is not less than 1.5m x 2.5m. Model shall be kept over a table and fitted within a wooden box having glass on its top.

### 1.5.2 Trial Run of WWTP

The trial run and commissioning period shall be of six months from the date of completion of construction works during which the contractor shall demonstrate satisfactory performance to the Engineer.

The cost towards Contractor's Engineer and other operating personnel during the period of trial run, along with cost of tools and spare parts, chemicals and other consumables which are required for operation and maintenance of the Plant and equipment during the commissioning and trial run period, shall be borne by the Contractor and shall be included in the tendered price. In the event that the plant or any of the facilities do not satisfactorily achieve the required performance standards during this period, the trial run period shall be extended until such time as the Contractor has satisfactorily rectified any deficiencies as may be necessary to satisfy the performance requirements. No additional compensation will be paid to the Contractor for such extension.

No payment on account of manpower, consumable & preventive maintenance / replacement are admissible to the contractor during Trial run & commissioning period of the WWTP.

The cost of electricity / Power supplies shall be paid directly by Municipal Corporation Chandigarh/ Engineering Department U.T. as applicable to electricity Supply Company as per the provision mentioned in Volume-1.

All commissioning tests shall be carried out in the presence of Employer's representative and approval for the same shall be obtained in writing before commissioning and installation. All instruments and accessories required for testing and commissioning of the equipment specified herein shall be provided by the Contractor at no extra cost to the Employer.

All type (as applicable), routine tests at manufacturer's works and acceptance tests shall be conducted, in the presence of Employer's representative or any agency (third party) agreed by the employer, on all the equipment as per latest applicable standards without any extra cost. Typical type test reports for other equipment shall be submitted by the Contractor for approval by Employer.

### 1.5.3 Operation and Maintenance of WWTP

#### 1.5.3.1 During Defect Liability Period (DLP) of One Year

The Contractor shall be responsible to operate the Plant and all other allied works under this Contract for the Twelve (12) Calendar months (one year) following successful completion of the Trial Run and Commissioning Period.

For this period, the scope of work shall include, but not be limited to the operation of the complete Plant from the common inlet chamber up to the treated effluent channel, solid handling units & power generation.

The Contractor's Personnel shall be fully experienced in managing and operating all aspects of the plant and shall be fully responsible to monitor and ensure the successful performance of the Plant throughout the DLP.

All the routine operating cost for manpower and consumables (like chemicals, laboratory glassware, oil/lubricants, fuel etc.), transportation, disposal of treated effluent, reuse of treated sludge, disposal of screenings, grit and sludge, maintenance of Civil / Electrical / Mechanical / Pipeline / Automation, etc shall be in the scope of the Contractor. The cost of electricity / Power supplies shall be paid directly by Municipal Corporation Chandigarh to electricity Supply Company as per the provision mentioned in Volume-1.

If during the Defect Liability Period any defect is found in the design, Engineering, materials and workmanship of the Site, Plant, Goods or Materials supplied or of the work executed by the Contractor, the Contractor shall promptly, in consultation and agreement with the Employer rectify, repair, replace or otherwise make good such defect as well as any damage to the Plant caused by such defect at its own cost.

If the repair, replacement or making good is of such a character that it may affect the efficiency of the Plant or any part thereof, the Employer may give to the Contractor a notice requiring that tests of the defective part of the Plant shall be made by the Contractor immediately upon completion of such remedial work, whereupon the Contractor shall carry out such tests.

If such part fails the tests, the Contractor shall carry out further repair, replacement or making good, as the case may be, until that part of the Plant passes such tests. The tests shall be agreed upon by the Employer. If the New Facility or any part thereof cannot be used by reason of such defect or making good of such defect, the Defect Liability Period of the New Facility or such part, as the case may be, shall be extended by a period equal to the period during which the New Facility or such part cannot be used by the Employer because of any of the aforesaid reasons.

#### 1.5.3.2 Operation & Maintenance of the Plant for a Period of 15 Years.

After satisfactory completion of one year defect liability period and issue of necessary certification from the engineer, the contractor shall carry out Operation and Maintenance of the plant for 15 years. All the cost for O&M of the WWTP such as manpower, chemicals, consumables, spares, tools, transportation, disposal of treated effluent, reuse of sludge, disposal of screenings and grit, maintenance of Civil / Electrical / Mechanical / Pipeline / Automation equipment, etc. and other works as described above in different sections is in the scope of the contractor.

The cost of electricity / Power supplies shall be paid directly by Municipal Corporation Chandigarh to electricity Supply Company as per the provision mentioned in Volume-1.

Other works included in the scope of O&M are as follows:

a) Maintaining a record of all required process parameters with respect to the plant operation and the regular preventive and breakdown maintenance of all components, recommended maintenance,

b) Preparation of operation and maintenance manual for plant and equipment.

c) All civil, electrical, mechanical, instrumentation and control equipment

The Contractor's scope of work includes preventive maintenance, repairs and replacements if necessary and no extra payment other than whatever has been quoted in the financial bid will be entertained by the Employer.

Within his quoted cost, the contractor is to ensure that the following guarantees are maintained:

i) Guarantee for quality of treated effluent
ii) Guarantee for consumption of chemicals
iii) Guarantee for consumption of net power after considering total power generation
iv) Guarantee for automation system
v) Guarantee for reuse of sludge in environmentally safe manner and non-dumping of sludge

The contractor shall maintain all E&M&I equipment in running condition with regular preventive and recommended maintenance. Apart from maintenance works mentioned above the contractor shall carryout painting of buildings and steel works at every 2 years interval, cleaning of storm water drains every year before rainy season, repair of potholes on roads as and when identified, re-carpeting of roads at every three years, cleaning and disinfections of water storage tanks at every 3 months interval and other day to day repairs. For all other utilities not specifically mentioned here, a maintenance schedule shall be drawn as per standard practice and got approved by the Engineer. The approved maintenance schedule shall be followed during the O & M period.

In the concluding year of O&M the Contractor shall prepared a detailed report in respect of all the E&M&I equipment's for the repair required and their likely cost to run the plant for a period of another 5 years beyond stipulated O&M period.

Payment to O&M will be released only when sludge management system would be operational.

### 1.5.4 Demolition of existing WWTPs

The scope of work includes demolition and dismantling of existing WWTP of Raipur Kalan and Raipur Khurd of 5 MGD and 2 MGD respectively and demolition and dismantling of abandoned WWTP Diggian Sector 66 without hampering the working of the plant till commissioning of new plant.

All such structures shall be demolished up to the foundation level or minimum 1 meter below the existing ground level in case the foundation level is more than 1 meter from ground level. The space /area shall be backfilled with suitable approved material including material generated from demolition of structure, compacted and leveled properly. However the top layer of minimum 500 mm of the backfill shall be of good soil so that plantation, green grass and other landscaping works can be carried out over this reclaimed area.

If the area/space of such existing structure is proposed to be utilized for construction of new structure, then demolition of the same shall be carried out up to the foundation level. Backfilling, in this case, shall be carried out with material as recommended in the foundation design of the new structure and approved by the Engineer.

The excess malba / debris / unserviceable material obtained during demolition shall be removed from the demolition site to a location as required by the local authority.

The old E&M equipment dismantled and removed from the existing structures of all the plants shall be stacked properly within the plant boundary at a designated place under proper watch and ward as directed by the engineer. These old E&M equipment shall be the property of CSCL.

The material obtained after demolition of sludge drying beds and other structures shall be stacked at site in heaps / stacks as directed by engineer. The serviceable material shall be issued to the contractor at rates as specified below; however, no demolished / dismantled material shall be used in the permanent works:

| | | | |
|---|---|---|---|
| i. | Bricks 1000 Nos. | = Rs. | 1900.00 |
| ii. | Stone soling per cu.m | = Rs. | 553.00 |
| iii. | Reinforcement bars per kg | = Rs. | 25.00 |

Specials measures have to be taken during demolition of digesters where the presences of trapped hazardous, inflammable or poisonous gases are very high. Such structures are to be vented properly by purging air or water to displace the trapped gases and absence of gas shall be tested before starting dismantling activity.

## 1.6 Submittals during Construction and O&M Period

The submittals include, but not limited to this only, general and specified procedures for transmittal of submissions; submission review and subsequent actions; schedule of submissions; resubmission; construction schedule; coordination of drawings; submission of drawings; insert and sleeve location drawings; reproduction of submitted drawings; sample; and construction photographs. Soft copies of all the documents, drawings, approved drawings, photographs shall be submitted. The contractor shall be responsible for the costs for transmission of submittals to the engineer and its representative.

### 1.6.1 General Obligations

The Contractor shall carry out, and be responsible for, the design of the Works. Design shall be prepared by qualified designers/professionals and the Contractor shall ensure that the designers shall be available to attend discussions with the Engineer and consultant appointed by the employer, at all reasonable times during the Contract Period. Contractor shall be responsible for approval of design, construction documents and drawings from the engineer.

### 1.6.2 Design, Drawings, Documents and Data (Construction Documents)

The Construction Documents are certified design, drawings and other documents prepared by the Contractor and submitted to the Engineer during the course of the Contract for approval and based on which the construction and erection works shall be carried out. The Engineer will not permit construction and erection activities to start on any part or section of the works unless Construction Documents for that part or section have been approved.

The contractor shall prepare construction documents in sufficient detail to satisfy all regulatory approvals, to provide suppliers and construction personnel sufficient instructions to execute the works as well as operation of the completed works.

The Engineer may require the Contractor to submit for approval, additional information at the contractors cost, if they are necessary to enable him to satisfy himself that the items are well designed, that they comply with the Employer's Requirements and that they are suitable for their intended purpose. The construction documents shall form the agreed basis for the execution of the Works. If changes are made in the approved construction documents then the same shall be rectified / revised and shall be submitted to Engineer for approval and the earlier copy of the drawings held by the Employer shall be marked 'superseded'. The revised copies shall be submitted by the contractor at no cost to the employer. Only the final approved design and drawings by the Employer shall be used for the purposes of the Contract.

#### 1.6.2.1 Basic Designs and Drawings for Approval

After signing the contract, within 30 days from the date intimated by the CSCL to proceed with the work, the contractor shall supply to the Engineer the basic designs and drawings having sufficient detailing so that Employer and its representative can clearly understand the Contractor's proposal for proceeding with construction of the WWTP. The basic designs and drawings shall inter alia comprise of:

1) Description of the treatment process, process design and layout of the plant;

2) Process flow diagram, hydraulic calculations and hydraulic flow diagram;

3) Control philosophy;
4) Chemical / biological process and process mass flow calculations including organic / hydraulic loadings;

5) Preliminary Process and Instrumentation Diagrams (P&IDs); the diagrams shall indicate in symbolic form the process, plant and systems of measurement, control and automation;

6) Layout plan and section drawings showing general arrangement of all the treatment units and buildings along with levels / contours for civil as well as E & M components;

#### 1.6.2.2 Detailed Engineering Designs and Drawings

After approval of the basic designs and drawings the contractor shall submit detailed engineering designs and drawings and shall inter alia comprise of:

**1. Civil Works**

a) Civil general arrangement drawings of all structures;
b) Architecture designs and concepts for treatment units, buildings, landscaping, etc;
c) Plan and elevation of all buildings;
d) Structural design calculations for all structures and buildings;
e) Reinforcement drawings and Bar bending schedule;
f) Transformer fencing;
g) Design of roads;
h) Plant storm water Drainage system;
i) Water supply, Sewerage and Plumbing drawings for buildings;

j) Drawing showing buried pipelines and other utilities along with N&E coordinates and offsets from permanent structures;
k) Cable trenches;
l) General arrangements and main sections of all plant areas;
m) A description of building services provisions proposed for the Works;

**2. Mechanical Works**

1) Mechanical general arrangement drawings of all structures;
2) Outline Dimensional and sectional Drawings with MOC for all mechanical equipment and not limited to the followings:
   a) Pipeline sizes and materials;
   b) Sluice Valve - Motorized and Manually Operated
   c) Non-Return Valve
   d) Dismantling joint
   e) H.O.T Crane & E.O.T Crane
   f) Sluice Gates both Motorized & Manually Operated
   g) Mechanical Medium and Fine Screens
   h) Pumps (Centrifugal, Progressive cavity, submersible, etc.)
   i) Grit Removal equipment
   j) Clarifier Mechanism GA drawings
   k) Diffusers with piping detail and its anchoring
   l) Disinfection system with accessories
   m) Process Air Blowers
   n) Chemical Dosing System
   o) Decanting Arrangement (Decanter)
   p) Treated Effluent pumping Station
   q) Mechanical Sludge Dewatering
   r) Treatment system for dewatered sludge for reuse
3) All Rotating equipment with adequate details of their performance
   a) Performance Curves : for Pump , Blowers , etc. Q vs. H, P, Efficiency and NPSH
   b) ISO-Efficiency curves of the pump model proposed
   c) Catalogues for all equipment's
   d) Details of modular units

**3. Electrical Works**

**1) Drawings:**

a) General Arrangement drawings;
b) Composite Single Line Diagram for electrical system for the WWTP;

c) Schematic drawings[1] for each HV / LV switchboard;
d) Internal and external[2] general arrangement for each switchboard;
e) Bill of quantities of each switch boards;
f) Transformer schematic and general arrangement drawings;
g) Cable block diagrams;
h) Cable connection diagrams (or schedules);
i) Cable routing/installation drawings;
j) Foundation and fixing details drawings;
k) Transformer enclosure drawings;
l) Earthing system general arrangement drawing.
m) Lighting drawings.

**2) Schedules:**

a) Cable Schedules;
b) Load and Power consumption schedule;
c) Junction Box schedule;
d) Protection relay setting schedule.

**3) Calculations for:**

a) Transformer sizing
b) Fault level;
c) Cable sizing ;
d) Coordinated protection study;
e) Earthing calculations;
f) Battery sizing.
g) Lighting calculations.

**4. Control and Instrumentation**

**1) Drawings:**

a) Power supply distribution single line and schematics diagrams[3] for each control panel;
b) Internal and external[4] general arrangement for each control panel (dimensional);
c) Control panel wiring diagram, relay logic diagram along with terminal block details;
d) System configuration and layout diagram along with bill of material, program listings, block logic diagram and control logic write up for PLC;
e) UPS and battery sizing calculations;

[1]Schematic drawings shall include a comprehensive schedule of the components used in each switchboard, CSCL and control panel including details of the type, manufacturer and rating of each component.
[2]The external arrangement of each switchboard, CSCL and control panel shall show the arrangement of all components including details of panel section, switch and instrument labels.
[3]Schematic drawings shall include a comprehensive schedule of the components used in each switchboard, CSCL and control panel including details of the type, manufacturer and rating of each component.

[4] The external arrangement of each switchboard, CSCL and control panel shall show the arrangement of all components including details of panel section, switch and instrument labels.

f) Control and instrumentation loop drawings[5];
g) Catalogues for all instruments;
h) Control and Instrumentation system configurations diagrams;
i) Instrument installation detail drawing[6];
j) Cable block diagrams;
k) Cable routing/installation drawings;
l) Foundation and fixing details and trenches drawings;
m) Mimic general arrangement (full color copies shall be provided);
n) Loop Diagrams and Interconnection Diagrams.

**2) Schedules:**

a) Cable schedule;
b) Cable interconnection schedule;
c) Control and instrumentation load schedule for each control panel;
d) I /O schedule;
e) Junction box schedule;
f) Instrument schedule with tag nos.
g) Instrumentation, process control set point schedule;
h) Instrument data sheets;

**3) Documentation:**

a) Functional design specification (FDS);
b) Factory acceptance test document (FAT);
c) Site Acceptance Test document (SAT).

The contractor shall also submit for all material / product / equipment / system the manufacturer's data including samples, catalog, brochures, circular, specifications, equipment operations and maintenance manuals and other printed information in sufficient detail and scope to verify compliance to the requirements. These shall include certified curves of equipment responses and performance characteristics as required. All material / product / equipment / system shall be accompanied by manufacturer’s certificate of compliance stating that the supplied items conform to the specifications.

### 1.6.3 Manufacturer’s Data

The contractor shall also submit for all material / product / equipment / system the manufacturer's data including samples, catalog, brochures, circular, specifications, equipment operations and maintenance manuals and other printed information insufficient detail and scope to verify compliance to the requirements. These shall include certified curves of equipment responses and performance characteristics as required. All material / product / equipment / system shall be

[5] Control and instrumentation loop drawings shall show on a single drawing the complete circuit associated with an instrument or device including details and location of power supplies, cabling and terminations.

[6] Hook up drawings shall detail how an instrument or device is installed.

accompanied by manufacturer's certificate of compliance stating that the supplied items conform to the specifications.

### 1.6.4 Equipment and Interconnection Diagrams

Equipment room layout drawings shall be based on actual requirements of equipment furnished and be consolidated for all trades, shall be to scale and shall show all pertinent structural and penetration features and other items, such as electrical cabinets, which affect available space. All mechanical and electrical equipment including electrical conduits, accessories, ductwork and piping shall be shown to scale in plan and also in elevation and / or section and resolve any conflicts or clearance problems. Physical descriptions of the various mechanical and electrical items shown on these drawings shall be submitted concurrently.

### 1.6.5 Number of Copies of Construction Documents to Submitted

#### 1.6.5.1 Basic Designs and Drawings

a) Contractor shall submit one (1) copy to the engineer and simultaneously submit three (3) copies to the consultant.

b) The Engineer will return one (1) approved copy to the Contractor and retain one (1) for the Engineer's use.

#### 1.6.5.2 Detailed Engineering Designs and Construction Drawings

The contractor on approval of basic designs and drawings shall submit copies of detailed engineering designs and construction drawings for approval as mentioned below:

a) Contractor shall submit one (1) copy to the engineer and simultaneously submit three (3) copies to the consultant.

b) The Engineer will return one (1) approved copy to the Contractor and retain one (1) for the Engineer's use.

#### 1.6.5.3 Submission of Sets of Approved Documents and Drawings

Immediately after approval, the contractor shall submit six sets of all approved documents and drawings to the engineer in hard and two soft copies (CDs).

### 1.6.6 As-Built Records

The Contractor shall prepare, and keep up-to-date, a complete set of 'as-built' records of the execution of the Works, showing the exact "as-built" locations, sizes and details of the work as executed, with cross references to relevant specifications and data sheets. As-built records shall include all such drawings, schedules, documentation and calculations as necessary for the complete understanding of the designs, sizing and capacities of the structures and equipment and operation and maintenance.

The 'As-Built' records shall consist of the fully up-dated versions of the approved Construction Documents incorporating any additional information which will assist the Employer in operating,

maintaining and if necessary modifying or extending the works at a later date. These records should extend and supplement the information given in the Operating and Maintenance Manuals.

The contractor shall submit three hard copies of the Draft 'As-Built' records to the Engineer for approval 30 days prior to the start of trial run of the plant.

On approval from the Engineer the contractor shall submit six sets in Hard and two sets in Soft (CD's) of approved 'As-built' records to the engineer out of which one copy shall be kept at site always.

### 1.6.7 Operation and Maintenance Manual

The Contractor shall compile operation, maintenance and overhauling instructions for the whole of the Plant in the form of single volume document termed as Operation & Maintenance Manual. It should serve following main functions:

i. As a text to be used for start-up training and plant start-up for the operators;
ii. To provide technical information about the plant and its equipment and controls, and provide plant staff with guidance regarding the operation of equipment and systems including startup, shutdown, and normal / alternative operations; and
iii. To provide assistance to the operating staff in continuing standard operating procedures after startup.
iv. Manual shall also cover plant unit operation philosophy, instrumentation philosophy, operation control logic, abnormal operation conditions, routine checks and operations, recommended corrective action during process upset, etc.

It shall be aimed at the plant operators and be written in clear unambiguous text complete with drawings which must be sufficient for clarification of any issue.

The manual shall include design operating parameters such as unit efficiencies, operating criteria, suggested design or process control test ranges, etc.

The manual shall include the suggested "maintenance program". By using this program the operating staff should be able to schedule, conduct and record all maintenance works as supplied by reputed vendors

The manual shall include safety discussion including hazards of sewers, mechanical and electrical equipment, explosion, bacterial infections, oxygen deficiencies, laboratory, etc. Safety relating to specific areas and equipment in the WWTP facility should be specifically covered and highlighted.

The manual shall be enclosed within A4 (Text) and A3 (Drawings) ring binders having tough grease resistant covers suitable for use on site and designed to permit the easy removal and insertion of the contents. The front cover and spine of each volume shall show details of the project, Employer, Engineer and a volume title. A1 drawings shall generally be folded and enclose in A4 box files. Where A1 drawings accompany text they shall be folded and enclosed in an A4 plastic wallet, one wallet per drawing.

The contractor shall submit three hard copies of the O & M manual to the Engineer for approval at least 60 days before the start of trial run of the plant.

On approval from the Engineer and after incorporating the modifications suggested the contractor shall submit six sets in Hard and two sets in Soft (CD's) of approved O & M manual to the Engineer out of which one copy shall be kept at site always.

### 1.6.8 Amended O & M Manual

The amended manual shall be an updated manual that includes revisions based on experience gained from actual operation of the plant plus other issues brought up by the equipment manufacturers and Employer. The amended manual shall be prepared by the cooperative effort between the Employer and contractors operating staff. The amended material is reviewed by the Chief Operator or Plant Superintendent and that the signature of his is affixed on the first page of the manual.

If any modifications are made during the defect liability period, the contractor, within 30 days of completion of defect liability period shall submit three hard copies of amended O & M manual for approval of the Engineer. On approval from Engineer, the contractor shall submit six sets in Hard and two sets in soft (CDs) of the amended O & M manual to the Engineer out of which one set shall be kept at site always for reference of O & M staff and other purposes.

### 1.6.9 Monthly Progress Report and Construction Photographs

Monthly progress report shall include progress photographs for each work of construction taken from common viewpoints each month. Photographs shall show general extent of the works by both exterior and interior views. Each viewpoint will be selected and the number of monthly repetitive photographs taken from exactly the same viewpoint as decided by the Engineer.

The Contractor shall provide photographs of such portions of the works, in progress and completed, in three soft copies (CDs). Each photograph shall display date and time on it. Photographs shall be properly referenced and captioned to the approval of the Engineer. Some selected photographs shall be uploaded on Project Monitoring System (PMS) on regular basis.

## 1.7 Quality Assurance

### 1.7.1 Policy

The Contractor shall apply the formal requirements of Quality Assurance to the design, supply, construction, testing and maintenance of the Works. This shall be achieved through the implementation of a Quality System compliant with the requirements of BS 5750or an equivalent International Standard.

Positive commitment to Quality Assurance shall be expressed in a formal policy statement given in the Contractor's Quality Manual.

The Contractor policy and objective will be to establish Quality systems and provide to the Employer such evidence as is necessary to demonstrate the effective implementation of a Quality system. To enforce the Quality system, the contractor shall afford reasonable availability of staff and documentation.

Construction Risk Workshop shall be arranged before commencement of works. It will be ensured that the Quality Control system of the complete project is made during design and planning stage.

The Contractor shall institute a Quality Assurance system to demonstrate compliance with the requirements of applicable codes and practices. Compliance with the Quality Assurance system shall not relieve the Contractor of his duties, obligations or responsibilities. The contractor shall prepare Quality Assurance and Quality Control (QA & QC) plan for the works and submit to Engineer for approval. The QA & QC plan so approved by the Engineer shall be subject to revision at all times during the contract period.

Details of all procedures and compliance documents shall be submitted to the Engineer for his information and approval before each design and execution stage is commenced. When any document is issued to the Engineer, it shall be accompanied by the signed Quality statements for such document. The Engineer shall be entitled to audit any aspect of the system and require corrective action to be taken. The Quality Assurance system and the audit of any aspect of system and necessary corrective action shall be at contractor's risk and cost.

### 1.7.2 Quality Assurance Plan

The implementation of the Quality System shall be through the establishment of a comprehensive Quality Assurance Plan issued to and approved by the Engineer. The instituted Quality Assurance system should ensure the quality and quantity continuously through properly designed monitoring systems / proformas for Test on materials, form work checkup, Bar bending schedule, pour card, post concreting checkups, daily progress report, labor / manpower deployed, quantity executed on periodic basis, observations thereof etc.

Quality Assurance plan shall include, but shall not be restricted to as noted herein.

a. Management procedures adopted for placing the Quality Control plan in action during design, manufacturing, testing, procurement & supply, construction, fabrication, erection, trial run, O&M, etc.

b. Procedures to control transmission of information across all interfaces both internally (that is, within the Contractor's Quality System) and externally. Those of the latter shall include all Statutory Bodies, Authorities and the Engineer.

c. All material, plant and equipment intended to be used in the project and workmanship comply with specifications.

d. Provide samples of materials to be tested in required quantities at locations where testing is to be performed.

e. When it is discovered on inspection that work is proceeding with incorrect materials or methods, ensure the corrections are immediately made and that improperly complete work is replaced on the Contractor's cost.

f. The Quality Assurance program, as approved by the engineer, shall provide inspection and testing of products during fabrication and installation as engineer may deem necessary to ensure that work is performed in compliance with the Contract.

g. The contractor shall engage, at no extra cost to the employer, third party independent professionals or firms or testing laboratories for inspection if required as per the applicable codes or specifications. All such engagements shall require prior approval of the engineer.

h. Provision of inspection and testing instruments and devices and facilities required to ensure proper performance of Quality Assurance at the job site.

i. Certification by producer / manufacturer that specified products meet requirements of reference standards as specified in applicable codes / specification.

j. Calibrate measuring and testing devices periodically against certified standard equipment. Calibration shall be verified by inspection firm.

k. Maintain continuity of Quality Assurance surveillance throughout fabrication of products and execution of work.

l. Submit details of Quality Assurance tests and methods inclusive of the specification.

m. Perform inspection on a continuing basis as each part of the works commences and on a regular basis to ensure constant compliance with the requirements.

n. Provide samples of materials to be tested in required quantities at locations where testing is performed.

o. Contractor's Quality Assurance representative at the site shall be responsible on receipt of items at the site for noting damage suffered by them during transit and for directing that they be rectified or replaced.

p. When it is discovered on inspection that work is proceeding with incorrect materials or methods, ensure that corrections are immediately made and that improperly complete work is replaced.

q. The Contractor shall impose Quality Assurance methods at the location of manufacture, fabrication and assembly of items to be incorporated in the works to ensure that they conform to requirements of the Contract Documents. This Quality Assurance shall not apply to proprietary catalog production products except as may be deemed necessary by the Contractor or as directed by the engineer.

r. Contractor shall provide notice to the engineer in writing at least 4 weeks in advance of packing of every batch of product components or assemblies so that the Employer or Employer's Consultants and their designated representatives may have opportunity at his / their choice of inspecting any such product components or assemblies prior to transportation at the cost of the bidder. The Contractor's Quality Assurance representative off-site shall be responsible for the release of items for transit to the job site.

s. The Contractor shall be responsible for protecting and maintaining items on the site. No damage to equipment and other materials shall take place during storage, erection, installation and maintenance.

t. All the field and site laboratory tests shall be carried out as per CPWD specifications. Minimum 10% of these field tests shall be got done from approved laboratory and all testing charges shall be borne by the contractor.

u. Each delivery / lot of cement and steel shall be accompanied by manufacturer / producer test certificate conforming that the supplied cement and steel conforms to relevant specifications. These certificates shall be endorsed to the Engineer for his record.

v. From each lot of Cement and steel samples shall be taken for carrying out mandatory test in accordance with latest CPWD specifications. These tests shall be got done from approved laboratory and all testing charges shall be borne by the contractor.

w. Water used in construction shall be tested in Municipal Corporation Chandigarh laboratory and cost towards testing shall be borne by the contractor.

x. The Contractor shall furnish manufacturer's test certificates and technical literature for any

admixture proposed for use. If directed, the admixture shall be tested at an approved laboratory.

### 1.7.3 Schedule of Quality Assurance Operations

The contractor shall provide the engineer with three copies of a schedule of Quality Assurance operations, both on-site and off-site, outlining the following:

i. Quality Assurance organization.

ii. Qualifications of Quality Assurance personnel.

iii. Authority and responsibilities of each Quality Assurance person.

iv. Schedule of inspections and tests with personnel assigned to each task and duration of each task.

v. Schedule of required services to be provided by inspection and testing firms.

vi. Testing methods.

vii. Methods of performing and documenting Quality Assurance operations.

### 1.7.4 Quality Assurance Reports and Feedback

All Quality Control tests and inspections carried during the execution of contract shall be documented and submitted in the form of report in triplicate to the engineer.

The report shall state the purpose of tests performed, description of methods used, test results and observations made and personnel involved. Similarly, the inspection report shall certify that which item are defective, nature of defect and what corrective methods have been adopted.

If inspection and testing is carried out by an approved inspection and testing firm, certified copies of test reports obtained by the firm shall be annexed with the Quality Assurance report.

The system shall include for the reporting back, recording and incorporation into the system of deficiencies and remedial measures to correct them noted during the control of the project.

## 1.8 Health, Safety and Environment Standards

The Contractor shall at all times maintain a safe system of working environment and shall comply with all enactments, regulations and working rules relating to safety, security, health and welfare of all persons who may be affected by his work. Municipal Corporation Chandigarh's safety code shall be followed by the contractor for maintaining safety and security at plant site.

Nothing which has been written into or omitted shall be taken to relieve the Contractor from his obligations under this clause. No clause in this Employer's Requirements shall prevent the Contractor from drawing the attention of the Employer's Representative to any feature of the Works which is not consistent with normal safety practices nor prevent him from putting forward proposals at any time which would increase the safety of the installations.

Not later than four weeks before work commences on the Site, the Contractor shall submit to the Employer's Representative his comprehensive proposals relating to the safety, health and welfare of all personnel on the Site.

The Contractor shall appoint a suitably qualified representative as Safety Officer who shall be responsible for the implementation of site safety procedures.

The proposals shall be appropriate for all grades of labour and personnel who will work on or visit the Site on behalf of the Employer, Employer's Representative or Contractor.

The Employer's Representative shall have the power to stop any activity or work in any area where there is a breach of the published site safety rules due to which health or life is put at risk.

The Contractor shall bring any violation of Site safety rules by others to the attention of the Employer's Representative in writing.

The Contractor shall provide at the Site such life-saving apparatus as may be appropriate and an adequate and easily accessible first aid outfit or such outfits as may be required by any government ordinances, factories acts, etc, published and subsequently amended from time to time.

The Contractor shall possess the valid electrical contractor's license of appropriate class from the concerned statutory bodies governing the area of work place. The Contractor shall fully comply with the relevant statutory rules and regulations and shall ensure safety of personnel and equipment. A prior approval from the Employer shall be sought before employing the electrical contractor. The Contractor shall be responsible for the electrical safety of all Plant supplied and installed. Whilst any equipment is being installed or tested, the Contractor shall ensure that all necessary precautions are taken to safeguard personnel working on site.

The Contractor shall ensure that the operations entailed in the construction of the Works do not cause annoyance to others working on the Site or to persons living adjacent to the Site.

During construction of the Works, statutory safety signs shall be adequately provided throughout the Works, both indoors and outdoors. These safety signs shall cover mandatory, prohibition, warning, emergency, fire-fighting and general notices. All signs shall be positioned around the Works at highly visible points with fluorescent colors where necessary. Provision of signs and the positions of signs shall be subject to the Employer's Representatives approval. Special attention shall be given to areas designated hazardous. Warning signs shall be written in English, Urdu, Hindi and Punjabi.

The Site working hours are detailed in the **Appendix to the Technical Proposal Volume 1.** The Contractor shall not increase the working hours without the prior approval of the Employer's Representative.

## 1.9 Protection of Existing Installations including Public and Private Services

### 1.9.1 Existing Installations

The Contractor shall apply to the Engineer in writing at least 28 days before starting any work that involves interference with existing structures, equipment, utilities, etc. The Contractor shall not execute such work until he has received permission to proceed, in writing from the Engineer.

The Contractor shall ensure that no earth, debris or rock is deposited on public or private roads or rights of way as a result of the Works and all vehicles leaving the Site shall be cleaned accordingly.

### 1.9.2 Protection of Existing Public and Private Services

The Contractor shall notify all public authorities, utility companies and private owners of proposed works that will affect them not less than two weeks before commencing the works.

The Contractor shall adequately protect, uphold, maintain and prevent damage to all services and shall not interfere with their operation without the prior consent of the public authorities, utility companies, private owners, or the Engineer as appropriate.

If any damage to services results from the execution of the Works, the Contractor shall immediately:

- Notify the Engineer and appropriate public authority, utility company or private owner.
- Make arrangements for its restoration without delay to the satisfaction of the authorities/ utility company /or private owner as appropriate without any extra cost. In case owing authority demands the restoration charges it shall be borne by the contractor.

The Engineer may issue instructions or make other such arrangements as he deems necessary, to repair rapidly any essential services damaged during the execution of the Contract. Such arrangements shall not affect any liability to pay for making good the damage.

### 1.9.3 Additional Safety Requirements

As the facility is an existing and operational facility the bidder shall specially take care of the following:

1. Barricade the operational section of the plant from the constructional section of the plant being upgraded.

2. Headcount safety procedure shall be adopted for the access to the operational area of the plant.

3. In the operational area of the plant only male labour shall be permitted. No female or children shall be permitted to enter the operational area.

4. All personnel entering the operational area of the plant shall necessary be equipped with Personal Protection Equipment for safety purpose like hard top shoes, hard hat, and reflective jacket.

5. All personnel in the construction area shall similarly follow personnel protection safety guidelines followed by CSCL in similar construction projects.

## 1.10 Work Program

Within 15 days of award of work, the contractor shall submit a work program pertaining to civil construction, procurement, supply, erection, installation, testing and commissioning of all equipment in the form of BAR and CPM / PERT chart in six (6) hard copies and two (2) soft copies (CDs). The work program shall be reviewed on quarterly basis by the Engineer. Any

slippages, if occurred during the preceding quarter, shall be covered up by reallocating resources, putting depending activities on fast track, etc. and by applying other project management techniques. The contractor after taking into account these measures shall submit the revised work program to the Engineer for approval.

## 1.11 Notice of Operations

The Contractor shall give full and complete written notice of all important operations to the Engineer sufficiently in advance to enable the Engineer to make such arrangements as the Engineer may consider necessary for inspection and for any other purpose. The Contractor shall not start any important operation without the written approval of the Engineer.

## 1.12 Topographical Survey Data

On award of the works and prior to commencement of any site works, the Contractor shall undertake a detailed topographical survey of the site and provide detailed digital photographs of the Site. The Contractor shall arrange all survey and measuring instruments of every kind necessary for his own use in the execution of the Works. Topographical surveys shall be carried out by using Total station equipment. Bench marks and reference lines shall be established by the contractor with approval of the Engineer. The Contractor shall be responsible for checking of all levels and providing copies of the survey data to the Engineer.

On completion of the topographical survey work, a detailed layout plan showing various treatment units, L-sections of existing channels and structures and other works will be prepared by the Contractor complete in all respect. The contractor shall also prepare a separate layout plan including location of site office, batching plant, go-down, steel yard, store, workshop etc., complete.

Layout of the plant shall be suitably arranged so as to allow space for future expansion, if any, and fits within the space allotted and compatible with the existing infrastructural facilities, inlet and outlet pipe work/channels and nearby water bodies. Underground services requiring to be relocated in order to accommodate the proposed site layout shall be identified by the Contractor to alignments and marked on the survey layout with coordinates and offset distances from permanent structures.

Engineer will approve the layout plans prior to commencement of construction work and up gradation works.

## 1.13 Soil and Geotechnical Data

On finalization of the layout plan, the contractor in coordination with engineer will determine the locations of buildings / sewage retaining structures and conduct additional soil investigation to find out actual soil characteristics at the site. At least 3 boreholes, each of 20 m depth to be carried out for each structure having liquid depth of more than 5 m. The contractor shall perform SPT, Plate Load Test, monitor ground water levels and other tests as directed by engineer. The contractor shall submit the report to consultant and engineer for approval. In case there is a discrepancy between the two reports (preliminary investigations provided by employer and those carried out by contractor) lower of the values of the safe bearing capacity

shall be considered for the design. The Preliminary Geotechnical Report is placed under volume-4 of the bid document.

## 1.14 Access for other Contractors

The Contractor shall allow reasonable access to other Contractors engaged on the site or on areas adjoining the site to carry out their works.

In the event of disputes over access or priority between Contractors, the Employer's Representative shall be informed in writing. The Employer's Representative shall inform all parties concerned in writing of his decision.

Where any part of the plant is associated with or is in physical contact with plant supplied under a separate contract, the Contractor shall be satisfied that the works carried out by the other Contractors are consistent with the correct operation of the plant. In the event of the Contractor considering any work being carried out or any work already completed to be detrimental to the ultimate operation of the plant, he shall report the matter at once to the Employer's Representative.

## 1.15 Interface with other Contracts

The Contractors of various works taking place at the proposed site shall co-ordinate with Employer as applicable and make all efforts to satisfy the requirements of the necessary interface.

## 1.16 Material, Construction and Erection of Plant

### 1.16.1 Material

The Engineer shall have the right at all times to inspect the sources of all materials. Such an inspection shall be arranged and the Engineer's approval obtained, prior to starting of construction and erection of the plant. Materials complying with codes/standards shall generally be used. Other materials may be used after approval of the Engineer and after establishing their performance suitability based on previous data, experience or tests.

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.

All materials cement, aggregate, water, admixtures, structural steel and steel for reinforcement shall be of best quality and subject to mandatory test. These tests shall be got done from Sri Ram Institute of Industrial Research or any other laboratory as directed by Engineer. All the testing charges including sampling, conveyance, packaging etc., shall be borne by the contractor himself.

Each delivery / lot of cement and steel shall be accompanied by manufacturer / producer certificate conforming that the supplied cement and steel conforms to relevant specifications.

These certificates shall be endorsed to the Engineer for his record. From each lot sample shall also be taken and got tested. Cost of such tests shall be borne by the contractor. In case the test results indicate that the cement and steel arranged by the contractor does not conform to standards specified, the whole lot shall be rejected and material removed from the site by the Contractor at his cost within a week's time after written orders from the Engineer.

All materials which do not conform to the Employer's Requirements shall be rejected.

### 1.16.2 Construction and Erection of Plant

Construction and Erection of Plant shall be phased in such a manner as not to obstruct the work being done by other contractors.

Plant shall be erected in a neat and workmanlike manner on the foundations and at the locations shown on the approved drawings. Unless otherwise directed by the Engineer, the Contractor shall adhere strictly to the aforesaid drawings.

The Contractor shall be responsible for setting up and erecting the Plant to the line and level required and shall ensure that all Plant is securely held and remains in correct alignment before, during and after grouting-in.

Any damage caused by the Contractor during the course of erection to new or existing plant or building or any part thereto, the Contractor shall at his own cost, make good, repair or replace the damage, promptly and effectively to the entire satisfaction of the Engineer.

The Employer has hired a Project Management Consultants (PMC) for regular Construction Supervision of the Works under this Contract. The PMC as directed by the Employer shall be responsible for regular monitoring and inspection of Contractor's progress of works and Quality Control on behalf of the Employer.

## 1.17 Packing and Protection during Transportation

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.

Before any equipment/ material is dispatched from a manufacturer's factory it shall be adequately protected and packed to ensure that it is delivered to Site safely and without any damage. The methods employed for protection and packing must be suitable for withstanding the conditions which may be experienced during shipment, delivery to the Site and prolonged periods of storage in the open, whether the items are shipped in packing cases, crates or only partially protected according to their nature.

Bright parts and bearing surfaces shall be protected from corrosion by applying a rust preventive lacquer, high melting point grease or similar temporary protection. A sufficient quantity of solvent shall be supplied with the plant to enable this coating to be removed on the Site. All machined flanges and other mating surfaces shall be protected by means of wood templates. The bolts for securing these templates shall not be reused in the final installation.

No one crate or package shall contain items of Plant intended for incorporation in more than one part of the Works.

All items of Plant shall be clearly marked for identification against the packing list, which shall be placed in a waterproof envelope inside every packing case or crate.

Every packing case and crate shall be indelibly marked to show its weight, serial number, top and bottom, shipping marks and handling instructions or sling marks.

Electrical Plant shall be enclosed in sealed airtight packages with dehydrating material, before being placed in packing cases on shock-absorbent material and secured by means of battens. Also the NGT guidelines are to be followed strictly.

## 1.18 Spare Parts

The spares shall comprise an adequate stock of the parts likely to be needed as routine replacements together with any major items or components which it may be desirable to hold in order to facilitate or expedite timely repair.

Spare parts shall be new and shall be packed separately in packages or containers designed to preserve the spares from the effects of long term storage under the ambient conditions specified. Any items that cannot be packed in this way must be protected from corrosion by applying temporary protective coatings and shielded from mechanical damage. All spares shall be clearly labeled with brief descriptions and part numbers.

The Contractor may use spare parts maintained in the stock to replace failed parts during the entire contract period. However, the Contractor shall be responsible for replacing those parts used with identical parts at no cost to the Employer. Spare parts to be supplied under this contract shall be interchangeable where possible within the treatment plants under this contract.

## 1.19 Special Tools and Appliances

The Contractor shall supply two complete sets of the special tools, lifting tackle, access equipment (ladders, scaffolding etc.) and greasing equipment necessary for the maintenance, repair, testing and overhaul of the Plant.

The tools and tackle shall not be used for the erection of the Plant except when the Engineer may call upon the Contractor to demonstrate their use.

The Contractor will be permitted to utilize the overhead gantry cranes supplied under this Contract for the purposes of installing the equipment in his supply. On completion of the installation the contractor shall make good of any damage or worn out components, if any, caused to the crane during its use.

All special tools and test equipment necessary for overhauling the Plant and testing its performance shall be included and mounted in suitably designed cabinets with lockable doors. Racks and clips shall be provided for individual items with outline markings and labels to show where any equipment is missing.

## 1.20 Equipment for Removal of Screening, Grit, Sludge & Solid Waste

The following minimum equipment shall be supplied by contractor for removal and transportation of screening, girt, sludge and solid waste to collection point.

- 2 Nos. Double wheel HDPE Light hand cart with puncture less tyres of 7.5 cu-ft. normal capacity (maximum capacity of 8.75 cu-ft.) at each plant while 4 Nos at 30 MGD Diggian plant.
- 2 Nos. Tractor Trolleys at each plant while 4 Nos at 30 MGD Diggian plant
- 1 No. Tractor at Diggian plant and 3 BRD Plant.
- 2 Nos Tractor for rest of the plant.
- 2 Nos. 20 ft. height aluminum extension ladder of 225-lb. capacity at each plant.

## 1.21 Preliminary Site Works

### 1.21.1 Site Clearance

The Contractor shall clear the Site to the extent required by the Employer's Representative for checking the setting-out. Clearance of the Site shall also include clearing of plants, bushes, rubbish, slush, necessaries demolition and removal of all articles, objects and obstructions which are expressly required to be cleared. The Contractor shall not clear the Site of any existing structure without the prior written instruction of the Employer's Representative.

The Contractor shall ensure that the parts of the Site to be occupied by the proposed Permanent Works are clear, and shall maintain the remainder of the Site as may be required for access and temporary works areas required for the project.

The Contractor shall remove the material arising from such clearance and dispose of it in a manner and at a location, to the approval of the Employer's Representative.

### 1.21.2 Temporary Works

Temporary works include site office, labor hutments and sanitary facilities, Go-down for storage of construction materials, field laboratory for carrying out material and other Quality Control tests, approach roads and diversions, etc.

Not less than 30 days before commencing any portion of the Works, the Contractor shall submit to the Engineer for his approval, comprehensive drawings and calculations for all Temporary Works which the Contractor proposes for the construction of that part of the Works. Notwithstanding the approval by the Engineer of any design for the Temporary Works, the Contractor shall be entirely responsible for their safety, efficiency, security and maintenance and for all obligations and risks in regard to such Temporary Works specified or implied in the Contract.

#### 1.21.2.1 Labor Hutment and Camp

The Contractor shall construct and maintain to the Employer's Representative's satisfaction a camp to provide living accommodation for all his staff and operatives who have no other local

accommodation. The Contractor's camp shall be located within the proposed plant site premises at a location approved by the Engineer.

Responsibility for providing all services to the living quarters and compliance with all sanitary laws and other laws and regulations shall be borne by the Contractor. Security and the fencing of these areas shall be the responsibility of the Contractor.

#### 1.21.2.2 Water Supply during Construction

The Contractor shall make his own arrangements for water supply for construction as well as for drinking purposes during the entire construction period and shall ensure that the quality of water remains suitable for the purpose for which it is intended. Water shall be tested in the Municipal Corporation Chandigarh's Laboratory. The frequency shall be once every three months.

#### 1.21.2.3 Toilet, Latrines, Washing Facilities and Wastewater Disposal

Throughout the period of construction of the Works the Contractor shall provide, maintain and cleanse suitable and sufficient latrines and washing facilities for use by his employees. He shall ensure that his employees do not foul the Site and use the latrines. Where practicable, the latrines shall be connected to the nearest sewer, or if this is not practicable the Contractor shall provide an adequately sized septic tank.

After completion of works, the latrines and washing facilities shall be removed and the surface reinstated to the satisfaction of the Employer's Representative.

The provision for disposal of waste from the SCADA cum Laboratory Building, Control Building, etc shall be made by the Contractor. Sewage generated from all buildings shall be collected at common location and shall be pumped to the inlet chamber of WWTP.

#### 1.21.2.4 Electricity for Contractor's Use on Site

The Contractor shall arrange and provide at his own cost electric connection of suitable load from Electricity Supply Agency. All electricity charges during construction period shall be borne by the Contractor. The Contractor will also keep ready Generators of adequate capacity as standby arrangement in case of electric failure during construction for running of pump sets, vibrators, mixer, needle sets and electric set and other electrically operated construction equipment etc. at his own cost. However, the Engineer will issue essentially certificate in favor of the Contractor for obtaining a temporary electric connection from Electricity Supply Agency. The cabling for electric connection shall be arranged by the Contractor himself at his own cost. The non-availability /sanction of electric connection shall be no excuse for delay in completion of work.

The installation shall comply with all the relevant regulations, Indian Standards and Codes of Practice, and Health and Safety requirements, etc. The Contractor must take all precautions to ensure that his installation is safe and injury to personnel or damage to plant and buildings is avoided. The Contractor shall be fully responsible for all safety aspects.

The Contractor shall test the temporary site distribution system every 3 months for compliance with the relevant standards.

### 1.21.2.5 Site Laboratory

The contractor shall establish and equip the field laboratory with performing the following tests and any other tests as required to be carried out at site during execution of works:

i. Tests on aggregates - Grain size distribution / Sieve analysis, Silt content, specific gravity, bulk density, crushing strength and impact value;

ii. Tests on concrete – Slump, consistency and cube strength;

iii. Test on bricks – Dimensions, compressive strength, water absorption and efflorescence.

### 1.21.2.6 Approach Roads

The contractor shall make temporary approach roads for accessing the different areas of sites for staff and vehicles. The Contractor shall be responsible for establishing and maintaining temporary road.

### 1.21.2.7 Godown / Shed for Storing Construction Material and Equipment

An area and/or building on the Site for use by the Contractor for safe and proper storage of equipment and materials prior to erection and construction will be subject to the approval of the Employer's Representative. Preparation of Go-down, stacking and storage of materials shall also comply with CPWD specifications.

The Godowns at each site shall be of sufficient capacity so that total stock of 7000 bags could be maintained at all times. For extra safety during the monsoon, the stack shall be completely enclosed by water proofing membrane such as polyethylene which shall close on the top of the stack.

The Contractor shall provide all facilities for the safe and proper storage of Plant, as recommended by the manufacturers, with particular consideration being given to temperature, rain/floods, and Sunlight, wind and ground conditions. The Contractor shall remain responsible to the Employer for the care and insurance of the Plant and the provisions of this Clause shall not relieve the Contractor of any of his liabilities under the Contract.

Stored Plant items shall be laid out by the Contractor to facilitate their retrieval for use in the programmed order. Stacked Plant items shall be protected from damage by spacers on load distributing supports and shall be safely arranged. No metalwork shall be stored directly on the ground. Steel reinforcement and structural steel shall be stacked and stored so as to prevent deterioration and corrosion. Bars of different classification, sizes and lengths shall be stored separately to facilitate issues in such sizes and lengths.

Small Plant items shall be held in suitable bins, boxes or racks and be clearly labeled.
Items of Plant shall be handled and stored so that they are not subjected to excessive stresses so that protective coatings are not damaged.

The Contractor shall comply with the manufacturer's package and plant markings concerning the use and location of lifting slings, chains and hooks.

### 1.21.3 Temporary Site Office

Within 60 days of start of work the Contractor shall make the site office of minimum 80 sqm area for the use of Employer. The site office shall have following features:

i. Two rooms, for Engineer, and representatives, one for consultants, one computer room, one meeting room, one pantry room.

ii. Air conditioners of required capacities for each room;

iii. One attached toilet with each room and Two common toilets;

iv. The site office shall be equipped with necessary furniture as directed by Engineer;

v. One no. multipurpose printer (Copy, Fax, Laser Printer, Scanner).

vi. Two no. "All in one Desktop Computer" installed with latest configuration and software's or as desired by engineer in charge (including UPS and Wi-Fi internet connection minimum 4 Mbps with unlimited data plan).

vii. All required internal water supply, sanitary, electricity fittings, etc.;

viii. Drinking water arrangement;

ix. Daily upkeep of the office;

x. One orderly staff;

The location and layout of the site office shall be approved by the Engineer before providing the same.

## 1.22 Maintenance of Existing Facilities

### 1.22.1 Construction Site

The Contractor shall maintain the site, equipment and provide related services until expiry of the Contract period or until such time as the aforementioned facilities are removed, with the permission of the Employer's Representative.

During the construction period the contractor shall barricade the construction site and display necessary warning signs for the movement of vehicles and safety of the operators, labor and staff deployed at the proposed site.

### 1.22.2 Areas outside the Site

In the event of the Contractor making use of any special or temporary way leave or accommodation acquired by him or any tip for the disposal of surplus materials, or any borrow pit or quarry, he shall obtain the written consent of the owner, occupier or authority having charge of the land in which such way leave, accommodation or tip is situated and shall make a record agreed by the owner, occupier or authority as aforesaid of the condition of the surface of that land before entering thereon.

In such case the land in which such way leave or accommodation is situated shall be deemed to be part of the Site. On completion of the works at site, the Contractor shall reinstate the area to its original condition to the satisfaction of the Employer's Representative.

For the purposes of this Clause, `accommodation' shall be deemed to include housing, offices, workshops, warehouses, Godown and storage areas.

### 1.22.3 Existing Access Roads

The Contractor shall be solely responsible for the maintenance of the existing site access roads. This responsibility shall continue until the end of trial run & commissioning Period. Such maintenance work shall include general upkeep and any necessary repairs to the damaged road surfaces, pavement, drainage, associated slopes, etc. to a standard at least equal to their original condition. While carrying out such maintenance work, the Contractor shall make arrangements to maintain through passage for the Employer's and his staff's vehicles and also those of other contractors over these access roads, which may comprise temporary diversions all to the approval and satisfaction of the Employer's Representative. The Contractor shall not run tracked or un-sprung vehicles on surfaced roads without the written approval of the Employer's Representative who may require that planking or some other protective material be used to protect the road surface.

### 1.22.4 Refuse Disposal

Refuse and rubbish of every kind shall be removed from the Site and disposed off by the Contractor at his own expense, frequently and regularly so as to keep the Site in an approved wholesome, hygienic and tidy condition to the satisfaction of the Employer's Representative.

## 1.23 Assistance to the Engineer and his Representative

The Engineer shall have the right at all times to inspect all operations including the sources of materials, procurement, layout and storage of materials, the concrete batching and mixing equipment and the Quality Control system.

The Contractor shall provide all necessary assistance to the Employer's Representative and his staff in carrying out their duties of checking, inspecting, measuring the Works and shall also provide standards, manuals and applicable IS codes. The Contractor shall provide chainmen, staff men, office attendants and laborers as may be needed from time to time by the Employer's Representative.

The Contractor shall provide for the Employer's Representative and his staff, consultants and their staff and visitors such protective clothing, safety helmets, gas masks and rubber boots of suitable sizes, hand lamps and the like as may be reasonably required by them.

The Contractor shall permit the Employer and the Employer's Representative and any person authorized by the Employer or the Employer's Representative including workmen of the Employer, other contractors or utility undertakings access for the purposes of the Contract to all areas of the Site and to any additional accommodation or temporary way leave for the duration of the Contract period.

## 1.24 Extra Items of Work

This being a DBO contract, extra items are not envisaged, however, if due to any reason the Employer decides to get executed any item not covered in the scope of work, the contractor shall execute the same after getting approval of the Engineer. For such item(s) of work the contractor shall be paid on the basis of DSR-2016 rates (without any plus or minus). In case the rates of such items of work are not available in DSR-2016, the payment shall be made as per the prevailing market rate + 15% (no further escalation shall be payable on the market rate based item).

## 1.25 Inspection of Equipment

The Contractor shall make all necessary arrangements/facilities for inspection of materials/ equipment at manufacturer's place within India or outside the country.

For inspections within India, travelling charges, boarding & lodging charges etc. of CSCL staff/PMC shall be borne by CSCL.

In case of inspections outside India, contractor shall make arrangement for inspection of equipment by an independent reputed third party duly approved by CSCL and payment to the third party shall be borne by the contractor and nothing shall be paid by CSCL on this account.

The Contractor shall keep a provision in the programme for 4 weeks' notice for inspection in India and 12 weeks' notice for testing/inspection overseas.

During the O&M Period, CSCL will examine, inspect, measure and test the quality, and check the progress of Operation and Maintenance works.

Contractor shall plan the inspection & dispatch of equipment to site whenever civil work is substantially completed. No equipment shall be dispatched to site without the written permission of engineering in-charge and unless civil work of respective unit is 70% completed so as to minimize the idle storage of such equipment at site.

## 1.26 Statutory Approval

All the statutory approval, permission from forest dept. or any other agency for tree cutting etc., is to be obtained by the contractor. Contractor will pursue various agencies for this purpose. Municipal Corporation Chandigarh will assist them by issuing necessary letters certifying the requirements. No extra claim will be entertained by CSCL on this account.

The Contractor shall also obtain all statutory approvals for /and on behalf of CSCL under the following:

i.) Factory Act

ii.) Electricity Act

iii.) Environment Act

iv.) Municipal Act

v.) Explosives Act

vi.) Consent to establish and consent to operate from DPCC

vii.) Any other act as may be applicable to wastewater treatment facilities during construction and operation.

Note: Apart from all the above statutory approvals, required periodical renewals, if any, along with deposit of fees during the O & M period of 15 years shall also be the responsibility of the Contractor.

## 1.27 Temporary Store for Dismantled Materials

The contractor shall construct the temporary water proof shade for dismantled material/equipment and shall be responsible for the safety, security, watch and ward up to DLP.

Dismantling and removal of all electrical and mechanical equipment for Phase-I presently installed in various units, transporting and stacking these properly shall be done by the contractor. A list of all the dismantled electrical and mechanical equipment/material shall be jointly prepared by the contractor & the engineer-in-charge and such equipment/material shall be stacked and stored safely by the contractor in a temporary store/shed. The safety and security of such dismantled equipment/material shall remain the responsibility of the contractor till such equipment/material is auctioned/issued to some other site of CSCL by the department or the same is handed over to the department (CSCL) at the time expiry of the DLP, whichever is earlier.

## 1.28 Certification on Completion

On completion of the Works, the Contractor shall clear any temporary works areas and temporary access roads and reinstate the areas to their original condition and to the satisfaction of the Employer's Representative.

After completion of installation work, the Contractor shall arrange for inspection and obtain approval from the concerned statutory bodies. Any fees that are to be paid to such statutory bodies for testing, inspection or calibration shall be paid by the Contractor. Any modification / revision in the equipment / installation of equipment as required by the statutory bodies shall be carried out by the Contractor.

All such costs / fees for revisions / modifications shall be deemed to be included in the prices of supply, installation, testing and commissioning of equipment as quoted by the Contractor.

Any changes from the approved drawings to suit site conditions, suggested by Employer, shall be incorporated in the final drawings by the Contractor. All test reports shall be properly maintained by the Contractor duly approved by the statutory bodies and shall be handed over to the Employer after completion of the job.

Employer's /Municipal Corporation Chandigarh's Safety Code

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

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

3. Working platforms, gangways and stairways should be so constructed that they should not sag unduly or unequally, and if the height of the platform or the gangway or the stairway is more
than 3.6 m (12 ft.) above ground level or floor level, they should be closely boarded; should have adequate width and should be suitably fastened as described in (2) above.

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

5. Safe means of access shall be provided to all working platforms and other working places. Every ladder shall be securely fixed. No portable single ladder shall be over 9 m. (30 ft.) in length while the width between side rails in rung ladder shall in no case be less than 29 cm. (1 11/2") for ladder up to and including 3 m. (10 ft.) in length. For longer ladders this width should be increased at least 1/4" for each additional 30 cm. (1 foot) of length. Uniform step spacing of not more than 30 cm shall be kept. Adequate precautions shall be taken to prevent danger from electrical equipment. No materials on any of the sites or work shall be so stacked or placed as to cause danger or inconvenience to any person or the public. The contractor shall provide all necessary fencing and lights to protect the public from accident and shall be bound to bear the expenses of defense of every suit, action or other proceedings at law that may be brought by any person for injury sustained owing to neglect of the above precautions and to pay any damages and cost which may be awarded in any such suit, action or proceedings to any such person or which may, with the consent of the contractor, be paid to compensate any claim by any such person.

6. Excavation and Trenching - All trenches 1.2 m. (4 ft.) or more in depth, shall at all times be supplied with at least one ladder for each 30 m. (100 ft.) in length or fraction thereof Ladder shall extend from bottom of the trench to at least 90 cm. (3 ft.) above the surface of the ground. The sides of the trenches which are 1.5 m. (5 ft.) or more in depth shall be stepped back to give suitable slope or securely held by timber bracing, so as to avoid the danger of sides collapsing. The excavated materials shall not be placed within 1.5 m. (5 ft) of the edges of the trench or half of the depth of the trench whichever is more. Cutting shall be done from top to bottom. Under no circumstances undermining or undercutting shall be done.

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

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

   ii) No electric cable or apparatus which is liable to be a source of danger ore cable or apparatus used by the operator shall remain electrically charged.

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

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

   i) Workers employed on mixing asphalt materials, cement and lime mortars shall be provided with protective footwear and protective goggles.

   ii) Those engaged in white washing and mixing or stacking of cement bags or any material which is injurious to the eyes shall be provided with protective goggles.

   iii) Those engaged in welding works shall be-provided with welder's protective eye Shields.

   iv) Stone breaker shall be provided with protective goggles and protective clothing and seated at sufficiently safe intervals.

   v) When workers are employed in sewers and manholes, which are in active use, the contractors shall ensure that the manhole covers are opened and ventilated at least for an hour before the workers are allowed to get into the manholes, and the manholes so opened shall be cordoned off with suitable railing and provided with warning signals or boards to prevent accident to the public, in addition, the contractor shall ensure that the following safety measure are adhered to:

a) Entry for workers into the line shall not be allowed except under supervision of the JE or any other higher officer.

b) At least 5 to 6 manholes upstream and downstream should be kept open for at least 2 to 3 hours before any man is allowed to enter into the manhole for working inside.

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

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

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

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

g) No smoking or open flames shall be allowed near the blocked manhole being cleaned.

h) The malba obtained on account of cleaning of blocked manholes and sewer lines should be immediately removed to avoid accidents on account of slippery nature of the malba.

i) Workers should not be allowed to work inside the manhole continuously. He should be given rest intermittently. The Engineer-in-Charge may decide the time up to which a worker may be allowed to work continuously inside the manhole.

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

k) Air-blowers should be used for flow of fresh air through the manholes. Whenever called for portable air blowers are recommended for ventilating the manholes. The Motors for these shall be vapour proof and of totally enclosed type. Non sparking gas engines also could be used but they should be placed at least 2 meters away from the opening and on the leeward side protected from wind so that they will not be a source of friction on any inflammable gas that might be present.

l) The workers engaged for cleaning the manholes/sewers should be properly trained before allowing working in the manhole.

m) The workers shall be provided with Gumboots or non-sparking shoes, bump helmets and gloves non sparking tools, safety lights and gas masks, portable

air blowers (when necessary) etc. They must be supplied with barrier cream for anointing the limbs before working inside the sewer lines.

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

o) If a man has received a physical injury, he should be brought out of the sewer immediately and adequate medical aid should be provided to him.

p) The extents to which these precautions are to be taken depend on individual situation but the decision of the Engineer-in-Charge regarding the steps to be taken in this regard in an individual case will be final.

vi) The Contractor shall not employ men and women below the age of 18 years on the work of painting with products containing lead in any form. Wherever men above the age of 18 are employed on the work of lead painting, the following precaution should be taken: -

a) No paint containing lead or lead products shall be used except in the form of paste or readymade paint.

b) Suitable face masks should be supplied for use by the workers when paint is applied in the form of spray or a surface having lead paint is dry rubbed and scraped.

c) Overalls shall be supplied by the contractors to the workmen and adequate facilities shall be provided to enable the working painters to wash during and on the cessation of work.

9. Contractor shall not employ women and men below the age of 18 on the work of painting with product containing lead in any form. Wherever men above the age of 18 are employed on the work of lead painting, the following: principles must be observed for such use:

i) White lead, sulphate of lead or product containing these pigment, shall not be used in painting operation except in the form of pastes or paint ready for use.

ii) Measures shall be taken, wherever required in order to prevent danger arising from the application of paint in the form of spray.

iii) Measures shall be taken, wherever practicable, to prevent danger arising out of from dust caused by dry rubbing down and scraping.

iv) Adequate facilities shall be provided to enable working painters to wash during and on cessation of work.

v) Overall shall be worn by working painters during the whole of working period.

vi) Suitable arrangement shall be made to prevent clothing put off during working hours being spoiled by painting materials.

vii) Cases of lead poisoning and suspected lead poisoning shall be notified and shall be subsequently verified by medical man appointed by competent authority of CSCL.

viii) CSCL may require, necessary medical examination of workers.

ix) Instructions with regard to special hygienic precautions to be taken in the painting.

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

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

i. These shall be of good mechanical construction, sound materials and adequate strength and free from patent defects and shall be kept repaired and in good working order.

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

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

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

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

12. Motors, gearing, transmission, electric wiring and other dangerous parts of hoisting

appliances should be provided with efficient safeguards. Hoisting appliances should be provided with such means as will reduce to the minimum the risk of accidental descent of the load. Adequate precautions should be taken to reduce to the minimum the risk of any part of a suspended load becoming accidentally displaced. When workers are employed on electrical installations, which are already energized, insulating mats, wearing apparel, such as. Gloves, sleeves and boots as may be necessary should be provided. The worker should not wear any rings, watches and carry keys or other materials, which are good conductors of electricity.
All scaffolds, ladders and other safety devices mentioned or described herein shall be maintained in safe condition and no scaffold, ladder or equipment shall be altered or removed while it is in use. Adequate washing facilities should be provided at or near places of work.

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

14. To ensure effective enforcement of the rules and regulations relating to safety precautions the arrangements made by the contractor shall be open to inspection by the Labour Officer or Engineer-in-Charge of the department or their representatives.

15. Notwithstanding the above Clauses from (1) to (15) there is nothing in these to exempt the contractor from the operations of any other Act or Rule in force in the Republic of India.

## 1.29 Additional Safety Guidelines as per the Employer (CSCL)/MCC

Following guideline /instructions should be adhered to in true spirit: -

1. The door may be fixed at the entry of the stair case and the open portion of the stair case of sump well should be protected by grill up to the height of 7 feet and compartments of the sump well should be covered with jallis/grating or should be barricaded property. Sewage pumping station should be secured by providing and fixing barbed wire fencing over the boundary wall.

2. An inspection register should be placed at the sewage pump house in which all the inspecting officers may record their observations. No unauthorized entry should be allowed.
3. Caution board showing the restricted entry area and name of components and moving mechanical part should be displayed.

4. The entry to all CSCL/MCC infrastructures should be restricted to the person /persons authorized by CSCL or having I.D cards issued by the chief security officer.

5. Just after entering the premises do's and don'ts should be displayed at prominent places in all four languages.

6. Even authorized visitors should be provided proper uniform /visitor badges helmet and

relevant safety gear and given instruction before showing such infrastructure.

No person below 18 years' age should be allowed on the premises where chances of mission of toxic gases are extensive.

## 1.30 Additional Safety Guidelines, issued by Employer

In continuation to the instructional order issued from time to time, a comprehensive instructional order on the subject is hereby circulated with respect to strict implementation of PEMS Act and their Rehabilitation Rule, 2013.

**1. The rule 3 to 8 of the PEMS Act and their Rehabilitation Rule, 2013 should be strictly followed and the same are reproduced below: -**

Rule 3. (1) No person shall be allow to clean sewer manually, with the protective gear and safety devices under these rules except:-

(a) For the removal of the concrete of FRP (Fiber Reinforced Plastic) or damaged manhole door where mechanical equipment's cannot be put into operation.

(b) For inter- linking the newly laid sewer main with the existing sewer main, in case of sewer of size of more than 300 mm diameter.

(c) For removal of submersible pump sets fixed at the bottom of the suction wells.

(d) For the reconstruction of the manhole or rectification of the sewer main.

(e) Any circumstance, when it is absolutely necessary to have manual sewage cleaning, after the CEO of the local authority has permitted to do so after recording in writing the specific valid reasons for allowing such cleaning.

(2) For the purposes of clauses (c) and (d) of sub- rule (1), before allowing entry of a person in the sewer, sewage shall be totally emptied.

Rule 4. Any person engaged to clean a sewer or a septic tank shall be provided by his employer, protective gear and safety devices including, but not limited, to the following:-

(i) Air compressor for blower
(ii) Air line breathing apparatus
(iii) Air line respirator with manually operated air blower
(iv) Air purifier gas mask/ chin cortege
(v) Artificial respiration / Reticulate
(vi) Barrier caution tape
(vii) Barrier cram
(viii) Barrier cone

(ix) Blower
(x) Breath mask
(xi) Breathing Apparatus
(xii) Caution board
(xiii) Chlorine mask
(xiv) Emergency medical oxygen resuscitator Kit
(xv) First Aid Box
(xvi) Face Mask
(xvii) Gas Monitor (4 gases)
(xviii) Guide Pipe Set
(xix) Fully body Suit
(xx) Fishing wader suit attached with boosts
(xxi) Hand gloves
(xxii) Head Lamp
(xxiii) Helmet
(xxiv) Helmet demolishing
(xxv) Lead acetate paper
(xxvi) Life guard pad
(xxvii) Modula Airlines Supply Trolley System
(xxviii) Normal face mask
(xxix) Nylon rope ladder 5 meters
(xxx) Nylon safety belt
(xxxi) Pocket book
(xxxii) Port oxy
(xxxiii) Raincoat
(xxxiv) Reflecting Jacket
(xxxv) Safety Belt
(xxxvi) Safety body clothing
(xxxvii) Safety body harness
(xxxviii) Safety goggles
(xxxix) Safety Gumboots
(xl) Safety helmet
(xli) Safety showers
(xlii) Safety torch
(xliii) Safety Tripod Set

(xliv) Search light

Rule 5. The local authority shall ensure that the following cleaning devices are used by persons engaged in cleaning sewer or septic tank including but not limited to the following:

(i) Sewer Line Cleaning Bucketing Machine
(ii) Jetting Machine
(iii) Suction Machine (Gulley Emptier)
(iv) Combined Machine (Jetting cum Suction)
(v) Manual Hand Operated Grab Bucket
(vi) Hydraulic Operated Trolley Mounted Grab Bucket
(vii) Truck Mounted Mounted Grab Bucket
(viii) Truck Mounted Motor and Winch Operated Grab Bucket Machine
(ix) Fixed Structure Mounted Motor and Winch Operated Grab Bucket Machine
(x) Rickshaw Mounted Winch and Motor Operated De-silting Machine for wet well
(xi) Rickshaw Mounted Winch and Auxiliary Engine Operated De- silting Machine for Manhole
(xii) Escort Hydra Crane Mounted Hydraulic Winch Operated Grab Bucket De-silting Machine
(xiii) Manual rods, shovels, spades, drainage cleaning machines and steel scrapers with handles
(xiv) Hoses and washing instruments.

Rule 6 (1) All protective gear and safety devices under these rules shall be checked every six months and necessary repair or replacements shall be made by the employer who engages a person for cleaning a sewer or a septic tank.

(2) Comfortable bodysuits shall be made available to the worker who has to enter sewers or septic tanks for their cleaning. The employer shall provide full body suits to workers entering manholes of depth less than five feet.

(3) The employer shall also ensure the following safety precautions before a person is engaged in the cleaning of a sewer or aseptic tank namely:-

(a) There shall be a minimum of three employees present all the time, one of whom shall be a supervisor.

(b) The atmosphere within the confined space shall be tested for oxygen deficiency and toxic and combustible gases including but not limited to poisonous gases like Hydrogen Sulphide, Carbon Monoxide, Methane, and gasoline vapors, through detection tests including the following:-

(i) Lowering a detector lamp into the manhole,
(ii) Inserting wet lead acetate paper which changes colour in the presence of hazardous gases.
(iii) Detection of gases through gas detector masks.

(c) Before starting the cleaning under sub- rule (1) the supervisor referred to in clause (a) of sub- rule (3) has inspected and determined if the sewer serves any industries nearby to anticipate any hazardous atmosphere that may be encountered.

(d) The condition of metal - rung ladders and the side walls of the manhole shall be checked to see if there is any danger of collapse.

(e) Traffic and pedestrian barricades are provided all the times.

(f) A flag man should be stationed at least 50 feet ahead of a site and should be visible to incoming traffic for at least 500 feet.

(g) Regular medical checkup of sewage workers which shall include the examination of respiratory organs, skin injuries and other occupational diseases and injuries for their treatment to ensure that sewage workers afflicted with such diseases or injuries do not enter sewers for cleaning.

(h) Regular vaccination against respiratory and skin diseases and other occupational diseases to which these workers are prone due to exposure to harmful substances and gases in sewers.

(i) All employees who are present on- site during cleaning work are given training and adequately familiarized with the knowledge to operate all equipment's involved in cleaning work, to avoid injuries or diseases associated with such work and to take necessary steps in case of emergency arising at the place of work and the training shall be conducted every two year and the employees shall be familiarized with any changes in method and technique with respect to the above.

(j) The supervisor possesses and keeps handy the names, addresses and telephone numbers of the nearest hospitals or clinics.

(k) Cleaning of sewer or a septic tank shall be done:-

i. Only in day light; and
ii. For duration not exceeding 90 minutes, at a stretch. There shall be a mandatory interval of 30 minutes between two stretches.

(l) Identify and close off or reroute any lines that might carry harmful substances to, or through, the work area.

(m) Ensure that written operating and rescue procedures are displayed at the entry site.

(n) If the entry is made through a top opening, use a housing devices with a harness that suspends a person in an upright position and a mechanical device shall be available to retrieve personnel from vertical spaces more than five feet deep.

(o) At least one person trained in first aid and cardiopulmonary resuscitation should be immediately available during any confined space job.

(p) Oxygen content in the manhole must be at least 19.5% in the confined space of the manhole measures at all levels (bottom, middle and top) and no person enters the manhole if oxygen level is below 19.5% and more than 21%.

(q) Ventilate the sewer line by opening at least two or three manholes on both sides where work is to be carried out.

(r) Manhole shall be opened at least one hour before the start of operation.

(s) The opened manhole shall be properly fenced or barricaded to prevent any person, especially children, from accidentally failing into the sewer. Dummy cover with welded fabric or wire- net may be used.

(t) All works use the safety gear and safety devices before entering the sewer line.

(u) The person entering the manhole or sewer line must be monitored using signal or camera or CCTV etc, throughout the operation period.

(v) Structural safety of manhole rungs or steps must be tested before entering the manhole.

(w) Portable aluminum ladder is available during the work period during the work period where necessary and the portable ladder is properly seated of fixed during use.

(x) No material or tools are located near the edge which can fall into the manhole and injure the workman.

(y) Equipment's used during sewer cleaning are explosion and fire-proof.

(z) Smoking open flames are prohibited inside the manhole as well as in the immediate vicinity of open manholes.

(aa) In the event of a sudden or unpredictable atmospheric change and emergency escape breathing apparatus with at least a 10 minutes air supply is worn.

Rule 7 The employer shall ensure the following safety precautions at the time when the person is engaged in the cleaning of a sewer or a septic tank:-

(i) Portable fans and air blowers with batteries in good working condition with a back up capacity of more than the estimated duration of the entry of the person in the sewer shall be carried into sewers for ventilation and a ventilation source shall be installed at the mouth of the manhole.

(ii) Flashlights and communication devices such as two- way radios shall be carried into sewers.

(iii) Presence of the following rescue equipment at the site:-

(a) A tripod and harness system, or some other method ensuring maneuvering of an injured worker to the surface.

(b) A basket stretcher or similar device shall be available for moving the injured worker to emergency transportation.

(c) First aid equipment as given in Annexure- I and trained personnel shall be immediately available.

(iv) The employer shall ensure availability of ambulance and follow-up in close proximity.

(v) The employer shall ensure that the assigned person has life insurance policy of at least ten lakh rupees and the premium for which shall be paid by the employer.

Rule 8 The employer shall ensure the following post- cleaning safety precautions after and person engaged in the cleaning of a sewer or a septic tank comes out of the sewer or septic tank after a session of cleaning: -

(i) Providing facilities for removal of contaminated clothing and for wash - up as well as cleaning dry clothing.

(ii) Wash up material shall include but not be limited to water, soaps, hand sanitizers and adequate and medically authenticated skin cream for applying on the body for post cleaning safety.

(iii) Any cuts / bruises on the skin or problems with a respiratory organ suffered on account of cleaning of sewer shall be immediately cured.

## 1. Do’s and Don't’

A comprehensive list of Do's and Don'ts for ensuring safety of the sewer workers while entering the sewer lines/ manholes has been prepared. It should be ensured by the Engineer in charge that it is followed invariably by all the sewer workers: -

**Do’s**

1. Place easily readable and clear warning signals firmly embedded and supported wall ahead of work area.
2. Provide Red Lanterns or electric light signals during night.
3. Place barricades or diversion boards indicating signs to channelize the traffic.
4. Barricade the opened manholes as well as trenches.
5. Keep a first aid box properly stocked including washing bottles to wash away skin and

eyes.

6. Ventilate the sewer line by opening 2 or 3 manholes at least one hour before start of operations on both sides where work is carried out.
7. Test for hazardous gases before entry of a person into the sewer line and also in between if the operation is carried out for a longer time. Nobody should be allowed to go inside the manhole if the content of gases is beyond the permissible limits. The silt should be disturbed by suitable means to remove the entrapped gases. Wear gas masks as a precautionary measure.
8. Use the air blowers for ventilation or gas masks, if required.
9. Test and use the safety harness and life line before entering the sewer line.
10. Use safety helmets while working in the manhole.
11. Use protective body suit or use oil (Coconut or sweet oil) on the body before entering into the manhole and take bath immediately after completing the work.
12. Use rubber hand gloves and boots before entering into the manhole.
13. Keep finger nails short and well-trimmed.
14. Try each ladder step or rung carefully before putting the full weight on it to guard against insecure fastening due to corrosion of the rung at the manhole.
15. Wash hands with soap and hot water before taking food or smoking and keep finders out of nose, mouth and eyes.
16. Wash all contaminated parts of the body after the work is completed.
17. Mix the scum well with sewage before entering into the manhole.
18. Leave the manhole at once if there is an unusual or peculiar smell.
19. Check carefully that all men have left the sewer of manhole.

**DON'TS**

1. Do not keep any material or tools near the edge which can fall into the manhole and injure the workman.
2. Do not enter the manhole without wearing your protective body suit, safety belts, gloves, gum boots etc.
3. Do not go inside the manhole during afternoon in summers when the temperature is high.
4. Do not work inside the manhole for more than 15 minutes at a stretch.
5. Do not smoke or use safety lamp inside the sewer or manhole.
6. Do not walk along a sewer inside without a lifeline with a person holding your lifeline standing outside.
7. Do not enter the manholes without written permission of ASI/ SI/ JE /ZE concerned.
8. Do not enter if the concentration of the hazardous gases is more than the permissible level.
9. Do not throw lighted match sticks in the manhole.

10. Do not leave any manhole or trench unmanned and /or properly barricaded.

The Don'ts may be read in conjunction with the Do's while entering the sewer line / manholes.

Protection and Safeguard of its workers working in hazardous conditions like cleaning sewer etc. is obligatory on the part of CSCL. To avoid accidents due to suffocation, drowning, physical injuries and exposure to toxic materials in the sewerage system, it is essential that the adequate safety measures are in place & proper precautions are taken. To ensure that all safety measures are taken, several instructional orders have been issued from time to time.

The following guidelines/ precautions are being reiterated and may be religiously followed to avoid any accidents: -

1. No man entry should be allowed in the manhole without issue of work permit by the competent authority.
2. All safety equipment's like Helmets, Gum Boots, Hand Gloves, Full Body Suit, Hand Blowers, Gas Detectors, Folding Ladders, Safety Belt, Oxygen Cylinder etc. must be available in adequate numbers and maintained in working condition by the store in charge.
3. As far as possible, mechanized cleaning operations should be carried out in deep pit work stations should be procured in adequate numbers by the Executive Engineers as per their requirement. Work permit system must be followed regularly.
4. Man entry should be allowed only after checking that the level of poisonous gases in the manhole is within the permissible limits. Proper level of gases must be checked by the Gas Detector. The permissible limits of various gases are tabulated: -

| S.No. | Gas | Maximum limit for 1hour exposure | Maximum limit for 8 hour exposure |
|---|---|---|---|
| 1 | CO | 0.04% by volume in air | 0.005% by volume in air |
| 2 | H2S | 0.02% by volume in air | 0.001% by volume in air |
| 3 | CH4 | Probably no limit provided oxygen percentage is sufficient | 1 % by volume in air |
| 4 | O2 | Oxygen level should be 19.50-21% by volume in air | |

It would be safer to consider limit of 8 hours exposure.

5. Ventilation of the manhole must be maintained by opening 2-3 manholes upstream & downstream sides. Blowers, if necessary, must be operated at least 30 minutes before start and during cleaning operations.
6. The workers should not be allowed to work in sewer for more than 15minutes in a single stretch. It should be ensured that all required safety equipment's are available and are being used by the sewer workers.
7. In peak summer season, man entry in sewer manholes may not be allowed between 11 AM to 4 PM.
8. The equipments required in case of rescue of the workers should be available outside the manhole/work area.

9. First Aid Box with all required medicines (within expiry date) must be readily available in case of emergency.
10. DOS'S and Don'ts for safe working in each unit should be displayed. Printed of written operating and maintenance schedule should be displayed near to each equipment in the language understood by all operating staff.
11. Proper ventilation is required to be made in raw sludge pump houses and return sludge pump houses and other buildings in the plant, Unite should have sufficient number of exhaust fans.
12. Smoking or carrying open flames in and around digesters and gasholders should be prohibited.
13. All electrical installations, wiring etc. shall be provided and maintained as per Indian Electricity Rules and standards approved by the department.

Safety of the sewer workers is the collective responsibility of CSCL. The safety & Disaster Management Cell conducts regular awareness programme/training to educate the sewer workers about the hazards of working in sewers. It is obligatory on the part of every office of CSCL involved in the sewer cleaning/hazardous operations to ensure that the sewer workers are working in safe working environment. It is instructed that the safety guidelines and instructional orders be followed in true spirit by all concerned.

## PRECAUTIONS TO BE TAKEN WHILE CLEANING OPERATIONS

### i) Precautions before commencing the operation:

1. As far as possible mechanized cleaning should be undertaken at the work place. In case it is not feasible to do so, no single person should be allowed to undertake the work of cleaning of sewerage facility.
2. There should be minimum of two employees present all the time and one of them shall be trained and experienced. The supervisor shall remain present at all time.
3. If the peak summer season entry of the person into the sewer manhole/ septic tank should not be allowed between 11 AM to 4 PM when concentration of gases is expected to be high.
4. First aid box to meet the emergency should be available at the work place before commencing the work. Keep the emergency contact numbers of ambulance, Police, fire Brigade handy for use to provide immediate relief in case of any accident.
5. It is the responsibility of the person who has engaged the labour to clean the septic tank/ sewage plant to apprise them about the "Do's and Don'ts" in advance to ensure safety.
6. Before undertaking the work, the manholes of the chamber/ septic tank/ sewers should be kept open for minimum 4 hr. Duration to ensure sufficient cross ventilation.
7. Before under taking the work it will be the duty of the employer to note down name of the person. his address, family whereabouts and emergency contact numbers of his near dear ones so that they can be contacted in case of emergency.

### ii) Precautions during operations

8. The person engaged for cleaning the septic tanks / sewers is not allowed to consume alcohol or take any drugs. Also the persons who are not physically fit should not be allowed to undertake the work.

9. The persons engaged for the job will be essentially required to wear the protective gear as per requirement of the work place.

10. The protective gear and safety equipment shall comprise of the equipments mentioned in clause (d) of sub - section (1) of section (2) of MS Act, which is as following (i) Safety body clothing / safety, body harness / safety belt (ii) Normal face mask (iii) Safety torch (iv) Hand gloves (v) safety goggles (vi) safety helmet (vii) Emergency medical oxygen resuscitator kit (viii) Gas Monitor (ix) Head lamp (x) Reflecting jacket (xi) Guide pipe set (xii) Safety tripod set (xiii) Wadder suit (xiv) Chlorine Mask (xvi) Air compressor for blower (xvii) Modular Airlines Supply Trolley System (xviii) Full face mask (xix) Safety Gumboots (xx) Raincoat.

11. If there is appearance of white foam and no live cockroach then there is strong possibility of presence of poisonous gases in that chamber. Use litmus paper /gas detector to confirm the same. Give sufficient time by opening the chamber to open sky and if possible use air blowers to allow the gases to escape before taking up the work.

12. Do not depend on the presence of the foot rests fixed in the chamber wall since there is a possibility that with passages of time grip/ hold of the footrest has given way and it may not be strong enough to take the load. Always us rope ladder after testing its carrying strength.

13. No person should be allowed to continue to work or stay in the chamber for more than 15 minutes at a stretch. The persons outside the chamber should remain in conversation with the person/ persons inside the chamber to ensure their well being in case of uneasiness to the person working inside the chamber a signal shall be given by shaking the rope attached his safety harness so that he can be pulled out of the chamber.

14. Smoking or carrying open fire flame in the near vicinity of the work place should not be allowed. Any electric installation should also be not switched on or switched off near the place of work. If electric wires happen to be nearby, they should be properly insulated.

15. No tools or equipment should be placed near the edge of the manhole to avoid any injury to the worker due to sudden fall of the equipment inside the manhole.

**iii) <u>Precautions post operations</u>**

16. Do not leave the injured person alone and avoid gathering of mob around him.

17. Occurrence of any accident resulting into injury / death if any at septic tank /sewage plant shall be informed to labour / police deptt. immediately. Injuries/ death suffered while undertaking cleaning / maintenance/ repairs of the sewerage systems shall be dealt with either under ESI Act, 1948, if applicable or under "The Employees Compensation Act. 1923" or any other Group Insurance as the case may be for the purposes of compensation to the injured person / legal heirs as the case may be.

18. Compensation to be paid to the family members of the victims shall be in accordance with the Hon'ble Supreme Court verdict dated 27.03.2014 in Writ Petition No. 583 of 2003 (Safai Karamchan Andolan and Others Vs UOI & Ors.).

19. The committee also recommends appointment of inspectors to identify the insanitary

latrines as defined under section 20 of the MS Act.

**Compensation Clause**

A clause shall be added in the contract conditions of all sewer cleaning works that "The successful bidder shall ensure that the safety measures mentioned in the contract conditions and PEMS Act and their rehabilitation rule 2013 are followed strictly. In case of any accident/ death, the contractor shall be liable to pay minimum compensation Rs. 10 lacs in accordance with the Hon'ble Supreme Court verdict dated 27.03.2014 in Writ petition No. 583 of 2003 (Safai Karamchari Andolan and Others Vs UOI & Ors.) and as provided in the PEMS Act 2013. In case of failure. CSCL shall have the right to make the compensation & recover the amount from the contractor. Further CSCL reserves the right to debar the firm from tendering/ black listing if the above condition is not adhered to be the firm/ contractor."

## 1.31 NHRC Guidelines

NHRC issued guidelines on safety code for operation/maintenance of sewerage system vide letter No.1069/30/2001-2002/F.C. dated 18.11.02. Same shall form part of agreement and has to be strictly followed during execution of work. Direction given by Hon'ble Supreme Court in the matter of National Campaign for Dignity & Right of Sewerage & Allied workers.

1. The medical examination and medical treatment will be given free of charge to sewer workers and the treatment will continue for all such workers found to be suffering from an occupational disease, ailment or accident until the workman is cured or until death.

2. The services of the sewer workers are not to be terminated, either by the respondents or the contractors engaged by them during the period of illness and they shall be treated as if on duty and will be paid their wages.

3. The respondents shall pay on the death of any worker including any contract worker, an immediate ex-gratia solatium of ten lakh with liberty to recover the same from contractors, if permissible in law.

4. The respondents shall pay/insure payment of all statutory dues such as Provident Fund, Gratuity and Bonus to all the sewer workers including contract workers, as applicable in law.

5. The respondents shall provide as soon as possible modern protective equipment to all the sewer workers in consultation with the petitioner organization.

6. The respondents shall provide soap and oil to all the workmen according to the present quota but on monthly basis and not at the end of the year.

7. The respondents shall provide all workmen including contract workmen with an accident-card-cum-wage-slip as set out in Clause 8 of the CPWD/PWD (DA)/Municipal Corporation Chandigarh Contractors Labour Regulations (for short "Labour

Regulations").

8. The respondents shall authenticate by signing the payment of wages register for contract workers in terms of Clause 5 of the Labour Regulations.

9. The Municipal Corporation Chandigarh is directed to ensure that the ex-gratia payment in case of deaths of sewer workers has been paid to the families of deceased workmen and in case such compensation is not paid, release the same within a period of eight weeks.

## 1.32 NGT Guidelines

NGT issued guidelines to the various departments for the information of the builders and general public.

The Hon'ble Green Tribunal has directed as follows:-

1. No government, authority, contractor, builders or any person would be permitted to store/ dump construction material or debris on the metaled road.

2. Beyond the metaled road the area where such construction material or debris can be stored shall be physically demarcated by the officers of all the concerned Authorities/Corporation. It shall be ensured that such storage does not cause any obstruction to the free flow of traffic and/ or inconvenience to the pedestrians. It should be ensured that no accidents occur on account of such permissible storage.

3. Every Builder or owner shall put tarpaulin on scaffolding around the area of construction and the building. No person including builder, owner can be permitted to store any construction material particularly sand on any part of the street, roads in any colony.

4. The construction material of any kind that is stored at the site will be fully covered in all respects so that it does not disperse in the Air in any form.

5. All the construction material and debris shall be carried in the trucks or other vehicles which are fully covered and protected so as to ensure that the construction debris or the construction material does not get dispersed into the air or atmosphere, in any form whatsoever.

6. The dust emissions from the construction site should be completely controlled and all precautions taken in that behalf.

7. Every worker working at the construction site and involved in loading, unloading and carriage of construction material and construction debris shall be provided with mask to prevent inhalation of dust particles.

8. Every owner and or builder shall be under obligation to provide all medical help, investigation and treatment to the workers, involved in the construction of building and carry of construction material and debris relatable to dust emission.

9. It shall be the responsibility of every builder to transport construction material and debris waste to construction site, dumping site or any other place in accordance with rules and in terms of this order.

10. All to take appropriate measures and to ensure that the terms and conditions of the earlier order and these orders should strictly comply with by fixing sprinklers, creations of green air barriers.

11. Compulsory use of wet jet in grinding and stone cutting.

12. Wind breaking walls around construction in site.

13. In the event of default they shall be liable to pay compensation for such environmental degradation or for pollution of ambient air quality in Chandigarh particularly.

14. If any person, owner and or builders is found to be violating any of the conditions stated in this order and or for their non-compliance such person, owner, builder shall be liable to pay compensation of Rs. 50,000/- per default in relation to construction activity at its site and Rs. 5,000/- for each violation during carriage and transportation of construction material, debris through trucks or other vehicles, in terms of section 15 of the NCT Act on the principle of polluter Pay. Such action would be in addition not in derogation to the other action that the Authority made take against such builder, owner, person and transporter under the laws in force.

**Section X- Part- 2: Plant & Process Requirements**

## 2.1 Project Objective

Smart Cities is an urban renewal and retrofitting program by the Government of India with a mission to develop 100 cities all over the country making them citizen friendly and sustainable. The Union Ministry of Urban Development is responsible for implementing the mission in collaboration with the state governments of the respective cities.

With increasing pressure on water as a result of limited availability, increasing urbanization and deterioration of water quality of surface as well as ground water, primarily due to pollution of sources of supplies, water recycling is becoming an established way of moving towards sustainable management of our water resources and environment. As, water is the precious commodity of the day and its judicious use is the basic need of present times, therefore, the main objective of use of TT water is to save the potable drinking water, which is presently being used for the purpose of gardening and irrigation of green spaces in various sectors of the city. Further Tertiary Treatment of sewage will improve the environment of city as the effluent of Tertiary Treatment is rich in nitrogen/manure and plants/grass will flourish by its use. Following are the major benefits of recycle;

- Helps conserve vast volumes of water while protecting the environment and reducing pollution;
- Compliance with pollution control regulations and clean environment through reduced effluent discharge;
- Additional savings through product recovery;
- Assured availability of water;
- Less requirement for fresh water, hence low water costs;
- In new projects, incorporation of recycle considerably reduces capital investment on water treatment.

Water recycling adopts the concept of using water that is “fit for purpose”. In practice, this means using high quality water for potable uses and non-potable water for recharge of ground, water for flushing of toilets, gardening, crop irrigation, firefighting and various industrial use particularly air conditioning, cooling, power generation (cooling and boilers),paper industry, steel industry etc.

There have been significant developments over the world in respect of use of Recycle/TT water. These initiatives are mainly driven by shortage of fresh water. Keeping in view the same, presently many cities around the world are using recycle/TT water to reduce their water demands. Therefore, the possible uses of sewage, which has received tertiary treatment, are following;

- Gardening, roadside arboriculture and green belts;

- Landscaped water bodies with fountains;
- Washing of roads, vehicles;
- Aquifer recharge;
- Cooling water for HVAC systems where substantial quantity of water would be lost by evaporation;
- Various industrial processes, etc.

The overall objective of this package is to Design, Build and Operate new WWTPs of total capacity i.e., of 30 MGD STP at Diggian, 5 MGD STP at Raipur Kalan, 2 MGD STP at Raipur Khurd , Primary Treatment Units (Equalization Tank and Clari-flocculator) of Existing 1.65 MGD at Dhanas , Primary Treatment Units (Equalization Tank and Clari-flocculator) of Existing 11 MGD at 3 BRD and 2 MLD STP at Sukhna Lake. Once the new WWTPs are commissioned and put into service, the old plants may be disconnected/demolished and the site / area will be developed as per requirement of employer

The Demolition of existing abandoned structure of STP at Diggian before construction of new 30 MGD STP. The scope of work includes demolition and dismantling of existing WWTP of Raipur Kalan and Raipur Khurd after commissioning new proposed WWTP of 5 MGD and 2 MGD respectively without hampering the working of the plant till commissioning of new plant.

## 2.2 Wastewater & Sludge Quality

### 2.2.1 Incoming Wastewater Flow:

**1.** STP Sector 66 Diggian

Influent water generation is generally from domestic. Based on the preliminary site inspection and information, influent and treated water quality data was collected for four sources of sewage treatment plant. The parameters being tested at each location of plant are listed below:

**SEWAGE WATER PARAMETERS TESTED FOR DIGGIAN STP**

| S. No | Parameter | Inlet | Unit |
|---|---|---|---|
| 1 | pH | 6.80 | - |
| 2 | COD | 521 | mg/l |
| 3 | BOD | 315.00 | mg/l |
| 4 | NO3-N | 3.4 | mg/l |
| 5 | NH3-N | 36.83 | mg/l |
| 6 | Phosphate | 4.26 | mg/l |
| 7 | TSS | 273.00 | mg/l |
| 8 | TDS | 482.00 | mg/l |
| 9 | Turbidity | 230 | NTU |
| 10 | TKN | 12.20 | mg/l |
| 11 | Faecal Coliform | $1.4x10^5$ | MPN/100ml |
| 12 | Oil & Grease | 8 | mg/l |

| | | | |
|---|---|---|---|
| 13 | Total Nitrogen | 17.2 | mg/l |

**2.** 11 MGD STP AT 3 BRD (SBR)

Influent water generation is generally from domestic. Based on the preliminary site inspection and information, influent and treated water quality data was collected for two sources of sewage treatment plant. The parameters being tested at each location of plant are listed below:

**Sewage Water Parameters Tested for 3BRD**

| S. No. | Parameter | Inlet | Unit |
|---|---|---|---|
| 1 | pH | 6.20 | - |
| 2 | COD | 541 | mg/l |
| 3 | BOD | 285.00 | mg/l |
| 4 | NO3-N | 3.1 | mg/l |
| 5 | NH3-N | 36.97 | mg/l |
| 6 | Phosphate | 4 | mg/l |
| 7 | TSS | 236.00 | mg/l |
| 8 | TDS | 475.00 | mg/l |
| 9 | Turbidity | 250 | NTU |
| 10 | TKN | 10.30 | mg/l |
| 11 | Faecal Coliform | $1.8x10^5$ | MPN/100ml |
| 12 | Oil & Grease | 10 | mg/l |
| 13 | Total Nitrogen | 17.1 | mg/l |

**3.** 5 MGD STP AT RAIPUR KALAN

Influent water generation is generally from domestic. Based on the preliminary site inspection and information, influent and treated water quality data was collected for two sources of sewage treatment plant. The parameters being tested at each location of plant are listed below:

**Sewage Water Parameters Tested for Raipur Kalan**

| S. No. | Parameter | Inlet | Unit |
|---|---|---|---|
| 1 | pH | 7.30 | - |
| 2 | COD | 542 | mg/l |
| 3 | BOD | 310.00 | mg/l |
| 4 | NO3-N | 4 | mg/l |
| 5 | NH3-N | 37.49 | mg/l |
| 6 | Phosphate | 3.17 | mg/l |
| 7 | TSS | 305.00 | mg/l |
| 8 | TDS | 512.00 | mg/l |
| 9 | Turbidity | 600 | NTU |
| 10 | TKN | 9.10 | mg/l |
| 11 | Faecal Coliform | $7.6x10^3$ | MPN/100ml |

| | | | |
|---|---|---|---|
| 12 | Oil & Grease | 14 | mg/l |
| 13 | Total Nitrogen | 12 | mg/l |
| 14 | Sludge Volume Index | - | mg/l |

**4.** 1.25 MGD STP AT RAIPUR KHURD

Influent water generation is generally from domestic. Based on the preliminary site inspection and information, influent and treated water quality data was collected for two sources of sewage treatment plant. The parameters being tested at each location of plant are listed below:

**Sewage Water Parameters Tested for Raipur Khurd**

| S. No. | Parameter | Inlet | Unit |
|---|---|---|---|
| 1 | pH | 7.80 | - |
| 2 | COD | 580 | mg/l |
| 3 | BOD | 370.00 | mg/l |
| 4 | NO3-N | 3.2 | mg/l |
| 5 | NH3-N | 42.46 | mg/l |
| 6 | Phosphate | 3.19 | mg/l |
| 7 | TSS | 308.00 | mg/l |
| 8 | TDS | 663.00 | mg/l |
| 9 | Turbidity | 620 | NTU |
| 10 | TKN | 7.80 | mg/l |
| 11 | Feacal Coliform | $5.4x10^3$ | MPN/100ml |
| 12 | Oil & Grease | 18 | mg/l |
| 13 | Total Nitrogen | 17 | mg/l |
| 14 | Sludge Volume Index | - | mg/l |

**5.** 1.65 MGD STP AT DHANAS

Influent water generation is generally from domestic. Based on the preliminary site inspection and information, influent and treated water quality data was collected for two sources of sewage treatment plant. The parameters being tested at each location of plant are listed below:

**Sewage Water Parameters Tested for Dhanas**

| S. NO. | Parameter | Inlet | Unit |
|---|---|---|---|
| 1 | pH | 7.70 | - |
| 2 | COD | 736 | mg/l |
| 3 | BOD | 411.00 | mg/l |

| | | | |
|---|---|---|---|
| 4 | NO3-N | 0.7 | mg/l |
| 5 | NH3-N | 52.10 | mg/l |
| 6 | Phosphate | 5.43 | mg/l |
| 7 | TSS | 276.00 | mg/l |
| 8 | TDS | 724.00 | mg/l |
| 9 | Turbidity | 425 | NTU |
| 10 | TKN | 6.90 | mg/l |
| 11 | Faecal Coliform | $1.5x10^5$ | MPN/100ml |
| 12 | Oil & Grease | 7 | mg/l |
| 13 | Total Nitrogen | 11 | mg/l |

The above data is based on raw wastewater quality observed at the existing plants. However, the contractor may conduct the sampling and tests of raw wastewater by himself to ascertain the raw wastewater quality for treatment process. The Employer (CSCL) will not be responsible for the above data and no relaxation will be given to the guarantee conditions of desired treated effluent quality. Bidder can also verify the operating data of existing plants. For design purpose values lower than the above mentioned values shall not be permitted.

### 2.2.2 Treated Effluent & Sludge Guarantees

The contractor shall design the process in such a way that the treated effluent quality (at plant outlet) meets the following standards or better for 30 MGD Diggian, 5 MGD Raipur Kalan, 2 MGD Raipur Khurd, 11 MGD 3 BRD and 1.65 MGD Sukhna Lake

| S No | Particulars | To be Guaranteed by Bidder |
|---|---|---|
| 1 | pH | 7.5 |
| 2 | TSS | ≤ 5 mg/lt |
| 3 | Total Nitrogen | ≤ 5 mg/l |
| 4 | Ammonical Nitrogen (NH4-N) | ≤ 5 mg/lt |
| 5 | $BOD_5$ | ≤ 5 mg/lt |
| 6 | COD | ≤ 50 mg/lt |
| 7 | $PO_4$-P (TP) | ≤ 1 mg/lt |
| 8 | Fecal Coliform | <230 MPN/100ml |

**For 2 MLD Sukhna Lake Treated Water Quality is given below:**

| SNO. | CONSTITUENTS | UNITS | VALUE |
|---|---|---|---|
| 1 | PH | - | 7.0-8.0 |
| 2 | $BOD_5$ | mg/l | <1 |

| | | | |
|---|---|---|---|
| 3 | COD | mg/l | <10 |
| 4 | TSS | mg/l | <1 |
| 5 | TN | mg/l | <2 |
| 6 | TP | mg/l | 0.1 (Target) Guarantee 0.5 |
| 7 | Coliform | MPN/100ml | 100 |

## 2.3 Demolition of Interfaces and Tie-Ins with Existing Facilities

All existing facilities that are to be demolished shall be properly decommissioned, removed, and appropriately deposited or stored by the Contractor at place as proposed by Employer in accordance with all applicable laws, regulations, and standards. Items, components, or materials, whether buried, exposed, submerged, or otherwise, shall not be abandoned or left on site unless such directions are explicitly provided in the Bid Document or instructed by Employer during execution.

List of Major Existing Units / Structures to be Demolished for Raipur Kalan, Raipur Khurd and Sector 66 Diggian WWTPs are given below. The bidders are required to verify the demolition scope from the site at their own level.

- Raipur Kalan
- Raipur Khurd
- Sector 66 Diggian

## 2.4 Sewage Treatment Process

Bidder shall construct the proposed WWTPs of Raipur Kalan (5 MGD), Raipur Khurd (2 MGD), Diggian (30 MGD), Sukhna Lake (2 MLD) including augmentation/upgradation of 3 BRD (11 MGD) and Dhanas (1.65 MGD) WWTPs. The existing WWTPs are currently in operation and shall remain in operation till the time new WWTPs of as mentioned capacity is commissioned.

The Bidder can propose any proven aerobic biological treatment process providing all the treatment units to meet the requirement of treated effluent and sludge dewatering and reuse as specified under clause no 2.2.2 but not limited to screening and grit removal, Biological system, tertiary system including disinfection, appropriate sludge treatment & sludge dewatering and reuse of treated. However, bidders should not propose any patented technologies for aerobic biological treatment process. The bidder shall only propose those treatment processes for which all equipment and spare parts shall be easily available in the Indian market.

Bidder shall need to provide a complete, fully functional facility designed for proper & easy operation to meet the stated performance requirements. This shall include any and all

additional, ancillary, supporting, or other processes, components, equipment, or other items necessary to achieve these objectives, regardless of whether such items are explicitly listed in this Tender Document or not.

The Bidder shall provide the detailed process calculations for arriving the sizes of the liquid and solids treatment/ handling units in the Technical Bid. Design of various process units shall be based on design guidelines including but not limited to Hydraulic Retention Time, Solids Retention Time, Surface Loading Rate, Weir Loading rate, Performance / Removal Rates etc given in CPHEEO Manual 2013 on Sewerage and Sewage Treatment. In case certain parameters are not available in CPHEEO manual then bidder shall refer to Wastewater Treatment and Reuse - Metcalf & Eddy latest edition. The Bidder shall account for flow and associated loads from Return streams including but not limited to backwash, dewatering centrate, and supernatant etc in the design. **The Bidder should provide complete design details with process flow diagram (PFD), P & I diagram, single line diagram (SLD), hydraulic flow diagram (HFD), mass balance, process calculations, plant layout, and hydraulic flow calculations and diagram in the Technical Bid**.

## 2.5 General Design Requirements of each plant

Contractor's design shall fully comply with the following requirements, regardless of whether or not such requirements or any related components are shown in any drawings included in the Tender Document:

- The Contractor shall perform a complete Hazardous Area Classification analysis as per IS 5572, "Classification of Hazardous Areas (other than mines) for all facilities and components in this contract and shall submit a complete report of such analysis as well as Hazardous Area Classification Drawings that delineate boundaries of all classified areas and indicate the classification of each area. All electrical or other powered equipment, instrumentation, or components shall fully comply with all requirements of IS 5571'Guide for Selection and Installation of Electrical Equipment for Hazardous Areas (other than mines)'.
- All components (including but not limited to equipment such as pumps, blowers, screens, diffusers, inline devices; instruments such as flow meters; and distribution and collection channels or pipes) shall be provided with appropriate isolation devices such as valves, gates, or other devices in order to allow isolation, drainage, cleaning, calibration, servicing, and maintenance of such components. Bypasses shall be provided around all electromagnetic flow meters and other in-line instrumentation such that the instrument can be isolated and removed for calibration and maintenance without interrupting the flow, regardless of whether or not such bypasses are shown in any drawings included in the Tender Document.
- Where necessary, equipment shall be provided with acoustic, sound-dampening enclosures to limit ambient noise during normal operation to the limits detailed in part-4 of volume-2. Such enclosures shall include ventilation and/or cooling provisions as necessary to prevent overheating and ensure operation of equipment at optimal temperature.
- All equipment shall be arranged and buildings and structures designed to permit safe

and easy access to and removal of all equipment.

- Fixed runways, lifting eyes, cranes, trolleys, hoists, and/or other appropriate devices and means shall be provided to permit safe and easy removal of all mechanical, electrical, and instrumentation equipment and components for maintenance or any other purpose. Overhead bridge cranes with 3-way electric movement shall be provided for Bioreactor pumps and blowers, in Digester Control Room for Gas Compressor, and for any other heavy process equipment. Lifting systems shall be of sufficient capacity to allow lifting of entire assembled equipment units (e.g. pumps, blowers, or other) one unit at a time.
- All structures, whether liquid-holding or not, shall be designed such that they can be fully and completely drained and will not float or move when empty, because of groundwater buoyancy or any other reason. The structures shall be designed to counteract any possible floatation without the use of any type of groundwater pressure relief valves.
- Non-liquid-holding areas, structures, or buildings where leakage or other wet activities can occur, whether in normal use or during maintenance, shall be provided with covered drainage channels which shall direct the spillage and any washings shall be suitably drained to the sump of Filtrate pump house.
- All channels below ground level carrying process liquid shall be fully covered with solid non- skid GRP cover plates (not grating)/ RCC slabs designed for human traffic live loads at a minimum and heavy vehicle live loads wherever the channel crosses traffic paths. For channels having top of wall (TOW) less than 1.0 m above ground level, suitable hand railing shall be provided as per the site requirement.
- All interconnecting channels shall be designed for peak flows.
- Inlets into tanks, reactors, or other structures via pipes, channels, valves, or gates shall be designed such that the incoming flow does not cause any damage or excessive wear whatsoever to the structure or any equipment in the vicinity under any hydraulic condition, including but not limited to the condition when the structure is empty.
- All piping shall be fully and adequately supported and braced to comply with all applicable codes and standards. Pipe supporting hardware shall also be of corrosion-resistant material. The design of pipe supports and anchors shall fully account for static and dynamic vertical, lateral, longitudinal, and seismic loads, fluid flow, and thermal expansion. Seismic bracing, thrust restraints and/or thrust blocks, and appropriate expansion joints or loops shall be provided as needed. Pipe lengths and joints shall be assembled and arranged for ease of removal in such a way that individual runs can be changed without dismantling adjacent pipes, by providing dismantling joints at regular intervals.
- For liquids and sludge, the velocity of full flow in pipes or conduits shall be maintained as specified under Part-4, Cl. no. 4.2.17.3 Piping Sizing & Material. All mixed liquor and sludge pipes shall have minimum 200 mm diameter and shall be provided with appropriate cleanouts and flushing arrangements for safe and easy flushing using high-pressure water.
- For liquids and sludge, the minimum velocity of flow in open channels or partial flow in pipes or conduits shall not be less than 0.6 m/s and the maximum shall be no more than 1.5m/s.

- All underflow sludge service pipes shall be provided with appropriate means for safe and easy drainage of the pipes, with flushing system, when not in service.
- All pipes shall be colour banded and suitably labelled with the stream designation and direction of flow at suitable minimum 5- meter intervals throughout their run, as per site requirement.
- All piping shall be arranged without clutter and shall be functional and neat in appearance. Where piping is installed in ducts, it shall be supported such that the flange rim is not less than 150 mm clear above the floor.
- All piping routed under any type of structure or equipment shall be fully and completely encased in cement concrete, with the encasement thickness beyond the outer diameter of the pipe being at least 200 mm on all sides. The encasement shall extend along the pipe length for a minimum horizontal distance of 1500 mm in each direction beyond the footprint of the overlying structure or equipment.
- All piping connecting to, entering, or exiting any and all structures shall be provided with appropriate restrained flexible connections and/or joints at all such interfaces with structures to allow for differential movement between pipe and structure in all directions without stressing or breaking the pipes.
- Appropriate restrained flexible connections and/or joints shall be provided for all pipes where they connect to any and all of the following:
    - Equipment such as pumps, blowers, or inline devices
    - Valves
- Where piping or other materials susceptible to damage from ultraviolet radiation are employed, they shall be protected from such radiation through the use of appropriate additives and/or coatings and shall be physically shielded from direct sunlight at all times in their normal service locations using enclosures, covers, canopies, roofs, and/or other similar means.
- Platforms, handrails/guardrails, ladders, and stairs shall be provided where necessary for proper, safe, and easy access to and/or operation of valves, gates, instruments, control panels, and other devices, equipment, or structures.
- Appropriate sampling ports and/or sampling valves shall be provided to allow easy, safe sampling of all process streams without spillage or contamination and without the need to interrupt normal operation.
- The influent flow meter and influent sampling location shall be such that the true influent flow and characteristics will be measured without inclusion of in-plant recycles or other extraneous streams. It is suggested that the appropriate location for influent flow measurement and sampling would be Common Inlet Chamber. Separate flow measurement and sampling shall be provided for the recycle streams.
- Foam, scum, fats, oil, grease, or any other floating material removed from any location in the plant shall be completely removed from the process flow path along with waste, digested, and/or dewatered solids leaving the plant and shall under no circumstances be recycled or returned to any location in the plant.

## 2.6 Plant Layout and Hydraulic Profile

An indicative layout and estimated hydraulic profile/hydraulic flow diagram based on A2O process are included in Volume 4 of the Bid Document for treatment scheme. These drawings shall be considered representative only. In the event of any conflicts between information in these drawings and Part 2 – "Plant and process requirements", the information in Part 2 – "Plant and process requirements", shall govern. Contractor shall provide independent, detailed and optimized plant layout and hydraulic design, which shall fully comply with the requirements and constraints specified herein. All the required process units including sludge management system shall be adjusted within the land area boundary marked in layout drawing in Volume 4 of the Bid document and no additional land will be available.

The Contractor's layout and hydraulic design shall comply with the following specific constraints and all other requirements described in the Tender Document.

- The entire Liquid treatment process right from inlet point till final discharge location after treatment shall be preferably designed with gravity flow.
- For all structures containing water, process liquid, or sludge, the minimum freeboard (distance by which top of wall is higher than the maximum level of structure contents) shall be 0.5 m unless specified otherwise. The maximum level of structure contents for this purpose shall be considered under the following conditions occurring simultaneously:
    - Maximum/high flood level in receiving waterbody/ structure
    - Operating flow equal to design peak hour flow
    - One unit of each unit process out of service
- All weirs in the plant, including variable height weirs on weir gates, shall remain un-flooded / un-submerged, with a minimum 75 mm free fall from the weir invert to the downstream water surface level under the following conditions occurring simultaneously:
    - Maximum/high flood level in receiving water body/structure
    - Operating flow equal to design average flow
    - One unit of each unit process out of service
- All Parshall flumes/flow measuring Channel shall remain un-flooded/un-submerged up to the design peak hour flow.
- Bypass facility shall be provided at following locations:
    - At Inlet Chamber
    - After Pre-treatment
- Available topographical survey information, benchmarks, contour maps, geotechnical/soil investigations, and effluent receiving water body/structure maximum or high flood level (HFL) elevations are included with this Tender Document and/or available from Employer on request. However, Employer makes no guarantees or representations regarding this information whatsoever. The bidders may use this information at their own risk. They shall independently obtain any and all site information they deem necessary for proper preparation of the bids and for the planning, design, testing, commissioning, operation, and maintenance of all components in the contract.
- All new plant components shall be fully contained within the designated site boundaries

and shall be placed so as to easily and logically accomplish all specified interfaces with existing components. Contractor's proposed site layout shall clearly show the space allocated for all plant components. Setbacks and clearances from the site boundary shall be provided as appropriate and as required by law. All existing utilities (including but not limited to water, sewer, and power, whether overhead or underground and whether physically located on the site or not) that must be relocated to accommodate the Contractor's proposed and approved site layout shall be relocated by the Contractor.

The plant layout shall fully comply with the following:

- Minimum clear distance provided to permit safe and convenient access for operation and maintenance shall be 5 m between adjacent treatment units or fixed structures and 500 mm between individual equipment units.
- For each set of mechanical equipment (e.g. pumps, blowers, etc.), an appropriately-sized adjacent open area shall be provided as a maintenance bay down area to allow safe and easy performance of maintenance tasks, as per manufacture's requirements.
- All electrical equipment installed open in the sky shall be located above the high flood level elevation of the site.
- Following units shall be designed for peak flow.

| Sr. No. | Process Unit |
|---|---|
| 1 | Head works including inlet chamber, screen and grit chamber and Parshall flume/flow measuring Channel |
| 2 | All interconnecting channels/pipes |
| 3 | Final Treated Effluent Channel |

For all components under this contract, the capacity to be provided shall be designed, constructed, and operated using multiple identical units or modules to ensure reliability, redundancy, and appropriate turndown for optimum capacity utilization and process efficiency. The design shall further ensure that all such units receive equal flow or loading at all times when in operation. The design shall ensure that multiple modules of various unit processes are fully integrated and can operate as a single plant and a single process stream – multiple parallel plants will not be allowed. Such integration shall be accomplished by means of common collection and distribution channels, boxes, or header pipes in between unit processes that combine the flow from multiple modules of the upstream unit process and redistribute it to multiple modules of the downstream unit process. Designs where each module operates independently of other modules will not be permitted.

The minimum number of working and standby units or modules required for each component shall be as under:

- **For Pumps, Blowers and Compressors**: If not mentioned specifically otherwise, provide minimum 50% standby unit for these equipment for each unit. For example if two blowers area provided for each stream, then number of standby blower units per stream shall be 1 number. However, if only one blower pump is provided per stream then one identical blower shall be provided as standby. Standby units shall be

permanently installed with piping and valves such that each standby unit can be put into operation in place of any of its designated duty/working units by opening and closing appropriate valves, without the need for installation or un- installation of additional components. Bidders are encouraged to provide energy efficient equipment with documentary evidence of successful operation of such units.

- **For Submersible Mixers**: If not mentioned specifically otherwise, provide one spare unit (in storage) for every set of 3 duty/working units or part thereof.
- **For Process Air Diffusers**: If not mentioned specifically otherwise, provide spare units (in store) equal to 5% of the total number of installed units, and spare units shall be full diffuser assemblies (i.e., base, orifice, membrane, and membrane retaining mechanism).

## 2.7 Layout and Facilities Description

An indicative plant layout based on A2O Process is provided in Volume 4 of Bid document for the general guidance of the Bidder. However, Bidder is free to propose any proven aerobic biological treatment process as per scope of work, having all the treatment units to meet the desired treated effluent and dewatered sludge standards as given in clause no 2.2.3 of this part.

## 2.8 Inlet Chamber

Inlet Chamber shall be designed for peak flow. Electrically operated (with manually override) Inlet / Outlet Isolation Sluice Gates shall be provided for controlling the flow from Inlet Chamber to medium and Fine Screen Channels. Bypass channel/pipe designed for peak flow from Inlet Chamber to the final effluent channel shall be provided. Sluice gate shall be provided for controlling the flow from Inlet Chamber to the By-pass channel/pipe. The Inlet Chamber shall be provided with Staircase and 1.2 m wide walkway with hand railing.

## 2.9 Medium and Fine Screens Channels

The raw wastewater from the inlet chamber shall flow by gravity to the Screen influent channel and flow shall be distributed equally to each screen channel. Screening shall be done in two stages and Contractor shall have to provide automatic mechanical medium screens to remove particles larger than 20 mm size and in second stage, there shall be fully automatic mechanical fine screens to remove particles larger than 6mm.

In addition to the mechanical screens, one number manual screen (SS316) for 15% of design peak flow shall be provided to remove particles larger than 20 mm size.

Medium screens shall be provided with belt conveyer system and fine screens shall be supplied with shaftless screw conveyor to convey the screenings to the automatic screening press and discharge system that including washing and then compacts, dewater and discharges the screenings through chute to the screenings storage system. The screens and shaftless screw conveyor shall be in SS 316 construction. The screen shall be movable bars / perforated band having a design life of 20 years. A straight line channel before the screen is mandatory. Minimum length of the channel shall be 5 times the width of the screen chamber. A similar channel after the screen channel shall also be provided.

The mechanical Screens shall be in continuous operation under normal condition & with all working and minimum one no as standby Screen during peak and minimum flow. The individual Screen Channel shall be provided with electrically operated (with manual override) Inlet & Outlet isolation Sluice Gates. Wastewater from each screen shall flow to common channel for further distribution to grit chambers. Electrically operated (with manual override) Inlet / Outlet isolation Sluice Gates shall be provided for controlling the flow from common channel to grit chambers. Suitable RCC platform of minimum 1.2 m width shall be constructed along the screen chamber to reach the screens for closer inspection of all screens and conveyor system. Access Staircase and railing shall also be provided.

## 2.10 Grit Chambers

De-gritting is required for removal of all grit and other inorganic solids of specific gravity 2.65 and above with particle size of 0.15 mm and above from wastewater. De-gritting shall be accompanied with grit washing to ensure that grit is free from organic matter before disposal. Grit Chamber shall be designed for design peak flow with 25% standby units.

Grit Separators are to be provided after the screening and shall be with low head loss type. The vortex type grit chamber consisting of a tank in which the flow shall enter tangentially creating a vortex flow pattern is required. The constantly rotating stirrer mounted in the tank helps the wastewater circulation within the grit chamber to maintain a constant velocity of rotation even under low flow conditions. The solids shall be collected within the hopper located at the centre of grit chamber and shall pass to the grit collection tank.

The grit evacuation from the grit separation hopper could be either by centrifugal pump or Airlift Pumps. In case of use of Air Lift Pump to transfer grit from the grit chamber there shall be individual air blowers per grit chamber.

The centrifugal or airlift pumps shall deliver the collected solids from grit collection tank into grit classifier or grit washer wherein solids are washed and organic material is returned to the plant, and the washed solids are collected in grit bins. The Grit Chamber shall have separate classifiers per grit chamber and grit collection hopper/trolley

The grit classifier or grit washer is to be located in such a way, wherein the solids can be separated and dewatered and organic particles can be removed. A grit storage hopper with proper slope towards bottom shall be provided for effective grit storage for the designed flow.

The bidders are to note that the silt & grit removed from grit chamber, does not form part of the TSS in the wastewater quality indicated in the tender document. Accordingly sludge calculations shall be done by bidders.

The grit removal device shall be capable of removing the following at the specified hydraulic peak flow rate, and no decrease in efficiency will be allowed at flows less than this design rate:

a) 95% of the grit greater than 150 microns in size,
b) 85% of the grit greater than 100 but less than 150 microns in size, and

c) The washed grit shall contain less than 3 % organic matter on dry basis
d) No TSS removal shall be considered in grit removal

Documentary evidence in support of the removal efficiency of the offered equipment shall be furnished by Contractor.

The wastewater from Grit Chamber shall flow to common channel for further distribution to the Biological treatment units. Electrically operated (with manually override) Inlet/ Outlet Isolation Sluice Gates shall be provided for controlling the flow from Grit Chambers to the combined channel.

## 2.11 Flow Measuring Channel (Area Velocity Flow Meter Type)

The wastewater from Grit Chambers shall flow to a common channel having facility for measuring flow with the Area Velocity Flow Measuring type Ultrasonic Flow Meter. The Area Velocity Flow meter Channel shall be designed as per the latest CPHEEO manual or as per manufacturer's requirement with proper clear straight length on the upstream & downstream for steady state of flow. Flow meter shall be fitted with an ultra-sonic type measuring device to provide local and remote read out of the flow into the plant.

The Area Velocity Flow meter Channel shall be connected with the Primary Sedimentation distribution chamber.

## 2.12 Primary Sedimentation Unit

Bidder shall provide sufficient number of appropriately sized units operating in parallel. Bidder shall design the units based on the "Surface Overflow Rate" and solids loading rate as per CPHEEO manual considering return flows, if any. Each settlement tank shall be fitted with a scum collection &removal system. The system shall be designed to minimise the volume of liquid discharged with the scum whilst providing efficient removal of the scum. All scum shall be sent directly to the sludge sump from where it shall be pumped to the appropriate sludge treatment system for further treatment and reuse.

## 2.13 Aerobic Treatment System

**Bidder can propose any proven Aerobic biological treatment process.** Aerobic biological treatment shall be designed to achieve the treated effluent parameters as outlined in clause no 2.2.3 of this document. The biological treatment system shall be designed for design average flow including recirculation and other flows, if any. Aerobic biological treatment process shall be so selected that, the treated effluent parameters as outlined in clause no 2.2.3 of this document are achieved along with meeting requirement of power generation.

However, the treatment processes listed below shall not be accepted:

- Oxidation pond (facultative/anaerobic/aerobic)
- Aerated Lagoons
- Oxidation ditch
- Upward Anaerobic sludge blanket (UASB)
- Waste stabilization Pond (WSP)
- Natural Treatment System
- Moving Bed Bio Reactor (MBBR)

The proposed technology shall be supported with detailed process and methodology along with permissible design parameters, components, and technical specifications with other process loading data confirming to standard operating manuals in consonant with CPHEEO Manual (2013) on Sewerage with specified size of each units with conceptual layouts. In case certain parameters are not given in CPHEEO manual, Sewage and Wastewater Treatment and Reuse - Metcalf & Eddy latest edition shall be referred.

The aeration system shall be designed such that the liquor in the aerobic zones is adequately mixed even during low load / low flow periods to prevent settling of biomass, and to avoid unmixed pockets within the aerobic zones. Bidder may consider any aerobic process (or its variants) in singly or in combination with in achieving the desired effluent criteria.

**Minimum requirement for some of the aerobic treatment process shall be as follows:**

**A2O** System is designed for biological removal of carbonaceous BOD, biological nitrogen removal as well as biological phosphorous removal, using basic principles of Activated sludge process with additional features of Anaerobic - Anoxic - Aerobic process i.e. A2O process. Reactor is designed in two streams, with suitable isolation arrangements. For aeration tank, air to be supplied through root blower and fine bubble diffused membrane diffusers, which are more efficient in terms of oxygen transfer.

**MLE** process which consists of the modification of a conventional activated sludge process where an Anoxic zone is created or added upstream of the Aerobic zone. The process uses Mixed Liquor Recycle flow that carries nitrates created in the nitrification process in the Aerobic zone along with the mix liquor to be mixed in the influent to the Anoxic zone. The amount of nitrates potentially removed in the Anoxic zone depends on the recycle flow and availability of influent BOD.

For **SBR treatment process**, the SBR sizing and design shall be such that the proposed cycle times, number of cycles per day, and phase times within each cycle shall all remain fixed up to the specified design peak day flow. No acceleration or premature advancing of cycles shall be allowed up to the peak day flow. The Cycles may be advanced as necessary for level control only when the actual influent flow exceeds the specified design peak day flow. SBR basins may or may not have internal partitions. Regardless of such internal partitioning, all SBR designs shall strictly comply with the design criteria and all other requirements specified in the tender documents. SBR designs that permit any overlap whatsoever between the fill phase and settle phase or the fill phase and decant phase ofthe SBR cycle shall not be accepted. Process air blowers as well as air piping and valves for SBRs shall be configured such that one or more blowers are dedicated to each SBR basin that is in the aeration phase at any given time. The discharge from any given blower shall be routed to no more than a single SBR basin at any given time. Scum collection and removal system shall be provided within SBR before discharge of the treated sewage through the decanters.

For **MBR process**, membrane basins shall be fully covered with solid / chequered non-skid GRP cover plates. The design shall provide for easy isolation of each MBR basin and shall include all required facilities for complete and automatic clean-in-place (CIP) functionality.

An electric overhead bridge crane or monorail chain pulley block with travelling trolley shall be provided for easy removal of the membrane modules. The crane or block shall provide adequate vertical clearance to safely lift the membrane modules above all piping, equipment, or other items that may be located in the travel path from the module location in the tank to an adequately-sized adjacent membrane "lay-down" area designated for membrane maintenance. The crane coverage shall include the entire MBR basin area plusthe lay-down area, if required.

The scope of supply for the MBR system shall consist of, but not limited to the following:

- A complete micro porous membrane system with relevant track record in sewage treatment application and associated pumps and process equipment as necessary to meet the performance requirements listed subsequently.
- All equipment associated with the backwash system (if the membrane is back washable) including pumps, chemical addition systems, air blowers, air compressors, dryers and receivers as necessary to sustain the permeability of micro porous membranes;
- Chemical storage, handling, injection and mixing systems, pumps, tanks, heaters and instrumentation associated with the microporous membrane Clean-In-Place (CIP) system;
- All interconnecting pipe works, fittings and valves,
- All interconnecting wiring (power and control)
- All required process control and monitoring instrumentation, and
- All on-line analyzers for performance monitoring and verification.

All the MBR associated equipment such as Scour Air Blowers, Permeate/ Back pulse Pumps, RAS Pumps shall be housed inside a building.

**Final Sedimentation tank (if applicable)**

In the Final Sedimentation Tanks, mixed liquor suspended solids will be settled to recycle the biological sludge back to the biological reactor. Appropriate detention time and surface loading shall be provided for settling of mixed liquor suspended solids. Bidder shall provide a sufficient number of appropriately sized units operating in parallel. Bidder shall design the tanks based on the "Surface Overflow Rate" and solids loading rate as per CPHEEO manual considering RAS flows. Each settlement tank shall be fitted with a scum collection & removal system. The system shall be designed to minimise the volume of liquid discharged with the scum whilst providing efficient removal of the scum. All scum shall be sent directly to the sludge sump from where it shall be pumped to the Sludge Management system for further treatment and disposal.

**Return Sludge Pump House (if applicable)**

Return sludge pump house shall be dry well type with easy access for pump installation and maintenance. Each FST / MBR tank shall have dedicated RAS pump(s) and WAS pump(s), with minimum 50% stand-by pump(s). A suitably located online flow meter(s) shall be installed with necessary ancillaries so as to allow measurement of RAS and WAS flow from each FST. The RAS and WAS pumps shall be installed with variable speed drives.

## 2.14 Tertiary System

Secondary treated effluent shall flow to tertiary filtration system units by channel under gravity for tertiary treatment. Contractor shall provide proven mechanical Tertiary Filtration system with low head loss requirement so as to fit the same in available head of plant and no pumping of effluent is desired. Tertiary treatment facility shall be provided in building.

The Bidder may propose any proven filtration system that has been implemented, worldwide. However, **Bidder may consider any of the following filtration process**:

For travelling bridge type, the filter bed depth shall be minimum 0.30 m. The filtration system should able to handle the average flow and peak flow. Each filter component shall be designed to withstand with a prudent safety factor all stresses that may occur during fabrication, erection, intermittent, or continuous 24 hour per day operation. The equipment and controls shall be provided as a complete package to ensure coordination and compatibility. Each filter shall include a travelling bridge assembly, backwash hood, a single submersible pump, nozzles with integral tailpieces, air distribution header, under drain, Single or dual media i.e. consisting of high grade silica sand and if dual media anthracite media shall be provided, indexing tabs, power cable, rail, influent ports, backwash discharge launder, and controls. Access Staircase with hand railing shall also be provided. The filter backwash shall be recycled to the inlet works.

Cloth Media Disc filtration system should be able to handle the average flow of and peak flow. Each filter component shall be designed to withstand with a prudent safety factor all stresses that may occur during fabrication, erection, intermittent, or continuous 24 hour per day operation. The effective filtration area will be considered the actual media area which will be submerged and available for filtration. Maximum effective filter loading rate at average & peak design flow shall be 8 and 16 m3/m2/hr respectively. The equipment and controls shall be provided as a complete package to ensure coordination and compatibility. Each filter shall include all the necessary ancillaries such as pipe work, actuated valves for automatic operation, local control panel with a controller, communication link to main plant PLC etc. Access Staircase with hand railing shall also be provided. The filter backwash shall be recycled to the inlet works. Contractor shall submit calculation and sufficient evidences for verifying the effective filtration surface area. The filtration system shall be complete with PLC controlled operation and backwash system.

The Membrane filtration system shall be either the submerged or low pressure type and shall be capable of filtering average flow and peak flow and achieve the desired treated effluent quality. The contractor shall be responsible for the design of the necessary pre-treatment system for the selected membrane filtration unit. Concurrently, the supplier of the membrane filtration unit shall certify that the pre-treatment system designed by the contractor is sufficient based on the effluent quality information provided. However, the maximum Flux with one unit out of service shall be 76 LMH for submerged membrane and 110 LMH for low pressure membrane.

## 2.15 Poly-Electrolyte Dosing System

Polyelectrolyte solution preparation tanks shall be provided for preparation and dosing of polyelectrolyte solution. Tank will provide with feed water lines, over flow drain and outlet lines. The Polyelectrolyte tank is provided with level transmitter and level indicator with low and high alarm for sensing in the level in the tank. All the running pumps are tripped automatically at low level.

Tank is also equipped with agitator for dissolving poly electrolyte. The polyelectrolyte solution from the solution preparation tanks shall be dosed to Centrifuge with the help of dosing Pumps. All PE Metering pumps shall be equipped with Electric operated diaphragm valve in suction and discharge line for operation at auto mode

## 2.16 Treated Effluent Channel

Proposed Treated Effluent channel shall be provided to carry treated effluent from disinfection unit to the final disposal point. Channel shall be designed for design peak flow. New treated effluent channel shall discharge the treated effluent into existing treated effluent channel.

## 2.17 Treated Effluent Reuse Pump House

Treated Effluent Reuse Pump house having sump, pump house and control panel building shall be constructed. The treated effluent reuse pumps shall be provided for 30 MGD capacity to meet the reuse requirement including the requirement of existing 40 MGD of treated effluent to other parts of Chandigarh and for various in-plant uses including but not limited to tanker filling stations. Bidder shall provide the details of the in-plant water requirement.

Sump shall be provided for 50 MGD capacity. However, duty pumps (Hz centrifugal type) of sufficient capacity (approx. 60 m total head) along with 50% standby pumps for supplying 40 MGD treated effluent to other reuse locations in Chandigarh and also pumps required for meeting in-plant requirement shall be provided. Interconnection of the existing Rising Mains from old pump house to the proposed treated effluent reuse pump house shall be connected by Contractor.

Also, 3 nos. submersible pumps shall be installed in the sump to pump the treated effluent to 3 nos. Tanker Filling Stations. Pipe network for pumping the treated effluent to the tanker filling stations shall be provided by the Contractor. The sump shall be fully covered with suitable SS grating. The sump shall be constructed in RCC as liquid retaining structure. The sump shall have SS hand railing of minimum 1.0 m height all around. The plinth level of the building shall be minimum 500 mm above the FGL

## 2.18 Sludge Digestion System

Bidder are required to provide entire Sludge digestion system including but not limited to thickening, Anaerobic Digestion, Dewatering and safe reuse of sludge without dumping. Contractor shall be solely responsible for the digestion of the sludge and handling the same in an environmentally safe manner. Contractor can adopt any other advanced treatment processes which lead to the reduction in the overall sludge volume, making its handling safer and easier and can be reused further. Appropriate sludge thickening and dewatering process shall be provided by the Bidder.

### 2.18.1 Sludge sump and Pump House

Sludge Sump/Centrifuge Feed Sump & pump house shall be provided to withdraw the sludge and store the same in sludge sump/centrifuge feed sump and then pump the same to sludge dewatering system i.e. centrifuge system. Sludge shall be pumped to mechanical sludge dewatering system consisting of centrifuges. The top level of the sump shall be minimum 500 mm above the F.G.L with minimum 1.0 m high hand railing all around it. Digested sludge sump shall be provided with submersible mixers for mixing.

Sludge Pump House shall be provided to accommodate working and 50% stand by sludge pumps and shall include all accessories and associated works including all interconnecting piping works for the sludge pumps, specials, appurtenances, supporting structures, control panels etc. Sludge Pump House shall be provided with Mechanical Ventilation system, Fire fighting system.

### 2.18.2 Dewatering Centrifuges and Control Building

For dewatering of sludge, sufficient no. of centrifuges of adequate capacity shall be provided as working along with 100% as standby units.

Dewatering Centrifuge building shall be a two storey building with RCC framed structure and brick panel walls of 230 mm thick. Dewatering Centrifuge and all associated/ancillary equipment required for proper operation and performance shall be provided at first floor of the building as specified, including but not limited to a dewatered sludge conveyors, sludge storage/loading bins/hoppers, and truck access and loading facilities. Design, sizing, construction, and operation of the dewatering units and related equipment, including but not limited to solids and hydraulic loadings, shall be adequate to ensure that all specified performance requirements, including but not limited to dewatered sludge concentration and solids capture, are fully met under the specified dewatering operating schedule. Centrifuge shall be provided of suitable capacity as per process requirement with 50% standby capacity. Dewatering centrifuge shall be provided to achieve the desired solids consistency with polymer dosing system. Dewatering units shall operate for up to 2 shift i.e. 16 operating hours per day and 7 days/week.

### 2.18.3 Plant Drain Sump & Pump House

The pump house shall be suitable for installation of submersible pumps. The sump shall be constructed as liquid retaining structure. The top level of the sump shall be 500 mm above the F.G.L with 1.0 m high hand railing all around it. There shall be RCC framed structure with outer brick walls of 230 mm thick over the sump of adequate floor area as required. This structure shall house panels and other electrical / mechanical fittings. The plant drain sump and pump house shall be provided as specified to collect the flow from various units such as centrate from pre-dewatering and dewatering units, backwash from filtration units etc. and shall be pumped back to the inlet chamber. All components including but not limited to the wet well and the pumps shall be adequately sized to accommodate all continuous, periodic, and intermittent recycles as well as periodic maintenance- related draining of various

structures within the time intervals specified.

### 2.18.4 Sludge Treatment and Reuse

The Bidder shall specify the detailed plan and methodology for the treatment (post dewatering) and selling of treated reusable sludge. It is hereby clarified that all costs and charges relating to handling, transportation, marketing and sale of the reuse of sludge post dewatering shall be solely borne by Contractor. The bidder can choose any option(s) while considering reuse of sludge for beneficial use.

Disposal /dumping of sludge for filling in low lying areas shall not be allowed.

## 2.20 Electrical Main Sub Station(If required)

1 no. electrical main substation EMS to be provided for accommodating 33 kV metering panel which will receive electricity from 33kV from electric supply authority. Apart from the metering panel this building also accommodates 33kV HT switch gear panel battery and battery charger for control supply to all breakers.

This building should be in RCC framed structure and brick panel walls of 230mm thick. Substations shall be designed as per tender specification clause no 5.3.15 Vol 2, Section 10, part 5 of Bid document.

## 2.21 Electrical Sub Stations/Panel

Electrical Sub Substations to be provided such as near Bioreactors, Tertiary system units, Treated effluent reuse pump house as per specification given in Part 5, Section X, Vol 2.

## 2.22 Instrumentation Works

The treatment plant conceived is an auto control plant capable of Automatic Operation requiring minimal operator attention.

Instrumentation system i.e., type & quantity of instruments shall be considered to meet the process requirement and the control philosophy of the plant. For detailed scope of work and specification of instrumentation system Section-X Part-6 shall be referred.

## 2.23 Utility Buildings

### 2.23.1 Fire Fighting Pump House

The contractor shall design and construct suitable fire fighting system along with pump sets, fire hydrant shall be provided in the fire fighting pump house. The system shall be complete with motor and diesel driven fire pump including Jockey pumps and other accessories for meeting the fire fighting requirement of buildings located in the plant area.

Final treated effluent shall be the source of water supply for firefighting purposes which shall be conveyed to the fire fighting pump house in which all pumping machinery shall be installed. Delivery head for the pump should be sufficient to supply the water to all structures and to meet the fire fighting requirement. Fire hydrant shall be provided near all the units of buildings/ pump houses/ panel rooms conforming to the directions of Engineer.

All fire fighting network shall be of pressurized HDPE pipes class PN-12 and material

classification PE-100 conforming to IS:4984., a fire fighting water store of adequate capacity using treated wastewater as water for fire fighting. The pump house shall be suitable for installation of pumps.

This shall be RCC framed structure with outer brick walls of 230 mm thick over the sump. The minimum plan area shall be 120 sqm. Height of the roof / ceiling up to the soffit of the beam shall be minimum 4500 mm. This structure shall house panels and other electrical / mechanical fittings.

### 2.23.2 Workshop and store

Workshop and Store building shall be a single storey building in RCC framed structure with brick walls as 230 mm thick. The minimum ceiling height up to the soffit of beam shall be 5000 mm.

The flooring shall be of cement concrete with metallic hardener topping.

### 2.23.3 Administration Building Including SCADA and Laboratory Room

The administration building shall be a two storey building having Conference room, Laboratory and model room at ground floor and SCADA Control Room, Plant Manager &Staff Room for Management /Supervisors at first floor. The minimum carpet area of each floor shall be 240 m2 per floor, with a total area of 480 m2.

Building shall be RCC framed structure with brick panel walls and shall have entrance porticos. All brick walls shall be 230 mm thick, except for partition walls of toilets which shall be 115 mm thick.

The Conference room shall also have separate pantry room. The ground floor and first floor shall have 2 nos. toilets at each floor, one each for men and women of size, with fittings as specified in part 3 – civil specifications clause 3.3 particular civil requirements. The taps on wash basin shall be of censor type. The urinals shall be fitted with automatic censer type flushing system. Two nos. Triple layered polyethylene water storage tanks of size 1 KL each shall be provided at the top of the building.

SCADA Control rooms shall be provided with adequate ventilation with moisture and temperature control (Cooling and heating) as per the weather requirement.

The temperature control should be suitable for working corrosive atmosphere containing H2S gases. Standard temperature control equipment like Direct Compression Air Conditioners are not be suitable, instead, it is necessary to go for chilled/hot water temperature control system with centralized heating/cooling facility.

For sizing the central chilled water cooling facility the cooling requirement shall be calculated based on Heat load of electrical equipment including UPS, heat generation by power panels etc. The heat load of buildings shall be considered as 1 Tr per 40 m3 building volume.

Laboratory shall be provided with two platforms projecting 750 mm from the wall out of which one shall be at about 150 mm height from floor Level and the other at sill level. The upper platform shall be of RCC. Central RCC platform of minimum 1.5 m width & required

length shall be provided at working level height. The platforms shall be covered with Granite stone on top surface. Ceramic tiles on the walls all along the RCC platforms upto the 750 mm shall be provided. Two laboratories sinks on the RCC platform and one wash basin along the opposite wall. The sinks and wash basin shall have direct water supply connection and not from the service tank. The space below the platform shall have cabinet/ cupboards for keeping laboratory materials.

The first floor shall have two rooms and one meeting room, pantry and toilets one each for men and women. The size of toilets and facilities shall be similar to that provided at ground floor / laboratory. One SS sink with two CP drinking water taps shall be provided in the pantry. In addition to above, one room and meeting room shall also have attached toilets.

The outer face of the building shall be provided with aluminium cladding system comprising of PVDF/Dura glass 5000 coated 4 mm thick approved aluminium composite panels as per specifications and as approved by the Engineer.

Before commencing the construction of the office, the Contractor shall submit to the engineer for his approval a drawing of the proposed building showing all architectural and finishing details. After approval of these details, contractor shall submit structural designs and drawings.

The Contractor shall furnish the rooms as the engineer directs and the equipment, furniture, furnishings and fittings to be supplied shall be new items and also of approved make.

All the operating expenses, water, lights and other charges shall be regarded as an inclusive cost of the Contractor's operating costs and part of the contract price.

The Conference Room, Control Room, Plant Manager Room and Staff Room for Management/Supervisors shall have the following facilities (minimum) for each plant:

a) Furniture including tables, chairs, etc as per the space management and as directed by Engineer,
b) Copy, **Email**, Fax, Print, Scan multipurpose machine - 1No.,
c) Two Desktop of approved configuration installed with required operating software,
d) Two UPS of size as directed by Engineer,
e) Internet connection with telephone connection,
f) Split type air conditioner of capacity 2 Tons – 4Nos.,
g) Two 1 KL triple layered polyethylene water storage tank at the rooftop,
h) Water supply, sanitary, electricity fittings, power back-up, etc.

The contractor shall be responsible for maintenance of building and housekeeping, during the entire contract period including O & M.

## 2.24 Architectural Concepts and Designs

An Architectural Design Basis Report will be submitted to the engineer including proposals for the following scheme components: shape, form, color, and basic materials for interior and exterior architecture along with an appropriate landscaping scheme. All schemes will be

supported by architectural statement explaining the factors considered in the design.

Architecture work shall include walls, roof, flooring and floor finish, roof water proofing, down water pipes, windows, ventilators, doors, glazing, equipment access doors, painting and other ornamental works. The contractor shall get all Architectural, Structural and RCC drawings and design calculations, etc approved by engineer prior to construction of works at site.

## 2.25 Public Addressing System

A centralized amplifier based system that's been designed to provide voice paging and to broadcast alarm tone during emergencies.

The system can transmit alarm tone and routine voice messages, from a central location, to all or selected areas of the facility, in a reliable and safe manner, by the use of loud speakers.

The system shall be provided at minimum three locations.

## 2.26 Plant Development Infrastructure Works for each plant.

### 2.26.1 Internal Roads and Drains

#### 2.26.1.1 Existing Roads

All existing roads in the plant are bituminous roads and the contractor shall repair the same and re- carpet with a final bituminous finish coat as per CPWD specifications.

#### 2.26.1.2 New Roads

All new main internal roads, wherever required shall have minimum 6 m wide bituminous portion and 1 meter wide shoulders on either side. Other connected roads shall have minimum 4 m wide bituminous portion. Shoulders top shall have factory made interlocking paver blocks 80 mm thick in M 40 CC laid over 50 mm thick compacted bed of fine sand, filling the joints with fine sand etc all complete. The RL of internal roads shall be kept in accordance with the approach road to WWTP area and formation levels in the plant area.

### 2.26.2 Pathways

All buildings and structures should be interconnected by 1500 mm wide Cement Concrete pathway with a non skid surface. The pathway shall be at least 150 mm above the area FGL. The pathway shall be constructed using brickbats and cement concrete of 100 mm thickness.

### 2.26.3 Storm Water Drains

Storm water side drains shall be designed and constructed only along one side of the internal roads. These drains shall be covered with factory made perforated concrete covers.

Adequate longitudinal and cross gradients shall be provided in the road for efficient and quick drainage of storm water. Required longitudinal slope shall be maintained in road side drain also.

The designed storm water drainage system shall be integrated with existing treated effluent channel either by gravity or by pumping.

### 2.26.4 Pipes and Ducts for Road Crossings

RCC pipes and ducts carrying utilities like cables, water and sewerage lines, storm water, etc shall have minimum one meter cover while laid under roads. Access chambers and manholes shall have size not less than 600 mm x 1000 mm and be provided at intervals as directed by engineer. All such pipes and ducts shall be designed structurally for calculated imposed loads and the design be got approved by engineer.

### 2.26.5 Cable and Pipe Trenches

As far as possible, the alignment of the cable route shall be decided after taking into consideration the present and likely future requirements of other services like drains, water supply pipelines, etc. This aspect shall be brought to the notice of the Engineer while planning the works and approval be taken. Cable trenches should be constructed in such a manner that sharp bends are avoided, however, at the same time route should be kept shortest. Separate trenches shall be provided for LV/MV and HV cables, however, if there is restricted space then provision for fixing different level cable trays be made and LV/MV cables shall be laid above HV cables.

Cable and pipe trenches shall generally be constructed in reinforced concrete, however, 500 mm x 500 mm size or smaller trenches, not on fill may be constructed in 350 mm thick brick masonry in 1:4 cement mortar. The brick trenches will be plastered internally with cement mortar 1:4 and externally in cement mortar (1:3) as directed by engineer. The cable trench work shall have recess (monolithic with drain structure) for placing top covers. Necessary fasteners shall be fixed at the time of construction itself for supporting the cables or cable trays.

Trenches within the buildings or plant areas not exposed to direct rain shall be covered with M.S chequered plates, suitably painted and those outside the buildings shall be covered with factory made precast concrete covers as directed by engineer. The trenches shall be suitably sloped to drain rain water to a designated outlet point connected to the plant sewerage or storm water drain system. In case the location of trench does not permit direct connection with plant drainage system then a catch pit should be constructed at the lowest point with necessary dewatering arrangement.

### 2.26.6 Potable Water Supply

Presently water is being supplied to existing office building complex through a Water tankers of Employer and the water pipe lines is passing near the road .A connection has to be taken by the contractor for drawing water supply to existing administrative block and other buildings shall include connection from MCC pipeline, supplying water to existing buildings. The new connection shall be through 50 mm HDPE pipeline of required class and length. The contractor shall design and construct distribution network of suitable size (including water appurtenances like sluice valve, scour valve, air valve, non return valve etc), connecting all the

water storage tanks / structures and additional connection points for cleaning purpose.

### 2.26.7 Staircase, Walkway Platforms, Hand Railings and Ground Pathways

RCC staircase shall be provided at all locations for accessing the elevated RCC walkway platforms. RCC walkway platforms of minimum 1200 mm wide shall be provided.

RCC walkway platforms shall be provided in a continuous manner interconnecting all the digester units and similarly gas holder units. The aim behind constructing continuous walkway platform is to allow the person to inspect both these units, without getting down and climbing at intermediate units again and again.

Handrail shall be provided with stainless steel AISI SS handrail and balustrade system having 38 mm dia. tube handrail (1.5mm gauge) connected with unified stem keys in bead blasted finish to 12 x 54 mm stain finish flat vertical member erected with chemical grout to be fixed on the top of floors/ staircase at maximum distance of 1500 mm with infill of two horizontal mid-rail of 22 mm dia. and as approved and directed by engineer.

All ground pathways interconnecting buildings, treatment units, pump houses and other structures shall be minimum 1500 mm wide.

### 2.26.8 Fencing, Boundary Wall, Gate & Security Room

Contractor shall provide PVC coated galvanized steel chain link fencing of minimum 2.4 m height above the FGL around the inner periphery or part of WWTP facilities located within the existing phase I WWTP as shown in the indicative plant layout given in Volume 4 of Bid document.

Also, Contractor shall also provide boundary wall around outer periphery of WWTP as indicated in the indicative plant layout given in Volume 4 of Bid document. Boundary wall shall be constructed in the rubble stone masonry work and height matching to the existing boundary wall.

Contractor shall also provide fencing of minimum 1.8 m height all around the digester area. Entire Gas Holder area shall be protected by providing sheets of suitable material upto the height of the membrane to give an aesthetic look so as to avoid any damage to the membrane.

Five numbers SS/ Aluminum heavy duty gate (minimum 5.0 m wide and 2.1 m high) fixed on RCC pillars and painted as per approval of the Engineer shall be provided.

Security rooms with minimum area of 12 sqm to be provided near gates.

### 2.26.9 CCTV Cameras.

Providing, installation and testing of day/night surveillance cameras (all cameras shall be suitable for hazardous area) near the security guard room, digester and gas holder area. The cameras shall be placed in such a manner so as to cover the entire area required to be secured. The system will be used for monitoring at a predetermined place within the plant. The proposed surveillance system shall consist of camera, HD DVR (High Definition Digital

Video Recorder), 21 inch (min.) LED monitor with power backup up to 1 hour. The DVR unit should direct recording of cameras in real time. The resolution of the picture should be high and have clarity in pictures. Multiple frame monitors should be used for effective monitoring. The operator should have the facility to choose any given camera for viewing on the other monitor. Each image should be recorded with a camera number, title, date, time, recording speed and also have a recording storage of minimum 15 days.

Camera shall have IP66 protection, minimum illumination 0.5 Lux/F1.2, 3.14 Megapixel – 2048(H) x 1536(V), Lens – IRIS and CS interface more than 2.0 Megapixel, power supply AC/DC = 10 – 24V, power < 2.5 W, S/N ratio > 60dB, WDR 80 dB, video format – 1080P50/60; 1080P25/30; 1080I50/60; 720P25/30; 720p50/60 and video output 1 channel SDI interface. The contractor shall provide the data sheet to the engineer for approval. Approved makes are Sony, Panasonic and LG.

### 2.26.10 Land Development, Horticulture, Arboriculture and Landscaping

Contractor shall do the land development of the existing plant area during construction and rehabilitation based on the topography of the area and shall also provide pipe network made of polypropylene pipes and fittings conforming to ASTM F2389 with hydrants at 50 meter intervals or as directed by engineer for horticulture purpose. The source of water supply shall be the final treated effluent pumped from new sump & pump house. Suitable pumping arrangement and network shall be designed and constructed for horticulture purposes.

The contractor shall from the date of commencement of contract, furnish all materials, labour, and related items necessary to complete the work indicated and specified herein. The work shall include the following but not limited to this:

- Green belt plantation
- Create a buffer of Green and pleasantly fragrant flowers
- Lawns;
- Indoor Plantation Works for Admin Building along with decorative pebbles;
- Static Water fountain with all necessary civil works;
- Pathways with interlocked paver blocks of specified design and shade;
- Sprinkler system for lawns.

The landscape contractor will be generally responsible for the entire site but in particular to works listed above. Along with site management, the responsibilities will include landscaping works and arboriculture works and maintaining the same.

Plants and shrubs suitable for similar type of conditions shall be sourced by the contractor from available nurseries, unless otherwise specified. Seeds shall be acquired from reputed organizations and hybrid seeds will be used where possible – particularly for flower varieties. The contractor shall submit the list of type of plants and shrubs proposed to be planted in the area along with layout plan showing plantation to the engineer for approval. No plant material shall be changed without the consent of the engineer.

Those plants that are not up to the standards and not meeting the specifications shall be

replaced by the contractor at no extra cost to the Employer. When the plants are to be replaced either for filling gaps or poor quality, then the contractor shall replace with plants of equal height , size and age of the plants in that area.

In addition, the contractor will also be responsible for filling gaps, thinning and transplanting, or replanting where plants may need to be replaced. Along with other planting, the contractor will also be responsible for improving soil conditions for planting. This may include import /export of sand/soil to/from site. The contractor will also clear vacant area from existing grasses, keep the site clean and maintain the already planted areas free of weeds, pests or insects that cause diseases. All weeds, unwanted grasses and plant material will be cleared up to 1000 mm from the edge of planting of newly created and already existing horticultural works (such as boundary trees).

Planting of trees, shrubs and plants shall include digging of pits, mixing the top soil with manure and filling in the pit before and after planting, backfilling, staking with 1 meter long stake to prevent excess movement of the plant, adequate watering immediately after planting and during the growing season, mulching of open soil around the plantation with straw or hay at regular intervals and necessary protection.

All plants proposed to be planted by edge of building in front façade of building should be planted with special care so as to ensure the following:

a) The painting/cladding of walls is not soiled and kept clean at all times,

b) Watering is done with care so as to ensure water is not entering windows or muddy water is not splashed on walls.

c) All plants growing over the height of windows should be trimmed below window height.

d) Lawns: The area for planting the lawn shall be maintained free from weeds, whatever may be the nature of soil, complete surface shall be trenched over to a depth of 300 – 450 mm. Grading and final leveling of the lawn shall be completed at least 2 weeks prior to the actual sowing. The soil itself shall be ensured to the satisfaction of engineer to be a good fibrous loam, rich in humus. Pest/termite prevention chemicals to be mixed if required. Top soil shall be mixed with farm yard manure or coco-peat and mixed with river sand in ratio of 15% manure, 25% river sand, 35% red soil and 25% excavated earth and leveled to maintain positive drainage or specified slopes.

   Carpet lawns will be used and nodes of specified grass shall be dibbled not more than 50 mm apart on above mentioned soil conditions. The carpets will be laid next to each other in an even pattern to ensure that all lawn area is covered. After laying of carpet, it should be lightly pressed into the ground to ensure that it does not shift, and to ascertain that the roots are in soil. Positive slopes will be maintained to ensure that there will be no low lying areas in center where water logging or pools arecreated.

   In the absence of rain, lawn shall be watered daily - heavily, soaking the soil thoroughly to a depth of at least 150 mm. Edges shall be kept neat and must be cut regularly with the edging shears. Fertilizer / manure shall be fed once a month. The contractor shall

carefully remove unsightly weeds as and when observed.

### 2.26.11 Sign and Warning Boards

All buildings and treatment units shall be provided with sign boards as directed by engineer indicating the name and function of these.

All the signboards displaying name of the technical units and directions shall be written in English and Hindi.

At the start of construction work the contractor shall erect signboards one at the entry of the construction site and another near the temporary site office displaying all the project related information like name of the work, client, funding agency, value of the works, start and completion date as per contract, capacity of the plant, number of units and other details as directed by engineer. The size of the board shall be decided in consultation with the engineer.

Necessary sign and warning boards shall be supplied and erected at the locations to be specified by engineer. The size of the board shall be 1200 mm x 1200 mm minimum or as directed by engineer. The signboard shall be partially reflective Flex type on SS Grade 304 minimum 1.2 mm thick supported with frame of aluminium channels / double back channels minimum 3 mm thick through aluminium rivets. The signboard shall be subsequently attached to the post(s) through steel bolts. The posts shall be 75 mm diameter galvanized steel with welded top cap in case the signboard is supported on one post only, however, if two posts are used to support the signboard the diameter of each shall be minimum 40 mm and thickness 1.6 mm. The steel posts shall be embedded in RCC footing of size as approved by the engineer or as per the design. The total height of the post shall be 1800 mm + size / depth of the signboard. For larger size boards, more than 1200 mm x 1200 mm, the contractor shall submit the designs and drawings, wind load calculations, etc for approval of engineer prior to its construction.

### 2.26.12 Vehicle Parking Shed

The contractor shall fabricate and install car shed near SCADA Control Room cum Laboratory Building for occupants' vehicles. The car shed shall cover about 8-10 car parking spaces and about 10 nos. two wheeler parking spaces.

The shed area shall be paved with interlocking paver blocks 80 mm thick and constructed in CC M.

Proper approach road leading to the vehicle parking shed shall be provided.

### 2.26.13 Rain Water Harvesting System

The contractor shall submit the general arrangement drawing for roof top rain water harvesting proposed to be adopted for buildings. The scope of work shall cover major buildings considered for collection and conveyance of rain water, trapping arrangements, filters, cleaning chambers, bore wells etc. The contractor shall submit detail design and drawings to the engineer for approval.

The design shall include the following:

a) PVC downpipes (along with clamping system),

b) PVC gutters / pipes for conveying rain water to filters,

c) First rain separator arrangement,

d) Leaf trap,

e) Filter,

f) Bore well, etc.

## Section X – Part 3: Civil Specifications

### 3.1 Technical Standards and Regulations

This section deals with civil construction of all the 6 plants, pumping stations and appurtenant works etc. complete under this contract, except where otherwise specified. Plant, materials and workmanship shall comply with the requirements of the Central Public Works Department (CPWD) Specifications and relevant Indian Standards (hereinafter referred to as IS) issued by the Bureau of Indian Standards (BIS).

In the absence of any IS or specifications, equivalent International Standard Specifications such as those issued by the International Organization for Standardization (ISO) or British Standards (BS) or the International Electro-technical Commission (IEC) or American Society for Testing and materials (ASTM) or American National Standards Institute (ANSI) or Japanese Industrial Standards (JIS) any other international standard, specifications or Manual may be followed or proposed by the contractor at the sole discretion of the Engineer or as may have been agreed in the Contract.

All standards and specifications, whether national or international, applied and used shall be with latest amendments / correction slips as available up to the date of submission ofbid.

In the event of conflict between any of these Specifications and the Codes referred, such specifications shall be defined, prepared by the contractor and submitted to the Engineer for approval. The decision of Engineer in such case shall be final and binding on thecontractor.

In referring to the Standards, Specifications, Manuals, etc. the following abbreviations are used:

| | | |
|---|---|---|
| 1) | IS | : Indian Standard |
| 2) | BIS | : Bureau of Indian Standards |
| 3) | ANSI | : American National StandardsInstitute |
| 4) | API | : American PetroleumInstitute |
| 5) | ASME | : American Society of MechanicalEngineers |
| 6) | ASTM | : American Society of Testing andMaterials |
| 7) | AWS | : American WeldingSociety |
| 8) | AWWA | : American Water WorksAssociation |
| 9) | ISO | : International Organization for Standardization |
| 10) | JIS | : Japanese IndustrialStandard |
| 11) | DIN | : Deutsches Institute fur Normung |
| 12) | BS/EN | : British Standard / EuropeanStandards |
| 13) | JWWA | : Japanese Water WorksAssociation |
| 14) | IEC | : International ElectrotechnicalCommission |
| 15) | IEE | : Institution of ElectricalEngineers |

16) IEEE : Institute of Electrical and ElectronicEngineers
17) NEMA : National Electrical ManufacturersAssociation
18) AGMA : American Gear Manufacturer'sAssociation
19) IP Ratings/IP code : Ingress ProtectionRatings
20) MORTH : Ministry of Road, Transport andHighways

All materials, plant and equipment shall be new and all materials and workmanship not fully specified herein or covered by an approved standard shall be of such kind as is used in first class work and suitable to the climate in the project area. All details, materials and equipment supplied and workmanship performed shall comply with these Standards. If Bidder offers equipment to other Standards, the equipment/material should be equal or superior to those specified and full details of the difference shall be supplied.

## 3.2 Structural requirements

### 3.2.1 Design Submissions

The design considerations described hereunder establish the minimum basic requirements of plain and reinforced concrete structures, masonry structures and structural steel works. However, any particular structure shall be designed for the satisfactory performance of the functions for which the same is being constructed.

Complete detailed design calculations of foundations and superstructure together with general arrangement drawings and explanatory sketches shall be submitted to the Engineer. Separate calculations for foundations or superstructures submitted independent of each other shall be deemed to be incomplete and will not be accepted by the Engineer. The contractor shall be responsible for the safety of structures, structural strength, stability, soundness, water tightness and accuracy, adequacy of design, workability and performance even after the approval of the same by the Engineer. During the job execution, if any deficiency or alteration is required, firm shall attend to the same within the contractual provisions and nothing extra shall be claimed/paid to the firm.

Approval conveyed to the firm will neither relieve the firm of its contractual obligations and its responsibility for the correctness of the dimensions, material, of the construction, weights, quantities, design perimeters, dimensions, assembly its, performance, particulars, conformity of the supplies with Indian statuary laws as may applicable nor will it limit the CSCLs rights under the contract.

The contractor may refer to the available topographical survey. The contractor has to undertake soil investigations and other surveys. The required re-routing and re- location of the services, as required, will be done by the contractor after approval of the proposals for the same by the Engineer with no extra cost. The Contractor is liable for any damage and disruptions caused to the works and should repair & make good all such damage and disruptions at his cost to at least the specifications to which the original works were constructed or as directed by the Engineer.

## 3.2.2 Design Loadings

All buildings and structures shall be designed to resist the worst combination of the loads/stresses during testing and under working conditions and shall be as per IS: 875. The loads considered shall include dead load, live load, wind load, seismic load, stresses due to temperature changes, shrinkage and creep in materials, dynamic loads and uplift pressure.

### i) Dead Load

This shall comprise all permanent construction including foundations, walls, floors, columns, roofs, partitions, stairways, fixed service equipments and other items of machinery. In estimating the loads of process equipment all fixtures and attached piping shall be included. The following minimum loads shall be considered in design ofstructures:

| | | | |
|---|---|---|---|
| (i) | Weight of water | : | 10.00 kN/$m^3$ |
| (ii) | Weight of saturated soil (irrespective of strata available at site and type of soil used for filling etc). However, for checking stability, actual weight of soil as determined by field test shall be considered. | : | 20.00 kN/$m^3$ |
| (iii) | Weight of plain concrete | : | 24.00 kN/$m^3$ |
| (iv) | Weight of reinforced concrete | : | 25.00 kN/$m^3$ |
| (v) | Weight of brickwork (exclusive of plaster) | : | 22.00 N/$m^2$ per mm |
| | | | thickness of brickwork |
| (vi) | Weight of plaster to masonry surface | : | 18.00 N/m2 per mm thickness |
| (vii) | Weight of granolithic terrazo finish or rendering screed, etc. | : | 24.00 N/m2 per mm thickness |
| (viii) | Weight of Sand Filter Media | : | 26.0 kN/m3 |

### ii) Live Load

The following minimum loads shall be considered in the design of structures:

| | | | |
|---|---|---|---|
| (i) | Live Load on Roofs | : | 1.50 kN/$m^2$ |
| (ii) | Live Load on Dome | : | 2.50 kN/$m^2$ |
| (iii) | Live Load on floors supporting equipment such as pumps, blowers, compressors, valves etc. | : | 10.00 kN/$m^2$ |
| (iv) | Live load on all other floors walkways, stairways and platforms | : | 5.00 kN/$m^2$ |
| (v) | Toilet | : | 2.00 kN/$m^2$ |

In the absence of any suitable provisions for live loads in I.S. Codes or as given above for any particular type of floor or structure, assumptions made must receive the approval of the Engineer prior to starting of the design work. Apart from the specified live loads or any other load due to material stored, any other equipment load or possible overloading during maintenance or erection/construction shall be considered and shall be partial or full whichever causes the most critical condition. Any such loading condition must be incorporated in design calculations with supporting documentation for approval.

**iii) Wind Load**

Wind loads shall be conforming to I.S. 875.

**iv) Earthquake Load**

Earthquake loads shall be conforming to I.S. 1893 considering seismic (Zone IV). Importance factor shall be taken as per Table 6 (Clause 6.4.2) of IS 1893 (Part 1), but not less than 1.5.

**v) Dynamic Load**

Dynamic loads due to working of plant items such as pumps, blowers, compressors, switch gears, travelling cranes, etc. shall be considered in the design of structures.

**vi) Vehicular Load**

IRC Class AA / Class A (wheeled vehicle) loading shall be considered for design of structures under or by the side of roads.

**vii) Temperature Load**

All structures will be designed for a temperature variation of minimum plus minus 5 deg. Celsius along with other loads. Parts of structures prone to thermal exposure / cracking, etc. shall be designed for a temperature variation of minimum plus minus 10 deg. Celsius. Digesters should be designed for a differential temperature of minimum plus minus 15 deg. Celsius& preferably be designed using working stress method as given in IS: 3370.

**viii) Joints**

Movement joints such as expansion joints, complete / partial contraction joints and sliding joints shall be designed to suit the structure requirements. Position and design of construction joints should be predetermined keeping in view the convenience in construction. All joints should be tested for water tightness and must be leak proof. The material used in the joints like joint filers, water bars, sealing compounds and other such materials should be resistant to chemical and biological action and require approval of Engineer.

### 3.2.3 Design Conditions for Completely / Partly Underground Liquid Retaining Structures

All underground or partly underground liquid retaining structures shall be designed for the following conditions:

i. Liquid retaining structures shall be designed as per the relevant codes and best practices. The limiting crack width will be 0.1mm for all liquid retaining structures. All likely loads and their combinations shall be considered to determine the direct and flexural stresses and their combination, shear, etc. As a design consideration to control crack and have sufficient strength and stability general requirements of IS 3370 and other codes (IS 456, etc.) shall be followed.

ii. Structure filled with liquid**:** Liquid depth up to full height of wall, irrespective of the actual height of liquid in the structure: no relief due to soil pressure from outside to beconsidered;

iii. Structure empty**:** full earth pressure and surcharge pressure, as applicable, to beconsidered;

iv. Partition wall between dry sump and wet sump**:** to be designed for full liquid depth up to full height of wall including freeboard;

v. Partition wall between two compartments**:** to be designed as one compartment empty and otherfull;

vi. Structures shall be designed for uplift in empty conditions with the water table indicated by the Contractor's own investigation or that approved by Engineer prior to design, with appropriate consideration of seasonal variation whichever is maximum, but not less than HFL. No reduction Factor for the uplift forces shall beconsidered.

vii. The dead weight of the empty structure should provide a safety factor of not less than 1.2 against uplift pressures during construction and inservice;

viii. Walls shall be designed under operating conditions to resist earthquake forces from earth pressure mobilization and dynamic waterloads;

ix. Underground or partially underground structures shall also be checked against stresses developed due to any combination of full and empty compartments with appropriate ground/uplift pressures from below to baseslab.

### 3.2.4 Design conditions for foundations

i. The minimum depth of foundations for all structures, equipment, buildings and frame foundations and load bearing walls shall be conforming to IS 1904. All foundations shall extend to a depth of **at least 1.5 meter** below virgin groundlevel..

ii. The foundations shall be placed on virgin soil and not on backfilledsoil.

iii. The earth fill above virgin ground level till formation level shall be taken as a surcharge load and shall be added in the loads coming on foundationsappropriately.

iv. Maximum safe bearing capacity of soil strata shall be taken as indicated in contractor's independent Soil Investigation Report or 10 T/Mtr Sq, whichever is less. For the foundation depths and types of footings other than those mentioned in the geotechnical reports, the maximum safe bearing capacity shall be appropriately computed from the parameters given in the geotechnical reports and got reviewed and approved by theEngineer.

v. Care shall be taken to avoid the foundations of adjacent buildings or structure foundations, either existing or not within the scope of this Contract. Suitable adjustments in depth, location and sizes may have to be made depending on siteconditions.

vi. Plinth level of all structures shall be at least 500 mm above formation ground level. The top of walls of liquid tanks/sumps shall be minimum 500mm above FGL. Safety handrails be provided if the height of barrier is less than1.0m

vii. If pile foundations are used, the bidder shall conduct the initial routine test as per IS 2911 at his own cost, to determine the safe load bearing capacity ofpiles.

viii. Pressure release valves are not permitted.

### 3.2.5 Design Requirements

The Civil & Structural design shall be carried out in accordance with BIS: 456, and BIS: 3370 and other relevant Indian Standard Codes. For the seismic forces, the structure should be designed as per IS: 1893 and all the factors as applicable for ZoneIV

The following are the design requirements for all reinforced or plain concrete structures:

i. All blinding and levelling concrete shall be minimum 100 mm thick in concrete grade M10 for Building & other Structures and concrete grade M15 for water retaining structures, unless otherwisespecified.

ii. All structural reinforced concrete shall be with a maximum 20 mm stone aggregatesize.

iii. The minimum grade of concrete shall be M-25 for RCC structures other than liquid retaining structures, for which minimum grade of concrete shall be M30.

iv. The minimum reinforcements in walls, floors and roofs of liquid retaining structures in each of two directions at right angles shall be 0.3% HYSDbars.

v. Any pipelines crossing below roads shall be designed for Class AA of IRC loading or as classified by the respective authority. NP3 RCC pipe as encasing shall be used below roads inside the plant.

vi. All pipes and ducts laid below the structural plinth and road works shall be encased with concrete of grade M-15 of minimum thickness 150mm.

vii. Minimum reinforcement and cover to the reinforcement shall be provided as per relevant IS standards.

### 3.2.6 Minimum Thicknesses of Reinforced ConcreteMembers

The following minimum thicknesses shall be used for different reinforced concrete members, irrespective of design thicknesses:

| | | |
|---|---|---|
| Walls for liquid retaining structures (except for Launders, Channels) | : | 200 mm |
| Bottom slabs for liquid retaining structures | : | 200 mm |
| Wall foundation (at junction of base slab & wall) | : | 300 mm |
| Roof slabs for liquid retaining structures | : | 150 mm |
| Launders & Channels – Base Slab & Wall | : | 150 mm |
| Floor slabs including roof slabs, walkways, canopy slabs | : | 125 mm |
| Walls of cables / pipe trenches | : | 75mm |
| Precast trench cover | : | 75 mm |

## 3.3 Particular Civil Requirements

Unless otherwise specified, all the buildings and structure works shall generally comply with the following particular specifications:

i. All buildings and treatment units shall be provided with 1000mm wide plinthprotection.

ii. Plinth level of the buildings shall be minimum 500 mm above finished ground level around thebuildings.

iii. All utility and control buildings including SCADA cum laboratory building shall be of RCC framed structure with brick panel walls. All brick walls shall be 230 mm thick, except for partition walls of toilets which shall be 115 mm thick. All brick walls 230 mm thick shall be built in 1:4 cement mortar (1 cement: 4 coarse sand). Half brick (115 mm) thick walls shall be in 1:3 cement mortar (1 cement: 3 coarse sand) and shall be provided with 2 Nos. 8 mm dia MS bars at every thirdcourse.

iv. The contractor shall provide and erect PVC coated galvanized steel chain link fencing of height 1.8 m from FGL around transformers, digesters areas and will have stainless steel swinggates.

v. The Contractor shall provide sheet fencing of suitable material all around the gas holders area up to the height of membrane of gasholders.

vi. Parapet over roof shall be minimum 500 mm high in brick work for non-accessible

roof and 1000 mm high in RCC for accessible roof.

vii. The design of buildings shall be such so as to allow entry of natural light to the maximum possible extent and wall openings shall be protected by weathercanopies.

viii. Transoms and mullions of 115 mm x 230 mm size with four numbers 8 mm bars and 8 mm links at 150 mm c/c shall be provided to form panels not exceeding 3500 mm x 3500 mm in size in 230 thick brickmasonry.

ix. Plastering on brick / RCC work shall be as follows:

| | | | |
|---|---|---|---|
| a. | Exterior surface | - | 20 mm thick in CM 1:4 (1 cement : 4 coarse sand) |
| b. | Interior surface | - | 12 mm thick in CM 1:4 (1 cement : 4 fine sand)for single brick thick wall |
| | | - | 12 mm thick in CM 1:3 (1 cement: 4 fine sand) for half brick thick wall |
| c. | Ceilings | - | 6 mm thick in CM 1:3 (1 cement : 3 fine sand) |

x. RCC staircases shall be provided to permit access to accessible roof of the building and platforms of the treatmentunits.

xi. PVC encapsulated footrests shall be provided for access to the tanks, pits, sump, manholes etc.

xii. All non-accessible roof tops of buildings and pump houses shall be provided with Cat ladder made of Stainlesssteel.

xiii. All RCC staircases inside the buildings shall be in Udaipur Green Marble with prefinished nosing to treads of steps and shall have SShand-railing.

xiv. Water bars shall be used in all liquid retainingstructures.

xv. All elevated RCC platforms, walkways around and across the various WWTP units including along the channels shall have flooring of chequered tiles of minimum 22 mm thick.

xvi. All uncovered staircases shall be provided with cement concrete flooring with metallic hardenertopping.

xvii. All elevated walkways, staircases, uncovered openings and RCC platforms in treatment units shall be minimum 1200 mm wide and shall have SShand-railing.

xviii. All buildings shall have reinforced concrete roofs which shall be made waterproof by laying integral cement based water proofing treatment with brick bat coba. This type of water proofing treatment shall also be provided for waterproofing of terraces and any other areas, locations as directed by the Engineer. The finished roof surface shall have adequate slope to drain quickly the rain water to down take inlet points.

The rain water inlet points near down take pipes shall have uPVCgratings.

xix. False ceiling shall be provided in Administrative building including SCADA room and laboratory as per specifications. Contractor shall submit drawings for approval of Engineer prior toconstruction.

xx. Top exposed surfaces of chajjas / lintels / canopies shall be given required slope so that no water is allowed to stand onit.

xxi. All doors, windows, ventilators in all the buildings including toilets shall be of uPVC. All windows at ground floor level shall be fitted with security grills of SS 304. The contractor shall submit the shop drawings including details of material, framing members, anchors, accessories, elevations, color, etc. to the Engineer for approval. The contractor shall fit and align the grill assembly including hardware; level and plumb, to provide smooth operation of windows.

xxii. All doors, windows, rolling shutters shall have lintels above in order to prevent the rain water splashing into the building. The minimum width i.e., projection from the building wall of chajja / lintels for doors, windows and rolling shutters shall be 750 mm, 600 mm & 900 mm respectively.

xxiii. For roofing drainage, HDPE / uPVC rainwater down take pipes and as directed by Engineer shall be provided. For roof areas up to 40 sq.m minimum two nos. 100 mm diameter down take pipes shall be provided. For every additional area of 40 sq.m or part thereof, at least one no. 100 mm diameter down take pipe shall be provided. Khurras's of size 45x45 cm shall be provided at roof over theselocations.

xxiv. Exterior of all the buildings shall be painted with three or more coats of anti carbonation painting as per specifications.

xxv. Interior of all the buildings shall be painted with two or more coats of Oil Bound Distemper as perspecifications.

xxvi. The inner walls and soffit/underneath of platforms/ walkways inside of all the liquid retaining structures shall be provided with polyurethane coating system. The coating shall be provided starting from the top of structure to up to 500 mm below the TWL or minimum 1.0 m height, whichever isgreater.

xxvii. Outer surface of all water retaining RCC structures shall be painted with three or more coats of water proof cement paint of make as approved by Engineer incharge.

xxviii. Emergency exit doorways shall be provided in all buildings in compliance with local and international safety regulations. All emergency exit points shall have extended paved path / areas for smooth escape of thepeople.

xxix. The minimum area of windows and ventilators shall be 15% of the floor carpet area of the building unless otherwisespecified.

xxx. The fitting and fixtures shall be of heavy duty as approved by the Engineer, durable

and of type matching to the size and weight of the door/window/ventilator shutters. These shall operate easily without hindrance and jamming, secured properly and shall require nominal maintenance.

xxxi. RCC staircases shall be minimum 1200 mm wide and maximum number of steps between two landings shall be 12. The size of tread and rise shall be 250 mm and 175 mm respectively.

xxxii. Steps / ramps shall be provided at the entrance of the buildings for Pedestrian/Vehicular, equipment entry. Minimum 1200 mm wide platform shall be provided in between entrance door and steps/ramps. Following dimensions of the steps/ramps shall be adhered to the following:

a. Tread = 250 mmMinimum
b. Riser = 175 mmMaximum
c. Slope of Ramp = Not steeper than 1:10. Ramp shall be finished with metallichardener topping with anti-skid grooves at top surfaces.

xxxiii. Two white vitreous china laboratory sink of size 600 x 450 x 200 mm with two CP drinking water taps 20 mm (mixer type) long body, etc. complete shall be provided in laboratory and one in workshop building.

xxxiv. The ground floor of all control building such as centrifuge building, digester control building, process air blower building and other such structures shall generally be made of 150 mm thick concrete grade slab on 100 mm thick PCC. The grade slab shall be provided with 8 mm reinforcement bars at 200 mm c/c both ways alternately or as per the approved drawings.

xxxv. Flooring of buildings shall be as follows:

| | | | |
|---|---|---|---|
| a. | Administrative Building/SCADA Building/ Laboratory | : | Vitrified glazed tiles 600 x 600 mm or any suitable size. |
| b. | Process Air blower Building/ Pump houses/Mechanical Thickening Building/ Digester control building/ Centrifuge Building/ Power generation room / Other operation buildings, etc. | : | Cement concrete flooring with metallic hardener topping. |
| c. | Toilet | : | Matt finish ceramic tiles |
| d. | Corridors and other covered passages | : | Udaipur Green Marble as per architectural controls and requirements. |

xxxvi. Dado work in buildings shall be as follows:

| | | |
|---|---|---|
| Pump houses at pump installations / Toilet | : | 2.1 meter high from floor in Glazed ceramic tiles of size 300 x 200 mm. |

| | | |
|---|---|---|
| Pump house operational room at ground floor | : | 0.9 meter high from floor in Glazed ceramic tiles of size 300 x 200 mm or any suitable size. |

xxxvii. All control rooms and pump houses shall be provided with toilet of minimum size of 2m X 3m. sewage generated from all buildings shall be collected at a common location and shall be pumped to the inlet chamber of the WWTP for treatment. Each Toilet shall have the followingfeatures:

a. The finished floor level of toilet shall be 25 mm below general finished floor level elsewhere in thebuilding.

b. One WC (European / Indian type of approved size and shade as directed by Engineer) along with fittings, cistern, etc all complete.

c. One white vitreous china wash basin of size 630 mm x 450 mm with one C.P. brass pillar tap 15 mm and other fittings. One soap dispenser at eachwashbasin.

d. One No. white vitreous china flat back half stall urinal each of size 580 x 380 x 350mm.

e. One C.P. brass cock along with drain pipe at a separate location having connection with potable water supplyline.

f. One mirror of superior glass of approved quality of rectangular shape of size 453 mm x 357 mm with 6 mm thick hard board backing, wall mounted type fitted over washbasin.

g. Stopcocks, bib taps, valves and pillar cocks shall be heavy duty chromium plated brass in required numbers and as directed byEngineer.

h. All fittings such as `P' or `S' traps, floor traps, vent pipes, down take pipes etc. shall be as directed byEngineer.

i. One triple layer polyethylene storage tank of 1000 litre capacity shall be provided at the roof of the building / toilet along with internal water supply with PP-R piping, fittings and connections to the toilets andsinks.

j. Connection with water supply line and sewage disposalarrangement.

k. Water proofing of cement concrete toilet floor slab shall be with integral cement, water proofing compound and water mixed slurry. All joints, corners, junction of pipes and masonry shall be sealed with this cement basedslurry.

## 3.4 General Civil Specifications

All raw materials including Cement and reinforcement/structural steel wherever to be used by the contractor shall confirm the latest BIS/CPWD specifications. All mandatory tests as required by BIS/CPWD specifications shall be carried out and test certificates to be

submitted to Engineer – in charge. However, the contractor shall be fully responsible for required performances of civil/ structural work. Makes of various items shall be as mentioned under relevant items or as approved by Engineer-in-charge. Costs of such tests are to be borne by thecontractor.

For testing of all materials, following shall be strictly adhered to -

a) All the tests shall preferably be done in government laboratories or Govt. accredited Laboratories or any other testing laboratory approved by Engineer. The contractor is required to take written approval from Engineer-in-charge, in thisrespect.
b) Cement and Steel shall be of a make approved by the Employer as detailed out in respective material sections of thisdocument.

### 3.4.1 Earthwork

Excavation may be involved in all types of soils including rock including saturated soil, sub-soil water or running sand including pumping or bailing out of water.

The Contractor shall furnish all tools, plant instruments, qualified supervisory personnel, labour, materials, any temporary works, consumables, any and everything necessary, whether or not such items are specifically stated herein for completion of the work in accordance with the Department's Requirements.

The Contractor shall survey the site before excavation and set out all lines and establish levels for various works such as grading, basement, foundations, plinth filling, roads, drains, cable trenches, pipelines etc. Such survey shall be carried out by taking accurate cross sections of the area perpendicular to established reference/grid lines at 10 m interval in case of buildings and 30 m in case of roads and pipe lines works respectively. Nothing extra shall be paid or recovered if difference in ground levels is observed between that shown in the drawings given by the Employer and that found at site. The Contractor shall Survey and finalize the ground levels and obstructions (which can cause delay in completion of the work), if he desires, at his own cost. Also nothing extra shall be paid or recovered if any obstruction is not shown in the plans given in by the Employer. In view of changes in actual ground levels if found at site some changes may have to be made in already approved invert levels, which may be made by the Contractor after getting fresh approval from the Employer. Such changes shall be at the cost of contractor.

The excavation shall be carried out to correct lines and levels. This shall also include, where required, proper shoring to maintain excavations and also the furnishing, erecting and maintaining of substantial barricades around excavated areas and warning lamps at night.

Excavated material shall be dumped in regular heaps, bunds, riprap with regular slopes and leveling the same so as to provide natural drainage. Rock/soil excavated shall be stacked properly as approved by the Employer's Representative. As a rule, all softer material shall be laid along the centre of heaps, the harder and more weather resisting materials forming the casing on the sides and the top. The excavated materials shall be kept in such a way that

no nuisance is created to traffic or pedestrians and nor it should appear as a hindrances for repairs to any of the public or private utility. Topsoil shall be stock piled separately for later re-use.

The excavated earth shall be stacked at a suitable approved location with all lead and lift from the periphery of the site. Earth suitable for backfilling shall be stacked separately.

Subsequent disposal of the surplus and unsuitable material shall be as per the direction of Employer's representative. Foundations, trenches shall be dug out to the exact dimensions, as minimum required or as directed by the Employer's Representative.

The bed of trenches shall be firmly consolidated and leveled by watering and ramming of the soft soil. Defective spots shall be dug out and filled with concrete of the same mix as of PCC or as directed by the Employer's Representative.

Excavated trenches shall have to be approved by the Employer's Representative prior to laying of PCC or any other Permanent Work.

Excavated materials shall not be placed within 1 m of the edge of the trench or half the depth of the trench, whichever is more.

Timber Shoring "closed" or "open" depending upon the nature of site and site conditions shall be carried out as directed by the Engineer.

The contractor shall plan necessary drainage system at the site and ensure that the excavated areas shall not get filled / submerged in rain / surface water.

The earth and sand used for filling shall be free from all roots, grass, shrubs, vegetation, trees, sapling and rubbish.

No filling shall commence until surface water discharges and streams have been properly intercepted or otherwise dealt with as per the approval of the Engineer.

In Administrative Building, Anti termite treatment of soil beneath the building and around the foundation shall be done with suitable insecticide as approved by the Engineer.

Excavations for column footings shall be carried to depths as required by Safe Bearing capacity (SBC) of the soil available from soil investigation work carried out by contractor. If ordered by the Employer's Representative, appropriate tests shall be carried out by the contractor.

Note: *Contractor will decide the layout of various units under this project keeping in mind the site conditions. Contractor shall take all necessary precautions in order to ensure safety of the adjacent structures. Necessary precaution/sheet piling shall be done during excavation and construction, for the safety of the adjacent structures/. Dewatering arrangement shall be done as per requirement. Contractor will include all cost in their price proposal. Nothing extra shall be paid on this account.*

### 3.4.1.1. EXCAVATION

#### 3.4.1.1.1. General

Excavation for permanent work shall be taken out to such widths, lengths, depths and profiles as are shown on the approved drawings or such other lines and grades as may be agreed with the Employer's Representative. Rough excavation shall be carried out to a depth of 150 mm above the final level. The balance shall be excavated with special care. Soft pockets shall be removed below the final level and extra excavation filled up with material as approved by the Employer's Representative. The final excavation should be carried out just prior to laying the blinding course.

To facilitate the permanent works the Contractor may excavate, and also backfill later, outside the lines shown on the approved drawings or as agreed with the Employer's Representative. Should any excavation be taken below the specified elevations, the Contractor shall fill it up with M- 15 PCC up to the required elevation at no cost to the department.

Any undulation in ground level, loose pockets or extra excavation done at "wherever necessary due to soft soil or low lying area shall be made good with M15 PCC and no extra claim shall be entertained on this account.

All excavations shall be to the minimum dimensions required for safety and ease of working. Prior approval of the Employer's Representative shall be obtained by the Contractor in each individual case, for the method proposed for the excavation, including dimensions, side slopes, dewatering, disposal, etc. This approval shall not in any way relieve the Contractor of his responsibility for any consequent loss or damage. The excavation must be carried out in the most expeditious and efficient manner. Side slopes shall be as steep as will stand safely for the actual soil conditions encountered. Every precaution shall be taken to prevent slips. If slips occur, the slipped material shall be removed and the slope shall be dressed to a modified stable slope.

All loose boulders, detached rocks partially and other loose material which might move therewith not directly in the excavation but so close to the area to be excavated as to be liable, in the opinion of Employer's Representative, to fall or otherwise endanger the workmen, equipment, or the work shall be stripped off and removed from the area of the excavation. The method used shall be such as not to render unstable or unsafe the portion, which was originally sound and safe.

Any material not requiring removal in order to complete the permanent works, but which, in the opinion of Employer's Representative, is likely to become loose or unstable later, shall also be promptly and satisfactorily removed.

In case of deep trenches where the soil is soft and not capable of being retained without the help of support, planking and strutting as required shall be carried out. It shall be the responsibility of the contractor to take steps to prevent slide/collapse. Method of planking/strutting will be largely influenced by the type of soil encountered and shall be got approved by the Employer's Representative.

#### 3.4.1.1.2. Trial Trenches

The Contractor shall also dig trial trenches at every 250 meter along the alignment so as to have full knowledge of the underground soil, characteristic of soil, water table and various utilities. Contractor shall also make local inquiries regarding the existing services and water table etc. No claim for not having known the existence of any utility shall be entertained by the Department.

#### 3.4.1.1.3. Site Preparation

Before start of excavation and pipe laying the Contractor shall carry out preliminary work of making the alignment onsite with wooden pegs, clearing and disposal of shrubs, grasses large and small bushes, trees, hedges, fence gates, portion of old masonry boulders and debris etc. lying along route of the pipe alignment. If any trees are to be cut they shall be cut as per terms and conditions of the approval granted by the Forests department or any other concerned agency and all re-plantation / transplantation requirements shall all be complied with. The transportation and disposal of the cut wood as directed shall be included in the contractor's scope of work. Tree roots with in 0.5 m from either side of the pipelines shall be completely removed before laying the pipes and such other things as mentioned earlier/elsewhere.

The bidder should collect all the correct data before submitting his tender. Ultimate responsibility for every requirement (proper alignment, designs and execution) shall be of the Contractor.

#### 3.4.1.1.4. Protection to Existing Services

The Contractor will provide at his own cost temporary supports, adequate protection and maintenance to all underground services and surface structures such as drains, sewers, water mains, electric and telephone cables, electric poles, telephone poles, telephone cable ducts, electric cable ducts, gas lines or any other utility met with during excavation and pipe laying. Nothing extra shall be paid for the above and nor any extension of time shall be given for proper checking or location of utilities and maintenance done by the Contractor. If shifting of any of the utility of cables, poles or gas line etc. is required or any permanent R.C.C support is required to be provided for any of the utility it shall be provided by the Contractor at his own cost.

The pipeline shall be so laid as not to obstruct access to other services for inspection, repairs and replacement. When such utilities are met-with during excavation the concerned authorities shall be intimated / approached by the Contractor and arrangements to protect/support the utilities in consultation with them shall be taken.

#### 3.4.1.1.5. Trench Excavation Width & Depth

The excavation shall be done to the required grade and formation as given in the approved L-sections. Special consideration shall be given to the trench depths so as to provide a

minimum cover of not less than the following above the top of pipe socket.

| Pipe Dia | Cover Depth |
|---|---|
| DI/HDPE/M.S. Pipe (lined and coated) | 1.0 M (minimum) |

Increased depth of excavation may be required to avoid surface drains, road crossing, railway or other crossings. In case of less cushion extra suitable designed protection over pipes be provided as per direction of Employer's Representative.

The width of the trench at bottom between the face of excavation or sheeting (where required) shall be such as to provide minimum 300 mm clearance between the pipe and the trench sides.

In case of excavation in rocky soil, the pipes shall be bedded on 300 mm of fine sand material for full width of the trench as per direction of Engineer In Charge / his authorized representative. Where pipes are bedded directly in good ordinary soil on the bottom of the trench an even fully compacted bed shall be provided. The Contractor shall also ensure that the soil has sufficient bearing capacity as not to settle under the load coming over it.

Wherever required the pipes shall be laid on 300 mm thick bedding under the pipe in PCC mix. M:20. In cases where the soil is weak or slushy pipes shall be supported by providing suitable footings or by piles with pile caps with pipe supporting structures as per site requirements.

In cases where the Contractor has done excavation deeper than the required the extra depth excavated shall be filled with P.C.C. (M-15). Nothing extra shall be paid for excess excavation and for the laying of P.C.C.

The pipelines to be laid by open excavation or may have to be laid by Trenchless technology depending upon the site condition, decision of the concerned authority and Employer's Representative shall be final and binding. All equipment for use of trenchless technology shall be arranged by the Contractor at his own cost.

#### 3.4.1.1.6. Blasting

Blasting for Excavation in rocky areas is not permitted. It shall be cut with chisels. Excavated rock shall be stacked as per directions of Engineer In Charge / his authorized representative and as per relevant specifications.

#### 3.4.1.1.7. Surface Material

The excavated materials which as per direction of the Engineer In Charge / his authorized representative are suitable for reuse in restoring the surface (roads or any other structure) shall be kept separate from the general excavated material as directed.

#### 3.4.1.1.8. Stacking Excavated Material

All excavated material shall be stacked in such a manner that it will not endanger the work or workmen and it will avoid obstructing footpaths, roads and drive ways, hydrants under pressure, surface unobstructed and accessible during the construction work. Gutters shall be kept clear or other satisfactory provision made for street drainage, and natural water-courses shall not be obstructed.

#### 3.4.1.1.9. Protection of Persons and Property

To protect persons from injury and to avoid damage to properties (Government or Private), the contractor shall take safety measures at his own cost for the progress of the construction work and until it is safe for traffic to use the roadways. All materials, pipes equipment and pipes which may serve as obstruction to traffic shall be enclosed by fences or barricades and shall be protected by illuminating proper lights when the visibility is poor. The rules and regulations of the local authorities regarding safety provisions shall be observed by the Contractor at his own cost. Any material which is not to be used at site shall be removed from the work site so that no inconvenience is caused.

### 3.4.1.2. FILL, BACKFILLING AND SITE GRADING

#### 3.4.1.2.1 General

All fill material shall be subject to the Employer's Representative's approval. If any material is rejected by Employer's Representative, the Contractor shall remove the same forthwith from the site. Surplus fill material shall be deposited/disposed off as directed by Engineer In Charge / his authorized representative after the fill work is completed.

No earth fill shall commence until surface water discharges and streams have been properly intercepted or otherwise dealt with to the approval of the Engineer In Charge / his authorized representative.

#### 3.4.1.2.2 Material

To the extent available, selected surplus soil from excavations shall be used as backfill. Soil used for filling shall be separately stacked as directed by Engineer In Charge / his authorized representative. Backfill material shall be free from lumps, organic or other foreign material. All lumps of earth shall be broken or removed unless otherwise stated. Where excavated material is mostly rock, the boulders shall be broken into pieces not larger than 150 mm size, mixed with properly graded fine material consisting of murrum or earth to fill the voids and the mixture used for filling.

If fill material is required to be imported, the Contractor shall make arrangements to bring such material from outside borrow pits. The material and source shall be subject to the prior approval of the Employer's Representative. The approved borrow pit areas shall be cleared of all bushes, roots of trees, plants, rubbish, etc. Top soil containing foreign material shall be removed. The materials so removed shall be disposed of as directed by Employer's Representative. The Contractor shall provide the necessary access roads to borrow areas

and maintain the same if such roads do not exist. No extra payment shall be made on this account.

#### 3.4.1.2.3 Filling in pits and trenches around foundations of structures, walls, etc.

The spaces around the foundations, structures, pits, trenches, etc., shall be cleared of all debris, and filled with earth in layers not exceeding 15 cm, each layer being watered, rammed and properly consolidated to the satisfaction of Employer's Representative. Earth shall be rammed with approved mechanical compaction machines. Usually no manual compaction shall be allowed unless the Employer's Representative is satisfied that in some cases manual compaction by tampers cannot be avoided. The final backfill surface shall be trimmed and leveled to a proper profile to the approval of the Employer's Representative.

The filling shall be done after the concrete or masonry is fully set and done in such a manner as not to cause undue thrust on any part of the structure.

#### 3.4.1.2.4 Plinth Filling

Plinth filling shall be carried out with approved material such as soil, sand or murum as the case may be, in layers not exceeding 15 cm, watered and compacted with mechanical compaction machines. When filling reaches the finished level, the surface shall be flooded with water, unless otherwise directed, for at least 24 hours, allowed to dry and then the surface again compacted as specified above to avoid settlement at a later stage. The finished level of the filling shall be trimmed to the level/slope specified.

Compaction of large areas is carried out by means of 8/10 ton rollers smooth wheeled, sheep-foot or wobbly wheeled rollers. In case of compaction of granular material such as sands and gravel, vibratory rollers shall be used. A smaller weight roller may be used only if permitted by the Employer's Representative. As rolling proceeds, water sprinkling shall be done to assist consolidation. Water shall not be sprinkled in case of sandy fills.

The thickness of each unconsolidated fill layer can in this be up to a maximum of 300 mm. The Contractor will determine the thickness of the layers in which fill has to be consolidated depending on the fill material and equipment used and the approval of the Employer's Representative obtained prior to commencing filling.

The process of filling in the plinth, watering and compaction shall be carried out by the contractor in such a way as not to endanger the foundation columns, plinth walls etc. already built up. Under no circumstances back cotton soil shall be used for plinth in filling.

Rolling shall commence from the outer edge and progress towards the centre and continue until compaction is to the satisfaction of Employer's Representative, but in no case less than 10 passes of the roller will be accepted for each layer.

The compacted surface shall be properly shaped, trimmed and consolidated to an even and uniform gradient. All soft spots shall be excavated, then filled and consolidated.

At some locations/ areas, it may not be possible to use rollers because of space restrictions, etc. The Contractor shall then be permitted to use pneumatic tampers, rammers, etc. and he shall ensure proper compaction.

#### 3.4.1.2.5 Sand Filling

Where backfilling is required to be carried out with local sand it 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. Filling shall be in layers of 15 to 20 cm. Compacted surface shall be watered with optimum moisture content and properly rammed. The surface of the consolidated sand shall be dressed to required level or slope.

### 3.4.1.3. GENERAL SITE GRADING

Site grading shall be carried out as indicated in the approved drawings.

If no compaction is required, the fill may be deposited to the full height in one operation and leveled. If the fill has to be compacted, it shall be placed in layers not exceeding 200 mm and leveled uniformly and compacted before the next layer is deposited.

To ensure that the fill has been compacted as specified, field and laboratory tests shall be carried out by the Contractor.

Field compaction tests shall be carried out in each layer of filling until the fill to the entire height has been completed. The fill will be considered as incomplete if the desired compaction has not been obtained.

The Contractor shall protect the earth fill from being washed away by rain or damaged in any other way. if any slip occurs, the Contractor shall remove the affected material and make good the slip.

### 3.4.1.4. FIELD DENSITY OF FILL MATERIAL

Unless otherwise specified the compaction, where so called for, shall comply with minimum 95% compaction by Modified Proctor at moisture content differing not more than 3% from the optimum moisture content. The Contractor shall demonstrate adequately by field and laboratory tests that the specified density has been obtained.

### 3.4.1.5. TIMBER SHORING / SHEET PILING

Timber shoring or Sheet piling will be provided where required, or where stipulated by the Engineer in Charge, and shall be as per the provisions of relevant BIS. No extra claim shall be entertained on this account.

### 3.4.1.6. DEWATERING

The Contractor shall ensure at his cost that the excavation and the structures are free from

water during construction and shall take all necessary precautions and measures to exclude ground/ rain water / seepage water so as to enable the works to be carried out in reasonably dry conditions in accordance with the construction programme. Sumps made for dewatering must be kept clear of the excavations/ trenches required for further work. The method of pumping shall be approved by Engineer In Charge / his authorized representative, but in any case, the pumping arrangement shall be such that there shall be no movement of subsoil or blowing in due to differential head of water during pumping. Pumping arrangements shall be adequate to ensure no delays in construction. The dewatering shall be continued for at least (7) seven days after the last pour of the concrete. The Contractor shall, however, ensure that no damage to the structure results on stopping of dewatering.

The contractor shall take all necessary steps to avoid uplifting of pipes due to buoyant action of the sub-soil water, or uplifting of the pipes during rainy season or due to any other reason.

The Contractor shall study the sub-soil conditions carefully and shall conduct any test necessary at the site with the approval of the Employer's Representative to test the permeability and drainage conditions of the sub-soil for excavation, concreting etc., below ground level.

The sub-soil water during pumping shall be discharged to the nearest drain/nallah as per direction of Employer's Representative.

The scheme for dewatering and disposal of water shall be approved by the Employer's Representative. The Contractor shall suitably divert the water obtained from dewatering from such areas of site where a buildup of water in the opinion of the Employer's Representative obstructs the progress of the work, leads to unsanitary conditions by stagnation, retards the speed of construction and is detrimental to the safety of men, materials, structures and equipment.

When there is a continuous inflow of water and the quantum of water to be handled is considered in the opinion of Engineer In Charge / his authorized representative, to be large, a well point system-single stage or multistage, shall be adopted. The Contractor shall submit to the Employer's Representative, details of his well point system including the stages, the spacing number and diameter of well points, headers etc., and the number, capacity and location of pumps for approval.

If any foundation pits are filled due to accumulation of surface flow during the progress of work or during rainy season, or due to any other cause, all pumping required for dewatering the pits & removing silt shall be done without extra cost.

### 3.4.1.7. FILLED UP SOIL

In case of filled up soil area, the load bearing capacity of the soil is very low. As such the Contractor shall apply such methods to increase the bearing capacity. In case the bearing

capacity cannot be increased, the Contractor will carry out excavations upto the firm soil and provide suitable foundations with R.C.C. pillars for shallow depth or shall provide piles with pile caps for higher depth and supporting blocks/structures for laying the pipes at the required levels at his own cost.

### 3.4.1.8. RAIN WATER

Grading in the vicinity of excavation shall be such as to exclude rain/ surface water draining into excavated areas. Excavation shall be kept clean of rain and such water as the Contractor may be using for his work, by suitably pumping out the same. The scheme for pumping and discharge of such water shall be approved by the Employer's Representative.

Dewatering including diversion of stream, providing cofferdams, bunds etc. as may be necessary for laying of pipes, specials & civil works and other parts of the work and bailing out and pumping out water during and after excavation shall be the responsibility of the contractor.

## 3.4.2 Plain and Reinforced Cement ConcreteWorks

### 3.4.2.1 Materials

**CEMENT**

i) The Contractor shall procure ISI mark OPC (Portland Cement) confirming to the relevant IS Code for the civil work only from the manufacturers as approved by Ministry of Industry, Government of India and holding license to use BIS certification mark for their product, whose name shall be got approved from Engineer-in-Charge before use. Supply of cement shall be taken either in silos or in 50 kg bags bearing manufacturer's name and BIS marking. Samples of cement arranged by the Contractor shall be taken by the Engineer-in-Charge and got tested in accordance with provisions of relevant BIS codes. Cost of such tests shall be borne by the contractor. In case test results indicate that the cement arranged by contractor does not conform to be relevant BIS codes the same stand rejected and shall be removed from the site by the Contractor at his own cost within one week time of written order from theEngineer-in-charge.

ii) The cement shall be brought at site in bulk supply of approximately 50 tonnes from the manufacturer direct, or as decided and approved by the Engineer-in-charge, as the case maybe.

iii) The cement godown of the sufficient capacity should be constructed by the contractor and at all time it should have a stock of minimum of 5000 bags. The contractor shall facilitate the inspection of the cement godown by the Engineer-in-Charge at any time. Storage of cement shall be as per CPWD specification.

iv) Cement brought at site and cement remaining unused after completion of work shall not be removed from site without written permission of theEngineer-in-charge.

**TMT STEEL & STRUCTURAL STEEL**

i) The contractor shall procure TMT steel reinforcement bars conforming to relevant BIS codes (Grade Fe 415D or 500D, BIS code 1786) and structural steel from main producers such as SAIL, TISCO, VIZAG and RASHTRIYA ISPAT NIGAM LTD or as approved by Engineer in charge from the approved list of Ministry of Steel. The steel reinforcement, structural steel shall be brought to the site in bulk supply of 10 tonnes or more or as decided by the Engineer-in-Charge. For small or occasional quantities of TOR steel reinforcement bars that less than 10 MT, the Engineer-in-charge may authorize the contractor to purchase the same from authorized dealers of the approved manufacturers. The contractor shall have to obtain and furnish test certificates to the Engineer-in-Charge in respect of all supplies of steel brought by him to the site of work. Samples shall also be taken and got tested by the Engineer-in-Charge as per the provisions in this regard in relevant CPWD/BIS codes. Cost of such tests shall be borne by the contractor. In case the test results indicate that the steel arranged by the contractor does not conform to CPWD/BIS codes, the same shall stand rejected and shall be removed from the site of work by the Contractor at his cost within a week's time after written orders from theEngineer-in-Charge.

ii) The steel reinforcement, structural steel shall be stored by the contractor at site of work in such a way as to prevent distortion and corrosion. Bars of different sizes and lengths shall be stored separately.

iii) For checking nominal mass, tensile strength, band test, re-band- test etc. specimen of sufficient length shall be cut from each size of the bar at random at frequency not less than that specified below or as per the relevant IS/BIS/CPWDspecifications.

| Size of Bar | For consignment below 100 tonnes | For consignment over 100 tonnes |
|---|---|---|
| Under 10 mm dia | One sample for each 25 tonnes or part thereof | One sample for each 40 tonnes or part thereof. |
| 10mmto 16 mmdia. | One sample for each 35 tonnes or part thereof | One sample for each 45 tonnes or part thereof. |
| Over 16 mm dia | One sample for each 45 tonnes or part thereof | One sample for each 50 tonnes or part thereof. |

iv) Steel brought to site and steel remaining unused shall not be removed from site without the written permission of the Engineer-in-charge.

**QUARRY MATERIALS**

The Contractor shall be wholly responsible to identify the suitable sources for quarry materials required for the Works, such as earth, sand, stone, murrum, etc., and to make his own arrangements for collection and transportation of the materials irrespective of the leads and lifts required. The quarry thus identified by the Contractor should have proper license from the concerned Government. All materials supplied by the Contractor shall satisfy the

requirements set forth in the Specifications and shall be subject to the approval of the Engineer-in-Charge. The Contractor shall take this into account while offering his rates, and no claims whatsoever shall be entertained for extra costs on this account.

### 3.4.2.2 Formwork

Formwork shall be properly designed for various types of loads anticipated to be imposed during the construction process. The design should also take into account the effect of vibrations created during operation of vibrators. The forms shall be capable of producing a consistent quality surface as required in the contract.

All the staging shall be of Tubular steel structure with adequate bracings or made of built up structural sections from rolled structural steel sections. Form work shall be steel or wood. Wooden form shall be made with 12 mm thick water proofing ply of approved quality.

For liquid retaining structures, securing formwork should not impair the water tightness of the structure. No nut-bolts passing completely through liquid retaining members shall be used for the purpose of securing and aligning the formwork.

Tie bolts shall be of the high tensile variety, fixed at right angles to the formwork. Only tie bolts which avoid embedding any metal parts permanently within 50mm of the concrete surface shall be permitted. No through bolt is permitted. Voids remaining after the removal of all, or part, of each tie bolt shall be sealed using a polymer modified cementations compound or other proprietary product as approved by the Engineer. Metal based expansive admixtures shall not be used. All such voids shall be prepared in accordance with the product data sheets, prior to filling to ensure that the bond is achieved.

Only one release agent shall be used throughout the entire area. Release agents shall be applied evenly and contact with reinforcement and other embedded items shall be avoided. Where the concrete surface is to receive an applied finish, care shall be taken to ensure the compatibility of the release agent with the finish.

Striking out / removal of formwork shall be done as per relevant BIS/IS code and the approval of Engineer. The surfaces of the RCC/ concrete work obtained after removal of shuttering shall be smooth and without honey combing/ pin holes, undulations and shall be such that it does not require any plastering. If at all any pin hole/ undulations are required to be made good, this shall be done with cement mortar 1:2 using coarse sand and finished smooth with steel trowel or as directed by Engineer- in-Charge. All works damaged through careless removal of forms shall be reconstructed within 24 hours.

### 3.4.2.3 Concrete

Design mix concrete shall be used for concrete of grade M 20 and above.

The contractor shall get the Mix design approved from Punjab Engineering College or any other reputed Institution approved by the Engineer. The Contractor shall not alter the approved mix proportions or the approved source of supply of any of the ingredients without obtaining the approval of the Engineer. The cost of the design mix of concrete shall be borne by the contractor.

The mixing of concrete shall be strictly carried out in the BATCHING & MIXING PLANT FOR CONCRETE. The contractor shall install a concrete batching plant as per site requirement and as approved by Engineer. For small concreting works up to 6 cum, mechanical concrete mixers may be used as approved by Engineer-in-charge. Hand mixing of concrete shall not be permitted at all.

The contractor shall submit method statement describing work procedure to be carried before commencing the concrete work. The method statement shall be approved by the Engineer. Routine quality control tests such as slump, cube strength, sieve analysis and any other mandatory test as directed by Engineer shall be done in the presence of Engineer or its representative in the laboratory established by the contractor at site.

In the event of any work being suspected of faulty material or workmanship requiring its removal or if the works cubes do not give the stipulated strengths, the Engineer reserves the right to order the Contractor to take out cores and conduct tests on them or do ultrasonic testing or load testing of structure, etc. The Engineer also reserves the right to ask the Contractor to dismantle and re-do such unacceptable work, at no cost to the Employer.

Styrene-Butadiene copolymer latex type admixtures may be used in the design mix concrete for improving the resistance to water penetration, abrasion resistance and durability. Admixtures based on sulphonated naphthalene for producing low water cement ratio high strength design mix concrete mix are permitted with prior approval of Engineer; however, the use of such admixture should notaffect the workability of concrete adversely. Other admixtures, as per the requirement of site, may be used for designing the concrete mix with prior approval of Engineer and after establishing its use and advantages.

#### 3.4.2.4 ConstructionJoints

All construction joints shall be provided as recommended in BIS: 3370 and 6494 and as per minimum site requirement. However, bidder is allowed to reduce the number of construction joints as per international practices with sufficient justification. The position of construction joints should be specified by the structural designer & indicated on the drawings.

#### 3.4.2.5 Other type ofJoints

Expansion joints, where required shall be provided as per BIS: 3414 Code of practice for design of joints and installation in buildings.

Movement joints such as expansion joints, complete contraction joints, partial contraction joints and sliding joints shall be designed to suit the structure.

Expansion joints of suitable gap at suitable intervals not more than 30m shall be provided in walls, floors and roof slabs of liquid retaining structures.

### 3.4.2.6 Preformed Fillers, Joint Sealing Compound and Polyethylene sheet

Preformed filler for expansion/ isolation joints shall be non-extruding and resilient type of bitumen impregnated fibres conforming to BIS: 1838 Part I or BIS 1838 Part 2.Bitumen coat to concrete/ masonry surfaces for fixing the preformed bitumen filler strip shall conform to BIS: 702. Bitumen primer shall conform to BIS: 3384.

Sealing compound for filling the joints above the preformed bitumen filler shall conform to Grade 'A' as per BIS: 1834.Other organic solvents such as polysulphate based joint sealents to BIS: 1433 Part-I or BIS 12118 Part-I may be used with the approval of Engineer.

In all liquid retaining structures, a layer of bond breaking material below the grade slab and lean concrete shall be provided by using polyethylene sheet of having minimum mass of 1 kg/sqm of make approved by Engineer as per requirement of IS 3370.

### 3.4.2.7 Hydrostatic Testing of Liquid Retaining ConcreteStructures

The contractor shall make all arrangements including provision of water for hydro-testing of liquid structures as per IS: 3370, temporary bulk heads, pressure gauges, pumps, pipelines, etc. Hydro-static test for water tightness shall be done upto top level of structure, as may be directed by the Engineer. This test shall be carried out preferably in dry season in accordance with the procedure given below: The water tightness test shall be carried out when the structures are ready for filling. Before the filling operation is started, the structure shall be jointly inspected by the Engineer and the Contractor's representative and the condition of surfaces of wall, contraction and expansion joints shall be noted and it shall be ensured that jointing material filled in the joints is in position and all openings are closed. The filling of the structure then shall be carried out gradually at the rate not exceeding 30 mm rise in water level per hour and shall preferably extend over a period of 72 hours. Records of leakages starting at different level of water in the structure, if any, shall be kept. The structure once filled shall be allowed to remain filled for a period of seven days before any readings of drop in water level are recorded. The level of the water shall be recorded again at subsequent interval of 24 hours over a period of seven days.

The total drop in surface level of a period of seven days shall be taken as indication of the water tightness of the structure, which for all practical purpose, shall not exceed 40 mm or as specified in the relevant IS code. If the structure does not satisfy the conditions of the test and a daily drop in water level is found, the period of test may be extended for a further period of seven days and if the specified limit is then reached the structure may be

considered as satisfactory. The Engineer shall decide on the actual permissible nature of the drop in the surface level, taking into account whether the structures are open or closed and the corresponding effect it has due to evaporation losses.

In case of structures whose external faces are exposed, such as elevated structures, the requirements of the test shall be deemed to be satisfied if the external faces show no sign of leakage or sweating and remain completely dry during the period of observation of seven days, after allowing a seven day period for absorption after filling with water.

Each compartment/segment of the structure shall be tested individually and then all together.

Backfilling of earth on the sides for underground or partly underground structures shall be withheld till the structures are hydro statistically tested and found leak proof to the entire satisfaction of the Engineer.

Any leakage that may occur during the hydro-test or subsequently during the trial run period shall be effectively stopped either by cement / epoxy pressure grouting, guniting or such methods as may be approved by the Engineer. All such rectification shall be done by the contractor to the entire satisfaction of the Engineer at no extra cost.

### 3.4.2.8 Screed Concrete

In all treatment units used for clarification or fitted with moving parts like scraper etc., the floor slab of the unit shall be finished with 50 mm thick M-25 grade screed concrete with neat finish at top surface.

### 3.4.2.9 Embedment's / Inserts in ConcreteWork

All the miscellaneous inserts such as bolts, pipes, assemblies, plate embedment's etc., shall be accurately installed in the building works at the correct location and levels, as detailed in the approved construction drawings. The contractor will have to suitably bend, cut or otherwise adjust the reinforcement in concrete at the location of inserts as directed by the Engineer. If the Engineer, so directs, the inserts will have to be welded to reinforcement to keep these in place. The contractor shall be responsible for the accuracy of dimensions, levels, alignments and center lines of the inserts in accordance with the drawings and for maintenance of the same until the erection of equipment structure or final acceptance by theEngineer.

The contractor shall ensure proper protection of all bolts, inserts, etc., from weather by greasing or other approved means such as applying white lead, putty and wrapping them in gunny bags or canvas by other means as directed by the Engineer to avoid damage due to movement of his labourers, material, material, equipment etc., The contractor shall be solely responsible for any damage caused to bolts inserts etc., due to negligence and in case damage does occur it shall be rectified to the satisfaction of the Engineer at the

contractor'scost.

### 3.4.2.10 Grouting

#### *a.* Standard Grout

The proportions of Standard Grout shall be such as to produce a flow able mixture consistent with minimum water content and shrinkage. Surfaces to be grouted shall be thoroughly roughened and cleaned. All structural steel elements to be grouted shall be cleaned of oil, grease, dirt etc. The use of hot, strong caustic solution for cleaning purpose will be permitted. Prior to grouting, the hardened concrete shall be saturated with water and just before grouting, water in all pockets shall be removed. Grouting once started shall be done quickly and continuously. Variation in grout mixes and procedures shall be permitted if approved by the Engineer.

The grout proportions shall be limited as follows:

| Use | Grout Thickness | Mix Proportions | W/C Ratio (max) |
|---|---|---|---|
| a) Fluidmix | Under 25mm | One part Portland Cement to one part sand | 0.44 |
| b) Generalmix | 25mm and over but less than 50mm | One part Portland Cement to 2 parts of sand | 0.53 |
| c) Stiffmix | 50mm and over | One part Portland Cement to 3 parts of sand | 0.53 |

#### *b.* Non-Shrink Grout

Non-shrink grout where required as instructed by the Engineer, shall be provided in strict accordance with the manufacturer's instructions / specifications on the drawings. Non shrink grout material properties shall comply with ASTM C1107 Standard Specification for Packaged Dry, Hydraulic- Cement Grout (Non shrink). Application of non shrink grout shall be as per manufacturer instructions.

### 3.4.2.11 Renovation or RepairWork

In case of renovation or work, for bonding new concrete with old concrete, suitable bonding agent (such as epoxy) from reputed manufacturers approved by Engineer's representatives shall be used. The composition of bonding agent, method of cleaning of old concrete surface as well as application method should be conforming to manufacturer's recommendations. Manufacturer should have sufficient documentation to prove utility of

his bonding agent conforming to relevant standards. Method of storage, shelf life of bonding agent etc. to be in accordance with manufacturer's recommendations and provided with supporting documentation. All repair (at no extra cost) schemes (materials and methods) shall be approved prior by the Engineer in charge. It shall be supported by proper site report.

### 3.4.3 Building Works

#### 3.4.3.1 Brickwork

Unless otherwise specified bricks having a minimum crushing strength of 7.5 N/sqmm shall be used. Mortar Mix proportion for one or more brick thick work shall be in 1:4 (1 cement: 4 course sand) for half brick thick work the mortar mix proportion shall be in 1:3 (1 cement: 3 course sand).

For resting RCC slabs, the bearing surface of masonry wall shall be finished on top with 12 mm thick cement mortar 1:3.

RCC/ steel beams resting on masonry wall shall be provided with M-25reinforced concrete bed blocks of 50 mm thickness, projecting 50mm on either sides of the beam.

Steel wire fabric of suitable size and thickness shall be provided at the junction of brick masonry and RCC before taking up plastering work.

The top most course of half or full brick walls abutting against either a de-shuttered slab or beam shall be built only after any proposed masonry wall above the structural member is executed to cater for the deflection of the structural element. Bricks for partition walls shall be stacked adjacent to the structural member on upper floor so as to pre-deflect the structural member (beam) before the brick wall is taken up for execution at lower floor.

Where the drawings prepared by the Contractor indicate that structural steel sections are to be encased in brickwork, the brickwork masonry shall be built closely against the steel section, ensuring a minimum of 20 mm thick cement-sand mortar 1:4 over all the steel surfaces. Steel sections partly embedded in brickwork shall be provided with bituminous protective coating to the surfaces at the point of entry into the brick masonry.

#### 3.4.3.2 Damp - ProofCourse

All the walls in a building shall be provided with damp-proof course cover at plinth to prevent water from rising up the wall. The damp-proof course shall run without a break throughout the length of the wall, even under the door or other openings. Damp-proof course shall consist of 50 mm thick cement concrete of 1:2:4 (1 cement : 2 coarse sand : 4 graded stone 20 mm nominal size) nominal mix with approved water-proofing compound admixture conforming to IS: 2645. The upper and side surface shall be made rough to afford key to the masonry above and to the plaster.

### 3.4.3.3 Doors, Windows andVentilators

#### a. uPVC extrudedsections

All profiles shall be made from uPVC (Unplasticised Polyvinyl Chloride) Type A material & only those additives are used that are essential in producing sound extrusions in accordance to BIS 7413:1991. No reworked material shall be used. The profile shall be a hollow 3 chamber (across depth) profile with a nominal 2.3 mm wall thickness, +/- 0.3mm of tolerance. The profile shall be uniform and free from foreign bodies, cracks or marks. The profiles shall be multi chambered, with a min. of three chambers. The central chamber, being for reinforcement, shall be fully sealed when main profiles are welded at joints. The color of profiles shall be as decided by Engineer.

All reinforcements for profiles shall be Galvanized Mild Steel. The reinforcement is secured to the profile so that it does not move or rattle and it maintains the structural integrity of the frame and satisfactory thermal separation. The structural frame assemblies must be capable of withstanding and accommodating satisfactorily wind loads and pressures in accordance with the requirements of relevant national / international codes.

The door / window / ventilator units shall be designed with all corner joints, transom joints and mullion joints being mitred and fusion welded. The joints must be completely moisture resistant and not permit any penetration into the profiles either externally or internally. All excess material is to be neatly trimmed and neatly feature grooved to corner, transom and mullion joints. No polishing of anyjoints are permitted. There is to be no mechanical jointing of the profile unless the profile section is less than 350 mm long. The units shall be designed so that the route of drainage is prevented from passing through the reinforcement chamber. The dimensional tolerances on the finished outer frame height and width is +/– 3mm.

All screws, nuts, bolts, rivets and other fastenings shall be of corrosion resistant or treated material, like stainless steel or ferretic steel, bi-chromate treated steel and be compatible with other metallic fixings used in the manufacture of the window, in accordance with relevant national / international codes. Fastenings be made from stainless steel 304 which has been finished by one of the following methods:-

a) Zinc plated and passivated.
b) Hot dip galvanized
c) Sprayed with metalcoating.

Hardware and ironmongery fittings and fixings are to penetrate at least two thicknesses of the uPVC profile and/or penetrate the reinforcement by at least 2mm. The locking mechanism is to be a Shoot Bolt Locking System operated by a single handle. Gearbox is to be sealed to stop the ingress of swarf during manufacture and use.

Glazing shall be with clear (obscure in bathrooms/wc) float glass panes. The glass shall be free from bubbles, scratches and other flaws. The glass shall be retained by suitable UPVC snap-on beads matching existing frame. All glazing gaskets & weather strips shall be of

EPDM rubber.

All windows and ventilators shall have float glass panes of 5.50 mm thickness.

The uPVC door shutters shall be 30 mm thick shall be made of styles and rails of a uPVC hollow section of size 60x30 mm and wall thickness 2 mm (± 0.2 mm), with inbuilt decorative moulding edging on one side. The styles and rails mitred and joint at the corners by means of M.S. galvanized/ plastic brackets of size 75x220 mm having wall thickness 1.0 mm and stainless steel screws. The styles of the shutter reinforced by inserting galvanized M.S. tube of size 25x20 mm and 1 mm (± 0.1 mm) wall thickness. The lock rail made up of 'H' section, a uPVC hollow section of size 100x30 mm and 2 mm (± 0.2 mm) wall thickness fixed to the shutter styles by means of plastic/ galvanized M.S. 'U' cleats. The shutter frame filled with a uPVC multi-chambered single panel of size not less than 620 mm, having over all thickness of 20 mm and 1 mm (± 0.1 mm) wall thickness. The panels filled vertically and tie bar at two places by inserting horizontally 6 mm galvanized M.S. rod and fastened with nuts and washers, complete as per manufacturer's specification and direction of Engineer.

**b. uPVC sections of rigid PVC foam sheet**

The door frame shall be of size 50x47 mm with a wall thickness of 5 mm, made out of extruded 5mm rigid PVC foam sheet, mitred at corners and joined with 2 Nos of 150 mm long brackets of 15x15 mm

M.S. square tube, the vertical door frame profiles to be reinforced with 19x19 mm M.S. square tube of 19 gauge, EPDM rubber gasket weather seal to be provided through out the frame. The door frame to be fixed to the wall using M.S. screws of 65/100 mm size, complete as per manufacturer’s specification and direction of Engineer.

The door shall be made of 30 mm thick pre laminated PVC door shutters consisting of frame made out of M.S. tubes of 19 gauge thickness and size of 19 mm x 19 mm for styles and 15x15 mm for top & bottom rails. M.S. frame shall have a coat of steel primers of approved make and manufacture.

M.S. frame covered with 5 mm thick heat moulded PVC 'C' channel of size 30 mm thickness, 70 mm width out of which 50 mm shall be flat and 20 mm shall be tapered in 45 degree angle on both sideforming styles and 5 mm thick, 95 mm wide PVC sheet out of which 75 mm shall be flat and 20 mm shall be tapered in 45 degree on the inner side to form top and bottom rail and 115 mm wide PVC sheet out of which 75 mm shall be flat and 20 mm shall be tapered on both sides to form lock rail. Top, bottom and lock rails shall be provided both side of the panel. 10 mm (5 mm x 2 ) thick, 20 mm wide cross PVC sheet be provided as gap insert for top rail & bottom rail, paneling of 5 mm thick both side PVC sheet to be fitted in the M.S. frame welded/ sealed to the styles & rails with 7 mm (5 mm+2 mm) thick x 15 mm wide PVC sheet beading on inner side, and joined together with solvent cement adhesive. An additional 5 mm thick PVC strip of 20 mm width is to be

stuck on the interior side of the 'C' Channel using PVC solvent adhesive etc. complete as per direction of Engineer-in- charge, manufacturer's specification & drawing.

**c. Galvanized Steel Rolling Shutters**

Rolling shutter shall be provided in workshop, gas generation room and other such buildings as directed by Engineer. GI Sheets and Plates used for manufacturing the guide channels, brackets and lock plate should be of hot rolled steel of thickness not less than 18 gauge conforming to IS5986. All components of rolling shutter to be hot dip galvanized with a zinc coating containing not less than 97.5% pure zinc. The galvanization of members shall conform to the requirements of IS 4759, IS 209, IS 2629, IS 2633 and IS 6745.

Rolling shutters shall conform to IS: 6248 and shall be suitable for fixing in position as specified i.e. outside or inside on or below lintel or between jambs of the opening. Shutters up to 10 sqm shall be on push and pull type and shutters with an area of over 10sqm shall generally be provided with reduction gear operated by mechanical device with chain or handle. The crank handle shall be removable.

Alternatively these can be power operated with the help of a push button station conveniently located besides the shutter or as shown on drawings. One emergency hand chain/ crank operation shall also be provided for use in case of failure of the electric system.

### 3.4.3.4 Vertical cat ladder

The nominal size of the steel ladder is the distance between the stringers of the ladders. It shall be 400mm. Ladders shall be made of stainless steel SS 304 free from defects likely to cause injury to persons using the ladders. Stringers shall not have sharp edges. Welding shall be in accordance with IS: 816-1969. The material used for the various parts of the ladder shall be as specified in IS: 226- 1975 or IS: 3039-1965.The thickness of the stringer shall be 10mm.The vertical distance between any two steps shall not vary by more than ±5mm.the vertical steel ladder of nominal size 400 shall be as per IS: 8172-1976.

### 3.4.3.5 Soling under Floors andFoundations

The work covered under this specification includes all type of soling works by rubble stones under floors / foundations, hand packed, complete as mentioned below and approved drawings.

The rubble stone shall be of best quality of black trap / granite / basalt or other approved variety of stone available locally. Stones shall generally conform to the requirements stipulated in IS: 1597 (PartI) and shall be approved by Engineer.

Stones shall be of height equal to the thickness of the packing proposed with a tolerance of ± 10 mm. Stones shall not have a base area less than 250 sq.cm nor more than 500 sq.cm,

and the smallest dimension of any stone shall not be less than half the largest dimension. Generally, PCC shall be preferred in lieu.

### 3.4.3.6 BaseConcrete

Base concrete shall be provided as per the approved drawings. The surface of the base shall be roughened with steel wire brushes without disturbing the base concrete. The base concrete shall be in M-15 (1 cement: 2 coarse sand: 4 graded stone aggregate 20 mm size) and of minimum 40 mm thickness or as directed by Engineer

### 3.4.3.7 Flooring

#### (a) Cement Concrete Flooring with metallic hardenertopping

Wherever floors are required to withstand heavy wear and tear such as in pump house floors, workshops, uncovered staircases etc. the metallic hardener topping flooring shall be used. The metallic hardener topping flooring shall be 52 mm thick with under layer 40 mm thick cement concrete 1:2:4 (1cement : 2 coarse sand : 4 graded stone aggregate 20 mm nominal size) and top layer

12 mm thick metallic hardener consisting of mix 1:2 (1metallic hardener mix:2 graded stone aggregate 6 mm nominal size ) by volume, hardening compound mixed @ 2 litre per 50 Kg of cement or as per the manufacturer's specifications including making chequers of patterns approved by the Engineer on steps, landingsetc.

Metallic Hardening Compound shall be of approved quality and screedable, iron aggregate cementatious system designed to provide a thin, high strength topping for applying over the concrete floors. The iron aggregates shall be free from non-ferrous metal particles, oil, grease sand, soluble alkaline compounds. Sample of the compound shall be got approved from the Engineer before use.

The flooring shall be laid in panels of uniform size and no dimension of panel shall exceed 2 m and the area of a panel shall not be more than 2 sqm. The border panels shall not exceed 450 mm in width and the joints in the border shall be in line with panel joints. Aluminum strips of 2 mm thick shall be provided at the junction of twopanels.

#### (b) Chequered Tiles Flooring

Mainly these shall be used in walkways, landscaping, and parking space or as specified. The size and thickness of tiles to be used shall be as shown in drawings. The thickness of tiles shall not be less than 22 mm. The chequered tiles shall conform to IS: 13801. Color/ shade of the tile shall be as approved by the Engineer or indicated in approved drawings.

For approved makes; kindly refer to Section X: Part 9 – List of Approved Makes.

#### (c) Ceramic Tile Flooring

**Flooring**

The tiles shall be of approved makes; kindly refer to Section X: Part 9 – List of Approved Makes and shall generally conform to IS:15622. They shall be flat and true to shape and free from blisters, crazing, chips, welts, crawling or other imperfections detracting from their appearance. The tiles shall be tested in accordance with IS:13630.

The tiles shall be square or rectangular of nominal size such as 150 x 150 mm, 200 x 200 mm, 300 x 300 mm or any other size as per the approved by engineer in charge. The thickness of the tiles shall be as specified by the manufacturer. The top surface of the tiles shall be glazed and the glaze shall be either gloss yormatt finished or as directed by Engineer.

Samples of tiles shall be got approved from the Engineer before bulk procurement for incorporation in the work.

**Skirting and Dado**

The tiles shall be of approved make and shall generally conform to IS :15622 for dimensional tolerance, physical & chemical properties. The tiles shall be pressed ceramic covered by aglaze thoroughly matured and fitted to the body. The tiles shall be sound, true to shape, flat and free from flaws and other manufacturing defects affecting the irutility. The thickness of the tiles shall be as specified by the manufacturer. Half tiles for use as full tiles shall have dimensions which shall be such as to make the half tiles when joined together (with 1 mm joint) match with dimensions of full tiles.

For approved makes; kindly refer to Section X: Part 9 – List of Approved Makes.

*a. Vitrified Tile Work – Flooring / Dado /Skirting*

***Material***

The tiles shall be of approved make and shall generally conform to IS: 15622. They shall be flat and true to shape, free from cracks, crazing spots, chip pededges and corners. Unless otherwise specified, the nominal sizes of tiles shall be as under:

The tiles shall be square or rectangular of nominal sizes such as : 500 x 500 mm, 600 x 600 mm or any other size as approved by the engineer in charge.

Thickness shall be as per recommendations of the approved manufacturers. Technical specifications of the tiles shall be generally conforming to the following standards:

| | | |
|---|---|---|
| 1. | Deviationinlength | (+/-)0.6% |
| 2. | Straightness ofsides | (+/-) 0.5% |
| 3. | Rectangularity | (+/-) 0.6% |
| 4. | Surfaceflatness | (+/-)0.5% |
| 5. | Water absorption | < 0.50% |

| | | |
|---|---|---|
| 6. | Mohs.Hardness | > 6 |
| 7. | Flexuralstrength | > 27 N /mm2 |
| 8. | Abrasionresistance | < 204 mm2 |
| 9. | Skid resistance(frictioncoefficient) | > 0.4 |
| 10. | Glossiness | Min. 85%reflection |

Samples of tiles shall be got approved from the Engineer before bulk procurement for incorporation in the work.

For approved makes; kindly refer to Section X: Part 9 – List of Approved Makes.

*b. Udaipur Green Marble Flooring*

The marble slabs shall be of selected quality, hard, sound, dense and homogenous in texture, free from cracks, decay, weathering and flaws. Before starting the work the contractor shall get the samples approved by the engineer. This shall be repeated for all the lots supplied at site. Samples shall be tested in accordance with IS: 1124.

The marble slabs shall be hand or machine cut to the required thickness and shape and fine chisel dressed on the sides to the full depth so that a straight edge laid along the side of the stone shall be in full contact it. All angles and edges of the slabs shall be true, square and free from any chippings thus giving a plane surface. Slabs shall have the top exposed surface machine polished (first grinding with carborundum stone) before being brought to site, unless otherwise specified. The edges shall be table rubbed with coarse sand or machine rubbed before placing.

The thickness of the stone slab after it is dressed shall be 18 mm. Tolerance in thickness shall be

±2mm. In respect of length and breadth of slabs, tolerance of ±5mm for hand cut slabs and ±2mm for machine cut slabs shall be allowed.

The marble stones shall be laid over 20 mm (average) thick base of cement mortar 1:4 (1 cement:4 coarse sand) laid and jointed with grey cement slurry, including rubbing and polishing complete.

*c. Udaipur Green Marble in risers and treads of steps, skirting andDado*

For approved makes; kindly refer to Section X: Part 9 – List of Approved Makes.

### 3.4.3.8 Cement Plastering Work

The mixing of the cement mortar for plastering shall be done thoroughly in a mechanical mixer unless hand mixing is specifically permitted by the Engineer. If so desired by the Engineer, sand shall be screened and washed to meet the Employer's requirements. The mortar thus mixed shall be used as soon as possible preferably within 30 minutes from the time water is added to cement. In case the mortar has stiffened due to evaporation of water

this may be re- tempered by adding water as required to restore consistency but this will be permitted only up to 30 minutes from the time of initial mixing of water to cement. Any mortar which is partially set shall be rejected and removed forthwith from the site. Droppings of plaster shall not be re-used under any circumstances.

*Interior plain faced plaster* - This plaster shall be laid in a single coat of 12 mm thickness in cement mortar 1:4 (1 cement: 4 fine sand).

*Plain Faced Ceiling plaster* - This plaster shall be applied in a single coat of 6 mm thickness in cement mortar 1:3 (1cement: 3 fine sand).

*Exterior plain faced plaster* - This plaster shall be 20mm thick in cement mortar 1:4 (1 cement: 4 coarse sand).

### 3.4.3.9 False ceiling

False ceiling shall be 15 mm thick densified regular edged eco friendly light weight calcium silicate false ceiling tiles of approved texture of size 595 x 595 mm in true horizontal level, suspended on inter locking metal grid of hot dipped galvanized steel sections (galvanizing @ 120 grams per sqm including both side) consisting of main 'T' runner suitably spaced at joints to get required length and of size 24x38 mm made from 0.33 mm thick (minimum) sheet, spaced 1200 mm centre to centre, and cross "T" of size 24x28 mm made out of 0.33 mm (Minimum) sheet, 1200 mm long spaced between main 'T' at 600 mm centre to centre to form a grid of 1200x600 mm and secondary cross 'T' of length 600 mm and size 24 x28 mm made of 0.33 mm thick (Minimum) sheet to be inter locked at middle of the 1200x 600 mm panel to from grid of size 600x600 mm, resting on periphery walls /partitions on a Perimeter wall angle pre-coated steel of size(24x24X3000 mm made of 0.40 mm thick (minimum) sheet with the help of rawl plugs at 450 mm centre to centre with 25 mm long dry wall screws @ 230mm interval and laying 15 mm thick densified edges calcium silicate ceiling tiles of approved texture (Spintone / Cosmos/hexa) in the grid, including, cutting/ making opening for services like diffusers, grills, light fittings, fixtures, smoke detectors etc., wherever required. Main 'T' runners to be suspended from ceiling using G.I. slotted cleats of size 25x35x1.6 mm fixed to ceiling with 12.5 mm dia and 50 mm long dash fasteners, 4 mm G.I. adjustable rods with galvanized steel level clips of size 85 x 30 x 0.8 mm, spaced at 1200 mm centre to centre along main 'T', bottom exposed with 24 mm of all T-sections shall be pre-painted with polyster baked paint, for all heights, as per specifications, drawings and as directed by Engineer. The calcium silicate ceiling tile shall have NRC value of 0.50 (Minimum), light reflection > 85%,non - combustible as per B.S. 476 part IV, 100% humidity resistance and also having thermal conductivity <0.043 w/m 0 KC.

### 3.4.3.10 Aluminium Cladding Work

The outer face of the building shall be provided with aluminium cladding system in straight curved and profile section comprising of PVDF/Dura glass 5000 coated 4 mm thick

approved aluminium composite panels in approved colors, including approved aromatized aluminium sub structures frame work. Aluminium, brackets, gaskets, approved fixing arrangement to main structures etc. Complete at all height, levels and locations as directed by the Engineer. This includes bird/vermin proof closures at bottom and PVDE coated aluminium flushing bent to profile, made of single piece and fixed in slope the corner pieces of the cladding system shall be as per approved shop drawings andspecifications.

For approved makes; kindly refer to Section X: Part 9 – List of Approved Makes.

### 3.4.3.11 Epoxy LiningWork

The epoxy resin and hardener formulation for laying of joint-less lining work in floors and walls of concrete structures etc. shall be conforming to the requirements of IS: 9197 (Specification for epoxy resin, hardeners and epoxy resin composition for floor topping).

The hardener shall be of the liquid type such as Aliphatic Amine or an Aliphatic/Aromatic Amine Adduct for the epoxy resin. The hardener shall react with epoxy resin at normal ambient temperature. Contractor shall furnish test certificates for satisfying the requirements of the epoxy formulation approval of the Engineer.

The concrete surfaces over which epoxy lining is to be provided shall be thoroughly cleaned of oil or grease by suitable solvents, wire brushed to remove any dirt/dust and laitance. The surfaces shall then be washed with dilute hydrochloric acid and rinsed thoroughly with plenty of water or dilute ammonia solution. The surfaces shall then be allowed to dry. It is essential to ensure that the surfaces are perfectly dry before the commencement of epoxy application.

Just adequate quantity of epoxy resin which can be applied within the pot life as specified by the manufacturer shall be prepared at one time for laying and jointing.

The minimum thickness of epoxy lining shall be 3 mm. It is essential that the concrete elements are adequately designed to ensure that water is excluded to permeate to the surface, over which the epoxy lining is proposed.

Lining shall be allowed to set without disturbance for a minimum period of 24 hours. The facility shall be put to use only after a minimum period of 7 days of laying of the lining.

### 3.4.3.12 Water-Proofing

Integral cement based water proofing treatment with Brick Bat Coba shall be provided for waterproofing of building roofs, terraces, any other areas or locations etc. as directed by the Engineer. All water proofing admixtures used shall be conforming to IS: 2645 and of approved manufacturer. The admixture shall not contain calcium chloride. The quantity of the admixture to be used for the works and method of mixing etc. shall be conforming to manufacturer's instructions and as directed by theEngineer.

### 3.4.4 Painting of Concrete and PlasteredSurfaces

#### 3.4.4.1. Surface preparation

All RCC and plastered surfaces to be painted shall be made dust free, remove any type of loose material, oil, grease with chiseling (if required) or by grinding.

Pot holes, crevices, honey combing, etc. on RCC surfaces shall be grouted / treated with Two component epoxy modified mortar (Solvent Free epoxy Mortar for high early strength) with compressive strength (As per ASTM C881) of 50 N/mm2 in 7 days, bond strength (as per ASTM C881) of more than 1.5 N/ mm2 and mixing ratio 2 : 1 (Resin : Hardener). The finished surface shall be cured for 4 to 6 hours as per manufacturer recommendations.

Pot holes in cement plastered surfaces shall be cured with rich cement mortar 1:3 (1 cement: 3 coarse sand) and providing a proper curing of minimum 3 days.

For approved makes; kindly refer to Section X: Part 9 – List of Approved Makes.

#### 3.4.4.2. Painting of plastered surfaces not in direct contact withwater

Apply one coat of single component Acrylic based anti-carbonation primer on the surface which fills the capillaries in the concrete and creates a saturated surface for the Anti-carbonation paint. The curing time of primer will be minimum 4 hours. Consumption can vary from 200 – 300 gms / sq.m depending upon the product manufacturer.

Apply Anti-carbonation paint on the surface of desired color based on Single Component Acrylic co- polymer technology. The paint should be Anti-fungal, should have crack bridging capacity of minimum 1 mm with elongation above 300%,Solid Contents 55% and DFT of 200 micron after two coats.

For approved makes; kindly refer to Section X: Part 9 – List of Approved Makes.

#### 3.4.4.3. Painting of exposed RCC surfaces not in direct contact with wastewater

Exposed RCC surfaces of all the units and buildings shall be applied with two or more coats of water proofing cement paint. The cement paint shall conform to IS 5410. The primer shall be a thinned coat of cement paint. The cement paint shall be the best quality from an approved manufacturer. Contractor shall obtain prior approval of the Engineer for the brand of manufacture and the colour/shade. All materials shall be brought to the site of works in sealedcontainers.

For approved makes; kindly refer to Section X: Part 9 – List of Approved Makes.

#### 3.4.4.4. Painting of exposed RCC surfaces and in direct contact with waste wateror splashes

Protective coating shall be provided for the splash zone of the liquid retaining concrete

structures. Coating shall be appropriate to the exposure to sewage. It shall be provided on a properly/ recommended prepared surface so that the roughness, water content/ saturation is within the required limit to give un-flawed coating. The coating shall be suitable for withstand alternating drying and wetting, structural expansion / contraction and biological & chemical exposure of the sewage. The chemical base of the product shall be Polyurethane Resin(s). It shall have a specified mixed density of ~1.35 kg/l at 27°C, solid content of ~84% by weight and/or ~77% by volume and bond strength on concrete shall be >1.5 N/mm2. As per surface condition, appropriate recommended primer may be used. The usage/ coverage should be ~0.15 kg per m2 per coat depending on porosity of substrate. The method of application shall be as recommended by the manufacturer to give the best results. The stable color(s) used shall be such as to distinctly distinguish it from sewage/ liquid. Test certificates of the product shall accompany each batch of the product and further tests shall be conducted by an independent approved agency. The supplied material shall be stored and used in the recommended conditions and manners only. In general products older than 6 months from date of production shall not be used in theworks.

**Technical and Physical Properties of PU resin based coating**

| | | | |
|---|---|---|---|
| 1 | Chemical base | : | Polyurethane Resin |
| 2 | Mixed density | : | ~1.35 kg/l at 27°C |
| 3 | Solid Content | : | ~84% by weight, ~77% by volume |
| 4 | Bond strength on concrete | : | >1.5 N/mm$^2$ |
| 5 | Substrate Preparation | : | +10℃ min. / +40 ℃ max. |

For approved makes; kindly refer to Section X: Part 9 – List of Approved Makes.

### 3.4.4.5. Painting of internal surfaces of thebuildings

All internal surfaces of the buildings shall be treated with white cement based wall care putty of approved make; kindly refer to Section X: Part 9 – List of Approved Makes. Application shall be as per manufacturer's instructions and as directed by Engineer.

Internal surfaces of all buildings shall be painted with three or more coats of Oil bound distemper of approved shade and as directed by Engineer. Oil bound washable distemper (internal application) shall be of approved make and conform to IS:428

For approved makes; kindly refer to Section X: Part 9 – List of Approved Makes.

## 3.4.5 Structural Steel Works

### 3.4.5.1. Material

All materials used shall be new, unused and free from defects. Structural steel and other related materials for construction shall conform to IS 2062 and shall be procured from reputed manufacturers andfor approved makes; kindly refer to Section X: Part 9 – List of

Approved Makes and as approved by the Engineer. Where steel castings are to be used the same shall conform to IS: 1030.

Tolerances for fabrication of steel structures shall conform to IS 7215. Tolerances for erection of steel structures shall conform to IS 12843.

Where steel work is directly exposed to weather and is fully accessible for cleaning and repairing the thickness shall not be less than 6mm. Where steel is exposed to weather but not accessible for cleaning and painting, the thickness of steel member shall not be less than 8 mm. A corrosion allowance of 2mm shall be considered over designthickness.

Where steel work is not directly exposed to the weather the thickness of steel member shall not be less than 6 mm.

Test certificate from the manufacturer for the material shall be made available along with each lot supplied at site. Scratched or abraded steel shall be given a coat of primer (For approved makes; kindly refer to Section X: Part 9 – List of Approved Makes) for protection after unloading and handling prior to erection and milling.

### 3.4.5.2. Inspection and Testing

The Engineer shall have free access to all parts of the job during erection and all erection shall be subject to his approval. In case of faulty erection, all dismantling and reworking required will be at the Contractor's cost. No paint shall be applied to rivet heads or field welds or bolts until these have been approved by theEngineer.

The Contractor shall give due notice to the Engineer in advance of the works being made ready for inspection. All rejected material shall be promptly removed from the shop and replaced with new material for the Engineer's inspection. The fact that certain material has been accepted at the Contractor's shop shall not invalidate final rejection at site by the Engineer if it fails to conform to the requirements of these specifications, fails to be in proper condition or has fabrication inaccuracies which prevent proper assembly nor shall it invalidate any claim which the Employer may make because of defective or unsatisfactory materials and/orworkmanship.

No materials shall be painted or dispatched to site without inspection and approval by the Engineer. The Contractor shall provide all the testing and inspection services and facilities for shop work except where otherwise specified.

For fabrication work carried out in the field the same standard of supervision and quality control shall be maintained as in shop fabricated work. Inspection and testing shall be conducted in a manner satisfactory to the Engineer.

Members shall be inspected at all stages of fabrication and assembly to verify that

dimensions, tolerances, alignment, surface finish and painting are in accordance with the requirements shown in the Contractor's approved fabricationdrawings.

In the event of failure of any member to satisfy inspection or test requirement, the Contractor shall notify the Engineer. The Contractor must obtain permission from the Engineer before any repair isundertaken.

The Engineer has the right to specify additional testing as he deems necessary, and the additional cost of such testing shall be borne by the Employer, only in case of successful testing.

The Contractor shall maintain records of all inspection and testing which shall be made available to the Engineer.

### 3.4.5.3. Welding

The sequence of welding shall be as per IS 9595. Welding shall be done by electric arc process as per IS 816 and IS 823. The work shall be done as shown in the shop drawings which should clearly indicate various details of the joint to be welded, type of welds, shop and site welds as well as the types of electrodes to be used. Symbol for welding on plans and shops drawings shall be according to IS 813. The maximum dia of electrodes for welding work shall be as per IS 814. Joint surfaces which are to be welded together shall be free from loose mill scale, rust, paint, grease or other foreign matter. All operation connected with welding and cutting equipment shall conform to the safety requirements given in IS 818 for safety requirements and Health provision in Electric and gas welding and cuttingoperations.

Inspection and testing of welds shall be as per IS 822 and IS 1182.

### 3.4.5.4. Painting

Primer and finish paints shall be compatible with each other to avoid cracking and wrinkling and shall be from the same manufacturer for each painting system.

#### a. Surface preparation

All non-galvanized steel surfaces shall be cleaned by grit or shot blasting in accordance with BS 7079 - General introduction to standards for preparation of steel substrates before application of paints and related products. The cleaned surface shall have maximum amplitude not exceeding 0.1 mm. The grit or shot blasted surfaces shall be primed within four hours of blasting.

#### b. Primer

Two coats of primer shall be applied on the steel structures. First coat of lead-free, oil-based, high-quality, corrosive resistant steel primers such as Red Oxide Zinc Chromate as specified shall be applied before any member of steel structure are placed in position or taken out of workshop. Second coat of primer shall be applied after the erection is

completed and before paintingcommences.

**c. Paint**

Two coat of Epoxy paint of approved make shall be applied on all structural steel members. Paint delivered to the fabrication shop/site shall be ready mixed, in original sealed containers, as packed by the manufacturer. Thinner shall not be permitted for usage unless specifically approved by the Engineer. The application of paint shall be as per manufacturer's instructions. The coating thickness shall consist of the following minimum dry film thickness, or as recommended by the manufacturer, ifthicker:

| | | |
|---|---|---|
| First coating | : | 100µm |
| Secondcoating | : | 100µm |

The contractor shall submit test certificates from the manufacturer for every batch of paint supplied. The contractor shall arrange for testing of paint (samples taken from every batch supplied) from approved laboratory if the Engineer directs to do so. Test results shall be submitted to the Engineer for approval.

For approved makes; kindly refer to Section X: Part 9 – List of Approved Makes.

### 3.4.5.5. Galvanizing of Structural Steel

Galvanizing of structural member shall conform to IS 4759, 209, 2629, 2633 and 6745.Galvanizing of each member shall be carried out in one complete immersion. Double dipping shall not be permitted, however, in case of members over 7.5 m long, the Contractor shall take prior approval of Employer's Representative for doubledipping.

Wherever galvanized bolts, nuts locknuts, washers, accessories etc. are specified, they shall be hot-dip galvanized. Spring washers shall be electro-galvanized. Re-chasing of bolt threads after galvanizing shall not be permitted. Nuts, however, may be tapped, but not to cause appreciable rocking of the nuts on the bolts. Readily available GI nuts, bolts and washers conforming to galvanizing requirements may also be used after obtaining approval ofEngineer.

All galvanized members shall be treated with Sodium dichromate solution or an approved equivalent after Galvanizing, so as to prevent white storage stains.

Contractor shall ensure that galvanizing is not damaged in transit. In the event of occurrence of any damages Contractor shall at his own cost adopt scraping and re-galvanizing the member to satisfy the specificrequirements.

## 3.4.6 Water Supply and Sanitary Works

### 3.4.6.1. SanitaryInstallation

The work covered under this section includes approved quality sanitary ware, accessories and their installation. The work shall be carried out complying in all respects with any

specific requirements of the local body in whose jurisdiction the work site is located and as approved by the Engineer.

Any damage caused to the building, or to installations therein, either due to negligence on the part of the Contractor, or due to actual requirements of the work, shall be made good and the building or the installation shall be restored to its original condition by the Contractor.

All sanitary ware shall be glazed earthware of fireclay as per the approved drawings and shall be the best quality manufactured by approved manufacturer and shall be finally approved by the Engineer prior to installation. All white glazed porcelain fixtures, such as wash basin, sink drain board, water closet pan, urinal, `P' trap etc. shall have hard durable white glazed finish. The material shall be free from any wrap, cracks, blemishes, blisters, uneven glazing and shall be smooth and free from crazing and deformations. Joints between earthenware and pipes shall be made perfectly air and water tight by caulking with neat cement mortar.

### 3.4.6.2. Water Closet andCistern

*Indian Type Water Closet*

This shall be Orissa pattern of size 580 x 440 mm with integrated type footrest made of white vitreous china conforming to IS 2556 part-III. High level flushing cistern of 10 litres capacity of approved make shall be Vitreous china (IS: 774) or Plastic cisterns (IS: 7231).

*European Type Water Closet*

This shall be "Siphonic Wash down type" of white vitreous china conforming to IS: 2556 (Part VIII) fitted with toilet seat water Jet. Standard toilet paper roll holder of approved type shall be provided, and this shall be surface mounted type fixed with CP counter sunk brass screws. Low level flushing cistern of 10 litres capacity of approved make shall be Vitreous china (IS: 774) or Plastic cisterns (IS: 7231) with all fittings and accessories.

### 3.4.6.3. Urinals

The urinal shall be half stall urinals of size 580 x 380 x 350 mm of white glazed vitreous china conforming to IS 2556 (Part VI).Granite stone partition slabs shall be provided as per the approved drawings between two urinals. Automatic flushing cistern (5 / 10 litres as required) for urinals conforming to IS.2326 shall be provided.

### 3.4.6.4. Wash Basins

Wash basin shall be of white glazed vitreous china of size 630 x 450 mm with a pair of 20 mm CP brass pillar taps, bottle trap and other fittings. All the waste fittings and installation shall be as per approved drawings and as directed by Engineer.

### 3.4.6.5. Sinks

The laboratory sink shall be white vitreous china conforming to IS 771 (Part-III) & IS 2556 (Part-V). The Stainless steel kitchen sink shall conform to IS 13983 and as approved by Engineer.

The waste fittings and plug fittings shall be Brass chromium plated. The chromium plating shall be of service grade No.2 conforming to IS1068.

### 3.4.6.6. Stop cocks and BibCock

Stopcocks and Bib Tap shall be of brass heavy class, chromium plated and of approved manufacture and pattern complying with IS: 781. They shall be of specified size and of the screw down type. The bib cocks shall open in anticlockwise direction. Chromium plating shall be done in accordance with IS: 1068.

### 3.4.6.7. uPVC Pipes for Rain Water Pipes, Soil Waste and Vent Pipes andFittings

The specification covers requirements for plain and socket end unplasticized polyvinyl chloride (UPVC) pipes for use for soil and waste discharge system inside buildings ventilating and rain water applications. All UPVC pipes and fittings shall conform to IS: 13592 (Type-A for rain water pipes & Type-B for soil pipes). Pipes shall be fixed to the wall by W.I. or M.S. holder bat clamps, unless projecting ears with fixing holes are provided at socket end of pipe. The clamps shall be fixed to the walls by embedding their hooks in cement concrete blocks (1:2:4) 10 cm x 10 cm making necessary holes in the walls at proper places. All holes and breakages shall be made good. The clamps shall be kept 25 mm clear of the finished face of the walls to facilitate cleaning and painting ofpipes.

### 3.4.6.8. Poly PropylenePipes

Three layer PP-R (Poly propylene Random copolymer) pipes PN-16, UV stabilized & anti - microbial fusion welded manufactured as per relevant IS code, having thermal stability for hot & cold water supply shall be used. The fittings shall include all PP – R plain & brass threaded polypropylene random fittings.

### 3.4.6.9. HDPE Pipes for Main WaterLines

HDPE Pipes of class PE – 80, PN – 4 shall be used. All pipes shall be ISI marked, manufactured as per IS 4984 – 2002 (Amended up to date). The pipes shall be procured only after approval of the manufacturer by theEngineer.

The contractor / firm shall submit the name of manufacturers of HDPE pipes from whom he is going to procure the pipes for verification of his ISI mark and previous experience in the field of manufacturing of pipes.

The HDPE Pipe manufacturer shall submit test certificates for raw material used for each lot of HDPE Pipes duly supported by purchaser invoices at the time of supply/inspection.

Employer reserves the right to inspect the Pipe Manufacturing unit if required to evaluate the capability and quality assurance before approving the make of pipes.

i. The Color of the HDPE pipe shall beblack.
ii. No reworked material to beused.
iii. The pipes shall be supplied in straight lengths of minimum6m.
iv. The internal diameter, wall thickness, length and other dimensions of pipes shall be as per IS: 14333.

The manufacturer should provide the test certificates for the tests conducted for each lot of pipes dispatched. The acceptance tests can be performed in the in-house laboratory of the pipe manufacturer. The Employer will depute his representative who will check and approve each lot of the pipes manufactured before they leave the factory after ensuring that they are meeting the required specifications.

*Jointing of HDPE Pipes*

Jointing between HDPE pipes and specials shall be done as per IS: 7634 part II. Method of jointing between the pipes to pipes and pipes to specials shall be with butt fusion welding using semi automatic, hydraulically operated, superior quality butt fusion machines which will ensure good quality butt fusion welding of HDPE pipes.

*Installation and testing*

The HDPE Pipes shall be laid in accordance with the latest IS 7634 Part-2.The pipe shall be laid over 150 mm thick sand bedding. After installation, the pipe shall be provided all around with 150 mm sand cover and then backfilled with the excavated material up to the formation level. The backfilling shall be done only after inspection of joints by the Engineer is completed and approvalgiven.

### 3.4.6.10. DWC pipes for internal sewerage system

All pipes shall be ISI marked, manufactured as per IS 14333 – 1996 (Amended upto date). The pipes shall be procured only after approval of the manufacturer by the Engineer.

All other details shall be as per clause 3.4.7.9 above.

## 3.4.7 Manholes, frames and covers

Circular manholes of varying sizes depending on the depth of sewer line shall be constructed with sewer bricks at an interval of 15 m centre to centre, at every turning and change in size of sewer line as per the approved drawings and as directed by the Engineer. The interior of manholes shall be cleared of all debris after construction and before testing the same for water tightness. The manholes shall be provided with ISI marked plastic

encapsulated safety footrest conforming to IS10910.

ISI marked Steel Fibre Reinforced Concrete (SFRC) cover and frame Extra Heavy Duty (EHD – 35 glade designation) of suitable size conforming to IS 12592 shall be provided and fixed as per the approved drawings.

### 3.4.7.1. Inspection and Gully Trap Chambers

Inspection and gully trap chambers shall be provided as per standard CPWD specifications. ISI marked Plastic encapsulated safety footrest conforming to IS 10910 shall be provided in case the chambers are more than 90 cmdeep.

### 3.4.7.2. Valve Chambers

Valve chambers of adequate of adequate size to accommodate valves shall be constructed as per the site condition. The construction shall be similar to that for Inspection Chambers except for benching for the drain pipes. Suitable hand railing on wall of the wall chamber shall be provided.

### 3.4.7.3. Pipelines, pipe work &fittings

(a) Ductile Iron Pipes andFittings

All Ductile iron pipes shall be class K-9 ISI marked conforming to IS: 8329 or equivalent as per ISO 2532/ BS EN 545 with Sulphate Resistant cement mortar lining. All Ductile iron fittings shall conform to IS: 9523.

Socket and Spigot type shall consist of elastomeric rubber ring gasket for forming an integral joint between pipes or pipe and fitting shall be ISI marked to IS: 12820. Flanged Joints, wherever specified in the drawings, shall be ISI marked conform to IS: 8329.

All pipes and fittings shall be internally lined with sulphate resistant cement mortar in accordance with ISO 4179/IS: 11906. Sulphate resistant Cement mortar lining shall be applied at the factory in accordance with the above mentioned standards. Pipe linings shall be inspected and any damage or defective areas shall be made good to the satisfaction of theEngineer.

On completion of the work, the contractor shall remove any oil stains or paint spots, leaving the pipes and fittings in a clean and acceptable condition.

(b) Reinforced Cement Concrete Pipes

RCC pipes shall be in accordance with the relevant clauses of IS: 458. The pipes shall be with Socket and Spigot ends. The pipes shall be lined with 3mm thick PE lining.

(c) Built-in Pipe-work and otherPlant

The pipes and other Plant in water retaining structures shall, wherever possible, be built in as the work on the structure proceeds. The Contractor shall ensure that delivery of the

requisite pipe work and other Plant is in accordance with the requirements of the construction program.

Where a pipe subject to thrust passes through a concrete structure or where an external seal is required, a puddle flange shall be used. The puddle flange dimensions shall conform to BS: 4504. The puddle flange shall be fixed to the collor pipe through welding only and shall not be drilled. The puddle flange and collor arrangement shall be fixed at right angle to the RCC wall during casting of the wall. The exterior of the pipe shall be cement washed symmetrically about the puddle flange by the manufacturer for a length at least equivalent to the thickness of the wall through which itpasses.

The Contractor shall be responsible through every stage of the Works for checking the correctness of the setting of built-in Plant and shall satisfy himself they are positioned in accordance with his approved drawings.

(d) Thrust Blocks

Thrust blocks shall be designed and installed wherever there is a change in the direction/size of the pipe line or the pressure line diagram, or when the pipe line ends at a dead end. If required, thrust blocks shall be constructed at valve location also.

The contractor shall prepare design and drawings of the thrust block and get it approved by Engineer. The minimum grade of concrete for construction of thrust block shall be M-25.

For slopes up to 30 degree good well drained soil carefully tamped in layers of 100 mm under and over the pipe, right up to the top of trench will not require anchoring.

For steeper slopes, one out of every three pipes shall be held by straps fastened to vertical supports anchored in concrete.

### 3.4.8 Plant Roads, Culvert / Cross Drainage, Roadside Drains and Ground Pathways

#### 3.4.8.1 PlantRoads

The roads shall consist of the following crust or layers. These are the minimum specified; however, the thickness and number of layers may change as per the design requirements:

| | |
|---|---|
| 1. | Soil subgrade shall be well compacted and tested at OMC to 97% Proctor density. The soaked CBR value of remoulded sub grade soil samples at the specified dry density and moisture content shall not be less than7% (average of at least 3 specimens), unless specifiedotherwise. |
| 2. | The Water Bound Macadam – shall consist of minimum following layers: |
| | a. Grading-1 - one layer of 100 mm compacted thickness of aggregate size ranging from 90 mm to 45 mmgraded.<br>b. Grading-2 - One layer of 75 mm compacted thickness of aggregate size ranging from 63 – 45 mmgraded. |

| | |
|---|---|
| | c. Grading-3- One layer of 75 mm compacted thickness of aggregate size ranging from 53– 22.4 mm graded. |
| 3. | Screening to fill the voids in the coarse aggregate shall be clean, dry stone dust / moorum other non-plastic material having liquid limit and plasticity index below 20 and 6 respectively provided fraction passing 75 micron sieve does not exceed10%.<br>Binding material to prevent reveling of WBM shall consist of fine grained material possessing P.I. Value up to 6. Application of binding material shall not be necessary where murrum or gravel is used as screenings. |
| 4. | Construction of earthen shoulders of approved design shall progress side by side with WBM construction. These shall be raised as the constructed height of road progresses. The top surface of the shoulder shall consist of 80 mm thick Paver blocks manufactured in minimum M 40 grade concrete (For approved makes; kindly refer to Section X: Part 9 – List of Approved Makes. / equivalent as approved by the Engineer) laid over cement-sand (1:10)of 25 to 50 mm compacted thickness. The top surface of interlocking Paver Blocks shall be flushed with Bituminous road surface on one side and top of drain on the otherside. |
| 5. | Tack coat consisting of a single coat of low viscosity liquid bituminous material to the WBM granular surface. The correct quantity of bituminous material shall be decided by the Engineer and shall be such that the maximum amount that can be absorbed by the surface without causing run-off of excessive primer and to achieve desired penetration of 10 mm. Hand spraying shall not be allowed except in small areas, inaccessible to the distributor, or in narrow strips where primer shall be sprayed with a pressure hand sprayer, or as directed by theEngineer. |
| 6. | Top layer shall be 50 mm thick dense graded bituminous macadam of prepared in hot mix plant. The Marshall method shall be used for determining the optimum binder content. |
| 7. | The bituminous macadam shall be covered with 2 (Two) cm premix carpet surfacing comprising of stone chippings and bitumen emulsion including consolidation with road roller of 6 to 9 tonne capacity. |

The initial or breakdown rolling shall be done with 8–10 tonne dead weight smooth wheeled rollers. The intermediate rolling shall be done with 8–10 tonne dead weight or vibratory roller or with a pneumatic tire droller of 12 to 15 tonne weight having nine wheels, with a tyre pressure of at least 5.6kg/sq.cm. The finish rolling shall be done with 6 to 8 tonne smooth wheeled tandem rollers. The schedule of rolling shall be as directed by Engineer.

In case of difference in specifications of new roads and repaired sections (including shoulders), the directions/ decision of the Engineer shall be final.

### 3.4.8.2 Slab & Box Culvert

1) Thecontractorshallstudythesoilinvestigationreportandbasedontherecommendationssh

all carryout structural designing of theculvert.

2) In general, RCC Box (single / multiple cell) with curtain wall of sufficient depth shall be adopted for new/extension of culverts. Box shall be placed over Bedlevel.

3) The work pertaining to sub structures and superstructures shall conform to guideline given under Clauses 2200 and 2300 respectively of MORTH Specification. Requirement of structural concrete shall conform to Clause 1700. Only TMT steel reinforcement (un-tensioned) conforming to clause 1600 of MORTH specification from original billet manufactures shall be used for all the component of culverts. Materials for structures shall conform to Clause1000 of MORTH Specifications.

4) Graded Gravel Free Draining Backfill On each side of the culvert abutments supporting the RCC slab a free draining backfill of thickness 200 mm shall be provided. The material for this backfill shall be granular consisting of sound, tough, durable particles of crushed or uncrushed gravel, crushed stone or brickbats which will not become powdery under loads and in contact with water. The material shall be free from soft, thin, elongated or laminated pieces and vegetable or other deleterious substances. It shall be graded and shall meet the grading requirements given in Tablehereunder.

| Sieve Designation | Percent Passing by Weight |
|---|---|
| 10 mm | 100 |
| 4.75 mm | 30-65 |
| 425 microns | 5-30 |
| 150 microns | 0-10 |

5) WeepHoles

Weep holes as shown on the drawings or as directed by the Engineer shall be provided in the RCC walls of the culvert to drain water from the backfilling. Weep holes shall be of PVC/HDPE pipes with necessary M10 concrete cushioning 75 mm thick. They shall extend through the full width of the RC wall at spacing of 1.5 m c/c and with slope of about 1 vertical to 20 horizontal (or as shown on the drawings) towards the drainingface.

### 3.4.8.3 PathWays

Necessary pathways of 2000 mm width shall be provided connecting various roads to the units. The pathways shall have factory made precast paver blocks 60 mm thick of M30 grade laid over cement- sand (1:10) of 25 to 50 mm compacted thickness. The sides of the pathways shall be protected by kerb stones manufactured in the factory. For approved makes; kindly refer to Section X: Part 9 – List of Approved Makes. The area where pathways are to be built shall be pre-rolled with a heavy roller after watering thesoil.

### 3.4.8.4 Road SideDrains

Road side drains shall be designed for an intensity of 40mm/hr for 100% run off. The scope of work covered under this specification in general shall comprise of construction of rectangular surface drains. Surface drains shall be provided along the sides of the roads or pavements to collect surface water. Minimum size of drain shall be 300 mm wide & 300 mm deep. The surface drain should have sufficient capacity and longitudinal slope to carry away all surface water collected. The side drains shall be provided at the edges of right of way. The outfall shall be towards the existing nallah / effluent plant drain or any natural surface drain. The longitudinal bed slope not milder than 1 in 1000 shall be provided for the side drains.

All buildings and paved areas in the plant area shall be provided with catch drains for collecting the roof top and surface water. All the drains and catch pits shall be covered with factory made precast perforated RCC slabs. Wherever the drains have to cross the road way, cross drainage such as slab or pipe culverts should be provided. All drains having depth less than 0.75 m may be in brick work and greater than 0.75m shall be constructed in RCC. The contractor shall carryout structural designing of the drains and shall submit design and drawings to the Engineer for approval.

In addition to above, provision shall be made for collection of roof top rain water from all the buildings in the Rain Water harvesting Chambers and transferred into the ground through Rain Water harvesting system.

In case of RCC drains, the bottom slab and side walls shall be of 100 mm thick (minimum) or as per designs and drawings approved by the Engineer in RCC of gradeM-25.

In case of drains constructed in brick work (minimum 230 mm thick) the internal surfaces shall be plastered (1:3, 20 mm) and finished with a floating coat of neatcement.

The combined design of entire drainage system is to be undertaken by the contractor. Consideration to be given for connecting catch drains. Other alternatives such as providing piped drainage system with catch chambers arrangement and manholes may be considered, as approved by the Engineer.

### 3.4.8.5 Fencing

PVC coated or galvanized steel chain link fencing having maximum mesh size of 50 x 50 mm along with stainless steel posts and other members for supporting the fence, etc. all works as per ASTM B6, F567, F668 and AASHTO M-181 or equivalent standards or as approved by Engineer. The minimum thickness of wire and PVC coating over it shall be 3 mm and 1.5 mm respectively thus making finished thickness of fencing wire as 6 mm ±1.5mm. Colour of fencing material as per the approval of Engineer. The PVC coatings and galvanizing shall be as per codes and of assured maintenance free long life.

In case of transformer fencing all metal posts, palings and chain link fencing or other forms of metalwork construction shall be bonded together and then to the substation main earth

using 50 x 6 GI earthing flats. Gates shall be bonded to the enclosure earthing system.

### 3.4.8.6 Construction of Boundary Wall :

Boundary Wall shall be of Random rubble masonry with hard stone in foundation and boundary wall heights as per CPWD specifications including leveling up with cement concrete 1:6:12 (1 cement: 6 coarse sand: 12 graded stone aggregate 20 mm nominal size). Concertina barbed wires on top of entire boundary wall as per standard design shall be provided.

### 3.4.9 Demolition

Demolition procedure/methodology, including list of equipment/ machinery shall be submitted for approval along with details of personnel that will be working to undertake demolition of various structures. Details of safety gear being mobilized should also be submitted.

Demolition and other works shall be carried out under proper supervision by qualified/ certified personnel only. All personnel should be adept at using the safety gear provided to them by the contractor.

Necessary precautions will be taken to keep noise and dust nuisance to the minimum and as per NGT guidelines as also given in Part1 of Volume 2, Section XI. This shall in general be applicable to other activities of the works.

All glass, fragile and combustible material shall be removed from the structure before demolition begins.

Special measures have to be taken for enclosed areas such as digesters which have to be vented properly including neutralizing active chemical/biological contents. Wherever there are hazardous, inflammable or poisonous gases or other materials present, the same have to be removed/ dismantled with all the necessary safety andprecautions.

In addition necessary masks, monitoring meters and neutralizing/ firefighting equipment have to be kept ready of any emergencies along with first aid equipment.

Before commencing demolition, the nature and condition of the concrete, the condition and position of reinforcement, and the possibility of lack of continuity of reinforcement shall be ascertained.

Attention shall be paid to the principles of the structural design to determine which parts of the structure depend on each other to maintain overall stability.

Safe and proper disposal of demolished and or emptied materials shall be the responsibility of the contractor and it shall be done in an environment friendly manner. In this the norm/

practice of the plant may be followed, as directed/approved by the Engineer.

### 3.4.10 PRECAUTIONS DURING EXECUTION

i) The successful tenderer shall comply all instructions in all respects issued by the Employer in respect of road maintenance and inter utility code of conduct for excavating trenches across and along various roads and other places.

ii) The contractor shall have to provide GI sheet barricading up to a minimum height of 2 metres above ground level all around the site of excavation and trenches as per direction of Employer's Representative. Such barricading must be provided before taking up the excavation work and must remain in position till complete filling back of excavated trenches and resurfacing work, if any. The GI sheets must be painted in red & White stripes with fluorescent paint.

iii) Proper supporting of all underground services such as water mains, sewers, cables, drains, water and sewer connections shall be provided by the contractor without any additional cost. If the services/connections are damaged the contractor will be responsible for the restoration of the same to original specifications at his own cost.

iv) The contractor shall provide necessary red flickering lights (blinkers) at all roads and required places at night for diversion/smooth flow of traffic without any extra cost. He shall also provide necessary sign boards painted and written with luminous paint for traffic diversion as per direction of Employer's Representative. The warning notice boards should be put at least 100 metres before the approach to the area on either side where the work is going on. In addition proper lighting arrangement will be made for all excavations works.

v) Proposed alignment of rising mains are to cross roads, nallahs, cables, water mains, and other underground services. Contractor shall be required to work under these constraints. Costs of such items are to be included in the bid of the contractor. Necessary statutory permission for road cutting will have to be arranged by the Contractor at his own cost and fee deposited to the concerned dept. will be reimbursed by the Employer on actual basis.

vi) As a result of excavation of trenches, the existing underground services (UGS) such as water mains, electric poles/cables/Telephone cable and sewer line etc. may become exposed and unsupported. It will be the responsibility of the contractor to make suitable and necessary arrangement for supporting such UGS to keep them functional. Such arrangement will be done as per direction of the Employer's Representative. No separate payment for supporting the services will be made by the deptt. Any damages caused to the above mentioned underground services due to negligence of the contractor or otherwise shall be made good by the contractor at his own cost. After laying the pipe, the contractor shall have to construct masonry pillars, to support the water lines/U.G.S. before the temporary supports are removed and filling of trenches is done.

vii) The excavation below sub soil water level shall be classified as excavation in saturated soil. The trench shall be kept in dry condition during the laying of pipelines and construction of manholes etc.

viii) Existing drains shall not be blocked by excavated earth or any other materials, the

contractor shall ensure that sullage/storm water flow un-interruptly.

# Section X: Part - 4 Technical Specifications: General and Particular – Mechanical

## 4.1 Introduction

This part of the Employer's Requirements sets out the general standards for mechanical plants used by the Contractor for the Works. Reference to any specific item does not necessarily imply that such plant is to be included in the Works but all the Plants to be used for the Works shall, unless otherwise specified, comply with the provisions of this chapter.

### 4.1.1 General

All the mechanical works shall be carried out as per latest national and international standards and codes, with amendments issued up to the date of submission of bid. In case the relevant specifications are not found applicable and adequate than the relevant CPWD/BIS specifications shall be used. Further in case, any of these are not applicable to particular tools, Equipments and machinery, then the manufacturer's specifications or their relevant instructions shall be followed.

All valves, pipes and specials used in the pumping stations and treatment plants shall conform to the specifications given here. Pre commissioning tests, commissioning and trial runs shall be as detailed in Special Conditions for mechanical work.

It is not the intent to specify herein all the details pertaining to the design, drawing, selection of equipment/materials, procurement, manufacture, installation, testing & commissioning, however, the same shall be of best engineering standard and shall comply with all currently applicable standards, regulations & safety codes.

The noise level produced by any equipment like pump sets, compressor sets and blower sets etc. shall not exceed 85 dBA measured at a distance of 1.86 m from the outer surface of the equipment. At the time of operation, the mechanical vibration shall not exceed the limits given below, at recommended points of measurement as per ISO 10816:1995.

Areas of high noise producing unit shall be provided with noise measuring instruments for monitoring of noise level.

| Equipment | Velocity of Vibration mm/sec |
|---|---|
| All rotating equipment not having reciprocating parts with motor KW less than or equal to 15 KW | 1.12 |
| All rotating equipment not having reciprocating parts with motor KW more than 15 KW and less than or equal to 75 KW | 1.8 |
| All rotating equipment not having reciprocating parts with motor KW greater than 75 KW | 2.8 |

### 4.1.2 Applicability

The following clauses specify general mechanical requirements and standards of workmanship for equipment and installation and must be read in conjunction with the

particular requirements for Contract. These general specification clauses shall apply where appropriate except where redefined in the particular required sections of the specification which shall be applicable.

### 4.1.3 List of Standards

Except as otherwise specified in these technical specification, the Indian Standards and Codes of Practice shall be adhered to for the design, manufacturing, inspection and factory testing, handling, installation and site testing of all material and equipment used for the work. Where an Indian Standard is not available or sufficient, an approved national or international standard shall be followed.

Only equipment supplied as per approved vendors list and as approved by the Employer's Representative will be acceptable. Following lists of standard to be adopted:-

| | |
|---|---|
| BS 5135 | Specification for arc welding of carbon manganese steels |
| BS 5316 Part-2 | Specification for acceptance test for centrifugal, mixed flow and axial pumps – Test for performance and efficiency |
| BS 6072 | Method for magnetic particle flow detection |
| BS 6405 | Specification for non-calibrated short link steel chain (Grade 30) for general engineering purposes : Class 1 & 2 |
| BS 6443 | Method for penetrate flow detection |
| ASTM A-36 | Specification for Structural Steel |
| ASTM A-216 | Specification for Steel Castings, Carbon suitable for fusion welding for high temperature service |
| ASTM A-276 | Specification or stainless steel and heat resisting steel bars and shapes |
| ASTM A-351 | Specification for castings, Austenitic – Ferric (Duplex), for Pressure containing parts |
| ASTM A-743 | Specification for castings, Iron – Chromium, Iron – Chromium – Nickel and |
| | Nickel Base Corrosion Resistant for general Application |
| ASTM A-744 | Specification for castings, Iron Chromium – Nickel, Corrosion – Resistant |
| IEC –189 Part 1 &2 | Low frequency cables and wires with PVC insulation and PVC Sheath |
| AWWA C 501 | Cast Iron Sluice Gates |
| IS 5 | Colours for ready mixed paints and enamels |
| IS 210 | Grey Iron Castings |
| IS 318 | Leaded Tin Bronze Ingots and Castings |
| IS 325 | Three Phase Induction Motors |
| IS 807 | Code of Practice for Design, manufacture, erection and testing (Structural Portion) of cranes and hoists |

| | |
|---|---|
| IS 1239 | Mild Steel tubes, tubular and other wrought steel fittings |
| IS 1536 | Centrifugally Cast (Spun) iron pressure pipe for water gas and sewage |
| IS 1537 | Vertically cast iron pressure pipes for water, gas and sewage |
| IS 1538 | Specification for cast iron fittings for pressure pipes for water, gas and sewage |
| IS 1554 | PVC insulated (Heavy duty) electric cables |
| IS 2062 | Steel for general structural purposes |
| IS 2147 | Degrees of protection provided by enclosures for low voltage switch gear and control gear |
| IS 3177 | Code of practice of electric overhead traveling cranes and gantry cranes other than steel work cranes |
| IS 3624 | Vacuum and Pressure gauges |
| IS 3815 | Point hooks with shank for general engineering purposes |
| BS 2910 | Methods for radiographic examination of fusion welded circumferential butt joints in steel pipes |
| BS 3017 | Specification for mild steel forged ram shorn hooks |
| BS 3100 | Specification for steel castings for general engineering purposes |
| BS 3923 | Methods for ultrasonic examination of welds |
| BS 4360 | Specification for weldable structural steels |
| BS 4772 | Specification for ductile iron pipes and fittings |
| BS 4870 | Specification for approval testing of welding procedures |
| BS 4871 | Specification for approval the sting of welders working to approved welding procedures |
| BS 4942 | Short chain link for lifting purposes |
| IS 5120 | Technical requirements of roto dynamic special purpose pumps |
| IS 5600 | Horizontal / vertical non clog type centrifugal pump for sludge handling |
| IS 7090 | Guide lines for rapid mixing devices |
| IS 7208 | Guide lines for flocculator devices |
| IS 10261 | Requirements for clarifier equipment for waste water treatment |
| IS 8413 | Requirements for biological treatment and equipment |
| Part-II | Activated sludge process and its modifications |
| IS 10037 | Requirements for sludge dewatering equipment |
| IS 6280 | Specification for Sewage Screens |
| IS 3938 | Electric Wire rope hoists |

Note: *The Standards to be referred shall be to the latest revision of that standard.*

### 4.1.4 Materials

All materials incorporated in the works shall be the most suitable for the duty concerned and shall be new and of first class commercial quality, free from imperfection and selected for long life and minimum maintenance.

### 4.1.5 Inspection, Pre-Dispatch Inspections and Testing by Employer

(i) The Employer reserves the right for pre- dispatch inspection of Equipment at the manufacturer's place in India by the representatives of the EMPLOYER along with Contractor or his/their representatives. The total cost of to & fro by Air or any other better conveyance charges, wherever the air routes are not available, boarding and lodging etc., shall be borne by the Contractor. In case the equipments are not found suitable for dispatch or whatsoever the defects may by, and another inspection is required that visit also shall be arranged and borne by the contractor. The EMPLOYER shall not entertain any request on this account; even such inspection may be one or more, as may be required, before the dispatch of the Equipments. The discrepancies of such equipments as pointed out by the representatives of the EMPLOYER shall be rectified at the cost of the Contractor or the Manufacturer and the EMPLOYER shall not hold any liability on this account, what so ever may be.

(ii) A mutually agreed quality assurance plan will be developed which provides for inspection and certification by EMPLOYER at specified times during the manufacture and fabrication of such items. All costs for independent inspection or testing will be borne by the Contractor, and the Contractor shall be fully responsible to ensure that adequate provisions are made in his tendered rates to cover independent inspections and testing for the following equipments and machineries to be incorporated in the Permanent Works:

| Sl. No | Name of the Equipment | Stages of inspection |
|---|---|---|
| 1. | Pumps | 1. Review of material test certificate for pump casing, bowls, shaft, impeller bearing, columns pipe etc.<br>2. Review of heat treatment certificate if any<br>3. Dynamic balancing of rotating parts/impeller, certificate to be reviewed<br>4. Examination of the shaft<br>5. Painting certificate to be reviewed<br>6. Hydro test of casing<br>7. Performance test at 49 Hz and 50 Hz frequency including vibration/noise level measurement covering following tests<br>• Capacity in LPM/LPS<br>• Delivery heads in meters<br>• Efficiency at the specified duty, with two readings above and below duty point<br>• Power absorbed by the pump at the specified duty |

| Sl. No | Name of the Equipment | Stages of inspection |
|---|---|---|
| | | • Maximum power required by the pump<br>• Shut off head of the pump<br>• Visual and dimensional check<br>• Strip test<br>• Visual and dimensional check<br>• Speed test at 49 Hz and 50 Hz frequency<br>• Test to be carried after installation at site:<br>• Discharge of the pump when only one is operated in the system<br>• Delivery pressure when only one pump is operated in the system<br>• Power absorbed by the pump when only one pump is operated in the system<br>• Efficiency of the pump when only one pump is operated in the system<br>• Performance of the Pumps operated at average flow and peak flow |
| 2. | Motors | 1. Dynamic balancing of rotor and visual examination of rotor assembly, certificate to be reviewed<br>2. Visual inspection and testing of stator assembly, certificate to be reviewed<br>3. Review of test certificate for conductor, stator coil, shaft bearing etc.<br>4. Verification of type test report |
| 3. | Switch Gear and Electrical Panels | 1. Visual and dimensional check<br>2. Verification of bill of material<br>3. Functional test<br>4. H.V./I.R. test<br>5. Verification of type test report<br>6. Voltage ratio, burden class, induced high voltage, applied high voltage test for potential transformers<br>7. Current ratio, burden class of accuracy, test for current transformers<br>8. Rate symmetrical braking capacity, rated making capacity, rated short time current, auxiliary voltage for release coils, impulse with standard voltage test for switch gear panels<br>9. Test result for relay provided |

| Sl. No | Name of the Equipment | Stages of inspection |
|---|---|---|
| 4. | Transformer | Visual inspection, dimensional check and verification of bill of materials.<br>Iron losses and Copper losses test at 90% of the rated voltage, 100% rated voltage and 110% of the rated voltage.<br>Resistance voltage test at HV side and L.V side.<br>Routine tests as per IS:2026.<br>Verification of type results, temperature rise test, Impulse test, Insulting oil test etc. |
| 5. | Capacitor | All routine and type test as per IS: 2834 such as sealing test test for output / capacitance, Insulation resistance test between terminals. Containers and loss angle measurements, test for efficiency of discharge divide, test for dielectric loss angle, thermal stability test, self healing test, voltage test between terminals. |
| 6. | Cables | Visual Inspection and dimensional check.<br>Routine test as per IS: 1554.<br>Insulation test, resistance test, current rating test, star reactance test, star capacitance test, short circuit current test, voltage drop test. |
| 7. | Valves | Visual and dimensional check.<br>Review of material test certificate for Valve body and internal parts.<br>Operational smoothness.<br>Hydrostatic test / leakage test as per applicable code. |
| 8. | Pipes & Specials | 1. Visual and dimensional check.<br>2. Review of chemical and physical test certificates as per the relevant Indian Standard specifications.<br>3. Hydrostatic pressure test as per the relevant Indian Standard specifications.<br>4. Ultrasonic testing of welded joints for MS pipes<br>5. Checking the integrity of epoxy lining for MS pipes at joints after laying and jointing pipes. |
| 9. | Sluice Gate | 1. Visual and dimensional check.<br>2. Review of chemical and physical test certificates as per the relevant Indian Standard specifications.<br>3. Hydrostatic pressure test as per the relevant Indian Standard specifications.<br>4. Checking the integrity of epoxy lining |
| 10. | DG set | 1. Visual check up.<br>2. All the manufactures test certificates shall be |

| Sl. No | Name of the Equipment | Stages of inspection |
|---|---|---|
| | | submitted. If EMPLOYER desires any test, contractor shall arrange to perform the same at no extra cost. |
| 11. | Compressor/ Blower | 1. Visual check up.<br>2. All the manufactures test certificates shall be submitted. If EMPLOYER desires any test, contractor shall arrange to perform the same at no extra cost. |
| 12. | EOT Crane | 1. Visual and dimensional check.<br>a. Load test at 25% in excess of rated load.<br>b. Test for Deflection<br>c. Test for lifting speed. |
| 13. | Actuators | 1. Visual and dimensional check.<br>2. speed for actuation<br>3. All the manufactures test certificates shall be submitted. If EMPLOYER desires any test, contractor shall arrange to perform the same at no extra cost. |
| 14 | Motors and Reduction Gears | 1. Visual and dimensional check up.<br>2. Test for speed<br>3. All the manufactures test certificates shall be submitted. If EMPLOYER desires any test, contractor shall arrange to perform the same at no extra cost. |
| 15 | PLC, Automation, Field equipments | Visual and dimensional checkup.<br>Checking for suitability in terms of connecting, fitting, auxiliary voltage, necessary change over contracts.<br>Test certificate of all equipment and performance of equipment after connecting all controllers at local level and at remote level through controller.<br>Display in terms of appropriate units and satisfactory calibration. Any error shall be removed.<br>Coding and addresses of all inputs and outputs.<br>Graphical representation alarm generation. |
| 16. | Screening Equipment | 1. Visual and dimensional check up.<br>2. All the manufactures test certificates shall be submitted. If EMPLOYER desires any test, contractor shall arrange to perform the same at no extra cost. |
| 17. | Aeration Equipment/ Diffuser | 1. Visual check up.<br>2. Oxygen transfer capacity. |
| 18. | Thickening/ Dewatering Equipment | 1. Visual and dimensional check up.<br>2. All the manufactures test certificates shall be submitted. If EMPLOYER desires any test, contractor |

| Sl. No | Name of the Equipment | Stages of inspection |
|---|---|---|
| | | shall arrange to perform the same at no extra cost. |

In addition to these the contractor shall carry out test of the other equipment in the presence of EMPLOYER engineers and shall submit test certificates for approval.

### 4.1.6 GUARANTEE

i) The Contractor shall guarantee all Equipment and machinery and their equipments supplied under the Contract, including erection and commissioning works, to be suitable for the application for which it is designed, and against defects due to manufacture or poor workmanship for a period of 12 months from the date of satisfactory completion of the stipulated trial run period. The Contractor shall be responsible to replace, free of cost, the whole equipment or parts thereof which may be found defective during this period, and to ensure the proper working of the equipment during the guarantee period. In case the Contractor fails to repair or replace any defective Equipment & machinery and equipment or part(s) thereof within 30 days from the date of intimation of any defects by the Engineer, the same will be done by the EMPLOYER/Engineer at the Contractor's cost.

ii) If it becomes necessary for the Contractor to replace or renew any defective portion of the pump house or equipment under this Sub-Clause, the machinery and equipment, so replaced and the work so renewed shall be guaranteed for a further period of 6 months from the date of replacement or renewal or until the end of the 12 month general guarantee period, whichever may be later. Only genuine spare parts are to be used under the supervision and with approval of Engineer.

## 4.2 EQUIPMENT: GENERAL SPECIFICATIONS, DESIGN AND MATERIAL OF SPECIFICATIONS

### 4.2.1 Mechanically Raked Coarse (Medium) Bar Screen

#### 4.2.1.1 Scope of Supply

The scope of supply shall provide complete automatic mechanical screen systems with all accessories and appurtenances, including, but not limited to:

- Mechanically operated screen;
- Screenings collection, (dewatering) sweeping, washing and disposalsystem;
- Automatic screen controlsystem;
- Electrical & Instrumentation for compliance of Automatic System (Electrical wiring between all screen components, instruments, control devices and the local control panels and the screen controls)

#### 4.2.1.2 Downstream WaterLevel

Bidders should state the maximum and/or minimum allowable water levels downstream of the screen in order to pass the required flow. To reduce the height of the screen above ground level, the screen might be located at a level such that there is a constant static water level in the screen chamber due to downstream tank water levels.

#### 4.2.1.3 Guaranteed Flow Rate and HeadLoss

The screen shall effectively screen all flows up to the design flow. The Contractor shall guarantee the following screen performance parameters:

- Clean water flow rate capacity (l/s) at the maximum allowable water depth downstream of the screen
- Clean water head loss at the max flow rate and maximum allowable water depth downstream of the screen
- Maximum sewage flow rate capacity (l/s) at the maximum allowable water depth downstream of the screen based on their expected screen blinding insewage

#### 4.2.1.4 General

(i) The screen shall be of the front rakingtype.

(ii) The aperture size of the screen shall be 20mm.

(iii) The screen shall be capable of performing the duties set out in this Specification. All the materials and sub-assemblies used shall be suitable for outdoor application. They shall be constructed so that maintenanceis kept to a minimum.

(iv) The mechanically cleaned screens shall be constructed from stainless steel (AISI 316) i.e. screen bars, screen body, carriage, rake and all other parts except for drive motor, gear reducer and non wastewater contact parts such cog wheels, chains etc. The screen with all its functions and accessories shall be completely lubrication free and fully automatic operated for minimum operationalcosts.

(v) There shall not be any moving part, sprocket, bearings, etc. continuously immersed in sewage.

All lubricating points shall be conveniently accessible from the deck level.

(vi) The screen shall be suitable for discharging 75% of the screened material lifted from the screen into thechute.

(vii) The screen shall be designed such that in case of heavy accumulation of solids the same is to be removed gradually without overloading or damaging the screen bars ormechanism.

(viii) The complete screen above slab level (except for drives & gear reducer) shall be enclosed in a stainless sheet metal of enclosure using SS-316 sheets of thickness not less than 2 mm and be suitably braced with stainless steel angle frame. The enclosure shall be such that the covers can be easily removed for inspection &maintenance.

(ix) The screen will be factory assembled and tested unit and has to be installed at the site in factory assembled condition to avoid chances ofmisalignments.

(x) Torque switch shall be provided to protect the screen from damages resulting from

excessivetorque.

(xi) The operating locus of the rake shall be designed in a way that before engaging the bars the rake performs digging action. This action will allow rake to penetrate, collect & remove the waste settled at the bottom most section of thescreen.

(xii) The bars of the screen shall preferably be curved at the bottom to match the locus of the rake operation with a view to enable the rake to obtain support / guide from the moment it start its upward raking operation.

(xiii) The rake shall be fitted with heavy-duty helical coil spring, which creates pressure on rake, so that the rake will always run in proximity to the bars & dead plate. This will avoid fall back of material during upward travel ofrake.

(xiv) These screens shall be provided with integrated scrape & wiper mechanism for discharging the screenings to discharge chute. The wiper mechanism shall be springloaded.

(xv) The profile should have non clogging feature and should offer lesser head loss than a rectangular profilebars.

#### 4.2.1.5 Frame Work

The frame work of the screen shall be of robust construction with intermediate cross bracing. The lower ends and sides of the frame shall be grouted in concrete. Each screen shall have an independent canopy at the top for weather protection.

#### 4.2.1.6 Bar Screens Assembly

Screen bar assembly shall be fitted across the screen chamber. Screen shall have a series of vertically oriented bars spanning the inlet channel and spaced as specified. Bars shallbe sufficiently rigid to prevent vibrations in stream wise and lateral modes and to withstand the maximum differential head that will occur with the screen totally blinded. Bars shall have tapered cross section to prevent jamming of screenings between bars. Bars shall have supports only at both ends. The bar rake shall be made of stainless steel half rounded flats of SS-316, 10 mm thick and 50 mm wide in section. The profile should have non clogging feature and should offer lesser head loss than a rectangular profilebars.

#### 4.2.1.7 Rake Carriage

The rake carriage shall comprise a stiffened frame work to which is attached replaceable rake tines. The rake tines shall be suitable to accommodate bulky screenings. Rake carriage shall incorporate suitable devices to enable the rake to ride over any small obstacles wedged in the screen and automatically stop the drive motor in the event of the rake jamming against a large obstruction. There shall not be any mechanical damage resulting from obstruction wedged in the screen bars. The rake carriage shall always come to rest in a parked position with the rake above the sewagelevel.

The screen shall be cleaned automatically through an adjustable timer. The rake lowered

will clear screen bars at the beginning of a cycle and accurately engage with the screen bars at the bottom of the channel. The tine profile and rake motion shall be designed to elevate screenings to the discharge chute at deck level without debris falling back or being forced through the screen. The rake shall be suitable for elevating debris encountered at any level. Rake tines shall bereplaceable.

The screenings shall be discharged from the unit by a wiper mechanism down to a discharge chute leading to a shaft less screw conveyor. Arrangement shall be such as to ensure that screenings are discharged to the discharge chute leading to the conveyor. The rake tines shall then be retracted and the unit ready for the nextcycle.

#### 4.2.1.8 Rake Lifting Mechanism

Lifting mechanism shall consist of a steel wire rope or chain and sprocket.

#### 4.2.1.9 Inspection Platforms

An inspection platform shall be provided for periodic checking and maintenance of the drive and other critical parts. A ladder with handrails for access to this platform shall be fixed. Suitable hand rails shall be provided for safety on the inspection platform andalso at deck level.

#### 4.2.1.10 Dead Plate

Dead plate extending from the top of the bars to the deck level shall be provided to ensure that screenings do not fall back. Dead plate shall be made of minimum 5 mm thick plate. The clearance between the tines and the dead plate shall not exceed 5mm.

#### 4.2.1.11 Driving Mechanism

The driving mechanism shall consist of a sturdy reduction gear unit driven through multiple ‘V’ belts or directly by an electric motor. Motor shall be mounted in such a way that the tension of the 'V' belts can be adjusted. A manually reset torque limiter shall be provided between the motor and gear unit, incorporating a limit switch to cut off the supply to motors in the event of an overload.

#### 4.2.1.12 Gear Reducer

(i) The reducer shall be sized and selected with a minimum service factor of 2.0 times the motor nameplate horse power rating in accordance with applicable American Gear Manufacturer's Association Standards. The reducer shall have a life of 40,000 hours based on the motor name plate horse-power. The reducer shall have anefficiency of not less than 90% based on reducerinput.

(ii) All gear meshes shall be oil lubricated. All gears shall be provided with an oil reservoir for instant lubrication on starting. The gear reducer housing shall be provided with an oil level indicator and oil drain with necessaryfittings.

(iii) The gear reducer shall be of cast iron construction. The reducer housing shall also include suitable lifting lugs and external gear train inspection covers for each gear train. The gears shall be matched for maximum tolerance variation. The gear reducer shall be suitable to reduce the motor asynchronous speed to achieve the required speedof raking.

### 4.2.1.13 Control System

(i) The screening operation shall be carried out through adjustable timers which are adjustable at site for 0-60 minutes for interval between twooperations.

(ii) Control system for the conveyor shall be designed to achieve thefollowing:

- Conveyor shall be started when any of the rakes starts it's upwardstravel.
- Conveyor shall be stopped with a time delay (by adjustable timer) after rake is stopped.

(iii) Weatherproof, lockable, emergency mushroom headed stop push buttons shall be provided near each motor for screen and conveyor operation of stop push button shall be included in the controlscheme.

(iv) Differential pressure switches shall be provided to annunciate screenjamming.

**Note:** The screen shall also be designed to operate automatically when level differences between upstream and downstream reaches a preset value & stop at preset differential level. The level controller shall be Ultrasonic type level controller. The screen will start from bottom of screening chamber at peak water level as well as near zero waterlevels.

(v) The control panel shall have IP 65 protection, painted with epoxy paint and shall be comprisingof:

- MCBs
- Mushroom head emergencystop.
- Overload relays for motorprotection.
- Electronic Equipment (Circuitry) to operate the screen with ultrasonic type level sensor.
- Selectorsswitch to operate the screen in Auto, off and JOG mode.
- Provision to run the screen on timer in case of failure of levelsensor.

### 4.2.1.14 Screenings Conveyance, Compaction andDewatering

The screening system shall be supplied with a duty and standby belt conveyor that will be used to convey the screenings to the automatic screenings press and discharge system that compacts, dewaters and discharges the screenings through a chute to the screenings storage system.

The screenings dewatering and compaction system shall compress and dewater the screenings such that the screenings from a consolidated mass with no free water entering

the screenings bag.

#### 4.2.1.15 Portable Screenings Container

These shall confirm to the specifications mentioned under Fine Screens.

#### 4.2.1.16 Motors

An Electro brake motor shall be provided to operate the rake mechanism. Motors shallbe squirrel cage type conforming to IS 325. The power rating of motor shall be at least 125% of maximum power requirement. The other features of motors shall be as follows:

i) Type of duty : Intermittent(S4)
ii) Method of Starting :DOL
iii) Class of insulation : F (Temperature rise limited to class B)
iv) Type of enclosure :TEFC
v) Degree of protection : IP55

#### 4.2.1.17 Raw Sewage Pumps

The Contractor shall provide system design of the pumps for the approval of the Employer's Representative. The selected pumps shall be suitable for operation in different combination/speed with the range as given in Part -2 for the following details:

**(i)** Flow range (Average) : Raw Wastewater pumping station (Part -2)
**(ii)** Minimum Drain level : As per Topography Survey details
**(iii)** Friction Formula : Hazen Williams
**(iv)** "C"- value : As per CPHEEO Manual/ Indian Standard

#### 4.2.1.18 Design Requirements

The Contractor shall provide required no. of submersible pumps (Working + Standby), required flow capacity, for the pumping station. All the pumps shall be of similar characteristics, suitable for parallel operation. Head of the pump shall be based on the design calculations. However, no claim will be entertained on this account.

The operation of the pumps shall be progressive in a straight line from 50 % to 130 %, controlled through variable frequency drives/motors.

The pumping operation shall be controlled by a DCS based automation system, on the incoming water flow, and the level of water in the sump.

#### 4.2.1.19 Submersible Pumps (Main Pumps)

##### 4.2.1.19.1 Design Requirements

The pump should be capable of developing the required total head at rated capacity. Pumps should be suitable for single as well as parallel efficient operation at any point in between the minimum and maximum system resistance indicated in the system resistance curves. The total head capacity curve should be continuously rising towards the shut off.

Pumps shall run smooth without undue noise and vibration. The velocity of vibration should be within 4.5 mm/sec. The noise level should be limited to 85 dBA at a distance of 1.8 M.

Operating range - system curve

The power rating of the pump motor should be the larger of the following:

- The maximum power required by the pump from zero discharge to zero head.
- 115% of the power required at the duty point. Considering the pump efficiency with 1% negative tolerance on quoted figure of efficiency (with zero negative tolerance).
- System resistance curve shall be applicable within ±5% of the duty point.
- Combined pump efficiency shall not be less than 0.70. Pumps Efficiency less than 0.75 shall not be accepted. Motor efficiency shall not be less than 0.94.
- The pump set should be suitable for starting with discharge valve open, as well as closed.

#### 4.2.1.19.2 Features of Construction

Pump should be non clog submersible type, suitable for applications in municipal sewage handling.

Pumps should be identical and suitable for parallel operation with equal load division. Components of identical pumps should be interchangeable.

Pump casing should be of robust construction Liquid passages should be finished smooth and designed so as to allow free passage of solids as specified below. The volute tongue should be straight across and filed to a smooth rounded edge. Casing should be provided with hardened renewable wearing ring.

Impeller should be non clog with toothed sharing ring on upper side of Impeller, closed type with smooth blunt edges and large water ways so as to allow free passage of large size solids. It should be free from sharp corners and projections likely to catch and hold rags and stringent materials.

The first critical speed of the rotor should be 30% above the operating speed. Complete rotor should be statically and dynamically balanced.

Pumps should be provided with anti friction bearings. Bearings should be easily accessible for inspection and maintenance. Bearings should be grease lubricated/ regreasable.

Pump should be furnished complete with automatic flexible coupling to lower along guide rail & ensure leakage free pumping.

Tappings should be provided at discharge pipes for pressure gauge connection.

**Operating data**

| | |
|---|---|
| Flow | – As per design (Part -2) |
| Head | - As per design |
| Operating speed | Less than 1000 rpm (Synchronize) |
| Min Pump Efficiency | 75 % |
| Quantity | As per design (Part -2) |
| Ambient temp range | up to 47 deg C |
| Free passage of solids | 80 mm |

**Design**

| | |
|---|---|
| Design | Submersible pump |
| Type of bearing | Antifriction |
| Lubrication | Grease / Regreasable |

#### 4.2.1.19.3 Material of Construction

**Pumps**

| | |
|---|---|
| Pump casing | Grey cast iron |
| Discharge covers | Grey cast iron |
| Impeller | stainless steel SS316 |
| Shaft | stainless steel SS316 |
| Bearing Bracket | Grey cast iron |
| Motor casing | Grey cast iron |
| Bolts, nuts | stainless steel SS316 |
| Shaft protective sleeve | stainless steel SS316 |
| Casing wear ring | Grey cast iron |
| O-ring | Nitrile rubber (NBR) |

**Shaft seal**

| | |
|---|---|
| Type of seal | Double mechanical seal |
| Arrangement | Tandem |
| Seal on medium side | With elastomer bellows |
| Mechanical seal, pump side | Silicon carbide |
| Mechanical seal, bearing side | Carbon/ silicon carbide |

**Monitoring**

| | |
|---|---|
| Thermal winding protection | Thermistors PT-100 in all three phase winding Explosion proof protection |
| Motor housing monitoring | By conductive moisture sensor electrode |
| Mechanical seal leakage detection | -By float switch |
| Bearing temp monitoring | Thermistors PT 100 in upper bearing |

**Installation**

| | |
|---|---|
| Type of installation | wet well installation design for automatic connection to a permanently installed discharge elbow will neoprene seal to avoid metal to metal contact |
| Flange dimension to | As per manufacturer's standard, PN 10 |
| Claw | Bolted to the pump |
| Installation depth | As per data provided |
| Guide system | SS316 |
| Lifting device | Stainless steel lifting chain |
| Length of lifting device | Suitable |
| Lifting loops | suitable |
| Installation accessories | Discharge elbow, fasteners, claw, bracket, lifting chain, guide bars etc. complete |

**MOTOR:**

| | |
|---|---|
| Min. motor efficiency | 94% |
| Degree of protection | IP 68 |
| Insulation class | F |
| Coolant temp | </= 400 C |
| Starting mode | Direct |
| Rated voltage | 3ph, 415 V |
| Rated freq | 50 Hz |
| Nominal speed | Less than 1000 rpm (Synchronized) |
| Voltage tolerance | ±10% |
| Motor casing | Grey cast iron |
| Main cable | complete with cable length as per requirement |

#### 4.2.1.19.4 Shop Testing – Witnessing

The following shop tests should be witnessed by Authority/Consulting Engineer.

Standard Running Test as per IS:5120, at rated speed, in manufacturer's works to measure capacity, power and efficiency at various head. Tenderer to quote pump efficiency with zero negative tolerance (and not 5% as indicated in IS: 5120). Pump with a limit of max. 1% drop in efficiency should be accepted. Pumps with more than 1% negative tolerance shall not be accepted. These tests shall form the basis for Pump acceptance except for vibration and noise. The pumps should be tested over the range covering from shut off head to the maximum flow. The duration of the test should be minimum one hour. Minimum five readings approximately equidistant should be taken for plotting the performance curve.

### 4.2.1.20 Dewatering Pump

#### 4.2.1.20.1 Design Requirements

Pump should be suitable for handling settled sewage containing grit and suspended

particles.

The pump motor should be suitable for working with or without submergence in sewage. The motor rating should be more than the maximum power required by the pump.

The pump set should be portable with necessary hooks.

The pump should be suitable for dewatering from a pit 900mm x 900mm x 100mm deep.

The pump should be vertical, centrifugal, non clog type.

The pump impeller should be mounted on the extended shaft of the motor.

The pump should be provided with mechanical seal.

The pump should be supplied with flexible hose pipe of 50mm, 50 M length.

Suitable cable of 50 M length should be supplied with the pump.

**4.2.1.20.2 Materials of Construction:**

| | | | |
|---|---|---|---|
| a) | Impeller | : | Stainless Steel |
| b) | Casing | : | Cast Iron |

**4.2.1.21 Delivery Pipes – Design Considerations**

All the piping shall be of DI as per IS codes.

The sizes of manifold pipes shall be as per design. Delivery pipes for pumps shall be sized to limit the velocity of flow below 2.0 m/sec. However the sizes calculated as per above shall be allowed to adjust up to ±3% so as to offer standard sizes of pipes/fittings. If after adjustment sizes are not within the standard sizes available, next higher size should be provided.

**4.2.1.22 GENERAL REQUIREMENTS FOR PIPES, SPECIALS AND VALVES**

**4.2.1.22.1** Some particular requirements for piping work are given below:

Pipes carrying raw or treated sewage shall be of ductile iron, flanged or with spigot and socket joints with rubber rings, according to individual circumstances. Generally, the following materials shall be used:

| | |
|---|---|
| Raw sewage, treated sewage, interconnection between the units | Ductile socket/spigot grade K7 and flanged medium range |
| Sludge, waste water, overflow | Sludge Line Gravity flow : DI K7 grade<br>Sludge Line - Pressure flow: SS 304 SCH 20 (min). |
| Process water in the plant, internal drinking water supply | Galvanized iron pipes, threaded joints; PVC class 3 for underground pipes |
| Air pipe | GI medium grade upto 150 mm/<br>MS heavy grade for 200 mm and above /Seamless |

N

o sludge line should be less than 100 mm dia. The dia. of suction pipe should be minimum 150 mm and delivery pipe should not be less than 150 mm dia. Further return sludge lines & associated pumping station system shall be designed to carry minimum

50% of main flow.

Pipes carrying chemical solutions or solutions or gases shall be selected according to the properties of the medium after approval of the Employer's Representative. Joints shall be kept to a minimum. All flexible pipes shall be supported on walls, or laid on trays or in pipe channels etc. to avoid sagging. Drain cocks shall be provided to empty the pipes whenever necessary.

**Ductile Iron Pipes**

The pipes will be centrifugally cast (spun) Ductile Iron pipes for Water and Sewage confirming to the IS 8329: 2000. The pipes used will be with push on joints (Rubber Gasket Joints) of the class K-9.

The pipes shall be coated with bitumen as per the provisions of Appendix C of the IS 8329: 2000.

The pipes will be supplied in standard length of 4.00, 5.00, 5.50 and 6.00 meters with suitably rounded or chamfered ends. Each pipe of the push on joint variety will also be supplied with a rubber SBR gasket. The gaskets will confirm to the IS 5382:1985.

The gaskets should also be supplied by the manufacturer of the pipes. They should preferably be manufactured by the manufacturer of the pipes. In case they are not, it will be the responsibility of the manufacturer of the pipes to have them manufactured from a suitable manufacturer under its own supervision and have it tested at his/sub contractor's premises as per the contract. the pipe manufacturer will however be responsible for the compatibility and quality of the products.

**Inspection and Testing:**

The pipes will be subjected to following tests for acceptance:

Visual and dimensional check

Mechanical Test

Hydrostatic Test

The sampling shall be as per the provisions of the IS 8329. Inspection will be witnessed by the departmental representative or any third party authorized by the employer.

The test reports for the rubber gaskets shall be as per acceptance tests of the IS Marking

All pipes will be marked as per Clause 18 of IS 8329 and show as below:

Manufacturer name/ stamp

Nominal diameter

Class reference

A white ring line showing length of insertion at spigot end

**Packing and Transport:**

The pipes should be transported by road from the factory and stored as per the manufacturer specifications to protect damage.

**Specials for Ductile Iron Pipes:**

All the DI fittings shall be of class K-12 manufactured to IS 9523. All the DI fittings shall

be supplied with one rubber ring for each socket. The rubber ring shall conform to IS: 12820 and IS: 5382. Flanged fittings shall be supplied with required rubber packing and the nuts and bolts.

Lubricant for ductile iron pipes and specials

The lubricant has to have the following characteristics:

must have a paste like consistency and be ready for use

has to adhere to wet and dry surfaces of DI pipes and rubber rings

to be applied in hot and cold weather; ambient temperature 0 - 50 °C, temperature of exposed pipes up to 70 °C

must be non toxic

must be water soluble

must not affect the properties of the drinking water carried in the pipes

must not have an objectionable odour

has to inhibit bacterial growth

must not be harmful to the skin

must have a shelf live not less than 2 years

**Fittings of DI pipes**

The fittings should also be supplied by the manufacturer of the pipes. They should preferably be manufactured by the manufacturer of the pipes. In case they are not, it will be the responsibility of the manufacturer of the pipes to have them manufactured from a suitable manufacturer under its own supervision and have it tested at his/sub contractors premises as per the contract. The pipe manufacturer will however be responsible for the compatibility and quality of the products.

**4.2.1.22.2** SPECIFICATIONS OF VALVES AND APPURTENANCES

All sluice gates, isolation valves, air release valves, check valves shall be designed for the medium carried in the respective pipeline, according to the diameter and the design working pressure of the pipeline. Manual operation shall always be provided; electrical drives shall be provided as per requirement unless otherwise specified.

The valves shall be installed between flanges. The dismantling shall be possible by the use of rigid or flexible dismantling pieces or flange adapters at one side. For this purpose, suitable flange adapters may be provided. All valves shall be installed in the pipe work in such a manner that they can easily be removed from the line for dismantling and maintenance.

The non return valves on the pump delivery branches shall be spring loaded and have high speed non slam closing characteristics.

Valves used in lines conveying chemical solutions and gases shall be manufactured of material suitable for the purpose and to withstand the corrosive and aggressive action of the medium.

Valves used on sludge conveyance piping etc. shall be of straight through type and non-clogging.

The pressure rating of valves must at least be equal to the maximum expected pressure at the point of installation.

The size of valves must not be less than the size of the respective main (suction, delivery) pipes.

#### 4.2.1.22.3 Sluice Valves

Sluice valves shall be generally conforming to IS: 14846:2000. Additionally they should meet the specific requirement given below. The valves shall be double flanged machined and drilled to IS-1538 Part IV & VI. The backside of the drill holes to be spot faced for proper seating of bolts & nuts. Reasonable clearance behind the rear face of the flange on body and bonnet to be kept to provide free access to use spanners for assembling and dismantling. No tap hole is acceptable. The pressure rating of the Valves on the Suction side / discharge side of the pump shall be as per design requirement. They should close with clockwise rotation of hand wheel. The direction of closing shall cast on hand wheel. Nominal size PN Rating and Brand name should cast on the body. The valves shall be of Rising Spindle type. They shall be with Back seat Bushing arrangement for replacement of packing without leakage. The Valve of size 350 and above should be supplied with 2 nos. Single trust deep groove Ball bearing on both end of spindle collar to reduce operating torque and vertical thrust on spindle. The valves of sizes 450mm and above should be supplied with enclosed grease packed bevel/worm gear box of suitable rating to ensure that the valve shall be operated with effort not more than 7 KgM at the pinion shaft. The valves shall be provided with position indicator for indication from full open to full close. They shall be provided with cast iron cleaning door at the bottom of sluice valve body. The clearance between the wedge nut housing lugs on the wedge and the inside surface of the valve body shall be adequate to insert the wedge nut into the wedge lug recess either in the direction of water flow or in perpendicular direction when the wedge is in closed position. The Valves shall be provided with Air Release plug arrangement on the top of the bonnet.

**Material of Construction**

| | | |
|---|---|---|
| Body | : | Cast Iron to IS: 210 Gr. FG200 |
| Wedge | : | Cast Iron to IS: 210 Gr.FG200 |
| Spindle | : | St. Steel to IS:6603 04Cr17Nil2MO2 |
| Seat Rings | : | St. Steel to CF – 8 |
| Spindle Nut | : | High Tensile Brass to IS-320 HT2 |
| Back Seat Bush | : | St. Steel to CF-8 |
| Shoe | : | St. Steel to CF-8 |
| Channel Lining | : | St. Steel to CF-8 |

**Shop Testing Witnessing**

Testing shall be done as per BIS and the applicable rating of the valves.

#### 4.2.1.22.4 Check Valve

Check valves shall be conforming to IS: 5312. Additionally they should meet the specific requirement given below. The valves shall be double flanged machined and drilled to IS-1538 Part IV & VI. The backside of the drill holes to be spot faced for proper seating of bolts and nuts. Reasonable clearances behind the rear face of the flange on body to be kept to provide free access to use spanners for assembling and dismantling. No tap hole is acceptable. The valves shall be of swing check type. Nominal size, PN Rating, Brand name and direction of flow should cast on the body. The valves of sizes 50 to 600 mm should be of Single Door Design & above 600mm should be multi door design. The check valves shall be with non slam characteristics. Non slam characteristics to be achieved by combination of hydraulic passage and additional disposition of weight on doors.

**Material of Construction**

| | | |
|---|---|---|
| Body & cover | : | Cast Iron to IS: 210 Gr. FG200 |
| Door | : | Cast Iron to IS: 210 Gr.FG200 |
| Hinge Pin | : | St. Steel to IS:6603 04Cr17Nil2MO2 |
| Seat Rings | : | St. Steel to CF – 8 |
| Bearing Bush | : | Teflon |

**Shop Testing Witnessing**

Testing shall be done as per BIS and the applicable rating of the valves.

#### 4.2.1.22.5 Kinetic Air Valves

The size of valve shall be as per CPHEEO manual and capable of exhausting air from pipe work automatically when been filled. Air being released at a sufficiently higher rate to prevent the restriction of the Inflow rate. Similarly the valve shall be capable of ventilating pipe work automatically when being emptied. The air inflow rate being sufficiently high to prevent the development of a vacuum in pipeline. The valve shall automatically release air accumulating in pipe line work during normal working condition.

Air valve shall be of double orifice type with a large orifice for ventilation for exhaust of the pipeline and small orifice for release of air under working pressure. The valve shall be suitable for maximum working pressure in the system. All air valves shall be provided with isolating valve and flanged end connection.

**Design Requirements**

Air valve shall be designed to prevent premature closure prior to all air having been discharged from the line. The orifice shall be positively sealed in the close position but float (Ball) shall only be raised by the liquid and not by mixer of air and liquid. The sealing shall be designed to prevent the floats striking after long period in the close position.

All branched outlets including outlets for Air valves will be with compensation pads (Dia of Main / branch Dia ratio greater than 3). Diameter of compensation pad will not be less than 1.75 times the O.D. of the branched outlet. Plate thickness for pads will be same as

that of the main.

For outlets with above ratio less than three, then the joints will be of plate reinforcement type.

The aperture of valves must be properly designed for which the contractor shall submit design calculations for necessary approvals before the procurement of valves.

All branched outlets including air valve tee's will be provided with one ½"BSP coupling duly plugged for measurement of pressure in due course. The closing plug will be in Stainless Steel (AISI 304 or equivalent) with Hex. Head.and will be provided with copper washer for sealing.

All flanges will be drilled as per I.S. 1538.

The gaskets shall be of nitrile rubber.

**Material of Construction**

| | | |
|---|---|---|
| Body | : | CI IS 210 Gr FG 260 |
| High Pressure Orifice & Plug | : | St. Steel AISI 410/LTB 2 |
| Low Pressure Ball | : | Vulcanite covered timber ball |
| High Pressure Ball | : | Rubber covered timber ball |
| Low Pressure Seat Ring | : | Dexine (Nitrile Rubber) |
| Sluice Valve | : | Isolating Sluice Valve conforming to IS 14846 |
| Spindle | : | Stainless steel |
| Bolts & Nuts | : | MS |

### 4.2.1.23 SPECIFICATION OF SLUICE GATES

Type of sluice gate shall be as per application requirement. It may be open channel type or thimble type as per relevant BIS code. The construction of Sluice Gates shall be in accordance specification and generally to relevant BIS. The Sluice Gate shall be designed for Seating & Unseating Head without sacrificing reasonable degree of leak tightness. The frame of Sluice gate shall be flanged back type and shall be machined on the rear face to bolt directly to the machined face of the wall thimble. The seating faces shall be made of solid section strip of Stainless steel. They shall be secure firmly by means of counter sunk fixing in finished grooves in the frame and slide face in such a way as to ensure that they will remain permanently in place, free from distortion and loosening during the life of the Sluice Gate. Sluice Gates shall be equipped with adjustable Side & Top wedging devices as required to provide contact between the slide and frame facing when the gate is in closed position. The gates shall be of Rising Spindle Type. They shall be operated through a suitable operating mechanism. The Lifting mechanism shall incorporate gearing arrangement, if required to keep the torque requirement within 7 KgM. In case of gearing, those to be enclosed grease packed Bevel or Worm Gear box type. Lifting mechanism shall be provided with suitable position indicator to show the position of the gate from full open to full close. The indicator to be provided in the head stock only. Stem Cover to be provided on the top of head stock for the rising spindle. The cross section of the wall thimble shall have the shape of the English letter 'F'. The Sluice

gate shall be provided with Flush bottom seal. This is a solid square cornered resilent rubber seal provided on the bottom facing of the slide. The seal may be secured fastened to the bottom of the face of the slide by a retainer bar and fasteners. The top surface of the bottom facing of frame shall be flush with invert of the gate opening. Bottom facing of the slide shall be accurately machined to make contact with the seal when the slid is closed.

The Sluice Gates shall be of Class – 2 i.e., suitable for maximum unbalanced head needs as per design.

**Material of Construction**

| | | |
|---|---|---|
| Frame & Slide | : | Cast Iron to IS: 210 Gr. FG200 |
| Wall Thimble | : | Cast Iron to IS: 210 Gr.FG200 |
| Stem & Extension Stem | : | St. Steel to IS:6603 04Cr17Nil2MO2 |
| Seating Faces & Counter Sunk Fixings | : | St. Steel to IS: 6603 04cr17Ni12MO2 |
| Head Stock | : | Cast Iron to IS-210 Gr.FG 200. |
| Spindle Nut | : | High Tensile Brass to IS-320 HT2 |
| Flush Bottom Seal | : | EPDM /Nitrile rubber |
| Guide | : | Cast Iron |

### 4.2.1.24 Electrical Overhead Traveling ( EOT ) Crane

The capacities of various EOT's shall be decided as per recommendations of IS: 875.

The crane shall be of single girder/double girder type (as per requirement) designed from lowest sump level and up to under size of the bridge.

Suitable crane rails complete with fixing bolts, nuts, washers and anchor plates shall be supplied for each crane.

The bridge structure shall be formed by a double cross girder with the hoist units traveling along the lower flange of the bridge girder.

The end carriages shall be fabricated adequately stiffened throughout their length to produce a section with high torsional resistance designed to eliminate and tendency for the bridge to cross whip. The carriage wheel shall be adequate proportioned in relation to its span to give a widely distributed load on the crane rails.

Proper selection of reduction gears shall be done to run drive motors. Wherever required the motor enclosure shall afford protection to IP: 55 of IS: 4691 and have cooling facility to IC: 41 of IS: 6362. Each drive motor shall be fitted with an automatic electro-magnetic brake to stop the crane on interruption of the power supply, whether intentional or accidental power failure.

Suitable end stoppers/buffers shall be provided on the bridge girder and at each end of crane rails.

The crane shall also be suitable for manual operation from the floor by means of chain and pulley arrangement via a safety clutch, for use in the event of a power failure.

Hand operated chain hoist complete with trolley running along the same flange of girder in addition to the electric hoist, shall also be provided, for use in the event of a power

failure.

The crane and hoist shall conform to IS: 3177, IS: 3832 and IS: 3938, class 2, medium duty and meet specified operational requirements.

Power feed to the crane shall be form a shrouded conductor rail system and that to the hoist shall be through close looped flexible suspension system with carriers sliding along a wire across the full span of the crane.

Proper illumination of the area shall be done under the crane and on the crane.

All the crane and hoist functions and excluding the illumination lights shall be controlled from a single pendant push button station. The pendant unit shall be suspended from a special track spanning the bridge length using a non-metallic cord and not the control cables. The pendant shall operate on a low voltage (typically 220 volts AC) source, incorporated with a key operated switch to operate switch to prevent unauthorized operation and indicators to indicate ail crane or hoist movements including start and stop.

| | | |
|---|---|---|
| Lifting speed | Low | 0.9 m/min |
| | High | 2.5 m/min |
| L.T. speed | | 10 m/min |
| C.T. speed | | 2.5 m/min |

The long travel speed shall not exceed 30 m/min. automatic reset type limit switches shall be provided for all movements of the hoist and the crane to prevent over travel.

However illumination lights to be operated by separate switch which will not be mounted on pendant.

Other Common specification:

| | |
|---|---|
| Brakes | All brakes are electro-hydraulic thruster brake |
| Operation | Through pendent push button |
| Gear box | Precise machine cut hardened material gear noiseless operation long life |
| Cable | All cables are insulated ISI Marked |
| Power supply | All 415:440 4 phase 50 Hz. AC supply |
| Control voltage | 220/230 volts-50 Hz |

The hoist shall comply with the performance requirement IS: 3938/IS: 3832 Class 2.

The electric hoist shall be fitted with right and left handed spiral grooved cast iron drum with a rope hoist arrangement with spring loaded rope band and guards to ensure accurate rope guidance and location.

Hoist rope shall be extra flexible, improved plog plough steel rope with well lubricated hemp core and having 6 strands 37 wires per strand with an ultimate tensile strength of 160/180 kg/sq.mm. The braking load for the hoist rope shall be as per IS: 2266.

Electromagnetic brake shall be provided to hold suspended load instantly, securely and automatically in the event of the electric current being cut off whether intentionally, accidentally or due to power failure.

The lifting hooks shall be single 'C' type complying with the requirement of IS: 2758/IS: 2759 made from grade 30 carbon steel or equivalent. The hook shall have a safety latch to prevent rope coming off the hook.

#### 4.2.1.25 ERECTION

#### 4.2.1.25.1 General

The Bidder's staff shall include at least one competent erection engineer who should be at least a graduate with 3 years erection experience and who should be permanent employees of the Bidder, to supervise the erection of the works using sufficient skilled, semi-skilled and unskilled labour and to ensure completion of the Works on time. The Bidder shall not remove any representatives, erectors or skilled labour from the site without the prior approval of the Employer's Representative

The Bidder's erection staff shall arrive on the site on dates to be agreed by the Employer's Representative who will give to the Bidders advance notice in writing of the dates on which they will be required. Before they proceed to the site, however, the Bidder shall first satisfy himself, as necessary, that sufficient material of his supply has arrived on site so that there will be no delay on this account.

The Bidder shall be responsible for setting up and erecting the equipment to the line and level required.

#### 4.2.1.25.2 Leveling and Grouting of Machinery

The pumps and motors shall be properly and accurately leveled and aligned on the concrete plinth by means of tapered metal wedges and metal packing pieces before any grout is poured. After correct alignment and leveling the foundation bolts shall be nipped up to hold the machine firmly in position and it shall be the Bidder's responsibility to check that the position is maintained after the grout has been poured but before it sets. The grout which will contain an approved expanding agent will be mixed and poured by the Bidder. Grouting material used for grouting should be as approved by Employer's Representative.

The horizontality of base plate top shall be within 0.05 mm/meter. The base plate top surface and pump motor box are to be blue matched to get a contact area of at least 80%.

After the grouting mixture has set, the foundation bolts shall be pulled up hard and the alignment and level rechecked. The Employer's Representative shall be informed at all times of the progress of this work and when any checks on alignment and level are to be carried out so that he may witness the checks if he so requires. The approval of the Employer's Representative or his intimation that the alignment or level of the machines is to his satisfaction shall in no way relieve the Contractor of his obligation under contract to properly install and align the machines and Pipe work and shall in no way prejudice the Employer's Representative's rights to order rectification of any installation work later found to be improperly carried out.

#### 4.2.1.25.3 Name Plates

Each main and auxiliary item to the pumping station shall have permanently attached to it, in a conspicuous position, a name plate and rating plate, each of weather-resistance and fire-resistance material. Upon these shall be engraved or stamped the manufacturer's name, type and serial number of equipment, details of the loading and duty at which designed to operate.

Details of proposed inscriptions shall be submitted to the Employer's Representative for approval before any labels are manufactured.

### 4.2.1.26 SPECIAL SPECIFICATION FOR MECHANICAL WORK (SEWAGE TREATMENT PLANT)

**General Equipments**

The major equipment which shall be used are listed below. However, this list is not exhaustive. The bidder is to consider all necessary equipment required for achieving the project objectives and as required in scope of work:

| | |
|---|---|
| Pumps | Centrifugal, Submersible, Progressive Cavity (Screw) pumps, Metering Pumps, Drainage Pumps, etc. |
| Blower | Rotary twin lobe positive displacement type<br>Centrifugal blowers |
| Valves | Gate, Butterfly, Ball, Knife gate<br>Pneumatically and manually operated |
| Gates and Penstocks | CI/ MS manually operated |
| Pipes & Fittings | DI, MS/ PVC, UPVC, HDPE, SS, Copper, Nylon Board for Water Services, Sludge, Chemical Services. Type of pipe shall be as specified elsewhere in NIT. |
| Decanters | For decanting the settled wastewater from the Sequential Batch Reactors. |
| Scrapers | For Clarifiers, Thickeners |
| Centrifuge | Solid Bowl Centrifuge of SS construction |
| Pneumatic System | Air filter lubricator, air regulator, pneumatic cylinder |
| Miscellaneous items | Crane, Hoists, Chain pulley block with traveling trolley, weighing machine, ventilation equipment, constant head tanks, reduction gears. |

All equipments shall be of best quality conforming to the standards mentioned elsewhere in the NIT.

Vendor has to submit detailed data sheet, specification, drawings both general arrangements and detailed drawings of different parts along with curves (wherever necessary), testing methods and quality assurance plan, inspection methods etc. for

approval. Any materials, dispatched without dispatch clearance shall be liable to be rejected.

Rotating equipments like pumps, blowers, compressors, etc. shall produce noise less than 85 dBA at a distance of 1.85 metres from the outer end of the equipments.

Vibration levels of rotating equipments shall be within the limits mentioned below. Points of measurement shall be as per ISO-2372-1974 amendment 1-1983.

| Equipments with prime movers motor | Velocity of vibration per m/sec |
|---|---|
| KW less than or equal to 15 kw | - 1.12 |
| 15 kw to 75 kw | - 1.8 |
| > 75 kw | - 2.8 |

### 4.2.2 FINE SCREENS

#### 4.2.2.1 Scope of Supply

The scope of supply shall provide complete automatic mechanical screen systems with all accessories and appurtenances, including, but not limited to:

- Mechanically operated screen;
- Screenings collection, (dewatering) sweeping, washing and disposalsystem;
- Automatic screen controlsystem;
- Electrical & Instrumentation for compliance of Automatic System (Electrical wiring between all screen components, instruments, control devices and the local control panels and the screen controls)
-

#### 4.2.2.2 Downstream Water Level

Bidders should state the maximum and/or minimum allowable water levels downstream of the screen in order to pass the required flow. To reduce the height of the screen above ground level, the screen might be located at a level such that there is a constant static water level in the screen chamber due to downstream tank water levels.

#### 4.2.2.3 Guaranteed Flow Rate and Head Loss

The screen shall effectively screen all flows up to the design flow. The Contractor shall guarantee the following screen performance parameters:

- Clean water flow rate capacity (l/s) at the maximum allowable water depth downstream of the screen
- Clean water head loss at the max flow rate and maximum allowable water depth downstream of the screen
- Maximum sewage flow rate capacity (l/s) at the maximum allowable water depth downstream of the screen based on their expected screen blinding insewage

#### 4.2.2.4 Screening Arrangements

Screening shall be done in single stage and contractor shall have to provide automatic

mechanical fine bar screens to remove particles larger than 6mm size.

It is proposed to install automatically operated mechanical fine screens (stainless steel grade –SS316) of opening size 6mm 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. Capacity of each channel shall be equal to peak flow. Fully automatic mechanical screen along with the level sensing instrument for automatic operation of screen mechanical and allied accessories, (local control panel near screen,) shaft less screw conveyor with/cum compactor are to be provided.

The fixed as well as movable bars/ perforated band, mechanism, support frame, fixings discharge chute shall be manufactured from stainless steel grade 316 for long life in the aggressive sewage environment.

#### 4.2.2.5 Automatic Screen Clearing and Screenings Removal

The screen shall be provided with the necessary controls and sensors to anticipate blockage of the screen, and automatically clear the screen and remove the accumulated screenings from the screen surface. The screen shall operate automatically when the upstream water level increases beyond a pre- set limit and it shall stop when the upstream level decreases to pre-set low level.

#### 4.2.2.6 Screenings Conveyance, Compaction and Dewatering

The screening system shall be supplied with a duty and standby shaft less screw conveyor that will be used to convey the screenings to the automatic screenings press and discharge system that compacts, dewaters and discharges the screenings through a chute to the screenings storagesystem.

The screenings dewatering and compaction system shall compress and dewater the screenings such that the screenings from a consolidated mass with no free water entering the screenings bag.

#### 4.2.2.7 Screen Washing System

The Contractor shall supply and install spray washing system that effectively cleans the screen area and screening press. The Contractor shall provide a high-pressure clean water supply for the washing system.

#### 4.2.2.8 Dewatered Screenings DischargeChute

The screenings discharge chute shall terminate 1.5 meters above ground level. A plastic screenings bag shall be secured around the chute, thereby creating a totally enclosed screenings collection system.

#### 4.2.2.9 Screen Covers

All screenings equipment shall be supplied with integral stainless steel covers that

prevent access to moving and wash water sprays. The covers need to be airtight to ensure that no odours emanate from the screen.

#### 4.2.2.10 Portable Screenings Container

Portable screenings containers made of galvanized steel duly epoxy painted shall be provided to store the screenings until time of pick up. The container shall have capacity of approximate 5 $m^3$and shall be of a convenient height to permit the discharge of screenings directly into the container without having to transfer the screenings manually. The containers shall have hinged covers and their design shall permit them being lifted by an overhead hoist or packer truck. The container will have four wheels each of about 20 cm diameter and two of which shall be swivel castors. The maximum height of container including wheels shall be 0.6m. The sides shall be constructed of minimum 12 gauge steel. The bottom of container shall be made minimum of 6mm plate steel. The containers shall be reinforced with 50mm x 50mm x 5mm angle iron.

#### 4.2.2.11 Electrical Motors

The motor shall be TEFC type with IP 55 protection & Class F insulation and shall be suitable for operation on 3 phase, 415V + 10% and frequency of 50Hz + 5%. Motors shall be squirrel cage type conforming to IS 325. The power rating of motor shall be at least 125% of maximum power requirement.

#### 4.2.2.12 Screens Control Panel

The Control Panels shall have IP 65 protection, painted with Epoxy paint and shall be comprise:

- Mushroom Head Emergency stop.
- Overload relays for motorprotection.
- MCB's, HRC Fuses and GlassFuses.
- Circuitry to operate the screen with levelsensors.
- Selector Switch to operate the screen on JOGmode.

#### 4.2.2.13 Access

Safe access shall be provided to all screen equipment and instruments to allow for cleaning, inspection and maintenanceactivities.

#### 4.2.2.14 CorrosionResistance

All metal parts of the screen equipment that are in contact with the sewage shall be constructed of a suitable grade of corrosion resistant stainless steel, aluminium or plastic.

#### 4.2.2.15 Design Life

The design life of major components shall be 15-20 years.

#### 4.2.2.16 Installation, Testing, Commissioning and Training

It is the Contractor's responsibility to install the screen system correctly and achieve the

required operation. The Contractor shall provide a representative who has knowledge and experience in the proper installation, start-up and operation of the screen equipment to inspect the final installation and supervise the commissioning tests.

### 4.2.3 Grit Removal System (Cyclonic / Vortex type)

After screening the sewage will flow to grit chambers. Grit chambers are designed to remove grit, consisting of sand, gravel, cinders, or other heavy solid materials that have a settling velocity substantially greater than those of the organic putrescible solids in sewage. Grit chambers shall be of vortex type with centre drive and independent washer and /or classifier as specified in Part 2, vol-2.

#### 4.2.3.1 Type of Grit Chamber

The type of Grit chambers shall be of vortex type with centre drive and independent washer & classifier. Grit Basin equipment, complete with all accessories including, but not necessarily limited to, gear motor, turntable, propeller drive tube, axial flow propeller shall be provided.

The Vortex Grit Basin equipment shall be installed in concrete basins. The equipment to be supplied shall be suitable for installation in these basins. The grit chamber shall be designed to operate on the vortex principle.

To maximize grit removal efficiency, Grit chamber hydraulics shall incorporate a toroidal flow path enhanced by a slow vortex.

#### 4.2.3.2 System Description

- Vortex Type Grit removal chamber with low head loss systems shall be proposed for this project. Each grit chamber shall be complete with all the required equipment and not limited to gear motor, gear head, axial flow propeller and scrapper with drive, grit removal pump and auxiliary equipment, washer and classifier system complete in all respects required for proper operation.
- The grit removal unit shall have low head loss and shall be capable of removing grit from raw waste or process water and depositing the grit in a storagehopper.
- An integral grit transporting system shall be provided to transport the grit from the storage hopper to the grit classifer and for grit washing and the dewatered grit shall be temporally stored in tilt abletrolley.
- To minimize the possibility of clogging, all internal openings in the piping to the grit pumping device as well as the grit pumping device shall be large enough to pass a 100 mm solids.
- No bends or elbows shall be allowed in the piping on the suction side of the gritpump.
- All drives, bearings and lubrication shall be readily accessible from walkways above the operating waterlevel.
- To minimize the possibility of organic capture, the floor of the grit separation chamber shall be flat/sloping as per manufacturers design and there shall be no

greater than a 80 mm opening for grit to pass through to the storagehopper.

- To ensure the efficient transport of the grit and simultaneous lifting and discharge of the organic material, the bottom of the upper chamber covering the storage hopper shall be constructed suitable corrosion proof / or thick steel plate , free from rotation, and shall beflat.
- The grit moving across the bottom of the chamber shall be hydraulically scoured by an air lift pump or a propellerpump.
- The grit shall pass from the removal chamber through an opening in the transition plate and drop into a grit storage hopper. The flow in the removal chamber shall travel between the inlet and the outlet a minimum (270°), providing maximum travel of the liquid for effective grit removal.
- The Grit Chamber shall handle all flows equal to or less than a hydraulic peakflow.
- The influent flume, transporting the liquid waste to the grit chamber, shall be of the size and shape to assure that grit does not settle in the inlet flume and to provide for proper operation of the gritchamber.
- Grit pump will be either an air lift educator pump or a turbo grit pump close-coupled, vacuum primed type with curved multi vane impeller.
- A regenerative (side channel) type blower shall have the capacity to provide sufficient quantities of air at the required pressure to ensure efficient operation of the air wash/airlift system.
- Alternatively hardened stainless steel grit pumps can be used
- Grit Classifier / Washer shall be Shaft less screwtype.
- All the equipment below top slab shall be removable through access hatch provided in basin cover.
- Material of Construction:
    a. All wetted parts shall be in SS316.
    b. Air Lift pump (if used ) SS316
    c. Turbo Grit Pump (if used ) : Hardened SS316 impellers, Ni hard volute, Stainless Steel shaft, heavy-duty bearings and mechanicalseal
    d. All parts above water, ie components like mechanism support etc shall be in Hot Dip galvanized structure
    e. Hand Railing in SS316 Drive Mechanism of GritScrapper
    f. Classifer : SS 316 with hardened scraper /tips
    g. Portable grit container shall be Hot dip galvanized structure.
- Performance Requirements:

  The grit removal device shall be capable of removing the following at the specified hydraulic peak flow rate, and no decrease in efficiency will be allowed at flows less than this design rate.

    - 90-95% of the grit greater than 150 microns insize,
    - 75-85% of the grit greater than 100 but less than 150 microns insize,

Documentary evidence in support of the removal efficiency of the offered equipment shall be furnished by Contractor.

#### 4.2.3.3 Equipment Description

The grit chambers shall generally conform to the following construction, operation guidelines and have the accessories as indicated below:

**1. Grit Collection Mechanism:**

- It shall be consisting of vortex type, non aerated, grit removal mechanism, each complete with drive unit, mechanical gear head, paddle drive tube and all the items necessary for complete grit removal
- It shall be capable of removing grit from raw waste water and suitable for installation in a circular concrete basin.
- Mechanism shall have no moving parts below the water surface which require lubrication or which will be subject to wear orblockage.
- Drives, bearings, and support equipment for grit mechanism shall be supported by and readily accessible from a concrete walkway above the watersurface.

**2. Grit Paddle Mechanism:**

- It shall be designed to promote removal of grit and assist in sweeping grit to a circular grit wet well located within the centre of the basin.
- Grit moving across the bottom of the grit chamber shall be hydraulically ccoured as the propeller blades pass over the moving grit and cause hydraulic currents to maintain the organics insuspension.

**3. Grit RemovalMechanism:**

It will generally consist of:

- Axial flow pitch propeller driven by drive tube powerd through a helical gearmotor.
- Alternately, air lift pump, driven by an external blower and complete with all required arrangements.
- Helical gear motor shall be oillubricated
- Spur-Tooth Bull Gear:
  - It shall be enclosed in grease packed heavy cast iron gear case.
  - It shall be of forged steel with minimum Brinell hardness of200.
  - Pinion shall be cut from high strength normalized steel
  - It shall be mounted on turn tablebearing.
- Bearing:
  - All bearings of Drive Unit shall be having bearing life of 50000 hours
  - Turntable Bearing Supporting Propeller Assembly shall be having bearing life of20 years.
- Pinion & Bull Gear Service Factor: Five orgreater.
- Gear Box shall be sealed type and furnished with air bell around bottom opening

of drive tube to prevent water from entering gearbox.

**4. Other Accessories:**

- Lifting Lugs
- Anchor Bolts

#### 4.2.3.4 Grit Classifier Mechanism

- Grit classifier shall consist of shaft less spiral screw conveyor and hopper. Grit from vortex grit tank shall be delivered to Grit classifier at determined time intervals. Screw conveyor shall convey and dewater the grit prior to being disposed into container. The screw conveyor shall also be fitted with washers to remove organic matters from thegrit.
- The grit classifier must be capable of separating small, fast settling materials. Provision shall be made to receive grit from the grit pumps in a storage reservoir allowing sufficient retention time allowing the grit to separate from the rawsewage.
- The grit must then be removed from the storage reservoir using a shaft-less screw conveyor.
- Sufficient clearance must be provided between the shaftless screw conveyor and the trough to allow liquid above the storage reservoir level to flow back to the reservoir. A 30% dry solid product must be discharged from the end of the screw conveyor into a container to be supplied under this contract. The clarified liquid must pass over a weir and be discharged into the inlet channel upstream of the grit removal equipment. The equipment shall be complete with electric motor and gearbox, screw conveyor trough and storage reservoir with supports and pipe work, etc.
- Discharge pipe work from the pumps in separate rising mains must be provided and connected to the storage reservoir, complete with support brackets from the vortex degritter to the grit classifier equipment.

#### 4.2.3.5 Pipe Work

- The Contractor shall include for the supply and delivery to site and for the erection and testing of all pipe work and fitting between the degritter and screw.
- All pipe work shall be stainless steel. Flanges shall comply with BS: 4505. Bends shall provide non- turbulent flow conditions and the layout of pipe work shall be such to facilitate dismantling and inspection. The pipes shall be properly supported and so arranged that all stress created in the pipeline by static and dynamic forces, including recoil shock will betaken up by suitableanchors.

#### 4.2.3.6 Painting

Painting of different units shall be done as per details mentioned below:

(i) Painting of Wetted Parts: Surface preparation- blast cleaning, one coat of Epilux 610 or equivalent primer, Dry Film Thickness (DFT)/coat of 35 microns and three coats of Epilux 5 coal tar epoxy or equivalent, DFT /coat of 100 - 125 microns. Total DFT shall not be less than 300microns

(ii) Painting of Non Wetted Parts: Surface preparation: blast cleaning, coats of anti-

corrosive red oxide primer, each of 30 microns & 2 coats of anti-corrosive synthetic enamel paint (DFT per coat of 30 microns). Total DFT shall not be less than 120microns.

(iii) All fixtures and bolting shall be of SS304

#### 4.2.3.7 Electrical Installation & Controls:

- Provision must be made for supply and installation of the control panel as well as all electrical equipments from this control panel. A red mushroom head push lock emergency stop switch with key operated lock-out facilities must be provided in close proximity of the drivenequipment.
- The entire process shall be controlled by a dedicated control system to provide automatic (timed) and manual grit removal operation; opening and closing of control valves; air/water scour operation; grit pump and classifier duty cycles along with Grit system remote control and alarmmonitoring.

### 4.2.4 Primary and Secondary Clarifiers

The mechanism shall comprise but not limited to the following main components:

- Bridge Superstructure spanning half the tank diameter with central maintenanceplatform
- Drive assembly complete with drive head, chain & sprocket, geared motoretc.
- Feed Well
- Center cage with Conescraper
- Rake arms with Tierods
- Scraper blades & squeegees
- Scum Blade & Skimmerassembly
- A-frame supports for the skimmerassembly
- Scum trough and ramp with supportangle
- Scum baffle withsupports
- Weirplate

The Clarifier Mechanism shall be suitable for installation in RCC tank and circular radial flow fixed bridge with scum collector; central turn table type clarifiers shall be provided and should conform to the following guidelines. The guidelines are essentially specified for the object, duty conditions, type of mechanism and accessories required as well as the material of construction. Corrosion allowance of 2 mm shall be taken in the structural sections of scraper arm, bridge etc. The equipment shall be fabricated out of mild steel plates of at least 6 mm thickness. Structural design calculations shall be submitted for all structures including scraper arm, bridge etc.

| | |
|---|---|
| Objective | To remove Suspended Solids /Biomassfrom mixed liquor / effluent coming |
| Type | Center Feed Peripheral Overflow |
| Skimmer | Required with 1/ 2 diameter with Scum Box and taken by gravity to Scum sump for disposal along withsludge |
| Sludge | Collection to center byscrapper & Hydraulically evacuated by pump for recirculation |

| | |
|---|---|
| Bridge Type | Fixed Bridge |
| Duty Specification | Continuous |
| Rake Tip Speed | between 3 to 4 cm / sec |
| Scraper sludge loading | 25kN/m |
| Clarifier Rake Driver | Electrical TEFC Motor with Insulation of Class F and Protection IP 55 |
| Continuous Design Operating Torque | based on the following formula |

The clarifier structural and center drive mechanism including center mechanism shall be designed for a peak instantaneous torque which shall be 2.5 times the continuous design torque calculated using following formula:

T(inkg-m) = LF x(Diameter)^2

Where Diameter is in meters and load factor (LF) is as given below.

| Type of Clarifier | Load Factor |
|---|---|
| Primary Clarifier | **8** |
| Secondary Clarifier | **6** |

**Material of Construction**

| | |
|---|---|
| Feed Well | SS 304, minimum 3 mm thick |
| Bridge | MS with Hot dip Galvanized (galvanizing minimum thickness shall be 80 micron) (welded/nut bolted/riveted truss in a consolidated single component and no site welding shall be allowed) |
| Rake Arm | MS with Hot dip Galvanized (galvanizing minimum thickness shall be 80 micron) |
| Center Cage | MS with Hot dip Galvanized (galvanizing minimum thickness shall be 80 micron) |
| Rake Blades | Stainless Steel Grade 316L; minimum 5 mm thick |
| V-notch weir | SS 304, minimum 6 mm thick and 300 mm wide |
| Squeegees | Neoprene rubber, 10 mm thick, adjustable type |
| Walkway | MS grating minimum 6mm thk with Hot dip Galvanized (galvanizing minimum thickness shall be 80 micron) |
| Handrail (both ways in two layers minimum 1 m high) | 32 NB SS Pipe, 32 mm dia vertical and top rail with 25 mm dia middle level .The hand railing on clarifier shall have a 6 mm toe guard made of hot dipgalvanised and be 100 mm wide x 5 |

| | |
|---|---|
| | mm thick. |
| Scum skimmer assembly | SS 304, minimum 5 mm thick and 300 mm wide |
| Scum Box | SS 304, minimum 3 mm thick |
| Scum Baffle | SS 304, minimum 3 mm thick and 400 mm wide |
| Fasteners – Under Water | SS-316 |
| Fasteners – Above Water | Galvanised |

**Note:**

1) The stainless steel and mild steel including hot dipped galvanized components where both are connected to the water / wastewater should be electrically isolated to prevent galvanic corrosion to the stainless steel surfaces
2) The sludge drawl pipe shall be provided with telescopic pipe with valve of suitable size.

   Replace the existing sludge drawl valve with timer controlled motorized valve of same size.

### 4.2.5 Submersible Mixers

Submersible mixers could be used in the bio reactor for the following purposes

1) In Anoxic/ De-aeration Zone to keep the Solids insuspension
2) In Aeration Zone to keep solids in suspension and to improve the aeration capacity.
3) In Sludge Storage sump/Tank

The mixer design guidelines are as follows:

| Mixer Duty Application | Minimum Pumping Rate | Mixer |
|---|---|---|
| Anoxic/ De-aeration Zone | 1.5 times tank Volume | Tip Velocity not more than 16 m / sec |
| Aeration Zone | 0.5 to 0.75 times tank Volume | Tip Velocity not more than 3 m / sec |
| All Sludge Sump ( thickened / digested) | More than 5 times tank Volume | Tip Velocity not more than 16 m / sec |

Not less than 2 mixers hall be provided pertank.

The mixers shall be of robust construction, designed for continuous operation under the most difficult operating conditions installed in aerationbasins.

The mixers shall be energy efficient with submersible type mixer with motor housing in CI IS 210 Gr FG 260 and 2 or 3 blades propeller in SS 316 construction with suitable IE3 premium efficiency motor at 415 ± 10% V, 50C/S.

The submersible mixer shall be complete with lifting device comprising of SS-316 of 60 mm tube, MS winch and stainless steel rope and handle with allaccessories.

**Material of Construction: -**

**Propeller: -** Stainless Steel 316 (1.4571) or Duplex Stainless Steel 1.4460 (AISI329)

**Shaft -** Stainless Steel 316 1.4401 (AISI316)

**Lifting Chain / Rope –** Stainless Steel

**Guide Tube –** Stainless Steel

### 4.2.6 Air Blowers

#### 4.2.6.1 General Requirements for All Types of Blowers

Air blower shall be rotary twin lobe positive displacement type. Blowers shall be provided with a suction air filter and silencer, outlet silencer, pressure retied valve, delivery pressure gauge and delivery isolating and no-return valve and acoustic enclosure of proper design shall be provided, so that decibel level shall be maintained as specified elsewhere. A metallic bellow joint is provided on the delivery side of each blower.

Vibration pads shall be provided at foundation level to keep vibration of the equipment within limits as specified elsewhere in the specification.

Casing of the blower shall be robust construction and shall be machined to proper tolerance. Rotor along with other un-machined rotating part shall be properly balanced so as not to cause any vibration during operation. Rotor shall be made in one piece and securely keyed to the shaft.

Means shall be provided to prevent loosening during operation including rotation in reverse direction.

Blowers shall be driven by squired case valves through a matched V-belt drive. Motors shall be mounted on slide rails mounted on a common bed plate, to facilitate the tensioning of the belts. The horsepower rating of the blower motor (including the service factor) shall not be less than 110% of blower design point BHP. Blowers shall not run above 1200 rpm.

Inlet to blowers shall be at the top and discharge at the bottom, the axes of both being vertical. Connecting pipe work shall be designed for a maximum velocity of 20 to 25 m/sec. Delivery end of the blower shall be flanged connection of appropriate specification.

The bidders should propose energy efficient air blowers/compressors of proven design working satisfactorily with documentary evidence. For large aeration capacities considering high efficiency, low maintenance cost, minimal foot print, minimize breakdown time and over all low life cycle cost energy air efficient compressors shall be preferred as per the duty application. The minimum number of standby blowers should be 50 % if numbers of installed blowers are 2 or more otherwise 100 % stand by.

The manufacture must be ISO 9001:2000 certified to assure the conformance to the highest quality standards of the industry each blower shall be designed according to the climatic conditions at site listed below.

| | |
|---|---|
| Elevation above sea level at blower installation location | 200 meters |
| Differential pressure required | As per duty Condition |
| Maximum air inlet temperature | 45˚C |
| Average air temperature | 20˚C |

| | |
|---|---|
| Lowest air temperature | 10 ˚C |
| Maximum temperature in the blower room | 40 ˚C |
| Maximum humidity with maximum air inlet temperature | 80 ˚C |
| Average humidity | 80 % RH |

The blower operating speed RPM should not be more than

1200 RPM in case of air cooled units

1800 RPM in case of water cooled units

**Special Requirements**

Though both air and water cooled units are acceptable, the preference is for air cooled unit. In case water cooled units are proposed, the bidder shall provide details of water quantity required and shall make the necessary arrangements for the same without any additional cost to the employer.

Blower shall be suitable for outdoor installation without any cover and be of suitable construction for protection against rain.

**Power transmission:** direct drive shall be preferred but alternative arrangement like V belt shall also be acceptable

The power rating of motor shall be at least 15 % above the maximum power requirement by the blower

**Material of construction**

Casing : C I conforming to IS: 210 Gr FG 260
Rotor : Alloy steel
Shaft : Carbon steel C40/EN 24/19
Timing gear : Cast alloy steel
Pulley and gear side plates and cover: CI conforming to IS 210 Gr FG 260
Manufacturing Code : BS 1571

**Tests**

Hydrostatic tests : Twice the maximum working pressure
Strip test : Clearances with tolerance limit
Performance test : As per BS: 1571
Mechanical balancing : ISO 1940 Gr. 6.3 or better
Visual Inspection : Before painting

**Air Compressor**

Compressor system shall be provided for supply of air for the pneumatic operation of

valves and instruments. It shall comprise of compressors, after-coolers and air-driers, together with control equipment, oil eliminating filters, flow regulators and oil mist lubricators as required.

Electrically driven air compressor sets shall operate upto 10 bar working pressure. The main compressor and the standby compressor set shall be provided complete with the following:

Pressure relief safety valve
Isolating valve
Air filter and silencer
Common bed plate for compressor and motor with foundation bolts and nuts
Necessary temperature indicators and pressure gauge etc.
V-belt and guard

Compressors shall be connected for automatic changeover on failure of the duty unit. Standby after coolers shall be provided as required .Water cooled and or air blast types will be considered.

**Special Requirements**

Both air and water cooled units are acceptable. The preference is however for air cooled unit. In case water cooled units are proposed, the bidder shall provide details of water quantity required and shall make the necessary arrangements for the same at no extra cost to the employer
The compressor should be suitable for outdoor installation without any cover and be of suitable construction and protection against rain even if it is installed inside a building
**Power transmission:** direct drive shall be preferred but alternative arrangement like V belt shall also be acceptable
The power rating of motor shall be at least 15 % above the maximum power requirement by the compressor

**Material of construction**

| | |
|---|---|
| Casing | : C I conforming to IS: 210 Gr FG 260 |
| Piston | : Alloy steel |
| Shaft | : Carbon steel C40/EN 24/19 |
| Pulley and gear side plates and cover: CI conforming to IS 210 Gr FG 260 | |
| Manufacturing Code | : BS 1571 |

**Tests**

| | |
|---|---|
| Hydrostatic tests | Twice the maximum working pressure |
| Strip test | Clearances with tolerance limit |
| Performance test | As per BS: / relevant IS |
| Mechanical balancing | ISO 1940 Gr. 6.3 or better |
| Visual Inspection | Before painting |

Air receivers shall be designed and fabricated in accordance with relevant approved standards. They shall be supported adequately so that sufficient space is available for

easy access.

Receivers shall be provided with drain traps piped to drain, pressure gauges and relief and check valves. Interconnecting pipe work shall be arranged to avoid low points which may trap water. Unavoidable low points shall be provided with drain cocks piped to waste.

#### 4.2.6.2 Turbo Blower

#### 42621 General Specifications

i) The high speed turbo blower should be gearless & direct driven with high frequency permanent magnet motor. The motor should be high efficiency type with H class insulation. Motor & the blower should have lubrication-free air-foil bearing or Magnetic bearings. Shaft material of construction of the shaft will be either Stainless steel Super alloy or Aluminium alloy or Titanium or any other rigid material suitable for the duty application preferred.

ii) The material of construction of the blower's impeller should be of stainless steel or aluminium alloy and preference will be for a corrosion resistant material and be rigidly fixed to the shaft and the shaft and impeller be dynamically balanced at the operatingspeed.

iii) The motor should have perfectly matching integrated invertor (VFD) which should be used for smooth start-up as well as capacity control from minimum of 45% to maximum of 120% output, it should be possible at all temperature. VFD control shall be based upon constant motor current, not constantrpm.

iv) The starting current should be less than 1.5 times of full load current of the motor /blower.

v) Both, the motor & Invertor (VFD) should be air-cooled/ fluid cooled type. All cooling shall be accomplished with ambient or cooled dry air. Heated air from the motor & inverter shall not be mixed with intake fresh air or water / fluidcooled.

vi) The blower package should be microprocessor controlled with graphical touch screen display HMI. It should be able to control following parameters – constant pressure, constant flow, and constant power & dissolved oxygen control with direct connectivity to D.O.sensor.

vii) The blower should be equipped with pressure, differential pressure, On-line flow meter vibration, speed, & temperature monitoringdevices.

viii) The flow measuring device can be an orifice or a bell mouth design with the flow being measured based on differential pressure. Actual ambient & discharge temperatures should be measured using temperature instrumentation. No assumptions or calculations regarding flow, pressure, temperatures or relative humidity shall be made. All process & performance conditions shall be measured, notcalculated.

ix) The HMI should display set value, actual instantaneous value & on-line trend of discharge pressure, flow, input power, rpm, suction temperature, performance curve / map with actual instantaneous operating point. It should also have provision to send this data for logging purpose.

x) Static pressure measurement should be carried out at exit of diffuser of the blower to ensure that it is equivalent to the total dischargepressure.

xi) The microprocessor controller should be able to accept external analogue input for remote setting of the parameter to becontrolled.

xii) The supplier should guarantee the total input power to the blower as per specified discharge flow &pressure.

xiii) Blower shall have built in automatic surge protection. Blower with high 'rise to surge' will be preferred.

xiv) Blower package shall be supplied with acoustic enclosure covering the entire blower package to restrict the noise level up to 80 dBA at 1 mt distance. Vibration measurement of the compressor shall be less than 1mm/s (RMS). Each blower shall be factory tested by the standard methods based upon ASME PTC-10:1997 measuring kW input for Wire to Air power at the inlet of the package and/or applicable test codes such as ISO 5389:2005, JIS B 8340.Acceptance criteria is 2% tolerance on power and flow. No negative tolerance on flow and pressure is allowed. All Blowers should be cooled by either Air or water cooling as per the area duty operating conditions to cool the VFD or themotor.

xv) Suitable Air cooling system shall be provided to reduce the temperature of compressed air from discharge of air blower before entering in to the Aeration zone. Delivery header line from Air blower up to Aeration zone SS-316 shall be provided with suitable type of insulation to avoid any accident during O&M due to expected high temperature on pipesurface.

xvi) Blower virtually should not have any maintenance costs except to change the cooling and process air filter elements when required. On average this should be once a year and should not take more than one hour. Other than that, over the expected 20 years operational lifetime of the blower, it is expected to replace the back-up battery once every 3 to 5 years and cooling fans in the VFD and MBC after every 50,000 hours operation (5 to 7 years)

### 42622 High Speed Turbo Motor

The high efficiency motor will make it possible to have very high efficiency (96-97%) over an entire operating range. The heat generation from the motor should be limited to a temperature rise of 20 deg C over operating ambient temperature. The motors will have low starting current to a maximum of 4 to 10 % of the Full Load Current.

Motor to be suitable for

i) Input Power: 3Ø, 415Vac, 50 Hz (±5%)

ii) Motor Power Range: including 15 % overload of duty pointFLC

iii) Harmonics Frequency filters to be an integral part of the motors to prevent Total Harmonic Dissertation to the electrical system. The THD shall be limited to +/- 5 % of the operating frequency.

iv) Blowers should have optimized VFD needs and small starting current (< 5% Full load current) and providing high efficiency (more than 95 %) Machine shall be designed for surrounding temperature of45'C.

v) Motor shall be IP55 grade

**42623 Material of Construction**

**i) Impeller:**

Stainless Steel or High Strength Aluminium Alloy.

**ii) Shaft:**

Alloyed Stainless Steel, Titanium or 6Cr16 steel.

**iii) Bearing**

Oil free Teflon-S Air foil or Permanent Magnet bearings made from corrosion free material like nickel, titanium alloy steel.

**iv) Acoustic enclosure**

Al-Zn coated steel, isolated with glass wool, IP55 enclosure

### 4.2.6.3 Single Stage Centrifugal Blower/Compressors

**42631 General**

The compressors shall be motor driven, single - stage centrifugal, integrally geared, Horizontal/Vertical split type. Each compressor shall be provided with end-suction and side discharge, with discharge adjustable radially increments every 15 degree angle. Each compressor shall be equipped with an integral intake filter/silencer, modulating inlet guide vanes and discharge variable vane diffusers, integral speed-increasing gear, discharge cone - silencer, direct coupled motor, coupling and guard, inlet and discharge flexible connectors; discharge check valve, backflow barrier, isolation valve, motorized blow-off valve with silencer, lube oil system, instrumentation and control system.

The compressor equipment shall include all the ancillaries with local control panels for each compressor and the master sequence controller integrated in the local control panels or can be external MCP.

The compressor equipment specified herein is intended to pressurize ambient air for the supply of oxygen to waste water treatment aeration zone.

The compressors will receive filtered air and will discharge to the main header. The capacity of each compressor shall be automatically controlled to provide the airflow rate through the compressor as required by the process. The blow-off valve shall be open during start-up and shutdown to allow unloaded start and stop, and to avoid surge conditions all the piping system from the blowers shall be interconnected to feed to all the basins.

Regulation shall be possible in the range of 120-45% (or less) of the projects design flow at all project design temperatures and at design pressure. The regulation should be achieved with the help of dual vane control i.e. Inlet Guide Vanes (IGVs) and Variable Vane Diffusers (VVDs) so as to ensure maximum energy saving during complete range. The blower shall be constructed with two independent regulation possibilities to optimize the efficiency when regulating in the

i) Isentropic Head (compression and temperature) regulation and

ii) When regulating the flow.

The regulation should be fully automated and contain a program for continuous optimization of compressor efficiency with respect to changes in inlet temperature, differential pressure and the required flow. The Isentropic efficiency should not drop more that 5% when regulating the flow from 120% to 45%, at max project design temperature and pressure.

Blower package shall be supplied with acoustic enclosure covering the entire blower package to restrict the noise level up to 80 dBA at 1 mt distance. Vibration measurement of the compressor shall be less than 1mm/s (RMS).

Suitable Air cooling system shall be provided to reduce the temperature of compressed air from discharge of air blower before entering in to the Aeration zone.

### 42632 Impeller Type

The impeller shall be of the semi open radial flow type, induced S-shaped with strong backward leaning blades, machined as one, not welded, casted or riveted.

The impeller shall be statically and dynamically balanced. The Supplier must demonstrate that theimpeller/shaft design is designed for operating at peripheral speeds up to 115% of the rated operating speed. The axial gap between the impeller and compressor casing must be adjustable by means of machined spacers in order to assure the prescribed gap.

### 42633 Shaft Seals

The shaft seals shall be of double mechanical seal non-contact, multi-point, labyrinth type with small clearances and sufficient touch points to minimize air leakage out of or into the casing while the compressor is running in the specified operating range or during start and shutdown and to ensure a 100% oil free air supply.

### 42634 Gear Box

a) The gearbox shall be of ample size and rated to transmit the maximum torque and power input requirements to the compressor under all operating conditions and continuous duty. The service factor shall be minimum 1.4. All exposed machined surfaces shall be coated with a corrosion-resistant compound prior toshipment.

b) The gear drive housing shall be of close graned cast iron GG20 or lightweight aluminium dicasted suitable for high temperature and sufficiently rigid to maintain the shaft positions under maximum loads. The gear housing shall be horizontally or vertically split in order to allow easy inspection and maintenance. The gear housing assemblies shall be machined to close tolerances for bearing fit, gear alignment and oil tightness.

### 42635 Oil Lubrication System

a) A complete lube oil system shall be provided with each compressor. The system shall

be capable of supplying clean lube oil at suitable pressure and temperature to lubricate the speed increasing gears and bearings. All components of the lubricating system shall be installed integral with the compressor base plate and arranged to permit ease of accessibility for operation, maintenance, inspection andcleaning.

b) The package shall include one gearbox drive shaft driven primary oil pump and one electric motor driven pre-lubrication oil pump, each of adequate capacity to supply lubrication for the air compressor/gearbox when operating under normal duty, during normal start/stop and during run down in case of power loss. The electric motor driven oil pump will operate at start/stop of compressor and at low oil pressure, activated by the control system located in the local controlpanel.

c) The lube oil filter shall be duplex cartridge type suited for the oil pump capacity, with replaceable cartridges which can be replaced without stopping the compressor. The filter grade shall be capable of removing particles over 10 microns with a clean oil filter and a pressure drop not exceeding 350 mbar at design temperature and flow. Filter cases shall be suitable for operation at a pressure not less than the relief valve setting. A visual gauge or an electric pressure switch shall indicate when the filters are contaminated and requires replacement.

d) Strainers shall be manually cleaned and equipped with a magnetic trap Design and installation shall permit ready access forcleaning.

e) An oil cooler for each compressor shall be furnished and shall be of the air-to-oil type. The cooler shall be capable of maintaining required cooling rate at all specified ambient temperatures. Each cooler shall be rated to dissipate the total emitted heat from the compressor gearbox. Air-to-oil cooler shall be furnished with an electric motor-driven air blastfan.

### 42636 Local Control Panel

a) Each compressor shall be furnished with an integrated and dedicated rack based PLC, All controls shall go into a safe condition by failure and not allow the machine to be operated with any defectivecontrol.

b) The Local Control Panel set-up shall include the Load Sharing functionality with Master Control Panel of adequatefeatures.

c) The local control panel shall consist of thefollowing:

d) Low voltage system with main switch and motor overload relays for auxiliary equipment such as blow-off valve, variable diffuser, and inlet guide vanes. Further, monitoring of the drive motor's temperature sensors, and relay for control of drive motor's main switch, with wiring to:

e) Control system - with automatic PLC(Not applicable to integrally geared units), and all necessary control circuits for oil pressure, oil temperature, surge limit, andrecirculation.

f) The front panel shall be equipped with Human Machine Interface with a screen of minimum 6" colour touch panel with indication of process values Low voltage and control systems mounted in a steel panel, IP55, and internallywired.

g) Terminal strip for external wiring.

### 42637 Inlet filter / Silencer

a) Each compressor shall be provided with an inlet filter / silencer designed for maximum air flow at absolute minimum pressure drop and connected directly to the inlet of the compressor via a flexibleconnection.

b) Filters shall be removable through easily accessible doors and have a removal efficiency of 99% on 10 micron. The filter has to have a minimum standard of EU3 in accordance to DIN 24185.

### 42638 Bearings

The bearings could be

i.) Hydrodynamic type sleeve type bearings

ii.) Magnetic Bearings

iii.) Hydro foil Bearings

All bearings shall be rated for a bearing life of minimum 100000 hours.

| | | |
|---|---|---|
| Vibration levels (P≤ 300 kW) ≤ | : | In accordance to ISO 10816-1 |
| Vibration levels (P>300 kW) ≤ | : | In accordance to ISO 10816-1 |
| Noise level ≤ | : | In accordance to 80 dB at 1 m |

Following has to be provided for each compressor by the supplier:

- Outlet pressure transmitters, inlet temperature transmitter and a thermal mass flow meter. The unit should allow for profibus communication to main SCADA controlsystem.
- Inlet Air Filter Differential PressureSwitch
- Oil TemperatureTransmitter
- Oil PressureTransmitter
- Oil Filter Differential PressureSwitch
- Variable Vane Diffuser PositionTransmitter
- Inlet Guide Vane positiontransmitter
- Gear vibration accelerometer transmitter
- Blower reverse rotationdetector

### 42639 Material of Construction

| | | |
|---|---|---|
| Casing | : | Inner Volute Aluminium , Cast Iron GGG40<br>Outer volute Aluminium Al Cu Alloy / cast iron GGG40 |
| Impeller | : | Aluminium AlCu2MgNi, open radial flow |

| | | |
|---|---|---|
| | | type with backward leaning blades |
| Gearwheels | : | High tensile SS316 / High Tensile 15CrNi6 |
| Shaft fast | : | High tensile SS316 /High Tensile 15CrNi6 |
| Shaft slow | : | High tensile SS316 / High Tensile 34CrNiMo6 |
| Coupling | : | Geared High Torque Steel Coupling with spacer |
| Filter material | : | As required |
| Machine mounts | : | St. SIS 1312, for damping natural rubber hardness 60 |
| Oil Cooling | : | Air cooled |
| Acoustic enclosure | : | Al-Zn coated steel, isolated with glass wool, IP55 enclosure |
| Motor | : | IE3 Premium efficiency motor, IP55, insulation class F with temperature rise F limited to B and temperature measurement in the winding as well as of anti-condensation heater. |
| Cone diffuser | : | Stainless Steel 316 |
| Compensator | : | Stainless Steel 316 |

#### 4.2.6.3.10 Performance Test Run

One compressor in each type/model shall be fully inspected and functionally tested at the factory for performance and proper operation. Performance test and acceptance according to ISO 5389 should be performed on manufacturer test stand and attested. The design values of the performance table according the contract must be within a manufacturing tolerance of ± 2% and a measuring tolerance of ±2%.

### 4.2.7 Diffuser

The aeration system shall be provided to meet the aeration requirement as per the process design requirement. Sufficient design calculations are to be provided along with manufacturer standard one having supplied diffuser during last five years to various waste water treatment plant.

The Type and number of diffusers are left to the bidders design subject to the following condition

(a) Aeration System Fine Bubble Diffused Aeration membrane diffusers with fixed type diffuser system

(b) Type Tube type or disc as per the bidders design conforming to the

following designconditions.

(c) Maximum O2 transfer of aerators at Std conditions

i.) for Disk Diffusers 18 gm O2/m3 air per m water depth at SOTE

ii.) For Tubular Diffusers 16 gm O2/m3 air per m water depth at SOTE

(d) Maximum Air to diffuser not toexceed

i.) DiscType 60 m3/m2 membrane area
ii.) TubularType 45 m3/m2 membrane area

(e) For Considering the AOR the following field correction factors shall be considered

i) Alfa Factor 0.60

ii) Fouling Factor 0.70

For fixed ( i.e. non retrievable diffusers ) which cannot be cleaned or serviced without emptying of tank

(f) Material of Construction for Diffusers & AirPiping

i) Diffusers Membranes : Silicone with laser drilledholes

ii) Diffuser Support : Non Corrosive material uPVC or equivalent

iii) Under Water Air Piping to : SS 316 diffusers including downers and aeration grid

iv) Air from Blower to SS pipe : SS 316 downer (HeaderPipe)

### 4.2.7.1 Fine Bubble Diffusers Assembly

#### 1. General

The subsurface aeration system is to be provided and air is to be introduced by diffusers submerged in wastewater.

A fixed header arrangement using a complete mixing pattern shall beprovided.

All components necessary to provide a complete mixing system within each Aeration zone shall be provided. Work shall include, but not necessarily be limited to, thefollowing:

- Flanged connections (SS 316) at the upstream side of each drop leg for connection to an isolation butterflyvalve.
- Stainless steel (SS 316) Droplegs.
- Stainless steel (SS 316) Slip joint connections to the air distributionheader.
- Stainless steel (SS 316) Air distributionheaders.
- Stainless steel (SS 316) Diffuserconnectors.

- Stainless steel (SS 316) AnchoredSupports
- Gaskets.
- Stainless steel (SS 316) Headerjoints.
- Stainless steel (SS 316) Bolts, nuts andwashers.

Two diffusers are to be provided at each header connection. These are to be mounted to a reinforced tee located on the bottom centerline of the header. The reinforced Tee shall be adjustable to allow accurate alignment of thediffuser.

The tube type diffuser shall be consisting of a single piece injection moulded polypropylene / ABS tube surrounded by a membrane sleeve which should bekept in position by 2 stainless steel grade 316 earclips.

The (OD) external diameter of pipe aerator should not be less than 65-68 mm and the effective length should not be less than 1000mm.

The membrane tube diffuser shall have complete system i.e. air header, support pipes, locking boltsetc.

The design of membrane sleeve should prohibit clogging of the pores which are self closing when air flow/pressure is interrupted. The membrane should have anti adhesive surface which is resistive to grease, oil, hydrocarbons & precipitatingchemicals.

The free end of Aerator / polypropylene support pipe should be open to ensure low buoyancy force. The leak preventing washer should be made up of stainless steel grade 316 and rubber seal should be of EPDMrubber.

The pipe aerator shall be designed for fine-bubble aeration and must be suitable for intermittent operations. Rubber membrane should have two grooves on opposite sides of the membrane circumference for defined fold line when air supply is switchedoff.

The air distribution channel should extend over the entire effective length for an even distribution of air for bubbleformation.

These membranes shall be provided preferably with lower perforation sizes with suitable perforation pattern which when applied with a lower diffuser throughput rate and correct distribution of the diffusers on the aerationzone floor will result in very high oxygen transfer efficiency (OTE).

The diffuser shall be with a perforation of not less than of 0.5 mm with a special perforation pattern with staggered pattern. Surface area shall be higher at the offered Diffuser throughput rate so as a bubble size of less than 0.65 mm is formed.

The rising velocity of bubble should belower.

The bubble should retain a solid sphericalshape.

Bubble should move in a helical fashion for lower bubble diameter so that it travels a longerpath.

The distribution of these bubbles should be uniform resulting in more energy transmitted to the waste water leading to bettermixing

Bottom deflector to prevent debris from entering diffuserassembly.

Orifice flow control is to be provided to ensure orifice head loss is at least 2.5 times the

head loss in the air header at all air flow rates in the diffuser's design operatingrange.

Diffusers are to be spaced along air header to provide uniform mixing of the pre-aeration zonecontents.

The Standard Oxygen Transfer Rate (SOTR) operating shall be achieved with all aeration zones operating at varying air supply rates. Contractors shall provide their recommended minimum airflow rate for each zone in order for their diffuser to maintain the activated sludge mixed liquor suspended solids (MLSS) in suspension and avoid deposition of sludge in thebioreactor.

Fine bubble membrane type diffusers shall be provided of a type that will prevent backflow. The Aeration system shall be suitable for prolonged isolation of the air supply. The membrane shall be provided fixed to the membrane holder in a manner which does not introduce unbalanced stresses and increases sealing pressure as the air flow rate to the diffuser risers. Provide a back flow prevention device built integrally with the diffuser that prevents backflow into the diffuser and airpiping.

A maximum diffuser flux rate shall be provided such that the stress in the diffuser material is within elastic loading limits with a safety factor of at least 10. The contractor shall submit test result, calculations and any other documentation to exhibit that the membrane material will be able to withstand operating loads without undue stress or strain leading to failure in compression or shear or creating significant mechanical creep of the material whichwouldimpair functioning or would cause enlargement of the membrane perforations or holes.

The tolerances of the diffusers mounted bases shall be provided such that the stress in the diffuser material is within elastic loading limits with such that any diffuser and any gasket may be assembled onto any mounting base and provide a seal capable of withstanding the applied hydrostatic and/or pneumatichead.

The contractor shall provide diffuser mounted by the action of a threaded component that shall require measurement of the applied torque to the threaded component during tightening. The torque measurement shall lie within the range of torques specified by the diffuser equipmentsupplier.

All rubber components shall be manufactured from synthetic proven to be resistant to corrosion, degeneration or abrasion in the environments proposed. Provide diffuser material resistant to chemical attack, UV light, weathering and aging. Submit test results, certifying the integrity of the membrane. Provide data indicating the susceptibility of the membrane material to attack by various chemicals.

The diffusers shall be capable of withstanding a maximum differential pressure of 30 kPa and a maximum air temperature of 800C.

Protective storage of rubber and plastic components of diffusers shall be provided prior to installation. Effective cover shall be provided to the diffuser after installation to protect them against physical damage and the ingress of dust and dirt before filling the new water. Documentary evidence of satisfactory service operation shall beprovided.

## 2. Aeration Pipe work

All pipe work, header and drop legs support bracket and fasteners shall be constructed of grade 316 stainless steel. All necessary pipe work shall be provided

including but not limited to all gaskets, fasteners, flanges, isolating valves, header pipe work, down comers, distribution pipe work and purge or drainage lines of each aeration zone located on the air header pipework.

Manually operated isolation valves to each of the banks of diffusers shall be provided. A purge system shall be provided to permit the bleed off any accumulated water in the diffuser lateral pipe work. The details of the purge system shall be provided by the Contractor at the time of detailed engineering. All material shall withstand all operating temperature at the top of the drop leg will be in the range of $20^0$ C to $80^0$C.

Prior to shipment all stainless steel piping shall be treated to the pickling process to provide a de scaled surfacefinish.

Prior to commissioning all pipe work is to be cleaned internally to remove all dust, construction material or any other foreign matter, which could damage and reduce the design life of thediffusers.

**a) Air Header and Drop-legs**

(i) Air distribution header shall be fabricated in sections up to a maximum of 12 meters in length.

(ii) Bottom elevation of the air distribution header shall be same throughout thetank.

(iii) Removable end cap at header ends shall beprovided.

(iv) Connections between sections of the air distribution header shall be designed to allow individual header sections to rotate independently of adjacent headersections.

(v) Header dimensions shall conform to dimensional tolerances specified in ASTM A554-89 and ASTMA530-87.

(vi) A drop leg shall be furnished from the air main connection at the top of thetank.

(vii) A slip joint connection shall be provided between the drop leg and distribution header.

(viii) The drop leg shall be supported from the connection at the airheader.

(ix) Only factory welding shall be used. No field welding shall be allowed. Outside of each weld area are to be wire brushed. All discoloration and deposits left by welding by pickling are to be removed. All diffuser connections are to be welded at Factory. Both the diffuser connectors and the headers are to be stiffened to withstand a moment of 56.5 Newton. Mat the connector without permanentdeformation.

(x) All SS 316 assemblies and parts after fabrication are to be passivated by immersion in a pickling solution of 6 percent nitric acid and 3 percent hydrofluoric acid at 60 for a minimum of 15 minutes. These shall be neutralized by immersion in a tri- sodium phosphate rinse. Certificate shall have to be submitted in conformation of the aboveactivity.

**b) Supports and Anchors**

(i) Necessary wall and floor mounting supports shall be provided for all drop legs and air headers to anchor firmly on the wall and to the bottom of the tank and as specified herein.

(ii) Anchor supports to concrete walls and floors using stainless steel expansion bolts sized and spaced as required for the loadsencountered.

(iii) Supports shall be designed to allow leveling the air header and diffuser assemblies to within specifiedtolerances.

(iv) Necessary expansion couplings shall be proved in the drop legs and air headers as to accommodate anticipated thermal expansion and contraction. Designs of expansion coupling as well as computations for sizing are to be submitted.

**c) On-line Diffuser Cleaning**

An on-line cleaning system shall be provided as an option to allow for cleaning of diffusers without taking aeration system off-line. The cleaning system may entail addition of formic acid (or other chemicals which are not detrimental to the biological process) through a tapping point in the down comers. All necessary tapping points, access and portable chemical mixing and injection equipment shall be provided. The recommended chemicals shall be able to permeate the pores of the diffusers where it shall dissolve the minerals and eliminates micro-organisms present in the deposited material. This combined action shall be sufficient for full restoration of the original quality of the diffuser. The cleaning shall be able to be carried out without interruption to the treatment process. The material of construction of pipework, fittings, valves and diffusers shall be chosen to withstand the exposure of appliedchemicals.

Bidders shall state in their tender the proposed method of cleaning the diffusers and distribution headers.

**3. Spare Parts**

The Contractor shall include in his offer a priced schedule of recommended spares.

**4. Special Tools**

The Contractor shall include in his offer any special tools for the equipment to be supplied.

**5. Installation**

It is the Contractor's responsibility to install the diffuser system correctly. The Contractor shall provide a manufacturer representative who has knowledge and experience in the proper installation, start-up and operation of the diffuser equipment to inspect the final installation and supervise the commissioning tests.

Installation of all components shall be ensured in accordance with the manufacturer's instructions andrecommendations.

## 6. Field Testing

The Contractor's manufacturer representative shall subject each bank of the diffuser system to the following tests. The tests shall include, but not be limited to:

(i) Checking alignment of all components and adjust ifnecessary;

(ii) Checking that each bank can be removed withoutinterference;

(iii) Checking that all equipments, safety devices and equipment protection devices function properly;

(iv) Examining protective coating and repair asnecessary;

(v) Running equipment for an appropriate time at the full range of design conditions and combination of operation duties and check for correctoperation;

(vi) Checking the operation of all equipments under fieldcontrol.

(vii) All Fine bubble diffused aeration systems will be fieldtested.

(viii) Testing will verify the installation as well as the diffuser's ability to deliver the specified air flow rates at the manufacturer's stated pressure loss. Testing will also verify the uniformity of mixingprovided.

(ix) Leveling tests:

- Clear water shall be introduced into each tank to the top of the diffuser elements.
- The level of the diffusers is to be checked that all element horizontal surfaces are within 10 mm of a common horizontal place and at the specified elevation.

## 7. Leakage and Distribution of FlowTests

The contractor shall demonstrate that the diffuser pipe work does not have air leaks under maximum and minimum flow condition by operating the diffusers under shallow submergence. In this regard, following activities shall beensured:

(i) After successful completion of the leveling tests, raise the water level to 50mm above themanifold.

(ii) Visually inspect the water surface to ensure that the airflow is uniformly distributed across thetank.

(iii) Pressure test:

- All of air supply pipe line shall be tested by pressure. Test pressure shall beat least 2 times higher than normal operationpressure.
- If Engineer is unsatisfied with any test results, repeat the test until the installation is essentially void of airleaks.
- Repair any leaks in the elements holders, elements, pipes or thelike.

## 8. Diffuser Pattern Testing

Ensure that the diffused Aeration system is adequately protected to prevent any damage or blockage for the duration of the contract. Demonstrate uniform air distribution through under minimum and maximum aeration flow rates. Demonstrate no significant "wave like" action of the liquid. Demonstrate that all diffusers are operating simultaneously.

**9. Diffuser Clean Water Performance (SOTR)Testing**

The Engineer shall have the right to require the Contractor to carry out Standard Oxygen Transfer Rate testing of all the aeration zones. The water depth in the tank for the tests shall be 6 meters. During the test the contractor shall demonstrate the guaranteed maximum and minimum oxygen transfer rates (SOTR) at the guaranteed airflows and pressures. The contractor shall carry out tests generally as set out in the American Society for Civil Engineers "Standard Measurement for Oxygen Transfer to clean water" LatestEdition.

The following shall be provided by the contractor during the testing:

At least three correctly calibrated portable dissolved oxygen probes in lieu of the Winkler test. Demonstrate calibration of the dissolved oxygenprobes;

All chemicals, chemical mixing, instruments (including air flow measuring devices), equipment, monitoring devices, recording systems or data acquisition and labor tocarry out the clean chemical dispersion water oxygen transfertest;

A written summary of the test procedure, including a schedule, calibration certificates of all equipment and monitoring devices, any special precautions required for the handling of chemicals and special disposal requirements;

Monitoring of the airflow to the diffused air system for clean water oxygen transfer tests.

Supply complete detailed and summary test reports to the Contractor within 14 days of the completion of eachtest.

All necessary corrections and adjustments made shall be recorded. A written statement shall be provided by the Contractor's manufacturer representative at the completion of the tests, certifying that the equipment has been properly installed and operates satisfactorily – all test records are to beappended.

**10. Reliability Tests**

Reliability testing shall not be commenced until the tests described above including the SOTR test if required, have been completed and approved by the Engineer.

The diffusers shall be required to operate under the normal operating conditions within the limits of performance offered by the Contractor, and their continuous or intermittent performance as may be more convenient for the operation of the works. The diffusers shall operate without failure of any kind for a period of one calendar month. Should any failure (other than that of an entirely minor nature) occurs in any portion of the diffusers, due to or arising from faulty design, materials or workmanship or staff training (but not otherwise) sufficient to prevent commercial use of the plant, the test shall be deemed to have failed. The test period of one

month will recommence after the Contractor has remedied the cause of the failure. The onus of proving that any failure is not due to faulty design, materials, workmanship or training will lie with the Contractor.

In cases where the responsibility for failure cannot be determined initially, the Contractor is to attend to such failure as though they were his responsibility. The taking-over certificate will not be issued until the Reliability Test has been completed to the satisfaction of the Engineer along with his written approval. When the Reliability test has been completed to the satisfaction of the Engineer, the Defects Notification Period shall commence.

### 4.2.8 Decanting Device

Type of Decanting device shall be as per Bidder's technology requirement and design. Minimum two numbers of Decanting devices shall be provided per basin. Decanting device shall be in SS 304. Depth of Decanting device shall be 1/3 of the tank liquid depth.

### 4.2.9 Tertiary Filtration System

Secondary treated effluent from secondary clarifiers shall flow to effluent filters by gravity for tertiary treatment.

### 4.2.10 Travelling Bridge Filters

#### 1. General

The Travelling Bridge Filters shall be capable of filtering effluent from secondary clarifiers with daily average flow and daily peak flow of respective WWTPs and achieve the desiredtreated effluent quality. The Traveling Bridge and Traveling Hood Filters should be capable of providing continuous water and wastewater filtration with automatic, on-line backwashing, specifically designed for low head filtration with shallow beds. The filters may be single media or dual media. The traveling hood shall be equipped with a single, centre-mounted traction unit, a pneumatic travel lift, and spring-loaded outboard stabilizers. Control is provided by a programmable controller through an interface of electrically actuated pneumaticvalves.

#### 2. Description

a) Minimum 10 filters in the concrete basin of traveling bridge type for end discharge of filter effluent shall be provided. The filter bed depth shall be minimum0.30m.

b) The total backwash water volume required shall not exceed 5% of the design influent flow. The backwash water shall be taken to the sump of Drain water pumpingstation.

c) Each filter component shall be designed to withstand with a prudent safety factor all stresses that may occur during fabrication, erection, intermittent, or continuous

24 hour per day operation. The equipment and controls shall be provided as a complete package to ensure coordination and compatibility.

d) Each filter shall include a traveling bridge assembly, backwash hood, a single submersible pump, nozzles with integral tailpieces, air distribution header, under drain, Single or dual media i.e. consisting of high grade silica sand and if dual media anthracite media shall be provided, indexing tabs, power cable, rail, influent ports, backwash discharge launder, andcontrols.

#### 4.2.10.1. Cloth Media Filters

The cloth Filters/Disc Filters shall be capable of filtering effluent from secondary clarifiers with daily average flow and daily peak flow of respective WWTPs and achieve the desired treated effluent quality. Each filter shall be installed in a concrete basin and each filter basin shall be provided with a butterfly drain valve. Each filter basin shall be fitted with 304 stainless steel mounting brackets to accommodate attachment of the filter components to inside of the basin. All mounting brackets shall be attached to the inside of basin wall with 304 stainless steel wedge anchors and hardware. All piping including external & puddle piping shall be provided by the Contractor. Cloth/frame assemblies shall be constructed such that each segment is easily removable from the centre tube, without special tools, to allow for removal and replacement of the cloth at the point of installation. Cloths shall have a nominal filtration rating of 10 microns. Each filter shall be providing with isolation valve at upstream. The cloth depth shall provide storage of captured solids, reducing backwash volumes while maintaining an operational headloss.The filter system shall provide for the collection of filtered solids on the outside of the cloth media surface to allow for the direct contact of cleaning systems. Filtered effluent shall be used for backwashing. The effective filtration area will be considered the actual media area which will be submerged and available for filtration 100% of the time. Hence framework and glued surfaces of filter will be considered while calculating the effective filtration area. Contractor shall submit calculation and sufficient evidences for verifying the effective filtration surface area. The filtration system shall be complete with PLC controlled operation and backwash system as per the recommendation of technology vendor. Access walkways, handrails and stair case etc shall be provided as per the tender specifications.

#### 4.2.10.2. Membrane Filtration System

The membrane filtration system shall be either the submerged or low pressure type and shall be capable of filtering effluent from secondary clarifiers with daily average flow and daily peak flow of respective WWTPs and achieve the desired treated effluent quality. The contractor shall be responsible for the design of the necessary pre-treatment system for the selected membrane filtration unit. Concurrently, the supplier of the membrane filtration unit shall certify that the pre-treatment system designed by the contractor is sufficient based on the water quality information provided.

### 4.2.11 Deleted

### 4.2.12 Sludge Thickener

#### 4.2.12.1 Gravity Sludge Thickener

Gravity Sludge thickener shall be Circular (radial), fixed bridge, central turn table type or central drive. The circular reinforced concrete thickeners tapering at bottom shall be provided for thickening process. Design shall be such that the sludge after thickening can be extracted from the bottom of the hopper portion. Interstitial liquid flows through peripheral weir at top. Tanks shall be deep enough to allow the sludge to settle by gravity. At least 50 cm freeboard shall be provided. Provision shall be made for collection of thickened sludge and pumping it to the digester units/dewatering units. Central drive arrangement shall be provided to rotate trussed rake arms having blades to sweep the sludge into sludge hopper. Full Diameter Bridge with central drive shall be provided with central platform for the installation of the scrapers and their drives and for the local control panel a radial scraper system with bottom scraper blades, suspended on thebridge.

The thickener shall have walkway for personnel access to the center, access stairs to ground level and SS hand railing, a motor driven sludge scraper complete with all necessary controls, delivery pipe work, a stilling well and overflow steel weir plates. The scraping gear shall be supported from the tank base and from a fixed bridge carrying the central electrical drive for the rotating gear. The equipment including driving motor, gears, shafting and scrapers shall be designed for continuous operation and sized for the most arduous operating condition including starting from rest with an accumulation of sludge in the thickeners. The electric motor, gearbox etc., shall be provided with a sunshade. The main gear drive shall be cast Iron construction and shall be enclosed in adust proof enclosure with oil bath lubrication. Suitable overload protection for the drive shall be provided to ensure that the sludge shall not overload the equipment and emergency stop pushbutton shall be provided. The scrapers shall be fitted with rotation monitors and over torque protection to alarm in the event of a failure.

The underwater parts shall have minimum 2 mm allowance for corrosion and structural design calculations shall be submitted for all structures including scraper arm, bridge etc. and also the calculation for drive head selection including the Torque Rating. V-notch weir shall be provided along the launders for uniform draw-off of the overflow. The weir plate shall be fixed to the launder by means SS304 grade clamping plates and fasteners. The hydraulic equipment will consists of the inlet pipe (runs along the bridge) to the central feed well of the thickener; sludge draw-off pipe with an manual & Motorized Knife Gate valve for intermittent operation according to an adjustable timer; a drain pipe with manually operated gate valve for the complete emptying of the unit; a discharge pipe/channel from the peripheral collecting channel to the main channel leading to the Supernatant sump. The sludge thickener mechanism shall be suitable for installation in a circular tank and shall include the following:

(i) Mechanism support beam spanning the diameter of thetank.
(ii) Walkway and hand rails from the edge up to 1 meter beyond the center of the tank.
(iii) Drive mechanism with internal geartype

(iv) Reduction gearbox.
(v) Chain & sprocket withguard.
(vi) Central shaft with scrapper arm and picketfence.
(vii) Inlet well of MS outside the centralweir.
(viii) Overflowweir.
(ix) Verticalpickets.
(x) Torque IndicatingDevice.
(xi) Overload Alarmprotection.
(xii) Auto liftingdevice.

The main structural and center drive mechanism including center mechanism shall be designed for a peak instantaneous torque which shall be 2.5 times the continuous design torque calculated using following formula

T in kg-m = LF x (Diameter)^2

where Diameter is in meters and load factor (LF) is as given below.

| Type | Load Factor |
|---|---|
| Radial Centre Peir Thickener | **12** |

**Material of Construction**

Bridge : MS with Hot dip Galvanized (galvanizing minimum thickness shall be 80micron)

Walkway : MS grating minimum 6 mm thk with Hot dip Galvanized (minimum thickness of Galvanizing shall be 80 micron).

Rake Arm : MS with Hot dip Galvanized (galvanizing minimum thickness shall be 80 micron)

Feed Well : SS316

V-notch weir: SS316

Squeegees : Neoprene

Handrail : SS 304 (radial upto center)

Anchor Bolt & fasteners: SS316

Note:

1) The stainless steel and mild steel including hot dipped galvanised components where both are connected to the water / wastewater should be electrically isolated to prevent galvanic corrosion to the stainless steel surfaces

2) The sludge drawl pipe shall be provided with telescopic pipe with valve of suitable size. Replace the existing sludge drawl valve with timer controlled motorized valve of same size.

#### 4.2.12.2 DAF Thickener

The Dissolved Air Floatation (DAF) thickener shall be designed to thicken the waste excess sludge from Secondary Clarifier. Thickened sludge from the DAF Thickener shall be pumped to Anaerobic Sludge Digester through Thickened Sludge Pumps continuously / intermittently as required for anaerobic degradation. The supernatant from DAF Thickener shall be recycled back to the inlet of Primary Clarifier Distribution Chamber by gravity if possible or otherwise by pumping through filtrate / supernatant sump. The size of DAF Thickener shall be provided as per the design parameter given in Section XI Part 2.

The material of construction of the parts of DAF system which are submersed in waste water shall be Stainless Steel 316 or non-corrosive material. The other parts which are not in contact with waste water shall be Mild Steel with hot dip galvanised (80 micron) or other non-corrosive material. Stainless Steel handrail of approved grade shall be provided on walkways, platform and staircases.

### 4.2.13 Sludge Dewatering Units

Sludge dewatering shall be done by mechanical sludge dewatering unit such as Solid Bowl Centrifuge for 100% of the digested sludge. The dewatering units shall include but not limited to the following equipments:

- Powder or liquid Polymer storage tanks/ Bach tanks with mixers
- Polymer metering pumps
- Mixers and solutiontanks
- Polymer service tanks
- Supply line & flushline
- Plant Water supplypumps
- Sludge feedingpumps
- Dewateringunit
- Cake hopper
- Flow meters for feeding Sludge, and for feeding chemicalsolution
- Control valves on sludge feeding line, and on Chemical feedingline
- Drainsystem

The dewatering system should be so located that the dewatered sludge can be loaded into trolleys/ drums/ bins directly – preferably the dewatering unit shall be so located that the dewatered sludge falls into the containers/ bins without requirement of another material handlingunit.

The dewatered sludge should be truck-able & be suitable for disposal by open body truck and should have a minimum solid concentration of 25% (+/-) 2% w/w (measured as dry solids w/w basis).

The dewatering unit should have a 95% solid recovery.

The centrifuge centrate should not contain more than 1000 mg/l solids.

The centrifuge should be capable of being operated at lower solid feed concentration in

case of maintenance.

Dewatering units shall be provided in a separate Sludge Dewatering Building. Feed pump station shall be provided at lower level/floor and dewatering units shall be provided at upper level/ floor.

The centrifuge station system shall work in damp and dust laden atmosphere hence contractor is required to maintain a proper working atmosphere inside the room by providing proper ventilation etc. The specifications of the different components are given below:

#### 4.2.13.1 Centrifuge Units

Centrifuge shall conform to IS: 10037 (Part 3) or any other international specifications superior to these specifications. It shall be capable of handling thickened/ digested sludge. The dewatered cake shall have a minimum dryness of 25% (+/-) 2% w/w or as specified in Section XI: Part 1/Part 2. The centrifuge shall be solid bowl centrifuge of co-current/counter-concurrent design. The centrifuge shall have sufficient clarifying length and differential RPM, so that separation of solids is effective. The centrifuge shall have adjustable weir plate, so that its pond depth can be raised. The centrifuge bowl, scroll support frame and its accessories shall be mounted on a common fabricated steel base frame so that entire assembly can be installed on an elevated structure. The base frame shall be in CS construction and provided with anti-vibration pads.

Under this contract required number of centrifuge with 100% standby shall be provided to meet requirement.

The centrifuge shall comprise the following components:

- Sludge feed system;
- Collecting vessel and support frame;
- Variable speed drive;
- Differential Scroll drive;
- Centrifuge washing;
- Concentrate collection; and
- Control system.

The centrifuge shall comprise a conical cylindrical bowl and scroll feed horizontally mounted in bearings on a frame.

The rotor shall consist of a solid bowl which rotates about a central shaft. An inner scroll shall be provided to convey separated sludge from the periphery of the cylindrical bowl to the beach at the conical end of the rotor.

The bowl and scroll and other wetted parts shall be made from stainless steel 316. The tungsten Carbide hard surfacing on conveyor scroll surface, feed chamber and solid discharge outlet shall be provided. The bowl shall be protected with solid strip liners.

Suitable drive with V-belt arrangement and turbo coupling shall be provided along with overload protection device. Differential speed and bowl speed can be adjusted by

changing the pulleys.

The feed inlet cake discharge and centrate outlet shall be provided with flexible connections so that vibrations are not transmitted to other equipment.

The drive motor shall be of 1450 rpm, 3 phase, 415 V +/- 5 %, 50 Hz. It shall have class of insulation: B, Type of protection: IP 55, Ambient temperature: 400 C, squirrel cage, foot mounted.

The operation of each centrifuge and its associated dedicated sludge feed pumps, polyelectrolyte dosing system, flushing system and other plant shall be automatic once the startup procedure has been initiated by the operator.

A typical start-up sequence shall proceed as follows:

- Start lubricating oilpumps
- Start bearing seal waterpumps
- Start cakeconveyors
- Startcentrifuge
- Start polyelectrolytepump
- Start sludge feedpump

The polyelectrolyte and sludge feed pumps shall not start until centrifuge has reached its full speed.

The shutdown sequence shall be a reversal of the aforementioned procedure. After stopping the sludge and polyelectrolyte pumps, the centrifuge shall be flushed out with clean water. This shall be carried out while the centrifuge is still running. Means shall be provided to divert the flushing water to the centrate drain.

The operation of low level sensor in the thickened storage tank shall automatically start the flow of sludge to the centrifuge.

Polyelectrolyte shall be dosed to the sludge flow via an in-line injection system and to be designed to achieve rapid and even distribution throughout the sludge.

The whole rotating assembly shall be enclosed by a Stainless steel (AISI316) fabricated casing incorporating a Centrate discharge hopper and outlet pipe, and a rectangular solids hopper which shall discharge the dewatered sludge into the disposal system.

The main scroll bearings shall be arranged for lubrication by an external central oil lubrication system. The complete rotating assembly shall be dynamically balanced and test certificates are also to be provided before final inspection & testing atworks..

Sludge shall be fed into one end of the rotor through a centrally positioned feed tube and dispersed to the bowl through an inlet chamber.

The bowl shall be provided with an adjustable 360° peripheral weir at its cylindrical end

to control the depth of the centrate in the rotor.

The fixed outlet castings of the rotor shall be designed to collect the centrate and dewatered sludge from the rotor. Baffles within the casing shall direct the separate phases to the relevant discharge points and prevent cross-contamination.

The centrifuge shall be mounted on heavy-duty vibration isolators, located between the machine and the supporting steelwork or foundations, to damp vibrations and prevent vibration transmission. Two axis vibration monitors shall be provided to stop the centrifuge automatically when excessive vibration isdetected.

Flexible connections shall be provided on the sludge fed system and the centrate system at the entrifuge. The dewatered sludge discharge system shall incorporate flexible chutes.

**(i) Variable Speed Drive**

A variable speed drive shall be provided to accelerate the rotor to operational speed and maintain that speed during the centrifuge's duty period. The bowl drive shall be electric and shall be coupled to the drive shaft by a multiple 'V' notch belt drive.

**(ii) Differential Scroll Drive**

The scroll drive shall be provided with a separate drive mechanism to control its rotation in the same direction but at a different speed to the outer bowl. The differential speed shall be adjustable.

The drive shall be linked to the main bowl drive by an epicyclic gearbox. The differential speed of the scroll shall be automatically and manually adjustable so that the moisture content of the dewatered sludge can be controlled as required.

For safe operation, contractor shall provide control panel showing proper Sequence of operation with interlocking.

Chutes and interconnecting piping shall be provided with flexible joint (minimum 10 mm flexible in all direction) to avoid vibration.

**Material of Construction**

| | |
|---|---|
| Bowel assembly, Conveyor assembly, Casing assembly | SS 316 |
| Protection | Tungsten carbide hard lining on the conveyor flights. Feed nozzle.<br>Solids discharge ports with tungsten carbide lining. |

### 4.2.13.2 Polyelectrolyte Solution Preparation and DosingSystem

Polyelectrolyte solution is required to be prepared and dosed for aiding sludge thickening and dewatering. Polymer Dosing system complete with Tanks with Agitator and Dosing pumps shall be supplied. The tanks shall be cylindrical, vertical with closed lids hinged

and nozzles forchangingpolymer, inlet, Agitator, Level Gauge, Level Switch, Overflow, Drain and Solution Outlet. The tank shall be provided with a propeller type agitator and drive unit.

The Dosing Pumps shall be positive displacement type. The dosing pump shall have PLC controlled adjustable capacity controller.

The material of construction of tank shall be FRVE as Liner + FRP (with is phthalic resin). Agitator and wetted parts of Pump shall be SS-316.

The bidder shall indicate quantity of chemicals required per ton (dry solid weight) of sludge dewatered by the dewateringmachines.

The polymer solution shall be prepared on a daily basis and the unit shall be suitably sized for one shift sludge dewateringoperation.

The polymer solution strength shall not exceed 0.2 %. here shall be two working solution preparation tanks plus 1 stanby tank for the daily poly requirement with the tank agitator having a speed not more than 100 RPM.

There shall be 100 % stand by poly dosing pumps with one dosing pump per poly solution use point. The dosing pump shall be sized for the feed solution concentration complete with pulsation damper, suction valves, NRV Pressure Safety Valves & isolation valves.

#### 4.2.13.3 Interconnecting Pipe Work

The complete pipe work, not limited to the following, shall beprovided:

(i) Sludge Balancing Tank to Centrifuge feed pump
(ii) Centrifuge feed pump to centrifuge
(iii) Centrate pipe work from centrifuge to supernatant and centrate pump house.
(iv) Water pipe work to Polymer Dosing Tank and Centrifuges (for flushing)
(v) Polymer Dosing pipe work from Dosing Tanks to Centrifuge inlet.
(vi) Sludge balancing tank to supernatant & centrate pump house.

The pipe work shall include all fittings, specials, valves, supports etc. and shall be completed in nature.

The sludge, centrate and water pipe work shall consist of pipes of DI-K7 and CI Gate Valves / GM Globe Valves. The pipe works shall be of Polypropylene and valves shall be PP ball valves. Suitable flexible connections shall be provided in the pipe work connecting centrifuge to prevent transmission of vibration

#### 4.2.13.4 Hoist

One No. EOT crane of suitable capacity is to be provided above Centrifuge and below centrifuge platform for maintenance purposes. The Hoist shall be such that it will be possible to lift equipment from ground level.

#### 4.2.13.5 Interlocking

Interlocking is to be provided in M.C.C as per sequence operation of Centrifuge for safe operation.

### 4.2.14 Pre-Dewatering

Pre-dewatering machines (centrifuge / screw press) or conventional thickener shall be provided that will receive the sludge from Biological treatment units. Each system shall have its dedicated feed pumps (sludge pump) and dedicated polymer dosing pump. Each system and its dedicated ancillary equipment shall be controlled through its own process controller. There shall be at least two standby machines or 1/3rd standby machines, whichever is greater.

### 4.2.15 Deleted

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### 4.2.19 Pumps

#### 4.2.19.1 Sump Dewatering Pump

Sump pumps shall be of the open-impeller type, vertically-mounted and close coupled to their fully submersible electric motors. Sump pumps of 1.5 KW and under shall incorporate an integral level detector, control and motor starter and shall be powered only with a suitably-fused three phase or single- phase low-voltage supply and with supply isolated at the supply point. Sump pump over 1.5 KW shall be controlled and started from the supply point. Control shall be by means of adjustable float level switches mounted near thepump.

Pumps shall be supplied with all necessary pipe work to discharge to surface drainage. Each pump shall be provided with delivery reflux and isolating valves, and suitable lifting gear for lowering and lifting the pump from the sump.

Pumps weighing 40 KG or more shall be lowered in to the sump on guide rails and be located to their respective discharge pipe work with an angle flange connection and self-locating clamps.

Pump impellers shall be designed to pass solids of the sizes which pass through the inlet ports of the pump and shall be capable of pumping solids of up to 50 mm diameter.

**Material of Construction**

| | |
|---|---|
| Impeller | SS CF 8M |

| | |
|---|---|
| Shaft | SS BS: 970, Gr 431 S29 |

### 4.2.19.2 Submersible Pumps

#### A) General

It shall be of single stage mono-block type with non-clog design. It shall be suitable for pumping all kinds of sewage containing long fiber, plastics, solid admixes, sludge etc.

Impellers for sewage pump shall be single vane/double vane type without the front shroud and wearing ringto avoid jamming and consequent over-loading of the pump due to build-up of plastic materials between impeller and wearingring.

The pump shall be able to pass through soft solids up to 80 mm and hard solids up to 60 mm and capable of dealing with the sewage with specified specific gravity. The pump shall befitted with special tearing system on the suction side for tearing solid material, viz, long fiber textile, cotton and plastics, which would otherwise cause clogging of thepump.

Maintenance free antifriction deep grease ball bearing with permanent grease packed shall take care of all the axial and radial forces at any point of operation. Profile gasket shall be provided in pump casing so as to avoid metal contact between pump and specially designed duck foot bend to ensure leak-proof joint with guidewire/pipe.

The motor shall be squirrel cage type, three phase submersible motor for continuous duty with class 'F' insulation. Winding of the motor shall be impregnated by resin in order to achieve required thermal withstanding capacity. Motor shall have integral cable port and cable entry shall be sealed. There shall be thermal protection against overheating of motor – winding. The motor shall be designed for non-over loading characteristics. Motor shall be sealed against entry of pump liquid in the motor by using mechanical seal. Moisture sensor tripping unit shall be located inside in the motorchamber.

The pump set shall be supplied along with the special duck foot bend flanged elbow, lifting chain with shackles, enough guide wire/pipe, sufficient tough rubber sheathed leather proof foundation bolts and nuts complete. All these items i.e. lifting chain with shackles, guide wire/pipe, bolts and nuts etc. shall be of stainlesssteel.

The cable should be designed and certified for permanent use in sewage water and suitable for a conductor temperature of 80 °C. It should be leak tight in respect of liquids and firmly attached to the terminalbox.

The weight of revolving parts of the pumps including un-balanced hydraulic thrust of the impellers shall be carried out by thrust bearing provided in each pumpassembly.

Valve chamber / valve pit shall be provided for housing valves and instruments of submersible pumps. The open valve pit shall be provided with a 1 m wide staircase with hand railings. A small pump pit of 400 mm x 400 mm x 300 mm deep (minimum) shall be provided at a suitable corner of the chamber to pump out water. Suitable rain hood shall be provided at minimum 2.20m height to prevent ingress of rainwater.

A suitable drain pump set with accessories shall also be provided in the valve chamber.

**B) Design Requirement**

**i. Pump Casing:**

It shall be conforming to relevant I.S and the internal surfaces shall be free from rough spots and must have central linedischarge.

**ii. Intermediate Oil Chamber and Mechanical Seal:**

Intermediate oil chamber shall separate the motor pump unit from pump unit and shall be filled with non-condensed oil. A mechanical seal shall be provided between oil chamber and motor. The purpose of the lower seal shall be to prevent the entry of the pumped liquid in to the oil chamber and function of the upper seal to prevent the entry of oil from the chamber to the motor.

**iii. Hydraulic Unit and Moisture Sensor:**

The necessary built-in safety device shall be incorporated within the pump itself which shall give timely warning of the impending failure of the mechanical seals; therefore seal monitor system shall be installed in the pump. Moisture sensor shall be provided in the oil chamber to detect failure of the mechanical seal and water leakage. The sensor will be for tripping the pump and also for alarm.

**iv. Impeller:**

The impeller shall be properly balanced dynamically as well as statically. The impeller shall be properly machined for liquid passage. Enclosed impellers shall be adjustable. In such a case, the pump shall be designed to take care of the additional thrust produced. Impellers shall be surely fastened directly to the extended shaft of motor with keys, taper housings of lock nuts.

**v. Impeller Shaft/Extended Motor Shaft:**

The impeller shaft shall be made of stainless and i t shall have a surface finish between 0.75microns or less. The shaft shall be straight within 0.125 mm for 3 meter length total dial indicatorreading.

**vi. Bearings:**

Bearing shall be of antifriction type. The bearing shall be able to take normal axial thrust loads due to unbalanced hydraulic loads on the impellers plus weight of rotating parts of pumps. Bearings shallbe designed with a minimum 40, 000 hours run. The bearing shall be grease lubricated for life and shall be maintenance free.

**vii. Guide Rail Assembly:**

It will have pedestal, bracket, delivery duck foot bend, guide rail pipe, upper guide rail holder complete. The pedestal and bracket shall provide automatic coupling between pump delivery and discharge bend.

**viii. Mechanical Seals:**

Double mechanical seals of approved type shall be provided to prevent pumped liquid entering into the motor winding. The seals shall be running in an oilbath.

**ix. Lifting Chain:**

Pumps shall be provided with SS steel lifting chains of suitable capacity. One end of the chain shall be adhered to the pump and the other end fixed near the upper bracket for guide rail/wire rope assembly by the mean of D-shackle. The chain shall give rings fixed at an interval about 1 mt for engaging the hook of chainpulley.

**x. Column Pipe:**

The standard lengths of column pipe shall be 1.00 m, 1.5 m, 2.5 m, or 3 m. The column pipes shall confirm to the heavy class of the relevantstandard

**1) Design Requirements**

a) Submersible pumps shall be completely submersible, with control panel and level switches suitable for solid passage of 100mm diameter andabove.

b) The pump shall be designed to operate satisfactorily without detrimental surges, vibration, noise or dynamic imbalance over the required head range. The head-capacity curve of the pump shall have a continually rising head characteristic with decreasing capacity over the whole range of total head. The shut off head of the pump shall be at least 120% of the total head.

c) Each pump must be capable of running satisfactorily in parallel with other sets in the system without throttling and by itself, without cavitation or overload under all operating conditions within the system resistanceindicated

d) The efficiency / pump shall be high at duty point and remain reasonably high during the full duty range at the pumpingsystem.

e) The pump shall be compatible with VFD and selected automationsystem.

f) The pump should be capable of developing the required total head at rated capacity. Pumps should be suitable for single as well as parallel operation at anypoint.

g) The pump should deliver at least 125% of its rated capacity at 75% of the specified total head. The H and Q curve should be continuously rising towards shut offhead.

h) Operating range – systemcurve

i) The velocity of vibration should be less than 4.5mm/ sec. with noise level 85 dBA at resistance of 1.85meter.

j) The power rating of the pump motor should be the larger of thefollowing:

   i. 110% of the maximum power required by the pump from zero discharge to run off point totalhead.

   ii. 115% of the power required (BKW) at the dutypoint.

k) The combined efficiency of the pump shall not be less than 70%. The motor shall be premium efficiency motors in accordance with IE3 as defined in IEC60034-30. The highest efficient pump set shall be considered forselection.

l) For pumps that are run with variable frequency derive then System Curve shall be submitted along with Motor Curve for the entire operative range of RPM for approval. Submission of pump data sheet shall be tagged as Variable Frequency Drive /NormalOperation.

m) Pump operating speed shall be less than 1200rpm

n) The pump set should be suitable for starting with discharge valve open, as well asclosed.

**2) Material of Construction**

**a. Pumps**

| | | |
|---|---|---|
| Pump casing | : | Cast Iron IS 210 FG 260 |
| Impeller | : | Stainless Steel 316/Duplex StainlessSteel |
| Shaft | : | Stainless Steel 316/Duplex StainlessSteel |
| Shaft sleeve | : | Stainless Steel AISI – 410 with 350 BHN hardness |
| Impeller key & bolt: | | Stainless Steel 316 |
| Chain | : | Stainless Steel316 |
| Guide Rail | : | Stainless Steel 316 |
| Eye Bolt | : | Stainless Steel316 |
| Bearing Bracket | : | CI IS: 210 FG260 |
| Motor casing | : | CI IS : 210 FG260 |
| Bolts, nuts | : | Stainless SteelSS316 |
| Casing wear ring | : | CI IS : 210 FG260 |
| O-ring | : | Nitrile rubber (NBR) |

**b. Shaft seal**

| | | |
|---|---|---|
| Typeofseal | : | Double mechanicalseal |
| Arrangement | : | Tandem |
| Seal on medium side | : | With elastomer bellows Mechanical seal, |
| pump side | : | Silicon carbide/NBR Mechanical seal, |
| bearing side | : | Silicon carbide/NBR |

**c. Monitoring**

Thermal winding protection: Bi metallic sensors in all three phase winding
Motor housing monitoring : DI moisture sensor Mechanical seal leakage

| | | |
|---|---|---|
| Detection | : | DI moisture sensor Bearing temp |
| monitoring | : | Bi Metallic sensor |

**d. Installation**

| | | |
|---|---|---|
| Type of installation | : | Wet well installation design forautomatic Connection to a permanently installed discharge elbow will neoprene seal to avoid metal to metal contact |
| Flangedimensionto | : | EN 1092-2, PN10 |
| Claw | : | Bolted to thepump |
| Installationdepth | : | As per data provided |
| Guidesystem | : | StainlessSteel |
| Liftingdevice | : | Stainless steel lifting chain Length |
| ofliftingdevice | : | Suitable |
| Liftingloops | : | suitable |
| Installationaccessories | : | Discharge elbow, fasteners, claw, bracket, lifting chain, guide bars etc. |

complete.

**e. Motor**

| | | |
|---|---|---|
| Type | : | Squirrel cage induction motor |
| Motor efficiency | : | Premium efficiency motors according to IE3 as defined in IEC60034-30 |
| Degree of protection | : | IP 68 |
| Insulationclass | : | H, Thermal Sensors set for 140 degC |
| Coolanttemp | : | </= 40 C |
| Tempriselimit | : | NEMA ClassA |
| Startingmode | : | Direct |
| Ratedvoltage | : | 3ph, 415V |
| Ratedfrequency | : | 50 Hz |
| Nominalspeed | : | Less than 1000- rpm (Synchronise) |
| Motorcasing | : | CI IS 210 IS FG260 |
| Main cab | : | Complete with cable lengthas per requirement |

### 4.2.19.3 Scum Pumps

Scum generated in primary clarifier shall be collected in scum pit wherein submersible chopper pumps shall be installed to handle all the latex, plastic material and hair from the top of clarifier. The operation of scum pumps shall avoid downstream clogging of the equipment. Scum line of 100 mm dia from each clarifier is also to belaid.

### 4.2.19.4 Horizontal Centrifugal Pumps

**1) Design Requirements:**

a. The pump shall be designed to operate satisfactorily without detrimental surges, vibration, noise or dynamic imbalance over the required head range. The head-capacity curve of the pump shall have a continually rising head characteristic with decreasing capacity over the whole range of total head. The shut off head of the pump shall be at least 120% of the totalhead.

b. The pump should be capable of developing the required total head at rated capacity. Pumps should be suitable for single as well as parallel efficient operation at any point in between the minimum and maximum system resistance indicated in the system resistancecurves.

c. The total head capacity curve should be continuously rising towards the shut off. The pump should deliver at least 125% of its rated capacity at 75% of the specified total head.

d. The required NPSH at duty point should be at least 1.0 M less than the availableNPSH.

e. Pumps shall run smooth without undue noise and vibration. The velocity of vibration should be within 4.5 mm/sec. The noise level should be limited to 85 dBA at a distance of 1.85M.

f. Operating range - -system curve shall be submitted along with that of motor if the pump/s are subjected to VFD application with the data sheet tagged as VFD application.

g. The power rating of the pump motor should be the larger of thefollowing:

i) 110% of the maximum power required by the pump from zero discharge to run offhead.

ii) 115% of the power required at the duty point. Considering the combined efficiency of pump and motor with zero negativetolerance.

h. The pump set should be suitable for starting with discharge valve open, as well as closed.

**2) Features of Construction**

a. Pump should be suitable for applications in municipal sewage handling or sludge handling as per process requirement, with back pull out design. It shall have end suction and side discharge. It should be of self-ventingtype.

b. Pumps should be identical for particular application and suitable for parallel operation with equal load division. Components of identical pumps should beinterchangeable.

c. Pump casing should be of robust construction Liquid passages should be finished smooth and designed so as to allow free passage of solids. The volute tongue should be straight across and filed to a smooth rounded edge. Casing should be provided with hardened renewable wearingring.

d. Impeller should be suitable for application, enclosed type with smooth blunt edges and large water ways so as to allow free passage of large size solids. It should be free from sharp corners and projections likely to catch and hold rags and stringy materials. Impellers should be provided with hardened wearing ring. Hardness of the Impellerringshould be at least 50 BHN more than that of casing ring.

e. The first critical speed of the rotor should be 30% above the operating speed. Complete rotor should be statically and dynamicallybalanced.

f. Replaceable shaft sleeves should be provided to protect the shaft where it passes through stuffing boxes. Surface hardness of shaft sleeve should be minimum 350BHN.

g. Pumps should be provided with anti-friction bearings. Bearings should be easily accessible for inspection and maintenance. Bearings should be greaselubricated.

h. Stuffing box should be of such design that they can be repacked without removing any part other than gland and lantern ring. Stuffing box drain with pipe connection should be provided at the lowest point so that no leakage accumulates init.

i. Lantern ring should be of axially split type. Grease should be used for stuffing box sealing. Water will not be available for this purpose. Gland should be of splittype.

j. Pump should be furnished complete with flexiblecoupling.

k. Coupling guard bolted to the base plate should befurnished.

l. Base plate for pump and motor should be common. Suitable holes should be provided for grouting. Foundation bolts should be complete with nuts andwashers.

m. Tapping should be provided at suction and discharge nozzles for pressure gauge connection.

n. Hand holes should be provided in the casing to allow easy access to the impeller as

well as to the casing throat. Casing drain connection with stainless steel collared plug should be provided.

**3) Material of Construction**

| | | | |
|---|---|---|---|
| a. | Casing | : | CI to IS:210 GR FG 260 with 1.5 to 2% Nickel. |
| b. | Impeller | : | Stainless Steel: ASTM A 743 CF8M |
| c. | Wearing rings | : | St. Steel ASTM A743 CA-15 |
| d. | Casingrings | : | St. Steel ASTM A743 CA-15 |
| e. | Shaft | : | Stainless Steel BS: 970, Gr 431 S29 |
| f. | Shaftsleeves | : | St. Steel ASTM A743 CA-15-(Minimum hardness-400 BHN |
| g. | ShaftSeal | : | Mechanical |
| h. | Baseplate | : | CI/MS fabricated IS 2062 epoxy painted. |
| i. | Coupling | : | CI |

### 4.2.19.5 Dewatering Pump

a. Pump should be suitable for handling settled sewage containing grit and suspended particles.

b. The pump motor should be suitable for working with or without submergence in sewage. The motor rating should be more than the maximum power required by the pump.

c. The pump set should be portable with necessaryhooks.

d. The pump should be suitable for dewatering from a pit 900mm x 900mm x 100mm deep.

e. The pump should be vertical, centrifugal, non-clogtype.

f. The pump impeller should be mounted on the extended shaft of themotor.

g. The pump should be provided with mechanicalseal.

h. The pump should be supplied with flexible hose pipe of 50mm, 50Mlength.

i. Suitable cable of 50 M length should be supplied with thepump.

**Materials of Construction:**

a) Impeller : Stainless steel ASTMA 743CF8M
b) Casing : Cast Iron
c) Shaft : EN8 (as per IS:970)

### 4.2.19.6 Screw and Progressive Cavity Pumps

The progressive cavity pumps shall be self-priming and designed to handle abrasive, shear sensitive and viscous materials, solids in suspension and liquid/solids mixtures.

Automatic Variable stroke frequency / stroke length arrangement shall be incorporated wherever remote application with PLC/SCADA is envisaged and process demands these

changes through remote, Local Control Panel shall also be envisaged with each pump with auto/manual selector switch and knob for these variations done manually.

### 1. General Design Requirement

Progressive Cavity Pumps comprising a stator manufactured from a resilient material and a helically ground rotor shall be considered for pumping industrial sewage, sludge or highly abrasive and corrosive products without rags andgrit.

### 2. Features of Construction

Pumps shall be manufactured with a short compact block design with close coupled drive or alternatively foot mounted drive via flexible coupling connection.

The pump shall be restricted to cavitations free operation throughout its rated band of speeds at its duty points. Pump shall be screw type, slow speed maximum 200 rpm having following construction features:

Pumps shall be of the type, in which a pumping action is generated by a helical rotating eccentrically within a resilient stator in the form of a double internal helix. The eccentric motion of the rotor shall maintain a constant seal across the stator as it travels through the pump to give a uniform positive displacement. The pumps shall consist of externally mounted stuffing box for easier maintenance ofseals.

Pumps shall be arranged generally with a single shaft seal at the suction end. Mechanical seals shall be used. If a flexible shaft is used to accommodate the eccentric motion, a corrosion resistant shroud shall be fitted to prevent fiber build up on the shaft. Enlarged inspection access holes shall be fitted to the suction chambers of all pumps for periodic removal of accumulated debris.

The shaft bearings shall be positively isolated from the fluid being pumped. The bearing shall of taper roller bearings to ensure rigidity and concentricity of shaft.

The rotor material shall be selected for corrosion and abrasion resistance for the fluid being pumped and for prolonged service life. Hard chrome or other approved coatings shall be not less than 250 micron thickness and shall be diffused in to the base material. The rotor shall generally be single-stage and shall incorporate not less than 360 o of twist, but for high-head applications, it may be necessary to use more than a single –stage.

The stator shall be of a resilient material selected for chemical and abrasion resistance for the fluid being pumped.

Pump speed shall suit the application, where variable delivery output is needed, the pump shall be provided with a variable speed drive. The size and speed range of the pump shall ensure that the highest expected duty point shall lie within the available speedrange.

The pumps shall be provided with a universal joint employing two sets of pins perpendicular to each other, each providing freedom of angular movement for facilitating smoother transmission of angular load and to withstand the axial forces.

Pumps shall be driven by a fixed – speed electric motor through reduction gearing and

the combined drive shall be continuously rated. Pump and motor shall preferably be mounted in-line on a common base plate.

Coupling guards shall be provided, which shall be rigid, securely fixed, and designed so that removal is not necessary during normal operation, routine maintenance and routineinspections.

All motor enclosures shall be provided with ingress protection to IP 55. Motor anti-condensation heaters shall be provided and shall be suitable for use on a 220 V single-phase, 50 Hz supply.

All bearings shall have a design life of not less than 40,000 running hours and shall be designed for loading 20% in excess of calculated maximumloading.

Pumps shall be fitted with individual dry-running protection to initiate pump trip. Dry running protection by 'under –current' monitoring or 'pipeline-intrusive' device shall not be used.

The pump must be protected from operating at pressures higher than recommended. A glycerin filled diaphragm pressure gauge with integrated magnet switch shall be installed in the discharge pipe work directly after the pump. When the pressure reaches the maximum set point a signal from the pressure switch must stop the pumpdrive.

Pumps shall be arranged generally with a single shaft seal at the suction end. Mechanical seals shall be used. Each pumps shall be provided with safety relief valve having following construction features:

| | | |
|---|---|---|
| Casing | : | CI IS 210-FG260 |
| Rotor | : | SS316 Hard Chromed plated |
| Base Frame | : | ISMC Fabricated Epoxy coated |
| Bearing Housing | : | CI IS 210-FG260 |
| Shaft | : | Stainless Steel BS: 970, Gr 431 S29 |
| Foundation bolt | : | HTS GALVANIZED STEEL |
| Stator | : | Hypalon/ Equivalent linning |
| Coupling | : | Flexible pin bush type |
| Coupling guard | : | MS Fabricated |

**i. Stator:**

Vulcanized synthetic rubber stators shall be manufactured with extended ends to form a collar to prevent twisting of the stator within the pumpcasing.

Optionally, slotted stators are required for retrofitting with a stator tensioning device to provide even clamping of the stator to rotor to prolong servicelife.

Suction casings shall be provided with clean-out/inspection ports.

**ii. Rotor:**

Rotor design shall incorporate low wear geometry by providing an elongated pitch, wider sealing line and reduced peripheral velocity of therotor within the stator thus reducing rotor slip back. Rotor surfaces shall be ground finish or coated with a minimum 250 micron

thickness non porous hard chroming compound diffused into the basematerial.

**iii. Rotating Drives:**

Drive torque shall be transmitted through two universal joints or flexible shafts. They shall be designed for continuous transmission of the maximum torque at the maximum speed and pressure. Joints shall be designed to enable replacement pins and bushes to befitted, manufactured from wear resistant steel.

Universal joints shall be protected from damage by the fitting of sleeves with 304 stainless steel guards to prevent ingress of pumped media. Sleeves shall be secured by two holding bands. Joints shall be lubricated with grease to provide a 10,000 hour lifeguarantee.

Drive shafts shall incorporate a 'plug-in' type design to allow dismantling of drive shaft and seal without dismantling the bearing housing

**iv. Over pressure Protection:**

A device to protect against overpressure shall befitted and in addition to a pressure relief circuit fitted with an adjustable valve to return flows to the suction of the pump a pressure switch shall also be installed in the delivery port to stop thepump.

**v. Suction/Flow Failure Protection:**

Suction protection shall take the form of a flow sensing device or, when installed, a low flow inhibit signal from a flow meter. The systems shall be complete with all necessary instrumentation for free issue to the control panel manufacture.

The pumps must be sourced from a supplier that is ISO 9001:2000 certified to ensure that the pump is manufactured to certified standards.

### 4.2.19.7 Polyelectrolyte Dosing System

Polyelectrolyte solution is needed to be prepared and dosed for aiding sludge thickening and pre- dewatering and dewatering. The polyelectrolyte will be dosed online at the centrifuge inlet. Minimum dosage of polyelectrolyte shall be worked out by the bidder. There shall be two poly-dosing tanks each suitable for minimum 8 hrs. of operation. Each-tank shall be equipped with slow speed mixer (100 RPM) to prepare polyelectrolyte solution. The solution will be fed using positive displacement metering type dosing pumps. There shall be dedicated dosing pumps to each centrifuge with 100% standby. The pumps shall be interlocked with centrifuge so that it can only be running in auto when centrifuge is on and should shut down when centrifuge stops. The dosing system shall be housed in centrifuge houseitself.

### 4.2.19.8 Dosing Pumps

The dosing pumps shall be selected to achieve optimum dosing technology and control safety with safety relieve valve. The pump shall have a resistant plastic enclosure that can safely be used for the selected application and shall provide soft and low-pulsation dosing.

The pump design shall incorporate positive stroke return. The maximum stroking speed

**shall** not exceed 100 strokes per minute (spm). Pump, motor and driving arrangement shall be mounted on a robust combined baseplate. The pump shall incorporate sensitive sensors that monitor the dosing flow and the diaphragm and provide process stability. The pumps shall be designed to have separation of hydraulics and electronics, to protected process from equipment failure, complete with motor, base plate, coupling bars, foundation bolts and pump flanges. Pump liquid ends shall be selected for compatibility with the pumped liquid. Suction and discharge valves shall be the single ball type allowing a free flow self-cleaning action. Ball and seat materials shall be resistant to abrasion.

Pumps shall incorporate a variable stroke mechanism to allow the output to be varied while the pump is running. Stroke adjustment shall be manual or where specified by electrical or pneumatically controlled stroke positioner. A stroke length indicator and digital stroke counter shall be fitted. Pumps shall be driven by a flange mounted IP 55 motor, via an oil bath reduction gearbox and variable stroke mechanism giving step less adjustment between zero and maximum stroke length. Where flow proportional dosing is required the variation of output shall be achieved by varying the speed of the pump motor and not the pump stroke length.

Each pump shall be provided with inlet and outlet isolating valves and where necessary, with pressure relief and non-return valves. Dosing pumps shall be provided with back pressure loading valves and pulsation dampeners.

| | | |
|---|---|---|
| Diaphram Valve, Gasket | : | PTFE, or Hypalon |
| Liquid End | : | Stainless Steel 316 |
| FoundationBolt | : | Mild Sleet Epoxy Paint |
| WettedPart | : | SS316 |
| BaseFrame | : | Carbon Steel, epoxy Painted. |
| Flanges | : | Carbon steel |
| Plunger | : | Carbon Steel |
| Accuracy | : | ±3% |
| Voltage | : | 415 ±10% |
| RPM | : | 1440 |
| CheckValves | : | SS-316 |

### 4.2.19.9 MLR Pump

1. **GeneralRequirement**

   The MLR pump shall be Submersible Propeller type, single stage pump suitable for pumping screened waste water with fibrous solids /MLSS from aeration zone where larger volumes must be pumped at relatively low heads. Pump should be single-stage close-coupled submersible pump unit with axial propeller for wet-well

installation in vertical column.

Its Self-sealing and self-centering design shall enable the installation and removal even when the column pipe is submerged. The propeller blades shall be self-cleaning by passing across a sharp relief groove in the wear ring the blades are cleared from debris upon each rotation. Motor and pump shall be directly coupled and be manufactured by the same manufacturer.

The pump set shall be mono-block type driven by squirrel cage induction motor. The motor shall be an integral part of the pump set. It shall be a totally sealed unit suitable for completely as well as partially submerged condition.

Each pump shall be provided with a positively driven dual, tandem mechanical shaft seal system consisting of two seals, each having an independent spring system. The seal material shall consist of Silicon carbide / Corrosion resistant tungsten carbide. The seals shall require neither maintenance nor adjustment and shall be capable of operating in either clockwise or counter clockwise direction of rotation without damage or loss of seal function

The motor shall be induction type with a squirrel cage rotor, housed in an air filled watertight chamber. Motor shall be, 3 phase Squirrel Cage Induction Motor, 415V +10%, 50 Hz, with IP-68 Enclosure with Class H Insulation, Temperature rise: According to class A, IE3 Premium Efficiency Motor. The stator shall be heat-shrink fitted into the stator housing. Propeller pump, pumps the liquid upwards in the steel pipe which will flow around the motor with this action motor cooling happens automatically.

Water pressure sealed connection chamber, with two stage cable entry, protected against excessive cable tension and bending. The cable shall be EPR insulated Double sheathed designed and certified for permanent use in sewage water and suitable for a conductor temperature of 80 °C. The motor and cable shall be capable of continuous submergence without loss of watertight integrity to a depth of at least 20m.

Bi-Metallic Thermal sensors should be provided in the each phase of motor winding & both (Upper & Lower) bearings to monitor temperature rise in motor windings and bearings. The sensors shall be connected in series and shall be coupled to the motor contactor coil such that any one-switch opening will shut down the motor. The temperature setting shall be 140°C +/-5°C and shall automatically reset once the stator temperature returns to normal.

DI Moisture sensors shall be provided in motor housing, mechanical seal oil bath and connection chamber of the motor for the purpose mentioned here below:

**a.** For Oil chamber - To detect the Mechanical Seal Failures.
**b.** For Motor housing - To monitor leaks in Motor housing.
**c.** For Connection Chamber - To detect failure through Cable entry.

Mating surfaces shall be watertight and fitted with nitrile O-rings

## 2. Design Requirement

a) Pump shall be vertical Shaft, wear resisting, single stage, submersible Propeller type.

b) The pump shall be designed to operate satisfactorily without detrimental surges, vibration, noise or dynamic imbalance over the required head range. The head-capacity curve of the pump shall have a continually rising head characteristic with decreasing capacity over the whole range of total head. The pump shall be capable to deliver (+/-) 20% of the desired dutyhead.

c) Each pump must be capable of running satisfactorily in parallel with other sets in the system without throttling and by itself, without cavitations or overload under all operating conditions within the system resistance; Components of identical pumps should be interchangeable.

d) The efficiency / pump shall be high at duty point and remain reasonably high during the full duty range at the pumpingsystem.

e) The pump shall be compatible with VFD and selected automation system.

f) The pump should be capable of developing the required total head at ratedcapacity.

g) The velocity of vibration should be less than 4.5mm/ sec. with noise level 85 dBA at resistance of 1.85meter.

h) The power rating of the pump motor should be the larger of thefollowing:

i) 110% of the maximum power required by the pump from zero discharge to run off point totalhead.

ii) 115% of the power required (BKW) at the dutypoint.

i) Minimum hydraulic efficiency of pump at duty point shall be 75% & the motor shall be premium efficiency motors in accordance with IE3 as defined in IEC60034-30. The highest efficient pump set shall be considered forselection.

j) For pumps that are run with variable frequency derive then System Curve shall be submitted along with Motor Curve for the entire operative range of RPM for approval. Submission of pump data sheet shall be tagged as Variable Frequency Drive /Normal Operation.

k) Pump operating speed shall be less than 1000rpm

l) Pumps should be provided with anti-friction ball or roller type bearings, lubricated-for-life, maintenance-free designed for a L10 bearing life of 100,000 hours at BEP and shall be of sufficient size to transfer all radial and axial loads to the pump housing and minimize shaft deflection.

m) Pump should be equipped with double mechanical seals by means of a SIC/SIC or Corrosion resistant tungsten carbide, independent of the direction ofrotation.

## 3. Material of Construction

### a. Pumps

| | | |
|---|---|---|
| Pumpcasing | : | EN GJL-250 or IS 210 to FG260 |
| Connectionchamber | : | EN GJL-250 or IS 210 to FG 260 |
| Diffuser /Inlet Diffuser | : | EN GJL-250 or IS 210 to FG 260 |
| Propellerhub | : | Cast IronEN-GJS-400-18 |
| PropellerBlades | : | CF 8M ASTM A 743 / Stainless Steel 1.4340 |
| Shaft | : | AISI 431 / AISI420 |
| Impeller key&bolt | : | AISI –316 |
| Wearingring | : | AISI 316 or EN1.4408 |
| Chain | : | Stainless Steel 316 as per DIN5688Gr.5 |
| LiftingHoop | : | AISI 316 /EN-GJS-400-18 |
| BearingBracket | : | EN GJL-250 or FG 260 as per IS210 |
| Motorcasing | : | EN GJL-250 or FG 260 as per IS210 |
| Bolts, nuts | : | Stainless Steel 316 /1.4401 |
| O-ring | : | Nitrile rubber (NBR) |
| Couplingring | : | AISI-316 / Cast Steel1.0446 |

**b. Shaft seal**

| | | |
|---|---|---|
| Typeofseal | : | Double mechanicalseal |
| Mechanical seal, pump side | : | Silicon carbide/NBR or Corrosion resistant Tungsten carbide WCCR |
| Mechanical seal, bearing side | : | Silicon carbide/NBR or Corrosion resistantTungsten carbideWCCR |

**c. Monitoring**

| | | |
|---|---|---|
| Thermal winding protection | : | Bi metallic sensors in all three phase winding |
| Motor housing monitoring | : | DI Moisture sensor |
| Mechanical seal leakage detection | : | DI Moisture sensor |
| Bearing temp monitoring | : | Bi Metallic sensor |

**d. Motor**

| | | |
|---|---|---|
| Type | : | Squirrel cage inductionmotor |
| Motorefficiency | : | Premium efficiency motors according to IE3 as defined inIEC60034-30 |
| Degree of protection | : | IP68 |
| Insulation class | : | H, Thermal Sensors set for 140 degC |
| Coolant temp | : | </= 40 C |
| Temp rise limit | : | NEMA ClassA |
| Starting mode | : | Direct |
| Rated voltage | : | 3ph, 415V |
| Rated frequency | : | 50 Hz |
| Nominal speed | : | Less than 1000- rpm (Synchronise) |
| Motor casing | : | EN GJL-250 or FG 260 as per IS210 |

| | | |
|---|---|---|
| Main cable | : | Complete with cable length as per requirement & shall be suitable for VFD operation. |

### 4.2.20 Pipe work

The piping material & work shall conform to the following standards for material & erection & testing.

IS-8329 and IS 9523 Ductile Iron pipes and fittings for water and sewage.
IS -1239 GI Pipes & Fittings
IS - 4984 HDPE Pipes
IS -8008 HDPE fittings
IS -7634 Code of practice for laying HDPE pipes
IS -780 Cast iron sluice Valves
IS - 638 Rubber for flanged joints
IS -1867 MS hexagonal bolts and nuts
IS - 6392 Steel pipe flanges
IS 7634 Laying & Jointing of HDPE pipes

#### 4.2.20.1 General

The term pipe work shall include all necessary supports, saddles, slings, fixing bolts and foundation bolts required to support the pipes and associated equipment. The pipe work shall be laid out and designed to facilitate the erection, painting in situ and dismantling of any section for maintenance and to give a constant and uniform flow of working fluid with a minimum of head loss. Where steel pipe work is used, the number of flanges shall be kept to a minimum and the size of each length of pipe work shall be determined by the ease of handling, installation and general appearance of the completed pipe system. Positions of flanges shall take account of any concrete pipe supports or thrust blocks needed. Flexible joints shall be provided where needed to facilitate removal of equipment or to allow for differential settlement of the building. Wherever practical, flexible joints shall be provided with tie-bolts or other approved means to transfer thrust or tension axially along the pipework.

Where steel and cast flanges are to be bolted together, the steel flange shall be machined over its full face after welding to its pipe is completed. Flanges shall be finished truly square with the pipe axis. Wherever possible, standard fittings shall be used in preference to special fittings. Pipe work layout within pumping stations shall be prepared to meet the requirement of the pump manufacturer. Valves, strainers and other devices mounted in the pipe work shall be supported independently of the pipes to which they connect. Flanges shall be drilled in accordance with the appropriate pressure rating. Where a pipe passes through a wall, a retaining wall, or is subject to end thrust, it shall incorporate a puddle flange. Puddle flanges shall be undrilled.

#### 4.2.20.2 Material of Pipes, Sizing & Design Basis

Unless otherwise specified, the water velocity in the suction branches of a pump shall not

exceed 1.5m/s and in the discharge branch shall not exceed 2.1 m/s when the pump is operating within its specified working range. There shall be no discernible noise due to hydraulic turbulence or cavitations within the pump or its associated pipe work and valves.

#### 4.2.20.3 Piping Sizing & Material

The piping and valves will be sized on the following basis for sizing

| Service / Flow | Basis | MOC |
|---|---|---|
| Gravity Lines for Sewage, Water & Waste Water | Velocity between 0.6 to 1.2 m/s & designed as pipe line flowing full | DI Class K 9 or equivalent as per ISO 2532/ BS EN 545 with Sulphate Resistant Cement Mortar Lining |
| Pressure/pumping line | Velocity between 1.2 to 2 m/sec | DI Class K 9 or equivalent as per ISO 2532/ BS EN 545 with Sulphate Resistant Cement Mortar Lining / MS Cement Mortar lined for sizes above 1200mm. |
| Sludge line | Gravity: Velocity 1 m/sec (maximum)<br>Pumping: Velocity 1.5 m/sec (maximum) but minimum size of pipe 200 mm | DI Class K 9 or equivalent as per ISO 2532/ BS EN 545 with Sulphate Resistant Cement Mortar Lining |
| Air (Pressurized Lines) for Aeration zone, Grit Chamber, Gas Mixing System etc. except common header pipe line from Air Blower to Aeration zone. | At velocities between 8 – 10 m/sec (desirable) with a maximum of 15 m/sec in small sections | SS – 316 conforming to schedule 10 S confirming to ASTM A312) |
| Air (Pressurized Lines) Common header pipe line from Air Blower to Aeration zone | At velocities between 8 – 10 m/sec (desirable) with a maximum of 15 m/sec. | SS – 316 conforming to schedule 10 S confirming to ASTM A312) with suitable type of Insulation. |
| Gas Mixing System complete | At velocities between 3.5 to 4.5 m/sec | SS – 316 conforming to schedule 10 S confirming to ASTM A312) |
| Bio Gas Piping | At velocities between 3.5 to 4.5 m/sec | SS – 316 conforming to schedule 10 S confirming to ASTM A312) |
| Service Water | Velocity between 1.4 to 2.0 m/sec | GI Class B |
| Chemical Feed Lines | Velocity between 0.6 to 1.5 m/sec | Polypropylene |

#### 4.2.20.4 Cast IronPipes

- The cast iron pipes shall generally conform to IS:1537/IS:1536 and pipe fittings shall conform to IS: 1538. All pipes and fittings above the ground level and inside pumping station shall be flanged.
- The material for cast iron pipes and fittings shall be of grey cast iron conforming to IS: 210, Gr FG200.
- The pipes shall be of uniform bore and straight in axis. Length of the straight double flanged pipes shall be within a tolerance of + 3mm.
- The flanges of the straight pipes shall be square to the axis of the pipe. The face of the flanges shall be parallel. The bolt hole circle shall be concentric with the bore and bolt holes equally spaced. In straight pipes the bolt holes in one flange shall be located in line with those in the otherflange.
- The faces of the flanges of the fittings shall be square to the directional axes. The holes shall be located symmetrically off the center line. The intersecting axes of the tees shall be perpendicular to eachother.
- The bolt holes on flanged pipes and fittings shall be drilled with the help of drilling jig. The blank flanges are to be machined anddrilled.

#### 4.2.20.5 Ductile Iron Pipes

The DI Pipes conform to IS 8329 /ISO 2531/BS EN 545 & Fitting conform to IS 9523/BS EN:545. These pipes can also be offered with standard thickness for smooth flow and corrosion resistance.

All the pipes, valves, specials and other pipe appurtenances shall be designed to withstand the maximum pressures to which it may be subjected to during the operation.

The pipes shall be such that they could be cut, drilled or machined.

In case of flanged pipes, the flanges shall be at right angles to the axis of the pipe and machined on face. The bolt holes shall be drilled as per stipulations given in the relevant BIS.

#### 4.2.20.6 DI Specials/ Fittings

DI specials shall be manufactured as per IS: 9523 and shall be ISI marked.

In case of flanged joints, the flanges shall be at right angles to the axis of the pipe machined on the face.

The bolt hole circle shall be concentric with the bore and bolt holes shall be located off the centre lines as per IS: 9523. Fittings shall be tested as per IS:9523

#### 4.2.20.7 Stainless Steel Pipes

All gas pipes, fittings and other related components inside the digester shall be of stainless steel SS- 316.

#### 4.2.20.8 Steel Pipes

All steel pipes shall conform to IS:3589.ERW steel pipes (200mm to 2000mm) for gas, water and sewage and laying should conform to IS:5822.

#### 4.2.20.9 Unplasticised Polyvinyl Chloride (UPVC)Pipes

The materials used in the manufacture of uPVC pipes and fittings shall comply with the physical properties indicated in relevant specification. They shall not contain any matter which could impart taste, odour, toxicity or be harmful to health or adversely affect the water conveyed.

Unless specified otherwise joints shall be of the complying with BS 4346/IS4985 having an elastomeric sealing ring. Joints shall be made in accordance with the Manufacturer's instructions.

Fittings shall be injection-moulded in uPVC to the requirements of BS 4346/IS4985. Fabricated uPVC fittings or fittings manufactured in other materials will only be permitted when the material and method of manufacture are approved by the Engineer-in-Charge.

#### 4.2.20.10 Dismantling Joints

Where dismantling joints, flexible couplings or flange adaptors are used these shall be of the Viking- Johnson type except where otherwise specified or approved. Pressure ratings shall match the pressure rating of the pipework in which they are installed, and materials used and methods of protection shall not be inferior to those used for the pipework. Where needed, joints and couplings shall be providedwith tie bolts to restrain the maximum axial thrust arising when in service.

The dismantling joints for ductile iron pipes shall be of ductle iron with EPDM seal ring.

### 4.2.21 Valves and Appurtenances

All sluice gates, isolation valves, air release valves, check valves shall be designed for the medium carried in the respective pipeline, according to the diameter and the design working pressure of the pipeline. Manual operation shall always be provided. Electrical drives shall be provided as per requirement unless otherwise specified.

The valves shall be installed between flanges. The dismantling shall be possible by the use of rigid or flexible dismantling pieces or flange adapters at one side. For this purpose, suitable flange adapters may be provided. All valves shall be installed in the pipe work in such a manner that they can easily be removed from the line for dismantling andmaintenance.

The non-return valves on the pump delivery branches shall be spring loaded and have high speed non slam closing characteristics.

Valves used in lines conveying chemical solutions and gases shall be manufactured of material suitable for the purpose and to withstand the corrosive and aggressive action of the medium. However for sludge pumps Knife gate valve can be accepted.

Valves used on sludge conveyance piping etc. shall be of straight through type and non-logging. Butterfly/knife edge gate valves may also be used on sludge line.

The pressure rating of valves must at least be equal to the maximum expected pressure at the point of installation.

The size of valves must not be less than the size of the respective main (suction, delivery) pipes. The material of construction of valve shall be as follows:

#### 4.2.21.1 Sluice Valves

Sluice valves shall be generally conforming to IS: 14846:2000. Additionally they should meet the specific requirement given below. The valves shall be double flanged machined and drilled to IS-1538 Part IV & VI. The backside of the drill holes to be spot faced for proper seating of bolts & nuts. Reasonable clearance behind the rear face of the flange on body and bonnet to be kept to provide free access to use spanners for assembling and dismantling. No tap hole is acceptable. The pressure rating of the Valves on the Suction side / discharge side of the pump shall be as per design requirement. They should close with clockwise rotation of hand wheel. The direction of closing shall cast on hand wheel. Nominal size, PN Rating and Brand name should cast on the body. The valves shall be of Non Rising Spindle type. They shall be with Back seat Bushing arrangement for replacement of packing without leakage. The Valve of size 350 and above should be supplied with 2 nos. Single trust deep groove Ball bearing on both end of spindle collar to reduce operating torque and vertical thrust on spindle. The valves of sizes 450mm and above should be supplied with enclosed grease packed bevel/worm gear box of suitable rating to ensure that the valve shall be operated with effort not more than 7 KgM at the pinion shaft for manual valve only. The valves shall be provided with position indicator for indication from full open to full close. They shall be provided with cast iron cleaning door at the bottom of sluice valve body. The clearance between the wedge nut housing lugs on the wedge and the inside surface of the valve body shall be adequate to insert the wedge nut into the wedge lug recess either in the direction of water flow or in perpendicular direction when the wedge is in closed position. The Valves shall be provided with Air Release plug arrangement on the top of the bonnet. Sluice valves shall be electrically operated with manual override facility in all pump houses on delivery side including header whereas on suction pipe all sluice valves shall be manually operated. The valves which are operated rarely i.e. not regularly shall be manually operated.

**Sewage Water Application**

**a. General**

1. Sluice valve shall be conforming to IS: 14846: 2000 and with ISI marking. Additionally they should meet the specific requirement given here under.
2. Sluice valve must be from ISO-9001 certified company towards Quality Management System.
3. The valves shall be double flanged machined and drilled to IS- 1538 Part 4 & 6. The back side of the drill holes to be spot faced for proper seating of bolts & nuts. Reasonable clearance behind the rear face of the flange on body and

bonnet to be kept to provide free access to use spanners for assembling & dismantling. No tap hole isacceptable.

4. The valves should close with clockwise rotation of hand wheel. The direction of closing shall be cast on handwheel.
5. Nominal size, PN rating & Brand name should cast on thebody.

**b. Design Requirement**

1. The valve should be of PN 1.0 rating / based on working pressure in thepipeline.
2. The valves shall be of Non-rising Spindletype.
3. The valves shall be with back seat bushing arrangement for replacement of packing without leakage.
4. The valve size 350 mm & above shall be provided with renewable Shoe & Channel arrangement to reduce the clearance between body and wedgelugs.
5. The valve size 350 mm & above should be supplied with 2 nos. Single trust deep groove Ball bearing on both end of spindle collar to reduce operating torque and vertical trust onspindle.
6. The valve size 450 mm & above should be supplied with enclosed grease packed bevel/worm gear box of suitable rating to ensure that the valve shall be operated with effort not more than 7 KgM at the pinion shaft.
7. The valves shall be provided with position indicator for indication from full open to fullclose.
8. The valves shall be provided with cast iron cleaning door at the bottom of Sluice valvebody.
9. The clearance between wedge nut housing lugs on the wedge and the inside surface of the valve body shall be adequate to insert the wedge nut into the wedge lug recess either in the direction of water flow or in perpendicular direction when the wedge is in closedposition.
10. The valve shall be provided with air release plug arrangement on the top of thebonnet.
11. The valves should also be compatible with Actuatorsystem.

**c. Material of Construction**

| | | |
|---|---|---|
| 1. | Body | : Cast Iron to IS: 210 Gr.FG200 |
| 2. | Wedge | : Cast Iron to IS: 210 Gr.FG200 |
| 3. | Spindle | : SS to BS 970 Gr 316S16 |
| 4. | SeatRings | : SS to BS 970 Gr 304S16 |
| 5. | SpindleNut | : High Tensile Brass to IS – 320HT2 |
| 6. | BackSeatBush | : SS to CF8 |
| 7. | Shoe &Channel Lining | : SS to BS 970 Gr 304S16 |

**d. Shop TestingWitnessing**

| | | |
|---|---|---|
| 1. | Seat Leakage Test(2Minutes) | :10Kg/cm2 |
| 2. | Body Leakage Test(5Minutes) | :15Kg/cm2 |
| 3. | Back Seat Leakage Test(2Minutes) | :10Kg/cm2 |

### 4.2.21.2 CheckValve

Checking valve shall be conforming to IS: 5312. Additionally they should meet the specific requirement given below:

1. The valves shall be double flanged machined and drilled to IS- 1538 Part 4 & 6. The backside of the drill holes to be spot faced for proper seating of bolts & nuts. Reasonable clearance behind the rear face of the flange on body to be kept to provide free access to use spanners for assembling & dismantling. No tap hole isacceptable.
2. The valve should be of PN 1.0 rating based on working pressure in thepipeline.
3. Nominal size, PN rating, Brand name & Direction of Flow should cast on thebody.
4. The Valves shall be of Swing Checktype.
5. The Valve sizes 50 to 600 mm should be of Single door design & above 600 mm should be Multi doordesign.
6. The Check Valves shall be with Non Slam Characteristics. Non Slam Characteristics to be achieved by combination of hydraulic passage and additional disposition of weight on doors without any external clamping arrangements or passages. The angle of sealing and door weight shall be designed to provide the most efficient working with least restriction toflow.
7. Valve of diameter greater than 450 mm shall be provided, in addition to others, supporting feet and jacking screws. Hinge pins / shaft shall preferably be square in section to ensure positive location of flaps and provide for securefixing.
8. If self closing without slamming cannot be achieved, external mechanisms may be used to control the closure rate. Details of mechanisms will be subjected to approval. Valves shall preferably be fitted with resilient faces orseats.
9. Non return valve used in raw water or sludge systems shall not be installed vertically or positioned so that water-borne solids can settle against the valve flap when the flap is closed. Direction of the flow shall be clearly embossed on the valve body. Valve of size 450mm and above shall be provided with supporting foot.
10. The valves shall be suitable for mounting on a horizontal pipeline and flow direction shall be clearly embossed on the valvebody.

**Material of Construction**

| | | | |
|---|---|---|---|
| a. | Body&Cover | : | Cast Iron IS: 210 Gr. FG 260 |
| b. | Door | : | Cast Iron IS: 210 Gr. FG200 |
| c. | HingePin | : | Stainless steel, IS 6603:1972, 04Cr 17Ni12MO2 |
| d. | SeatRings | : | Stainless steel, IS 6603:1972, 04Cr 17Ni12MO2 |
| e. | BearingBush | : | Teflon |
| f. | Fastener | : | carbonsteel |

**Shop Testing Witnessing**

1. Seat Leakage Test (2 Minutes) :10Kg/cm2
2. Body Leakage Test (5 Minutes) :15Kg/cm2

### 4.2.21.3 Kinetic Air Valve

#### a. General

1. Kinetic Air valves shall be conforming to IS: 14845: 2000. Additionally they should meet the specific requirement given hereunder.
2. Kinetic Air valves should be from ISO – 9001 certified company towards Quality Management System.
3. The Valves shall be flanged end machined and drilled to IS – 1538 Part 4 &6
4. The valves should have an isolating Sluice Valve attached toit.
5. Nominal size, PN rating, Brand name should cast on thebody.

**b. Design Requirement**

1. The valve should be of PN 1.0 rating /based on working pressure in the pipeline.
2. The Valves should double ball air valve consisting of large orifice (LP) & smallorifice.
3. The large orifice chamber should have built-in Kinetic features to avoid blocking of the large orifice during filling & emptying of pipeline. It should have a large timber ball covered with rubber to be seated on a large orifice rubberring.
4. The small orifice chamber should have a small timber ball covered with rubber to be seated on gunmetal orifice plug.

**c. Material of Construction**

| | | |
|---|---|---|
| Body, Cover, Cowl | : | Grey Cast Iron. IS: 210 – 1993 Gr. – 200 |
| Stem | : | Stainless steel, IS 6603, 04Cr18Ni10 High Pressure |
| Orifice | : | Stainless steel, IS 6603, 04Cr18Ni10 Low Pressure |
| seal ring and | | |
| Face ring | : | EPDM |
| BodySealRing | : | Stainless Steel IS:3444 Gr1 |
| Float (Low Pressure Orifice) | : | Seasoned timber ball covered with soft |
| Vulcanite Float (High Pressure Orifice) | : | Stainless Steel IS:3444 |
| Seat of large orifice | : | Neoprene Rubber |
| Isolating Gate valve | : | IS : 14846 (GM internals & AISI: 410Spindle) |
| Bolt & Nut | : | Carbon Steel |

**d. Shop Testing Witnessing**

Seat & Body Leakage Test (2 Minutes) : 10Kg/cm2

**e. Painting &Coating**

**Pre – inspection**

1st Step: Surface Preparation
Blast cleaning to near white – SA 2 ½ Gr.

2nd step: Application of Primer Coating after blast cleaning One coat of two component epoxy based primer

**Post – inspection, if applicable**

3rd Step: Application of Finish Coat
One coat of two component solvent free amine cured epoxy coating (Shade)

### 4.2.21.4 Butterfly Valves

Unless otherwise specified, valve body and disc shall be of close-grained gray cast iron. Valves shall be mounted with shafts horizontal. Valves shall be fitted with indicators to show the position of the disc, clearly marked with 'open' and 'closed' positions. Valves shall not contain any brasses containing more than 5% zinc. Gunmetal conforming to BS 1400 Grade LG2, aluminum bronze, or nickel components may be used for internal components. Resilient-seated valves shall have nitrile rubber seals.

Valve of diameter 450 mm and above shall be provided with enclosed gear arrangement for ease of operation. The operation gear shall be such that they can be opened and closed by one man against an unbalanced head 15% in excess of the maximum specified rating. Valve and any gearing shall be such as to permit manual operation in a reasonable time and not exceed a required rim pull of 400 N.

The actuator arrangement for Butterfly valves shall be provided as per the Automation requirement, however valves of diameter 600 mm and above shall be provided with electric actuator only.

All hand wheels shall be arranged to turn in a clockwise direction to close the valve, the direction of rotation for opening and closing being indicated on the hand wheels.

Valves shall be mounted with shafts horizontal. Valves shall be fitted with indicator to show the position of the disc, clearly marked with 'open' and 'closed' positions

For valves of 900mm and above, retaining rings shall be provided to enable the sealing ring to be replaced without the need to remove the valve body from the pipe work. Metal seated valves of 900mm and above, shall have seat clearances adjustable to obtain as near a watertight condition as possible, without the need to remove the valve body from the pipework.

Percentage Opening - Flow Curve shall be submitted along with data sheet mentioning area where such valves are subjected for any controlling of the fluid flow.

**Component Material**

1. Body : Cast Iron, IS:210 GrFG260
2. Inner lining : Stainless steel, BS:970 Gr304
3. Plate/Disc : Stainless steel, IS 3444 1987 Gr 7
4. Stem : Stainless steel, IS 6603:1972, 04Cr 17Ni 12MO2
5. Seat ring/Boss : Stainless steel, IS 6603:1972, 04Cr 17Ni 12MO2
6. Glandhousing : Cast Iron, IS:210 GrFG260
7. Glandpacking : Teflon Impregnated with asbestos + Rubber

### 4.2.21.5 Pressure-Relief Valves(PRV)

Pressure-relief valves shall be designed to prevent the pressure in the pipeline upstream of the valve rising above a preset level. The valve shall remain closed at lower pressures. The pressure at which the valve opens shall be adjustable. A pressure gauge shall be provided to indicate upstream pressure over the operating range of the valve. Safety valves shall comply with BS 6759: Part1.

They shall be designed to open at the specified pressure and re-close and prevent further release of fluid after normal pressure has been restored. The pressure / temperature rating shall be in accordance with relevant standards. Flanged ends shall be Class 900, raised-face type complying with ANSI B16.25 or relevant standards.

**Component Material**

1 Body Cast Iron : IS:210 Gr FG260
2 Inner lining Stainless steel : BS:970 Gr 304
3 Knife gate/ plate Stainless steel : BS:970 Gr 304
4 Stem Stainless steel : BS:970 Gr 304
5 Seat ring / Boss Stainless steel : BS:970 Gr 304
6 Gland housing Cast Iron : IS:210 Gr FG260
7 Gland packing Teflon Impregnated with asbestos+Rubber

### 4.2.21.6 Ball Valves

Ball valves shall conform where applicable to relevant standards. Multi-piece bodies shall be used where work on the ball and seats when installed may be needed. If valves need removal for servicing, one-piece bodies may be used. Seat materials shall be chosen for long life, with erosion and corrosion resistance. Ball supports shall be of the floating ball or trunnion type. If line pressure is too low to ensure a positive leak-free seal, built-in seat loading devices, or specially shaped seatings shall be used to ensuresealing.

**ComponentMaterial**

1 Body Cast Iron : IS:210 Gr FG260
2 Inner lining Stainless steel : BS:970 Gr 304
3 Plate Stainless steel : BS:970 Gr 304
4 Stem Stainless steel : BS:970 Gr 304
5 Seat ring / Boss Stainless steel : BS:970 Gr 304
6 Gland housing Cast Iron : IS:210 Gr FG260
7 Gland packing Teflon Impregnated with asbestos+Rubber

### 4.2.21.7 Knife Gate Valves

The valve shall meet standards C105/A21.5-10, C520-10, C706-10, C707-10, C713-10 and D106-10 and testing requirements of MSS SP 81.

Outer body may preferably be provided with inner liner in corrosion resistant stainless steel which shall extend into the gland. The body shall be devoid of any wedge/ dead pockets to avoid setting of suspended particles and solids in the service fluid.

The gate / plate shall be precision buffed and the edge contoured to a knife edge. The gate shall move along / be guided by the seat ring to ensure that it scraps any deposit / scale enabling smooth uninterrupted movement.

Seat shall be so designed that there is no recess / relieve groove to harbour deposition that

could build-up and swamp the valve. The design should also incorporate bosses that guide the gate and avoid deflection ensuring positive shut-off. The stem shall have double start threads cut in order to ensure smooth and speedyoperation.

Gland packing shall offer minimal frictional resistance and precludes external lubrication. As positive sealing elements, the packing shall also include a resilient rubber ring. The knife edge and seat face in flow path shall be hard faced to a hardness of 400 to 450 BHN to counter erosion. In such cases, provision shall also be made to ensure the fluid contact with the seat ring is minimal.

**Component Material**

Body – Cast Iron: IS:210 GrFG260
Knife gate/ plate – Stainless steel: BS:970 Gr304
Stem – Stainless steel: BS:970 Gr304
Seat ring / Boss – Stainless steel : BS:970 Gr 304 5
Gland housing – Cast Iron : IS:210 GrFG260 6
Gland packing – Teflon Impregnated with asbestos + Rubber

### 4.2.21.8 Cast Iron Flap Valves (Circular FlapValves)

The Flap Valves with circular aperture, single door and double flanges, shall be provided. The flap valves upto 600mm dia shall have sealing faces in angular section and secured to the frame and door by a force fit.For sizes above 700 to 2000mm dia the sealing faces are of rectangular section and are secured to the frame and door using countersunk taper headed screws in the same material as the sealing face. The flap valve shall be suitable for mounting on a vertical wall or flange for static seating heads up to 6meters.

**Material of Specification Frame**

Constructed in BS EN 1561 min. 250 cast iron designed for wall, thimble or pipe mounting applications.

**Door**

Constructed in BS EN 1561 min. 250 cast iron designed to withstand static seating heads up to 6 meters.

**Sealing Faces**

Copper alloy sealing faces to BS EN 1982 : 1999 are supplied as the standard material for ranges up to 600mm dia and for the ranges 700 to 2000mm dia phosphor bronze to BS EN 12167 : 1998. Sealing faces are set to 0.1mm feeler gauge non-acceptance to provide an effectiveseal.

**Hinge Links**

Manufactured in Spheroidal Graphite cast iron

**Fasteners**

Standard fasteners are supplied in stainless steel to BS EN 10088 : 1995 grade 1.4401 (316).

**Hinge Pins**

Manufactured from stainless steel to BS EN 10088 : 1995 grade 1.4401 (316).

### 4.2.22 Sluice Gates

Sluice gate shall be wall thimble mounted type. The construction of Sluice Gates shall be in accordance specification and generally to IS: 13349. The Sluice Gate shall be designed for Seating & Unseating Head without sacrificing reasonable degree of leak tightness. The frame of Sluice gate shall be flanged back type and shall be machined on the rear face to bolt directly to the machined face of the wall thimble. The seating faces shall be made of solid section strip of Stainless steel. They shall be secure firmly by means of counter sunk fixing in finished grooves in the frame and slide face in such a way as to ensure that they will remain permanently in place, free from distortion and looseningduringthe life of the Sluice Gate. Sluice Gates shall be equipped with adjustable Side & Top wedging devices as required to provide contact between the slide and frame facing when the gate is in closed position. The gates shall be of Rising Spindle Type. They shall be operated through a suitable operating mechanism. The Lifting mechanism shall incorporate gearing arrangement, if required to keep the torque requirement within 7 KgM except electrically actuated gate. In case of gearing, those to be enclosed grease packed Bevel or Worm Gear box type. Lifting mechanism shall be provided with suitable position indicator to show the position of the gate from full open to full close. The indicator to be provided in the head stock only. Stem Cover to be provided on the top of head stock for the rising spindle. The cross section of the wall thimble shall have the shape of the English letter ‘F’. The Sluice gate shall be provided with Flush bottom seal. This is a solid square cornered resilent rubber seal provided on the bottom facing of the slide. The seal may be secured fastened to the bottom of the face of the slide by a retainer bar and fasteners. The top surface of the bottom facing of frame shall be flush with invert of the gate opening. Bottom facing of the slide shall be accurately machined to make contact with the seal when the slid is closed. Gates shall be fixed for positive seating. Sluice gates shall be electrically operated with manual override facility. The Sluice Gates shall be of Class – 2 i.e., suitable for maximum unbalanced head needs asper calculation / design. The bypass gate shall automatically open if the flow exceeds the setflow.

**Material of Construction**

The materials of construction of important components of gates will be as under:

a. Frame & Shutter : Cast Iron IS: 210 Gr. FG200
b. Wall Thimble : Cast Iron IS: 210 Gr. FG200
c. Seating Faces & Counter Sunk Fixing : Stainless Steel ASTM A276 type316
d. Wedging Device : Cast Iron IS: 210 Gr. FG200
e. Wedge Linings : Stainless Steel ASTM A276 type316
f. Stem & Stem Coupling : Stainless Steel ASTM A276 type316
g. Stem Nut : Stainless Steel ASTM A743CF8M
h. Flush Bottom Rubber Seal : EPDM ASTMD200

| | | |
|---|---|---|
| i. | Seal retainer bar | : Stainless Steel ASTM A276 type316 |
| j. | Fasteners, Studs Anchor Bolt & Nuts | : Stainless Steel ASTM A276 type316 |
| k. | LiftNut | : Bronze IS: 318 TypeLTB-2 |
| l. | Headstock,StemGuide | : Cast Iron IS: 210 Gr. FG200 |
| m. | Hand wheel | : Mild Steel IS:2062 |
| n. | Painting | : Ordinary Black BituminousPaint |

**Standard Painting**

Unless otherwise specified elsewhere provide following standard painting.

- Surface preparation: Blast clean or Ground to near white metalfinish
- Priming: 1 coat of red oxide primer before and after shop testing. Total priming thickness 75 microns.
- Finish painting for gate assembly: 2 coats of black bitumen paint for gate assembly. Total paint thickness inclusive of priming 200microns.
- Finish painting for headstock: Grey enamel paint. Total paint thickness inclusive of priming 150 microns.

**Shop Testing Parameters**

- Leakage test at operating pressure for gate leakageperformance.
- Movement test for checking interference free movement of completeassembly.
- Seat clearance check for checking clearance between mating sealingfaces.
- Positive Material Identification test for all material other than castiron.

### 4.2.23 Lifting Arrangement:

The lifting arrangement shall be of type as mentioned below:

| | | |
|---|---|---|
| Type | : | If not specifically mentioned against any unit, type for less than 1 Ton capacity –HOT (Double Rail) and for more than 1 Ton - EOT (Double Rail) shall be provided. |
| Capacity | | a) Pumping Stations –1.5 x (Total weight of each set of Pump and motor or single any heaviest equipment to be lifted) whichever is higher.<br>b) Air/Gas Blower/compressor Building – 1.5 x (Total weight of each set of blower and motor or single any heaviest equipment to be lifted) whichever is higher.<br>c) Sludge Dewatering System building – 1.5 x (Total weight of each set of Dewatering machine or any single heaviest equipment to be lifted) whichever is higher.<br>d) Digester control building - 1.5 x (Total weight of each set of any single heaviest equipment to be lifted) whichever ishigher.<br>e) Power Generation Set Building – 1.5 x (Total weight of each set of Power Generation set or any single heaviest equipment to be lifted) whichever ishigher.<br>f) Filtration Building – 1.5 x (Total weight of each set of any single heaviest equipment to be lifted) whichever ishigher |

#### 4.2.23.1 Electrically Operated Hoist with Travelling Trolley

The monorail beam, hoist and trolley shall conform to BIS 3177 (Code of Practice for Electric Overhead Travelling Cranes and Gantry Cranes other than Steel Work Cranes), where applicable.

The trolley shall be of the underhung type supported by the monorail beam. The system's load capacity shall be 3,000 kg, with a lifting height of at least 5.0 m. The monorail beam shall be supported from the roof slab. The equipment manufacturer shall determine the spacing requirements for the support brackets and/or hangers.

The hoist and trolley shall be a single unit with a single motor. The maximum allowable distance from the bottom flange of the monorail beam to the hook (headroom) shall be limited to no more than 500 mm. The main hoisting speed shall be in the range of 2.0 to 3.0 m/min.

The hoist and trolley shall be equipped with the following:

(i) **Motor:** Of the conical rotor type, no larger than 3 kW at 440v/3ph/50 hz, with Class F insulation and a TEFC enclosure. Stalling torque shall be at least 290% of the full load torquerequirement.

(ii) **Gearbox:** Cast iron with alloy steel spur gears and ball bearings. The gear box shall be oil lubricated.

**(iii) Rope Drum:** Welded steel with roller bearings at each end. A rope guide shall be attached to the drum and be equipped with a rope tightener**.**

(iv) **Rope:** Steel core 8 x 50 with an ungalvanized steel outer wrapping.

(v) **Brake:** Cast iron disk type which can be maintained without removing any part except the end cover. The braking torque shall be 100% higher than the motor torque at the rated load.

(vi) **Micro speed Attachment:** Shall reduce the hoisting speed to 10% of the main hoisting speed.

This unit shall have a separate control from the main hoist.

(vii) **Control**: A pendant pushbutton station shall be furnished. The electrical supply shall be 220v/1ph/50Hz.

(viii)**Limit Switches:** The hoist shall be furnished with built-in limit switches to control the top and bottom positions of the hook. Tappets shall be provided to adjust limit switches to intermediatepositions.

A drum-lifting beam shall be furnished with the hoist unit.

The hoist and trolley manufacturer shall be responsible for designing and furnishing the entire system including the monorail beam and itssupports.

#### 4.2.23.2 Electrically Operated Overhead Travelling Crane

The crane shall be electrically operated, bridge type complete with all accessories including down shop conductor, crane rails and fixtures, and shall conform to BS 2573, 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, gear boxes and bottom sheaves on hook shall be lubricated manually by hand operated grease pump through respective greasenipples.

Wheel base and structural frame of the wheel mounting of the end carriages shall be designed so as to ensure that the crane remains square and prevent skewness. Bridge and trolley track wheels shall be of forged steel and shall be double flanged type. The wheel diameter and rail sizes shall be suitable for the wheel loads. The crane rails shall be manufactured from wear resistant austenitic manganese steel. Mountings of the wheels shall be designed to facilitate easy removal for maintenance. Walkways shall be at least 500 mm clear inside width with a 6 mm thick non-skid steel plate surface. Steel rail stops to prevent rails from creeping and trolley from running off the bridge shall be abutted against ends of rails and welded to the girders. Bridge and trolley stops to match the wheel radius shall be provided before the buffer stops.

All exposed couplings, shafts, gear, wheels, pinions and chain drives etc. shall be safely encased and guarded completely to prevent any hazard to persons working around. All bearings and gears shall have a design life of 100000 hours. Electro-magnetic and hydraulic thrust or brake shall be provided for the main hoist. One electro-magnetic brake shall be provided for each of the cross travel and long travel motions.

Hook shall be solid forged, heat treated alloy or carbon steel suitable for the duty service. They shall have swivels and operate on ball thrust bearings with hardened races. The lifting hooks shall comply with the requirements of IS 8610 or BS: 2903 / BS: 3017 or relevant internationally approved standards and shall have a safety latch to prevent rope coming off the hook.

Hoist rope shall be extra flexible, improved plough galvanized steel rope with well lubricated hemp core and having six strands of 37 wires per stand with minimum ultimate tensile strength of 1.6 X 106 kN/m2 of Right Hand Ordinary (RHO) lay construction. The ropes shall have a 6:1 safety factor on the specified safe working load, and shall conform to IS: 2266. Rope drums shall be grooved andshallbe either cast iron or cast steel of or welded steel conforming to IS: 3177, BS: 466 or relevant internationally approved standards.

Gears shall be cut from solid cast or forged steel blanks or shall be stress relieved welded steel construction. Pinions shall be of forged carbon or heat treated alloy steel. Strength, quality of steel, heat treatment, face, pitch of teeth and design shall conform to BS: 436, IS: 4460 and BS: 721 or relevant internationally approved standards.

Name Plate showing the capacity, year of manufacture and rated capacity of hoist, in figures not less than 150 mm height, shall be placed on each side of the crane girder.

The maximum deflection under full load shall not exceed 1/900 of the span (as per IS: 3177).

All accessory and auxiliary electrical equipment including drive motors, electrically operated brakes, controllers, resistors, conductors, insulators, current collectors, pendant push button station, protective devices, operating devices, cables, conduits, etc. necessary for the safe and satisfactory operation of the crane shall be provided.

Power to the crane shall be provided by down shop conductors manufactured from high conductivity hard drawn copper. Conductors shall be completely shrouded such that they have no exposed current carrying surfaces. Pendant type push button station shall be sheet steel enclosed and shall comprise the following push buttons and indicatinglamps:

a) `Start' and`Stop'.
b) Long travel - `Right' and`Left'.
c) Cross travel - `To' and`Fro'.
d) Hook - `Hoist' and`Lower'.
e) Red indicating lamp for supply `ON'indication.

Pendant type push button shall be supported independently of the electrical cable and shall be earthed separately, independent of the suspension. Automatic reset type of limit switches shall be provided to prevent overtravel for each of the following:

a) For `UP' and `Down' motions of thehook.
b) Long travelmotion
c) Cross travelmotion

Crane structures, motor frames and metal cases of all electrical equipment including metal conduit and cable guards shall be earthed. All motors, brakes, limit switches, panels, drum controllers, resistor unit sets shall be provided with two studs for earthing.

All motors shall be of the quick reversing type with electric mechanical brakes suitable for the duties specified. All movements shall be electrically powered suitable for operating with the hook loaded. Facilities shall be provided for the accurate location of the hook by means of `inching' the cross travel and down shop travel motions.

Sufficient slings, ropes, shackles, lifting beams, etc shall be supplied to handle all items of plant covered by the crane. They shall be labelled or marked with the Safe Working Load (SWL) and the purpose for which they are intended.

The crane, and all slings, ropes, shackles and other lifting equipment supplied shall be tested by the manufacturer at his works. The tests shall be carried out at 125% of Safe Working Load, and Test Certificates shall be supplied.

The Contractor shall include with the cranes all necessary contactors, control cubicles and protection equipment necessary to operate the crane and provide adequate electrical protection against overload, phase and earth fault and fail-safe protection in the event of an interruption in the power supplies. All access ladders and platforms necessary to carry out maintenance and repairs shall be provided and installed by the Contractor.

All electrical equipment shall be fully tropicalised.

Site tests shall be carried out by the Contractor who shall supply the necessary materials for the test load. The test load shall be removed from site by the Contractor after successful tests have been carried out.

#### 4.2.23.3 Hand-Operated Overhead Cranes

Cranes shall be designed and manufactured in accordance with BS: 2573 and shall comply with the requirement of BS: 466 class 2 medium duty. The crane details and ancillary equipment provided shall conform to applicable parts of the general requirements specified for electrically-operated overhead cranes, except that the crane shall be manually operated in all motions by conveniently mounted endless chains, arranged for operation by one man. The main features shall conform to the followings:

**General Requirement**

The crane bridge shall consist of a single bridge girder carting two wheels at each end of the span. Steel used shall be of tested quality steel conforming to IS: 2062. The girder shall have enough strength to carry the test load without causing undue stress or deflection.

The long travel bridge wheels shall be rim toughened; treated carbon steel or low alloy steel or CI tray shall be double flanged type. The wheels shall be machined on their treads to match the runaway rail section. The bridge shall have a geared shaft and pulley connecting to opposite wheels of the span, to achieve the long travel motion of the bridge, by means of a chain. The runway rails of adequate strength and rigidity, rail clamps and other accessories for mounting the rails and suitable end stops for the bridge shall be supplied by the Contractor.

**Trolley and Chain Pulley Block**

The chain pulley block shall be operated on the lower flange of the bridge girder.

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 than5.

The hand chains for the hoisting and traverse mechanism shall hang well clear of the hook and both the chains shall be on the same side. The hand chain wheel shall be made from pressed sheet steel and shall be provided with roller type guard to prevent snagging and foulingof the chain.

All the gearing shall be totally encased. Proper lubricating arrangements shall be provided for bearings and pinions. Gears shall be cut from forged steel blanks. Pinions shall be of heat treated alloy steel. Gears shall as per BS: 436/IS: 4460.

The trolley track shall be rim toughened, heat treated carbon steel or low alloy steel or CI and shall be single flanged and shall have antifriction ball bearings. The wheels shall be machined on their treads to match the flanges of the trackjoints.

The travelling trolley frame shall be made of rolled steel conforming to IS: 2062. The

side plates of trolley frame shall extend beyond wheel flanges, thus providing bumper protection for the wheels. The two side plates shall be connected by means of an equalizing pin. Axles and shafts shall be made of carbon steel and shall be accurately machined and properlysupported.

The lifting hooks shall be forged, heat treated alloy or carbon steel of rigged construction. They shall be of single hook type provided with a standard depressed type safety latch. They shall swivel and operate on antifriction bearings with hardened races. Locks to prevent hooks from swiveling shall be provided. Hook shall be as per BS: 2903/IS: 3815.

The brake for the lifting gear shall be automatic and always in action. Is shall be of screw and friction disc type self-actuating load pressure brake. Brakes shall offer no resistance during hoisting.

### 4.2.24 Emergency Equipment (General)

#### 4.2.24.1 Fire Extinguishers

The contractor shall provide fire fighting equipments including pumps and grid with fire hydrant in the STP complex in the fire fighting pump house. The system shall be complete with motor and diesel driven fire pump including JockeyPumps.

The Bidder shall also provide required no. of dry powder type CO2 fire extinguishers (10 kg) for the pumping station and switchyards at the following locations after consultation with the Engineer in Charge:

- Outdoor switchyard
- Indoor electrical room
- Pump rooms (maintenance bay)
- Control room
- GAS handling area

Besides above, Ionisation smoke, optical smoke & heat detectors shall be provided in control room with fire alarm panel having appropriate battery back-up. Fire alarm detectors shall be provided both below & above false ceiling, if any Fire alarm system and public address system shall be provided at the Plant.

All the smoke and heat sensors shall be wired up to nearest JB and interfaced to respective PLC/DDC for alarm annunciations.

## 4.3 Spillage and Leakage

Chemical preparing, dosing and transfer equipment shall be designed and arranged so that any leakage and spilling can be controlled and cannot enter ducts, channels, etc. and have a corrosive impact on pipes, cables or other equipment of the plant.

At all lubrication or greasing points grease trays or pans shall be provided to collect excessive lubricant or spillage onto the equipment or into sewage.

## 4.4 Installation Work

Equipment shall be installed in a neat, workman like manner so that it is level, plumb, square and properly aligned and oriented. Tolerance shall be as established in the

manufactures drawing or as stipulated by CSCL . No equipment shall be permanently bolted down to foundation of structure untilthe alignment has been checked and found acceptable by CSCL.

Manufacturer's drawings, instructions and recommendation shall be correctly followed in handling, setting, testing and commissioning of equipment.

### 4.4.1 Levelling and Grouting of Machinery

The pumps, motors and other equipment shall be properly and accurately levelled and aligned on the concrete plinth by means of tapered metal wedges and metal packing pieces before any grout is poured. After correct alignment and levelling the foundation bolts shall be nipped up to hold the machine firmly in position and it shall be the Contractor's responsibility to check that the position is maintained after the grout has been poured but before it sets. The grout, which will contain an approved expanding agent, will be mixed and poured by the Contractor. Grouting material used for grouting should be as approved by Engineer in Charge.

The horizontality of base plate top shall be within 0.05 mm/metre. The base plate top surface and pump motor box are to be blue matched to get a contact area of at least 80%.

After the grouting mixture has set hard the foundation bolts shall be pulled up hard and the alignment and level rechecked. The Engineer shall be informed at all times of the progress of this work and when any checks on alignment and level are to be carried out so that he may witness the checks if he so requires. The approval of the Engineer or his intimation that the alignment or level of the machines is to his satisfaction shall in no way relieve the Contractor of his obligation under contract to properly install and align the machines and pipe-work and shall in no way prejudice the Engineer in Charge's rights to order rectification of any installation work later found to be improperly carriedout.

## 4.5 Tests onCompletion

### General

When the Contract Plant has been installed on site and is ready for energizing, the Contractor shall notify the Engineer in writing that Tests on Completion are about to commence. At least three days notice shall be given. The Engineer and/ or his Representative may attend the tests at his discretion.

### Commissioning Tests

The Contractor's representative shall subject the screen to the following tests. The tests shall include, but not be limited to:

- Checking alignment of all components and adjust ifnecessary;
- Checking that all equipment, safety devices and equipment protection devices function properly;
- Examining protective coatings and repair asnecessary;
- Running equipment for an appropriate time and check for correctoperation;

- Checking the operation of all equipment under fieldcontrol;
- Demonstrating access coverremoval.
- All necessary corrections and adjustments made shall be recorded. A written report shall be provided by the Contractor's representative at the completion of the tests, certifying that the equipment has been properly installed and operates satisfactorily all test records are to be appended.

**Reliability Tests**

Reliability testing will not be commenced until the Tests on Completion have been completed and approved by the Engineer- in-Charge.

The Plant shall be required to operate under the normal operating conditions within the limits of performance offered by the Contractor, and their continuous or intermittent performance as may be more convenient for the operation of the works. The Plant shall operate without failure of any kind for period of one calendar month.

Should any failure (other than that of an entirely minor nature) occur in any portion of the Plant, due to or arising from faulty design, materials or workmanship or staff training (but not otherwise) sufficient to prevent commercial use of the plant, the test shall be deemed to have failed. The test period of one month will recommence after the Contractor has remedied the cause of the failure. The onus of proving that any failure is not due to faulty design, materials, workmanship or training will lie with theContractor.

In cases where the responsibility for failure cannot be determined initially, the Contractor is to attend to such failures as though they were his responsibility. When the Reliability Test has been completed to the Engineer's-in-Charge written approval, the Defects Liability Period shall commence.

## 4.6 Relevant Standards

The design, manufacture, supply, storage of all equipments shall comply with all Indian Standards (or in the absence of Indian Standards, the appropriate International Standards) Acts and Regulations in their latest amendment, including local statutes covering:

- Health and Safety
- Dangerous Goods
- Factories and Commercial Premises
- Buildings
- Electricity Regulations and Codes of Practice

The Standards referred shall form part of this Contract. Other Standards, Codes of Practice and Regulations not referred to, but which would be applicable to the design, manufacture, installation, testing or commissioning of the equipment under this contract shall be deemed part of the Contract.

## 4.7 Working Stress and Design

The design of all parts shall ensure that under the most onerous of conditions they will not be damaged or corroded.

Any joint that will need to be dismantled during maintenance shall be made by anti-

corrosion type fasteners.

All spare parts shall be fully interchangeable with the original part. If the spare part is unavailable due to cease of production, the Contractor shall give notice to the Employer in writing, detailing the options available to the Contractor.

All parts shall be designed to minimise the risk of fire and consequential damage. All parts shall be designed to prevent the ingress of vermin, dust and dirt. All electrically live or moving parts shall be adequately guarded to prevent accidental contact.

## 4.8 Name Plates

Each main and auxiliary item to the pumping station shall have permanently attached to it, in a conspicuous position, a name plate and rating plate, each of weather-resistance and fire-resistance material. Upon these shall be engraved or stamped the manufacturer's name, type and serial number of equipment, details of the loading and duty at which designed to operate.

Details of proposed inscriptions shall be submitted to the Engineer in Charge for approval before any labels are manufactured.

## 4.9 General Painting and ProtectionRequirements

### 4.9.1 General

The preparation, application and conditions for work shall comply with the recommendations of BS 5493 and BS 6150 or if the protection is of a special nature, in accordance with the manufacturer's directions.

Paints, primers and undercoats shall be obtained from the same manufacturer and except where a definite time is specified between mixing and application, shall be ready mixed for use. They shall be compatible with one another.

Paints shall be delivered in sealed containers bearing the manufacturer's name, batch number, etc. and shall carry a label giving details of quality and instructions for use.

No site painting shall be carried out unless the surface to be painted is dry, the air temperature above 4oC and the relative humidity less than 85% or as otherwise specified by the paint manufacturer, whichever is minimum. The Employer’s Representative shall approve the methods for removing all dirt, oil, grease, etc, before Site painting commences.

Test plates carrying finishes from the actual coating used may be required by the Employer’s Representative for inspection and test purposes.

To facilitate inspection, no consecutive coats of paint shall be of the same shade except in the case of white. Priming to two mating surfaces shall be applied prior to assembly.

All items of Plant shall be delivered to Site with the shop paint finish applied unless specified otherwise. A further coat of final finish paint shall be applied at Site, of

sufficient thickness to produce a uniform colour and appearance. Such painting shall be carried out within one month of successful acceptance trials for thePlant.

All paint thicknesses shall be checked using an Elkometer or equivalent instrument, supplied by the Contractor, for each layer of paint, to the reasonable satisfaction of the Employer's Representative.

All coatings applied to any part of the plant in contact with water to be used for drinking, washing or cooking shall be non-toxic, non-carcinogenic, shall not impart taste, odour, colour or turbidity to the water or foster microbial growth. No manufacturer's name-plate identification, vented filler plugs in gearboxes or grease nipples shall be painted over. Lead based paints shall not be used.

The Contractor shall liaise closely with the paint manufacturer who shall provide full facilities for him to inspect and check the preparation and painting during all stages. The Contractor shall report on his inspections to theEngineer.

The Contractor shall ensure that all coatings are free from defects and adequate in all respects for the purpose intended.

### 4.9.2 Painting SystemFailure

The painting system shall be deemed to have failed if:-

- After painting, damage has been caused by handling, impact, abrasion orwelding;
- Any portion of the paint film separates from any other or the parentmetal;
- After painting the total dry-film thickness is less than that specified. Failure shall notinclude:-
- Loss ofgloss;
- Variation of shade, not affecting the anti-corrosive properties of thesystem.

### 4.9.3 Colour Coding and Labelling of Pipes andEquipment

All pipes and equipment shall be colour coded to a schedule to be agreed with the Employer's Representative before any site painting starts, or earlier if necessary to suit manufacturing procedures. Valves and fittings shall be painted in the same colour as of the pipe of which they form a part. Where a pipe enters or leaves a piece of equipment the pipe colour shall extend up to but not including the flange attached to the equipment.

All pipelines shall be identified by stick-on 90 micron thick vinyl film labels showing the name of the material to be carried by the pipeline and an arrow indicating the direction of flow. Letters of titles shall be pre-spaced on carrier tape and the complete title protected by one piece removable liners. Titles shall be at intervals not less than 8 m, but shall in any case be provided in every space through which the pipe passes. Locations of labels shall be subject to prior approval by the Employer's Representative. Lettering sizes shall be between 16 mm and 75 mm in height depending on the size of the pipe.

Pipes smaller than 22 mm outside diameter shall be labelled by the use of tags instead of

labels. Tags shall be made of brass no smaller than 65 mm x 16 mm by 1.5 mm thick, with lettering etched and filled with black enamel.

Titles shall also be provided on all equipment in locations and in sizes to be approved by the Employer's Representative.

### 4.9.4 Cleaning and Preparing at Place ofManufacture

The Contractor shall be responsible for the cleaning and preparation for painting, priming or otherwise protecting as specified of all parts of the Plant at the place of manufacture prior topacking.

### 4.9.5 Cleaning

Parts shall be cleaned prior to testing at the manufacturer's works. Parts subject to hydraulic test shall be tested before any surface treatment. After test all surfaces shall be thoroughly cleaned and dried out if necessary by washing with an approved dewatering fluid prior to surface treatment.

#### 4.9.5.1 Preparation

Bright Parts: Bright parts and bearing surfaces shall be thoroughly polished and protected from corrosion by the application of rust preventive lacquer or high melting-point grease, as approved bythe Employer's Representative, before the parts are packed. A sufficient quantity of the correct solvent for removal of the protective compounds shall be supplied and packed with each particular part.

Embedded Parts: Embedded parts or those parts of an assembly which will be embedded in concrete shall be thoroughly de-scaled and cleaned to the satisfaction of the Employer's Representative and before being packed shall be protected by a cement wash or other approved method. No cast iron or steel work shall be bitumen or tar coated where it is to be cast into the concrete and provision shall be made for cleaning off any portions so coated.

Grit or Shot Blasted Parts: Grit or shot blasting shall be carried out in accordance with B.S. 7079 to a standard between `First Quality' and `Second Quality' given in Table 1 after which the maximum amplitude of the surface shall not exceed 0.1 mm.

Cast Iron and Steel Pipe work: All ungalvanised steel pipework including pump suspension mains, bearing spiders and tunnel tubes shall be prepared internally and externally by grit or shot blasting as specified above and the surfaces primed as specified within four hours of blasting.

#### 4.9.5.2 Painting and Finishing at Place ofManufacture

This Clause governs the methods for the protective coatings to be applied to structural steel, metalwork and ironwork as corrosion protection systems. The systems designed as specified here shall be applied as specified under Protective Coatings. Protective coating specified elsewhere for particular works such as pipes and cladding shall firstly be designed in accordance with particular requirements specified elsewhere and secondly in

accordance with any requirements herein which are not overridden elsewhere. This specification makes reference to the followingstandard:

**B.S.5493 "code of practice for the protective coating of iron and steel against corrosion"**

The Contractor shall design each protective coating system and shall submit details of each system to the Employer's Representative for approval. Submissions shall where possible be in the format of which examples are given at the end of this section with such additional information and samples as the Contractor may provide or the Employer's Representative may require to enable the system to be assessed.

Protective coating shall be designed in accordance with B.S. 5493 to have a long life, generally of at least 10 years to first maintenance. Protection systems shall be chosen to be easily maintained in the future and to allow non-specialist on-site re-coating where necessary using single part paints.

For the purposes of system design the general environment shall be as specified in B.S. 5493 Table 3 Part 2 `Exterior exposed polluted inland'. Bulkhead gates and stoplogs shall be assumed to be exposed to a Table 3 Part 8 `Non-saline water' environment unless otherwise approved by the Employer's Representative.

Interior spaces shall be considered to be dry in administration areas open to continuous access and damp or immersed in other spaces. The protective coating of components or structures which are continuously or infrequently immersed shall be designed for the more onerous of these two conditions relevant to the protection system used.

All exterior exposed items to be coated shall have a final coat of good appearance of a colour and type as approved by the Employer's Representative.

Protective coating systems shall generally fall into one of the following basic systems;

### 4.9.6 Protective Coatings

- Galvanizing;
- Galvanizing plus painting;
- Multi-coat painting; Bitumenenamel;
- Others as proposed by the contractor and approved by the employer's representative.

The Contractor shall submit to the Employer's Representative details of his proposals for the corrosion protection of each of the items requiring such protection, which will generally fall into the above categories, asfollows:

- Trash screens, flooring, ladders, access covers and frames, step irons and other components which are inaccessible but subject toabrasion/damage;
- Structural steelwork (including crane beams, monorails, crane structures and chassis), bulkhead gates, stoplogs, grappling beams, steel tanks and other large items readily accessible formaintenance;
- Valves and other corrosion-susceptible items which may be buried and are not covered by the provisions of other specifications:

- Other components not covered by the above for which the contractor may propose a system which he considers to be more suitable for theduty;
- Electrical switchgear, transformers, control panelsetc.
- All painting material shall be applied in strict accordance with the paint manufacturer's instructions.

**Plant supplied to site with final coating applied:**

Cubicles, cabinets etc. other than those specified in elsewhere in bid document.

Before any steel work is painted, the steel must be thoroughly cleaned and an approved anti-rusting priming coat applied so that the possibility of rusting or corrosion taking place is negligible. All surfaces should have not less than two stoved undercoats and two top coats or air drying paint. The undercoats shall be easily distinguishable in shade or colour from the priming and finishing coats. The two final coats shall be in a colour and finish to be advised by the Employer's Representative. The inside surfaces of any cubicles, cabinets etc. where condensation is liable to occur, shall be coated with an approved anti-condensation composition. The Contractor shall ensure that all component sections of a switch board wherever manufactured shall have a finish of uniform texture and an exact colour match.

**Chromium Plated Parts:** Where chromium plating is specified or offered by the manufacturer it shall comply with the requirements of B.S. 1224 including the following provisions. No blistering of any surfaces will be tolerated. The finished appearance shall be bright. Where the base metal is steel, plating shall be applied in accordance with Table 2. Other base metals shall be plated in accordance with Tables 3, 4, 5 as appropriate. For all base metals the service condition number 2 shall beused.

Small bore pipes, valves and fittings etc., which are sited in architecturally finished areas of the station and selected by the Employer's Representative shall be chromium plated. Damage to chromium plating shall be made good before TakingOver.

**Galvanized Parts:** All materials to be galvanized shall be shown on the approved drawings or specified. All punching, cutting, drilling, screw tapping and the removal of burrs shall be completed before the galvanizing process begins. Parts to be galvanized shall be shot blasted as specified above. Such parts shall be galvanized not more than four hours after commencement of shot blasting.

All galvanizing shall be done by the hot dip-process. No alternative process may be used without the approval of the Employer's Representative. No components shall be galvanized which are likely to come into subsequent contact with oil.

The zinc coating shall be uniform, clean smooth and as free from spangle as possible. In the case of component parts the zinc coating shall weigh not less than 610 g/sq.m of area covered and shall not be less than 0.090 mm in thickness.

Where hot-dip galvanizing is not practicable bolts and nuts shall be sherardised, which shall conform to BS: 4921. The Employer's Representative may select for test as many components to be weighed after pickling, and before and after galvanizing as he may

think fit.

All galvanized parts shall be protected from injury to the zinc coating due to differential serration and abrasion during the periods of transit, storage and erection. Damaged areas of the coating shall be touched up with an approved zinc-dust paint or other approved flake metallic compound.

**Cast Iron and Steel Pipework: (Internal surfaces)**

The internal surfaces shall have an approved coating. Where a bitumen based coating is used, it shall be in accordance with Type 2 of B.S. 4147. Prior to lining, the pipe shall be grit blasted and primed with an approved primer. The lining shall be in accordance with B.S. 534. After installation, the internal lining shall be made good and satisfactorily tested with required detector.

The coating shall be suitable for use in contact with drinking water. The type of coating shall be entered in Schedule L provided and the Employer's Representative reserves the right to call for test plates of the paint. The manufacturer shall at the time of ordering carry out the `Taste and smell test' (Appendix E of B.S.4147) and `Effects on water test' (Appendix C of B.S. 3416) and forward 3 copies of the test results to the Employer's Representative for approval.

Where pipes are to be welded after the protective coatings have been applied, the pipe surfaces shall be primed and all other coating stopped of the weld preparation. Collars and fillings shall be primed but no other coatingapplied.

The manufacturer shall supply a sufficient quantity of suitable materials to repair damage occurring during delivery to site and to provide a flush finished internal lining at welded joints. He shall supply sufficient coating to fill in the recesses at internal welds over the previously primed areas. The costs of these materials shall be included in the unit rates for the supply of the pipes andspecials.

The coating shall be applied in accordance with the manufacturer's instructions and with Appendices J and K of B.S. 3416.

Machinery- (Internal surfaces) e.g. pumps, valves, strainers, rising and suspension mains of wet wellpumps:

As for cast iron and steel pipework (Internal surfaces).

Cast iron and steel parts (External surfaces) immersed in Water:

All ungalvanised metal parts which will be immersed in water shall be cleaned by grit blasting and within four hours of blasting given a coating similar to that specified for internal surfaces.

Cast iron and steel (External surfaces) in manholes and areas of high humidity:

Ungalvanised metal parts exposed in manholes or areas of high humidity shall be cleaned by grit blasting and given two coats of a black bituminous solution.

Plant forwarded to site for final finishing.

Cast Iron and Steel Parts (External surfaces) outside buildings:

All ungalvanised metal parts which will be exposed to the outside atmosphere shall be cleaned by grit blasting and provided with two coats of an approved primer.

Cast Iron and Steel Parts inside buildings:

All exposed metal surfaces which will not be immersed in water or exposed in areas described above shall be rubbed down, cleaned by grit blasting and within four hours of blasting given one coat of an approved primer before packing.

### 4.9.7 Painting at Site

Immediately on arrival at the site, all items of plant shall be examined for damage to the paint coat applied at the manufacturer's works, and any damaged portions shall be cleaned down to the bare metal, all rust removed, and the paint coat made good with similar paint.

Steel and cast iron parts received at site shall be provided with adequate number of further coats of coal tar epoxy polyamine coating to a total dry film thickness of 275 microns including the primer coats. All sharp edges, nuts, bolts and other items difficult to be painted shall receive a brush coat of specified paint before application of each coat of epoxy based coal tar paint giving a total dry film thickness of at least 275 microns. In the case of fabricated steelwork this work shall be done after assembly.

Before painting is commenced the Contractor shall submit for the approval of the Employer's Representative, full details of the paints he proposes to use together with colour charts for the gloss finishes.

After erection, such items which are not finish painted shall be finish painted, items finish painted at the Manufacturer's works shall be touched up for any damaged paint work.

#### 4.9.7.1 Painting System Requirements

The painting work shall conform to the following requirements:

- The surface preparation shall be carried out generally in accordance with IS: 1477 Part I and IS: 6005.
- After surface preparation, two coats of primer-red oxide zinc chromate with modified phenolic alkyd base conforming to IS: 2074 shall be applied. Dry film thickness of each coat shall be 25microns.
- For finish painting, after application of primer as in (b) above, two coats of synthetic enamel conforming to IS: 2932 shall be applied. Dry film thickness of each coat shall be 25microns.
- Colours shall be selected as per IS:5

No painting shall be carried out unless the item has been inspected and accepted by Employer's representatives at the Manufacturer's works.

The dry paint film thickness shall be measured by Elcometer or other instruments approved by the Employer. In order to obtain the dry film thickness (DFT) specified, the Contractor shall ensure that the coverage rate given by the paint manufacturer will enable

this thickness to be obtained. Strengthof adhesion shall be measured with an adhesion tester and this value shall not be less than 10 kg/cm2. Painted fabricated steel Work which is to be stored prior to erection shall be kept clear of the ground and shall be laid out or stacked in an orderly manner that will ensure that no. poles of water or dirt can accumulate on the surface. Suitable packings shall be laid between the stacked Materials. Where cover is provided, it shall be ventilated.

#### 4.9.7.2 Painting System

The painting procedure shall be submitted in the following format:

- Surface Preparation
- ReferenceStandard
- Conditions ofWork
- Type ofMaterials
- Tests and inspection methods and sequence, thickness(DFT)
- Colour in final coat
- Total thickness of coats(DFT)
- Other necessary data and information

The following items in the plant are required to be painted;

- Outer surfaces of pumps, valves, pipes, fittings, motors etc., not exposed to treatedwater
- Steelwork exposed to weather, such as outer surface of surge vessel, valves, pipesetc.
- Internal Plant and pipework, cranes, exhaust fans, fire extinguishers and miscellaneous steelwork not exposed toweather
- Steelwork exposed to weather, such as platforms, ladders, hand railing,etc.
- Steelwork exposed to humid weather and requiring hard maintenance andrepairs
- Buriedsteelwork
- Buried pipes and fittings prior to application ofwrapping
- Other equipment, as per requirement ofemployer.

All buried steel pipes and fittings shall be coated and unwrapped with hot or cold applied, self- adhesive, polyethylene in accordance with AWWA C214 or equivalent Standard.

Cast iron or mild steel parts to be built into concrete shall remain unpainted. Immediately before it is cast in-situ, it shall be made perfectly free from dirt, scale, loose rust, paint, oil lime wash or any other coating.

No blast cleaning or painting shall be applied to corrosion resistant Materials such as stainless steels. Ni-resist cast iron, bronze and other metals used for seals, bearings, lighting fitting etc.

Machined surfaces such as gear teeth shall be coated with a thick layer of grease. Other mechanical surfaces such as shaft ends or other bright parts shall be coated with two coats of an anti-rust solution which can be removed easily when required. Permanently bolted mechanical interfaces such as flanges shall be coated with a thin coat of anti-rust compound beforeassembly.

All primers, under coats and finishes shall be applied by brush or airless spray, except where otherwisespecified.

Consecutive coats shall be in distinct but appropriate shades. All paints shall be supplied from the store to the painters, ready for application, and addition of thinners or any other Material shall be prohibited. Any instruction given by the paint manufacturer shall be strictlyfollowed.

All painting shall be carried out by the qualified, experienced & competent painters under supervision. Paint shall be applied to the dry surface which has been prepared in compliance with the approved procedure.

The Plant and equipment shall be inspected and reviewed at the various stages of the coating application both at the manufacturer's Works and at the Site of the Works. Samples may be taken from the paints as delivered and submitted to such tests as are deemed necessary. The completed paint systems shall be tested by instruments to ensure that the protection is of adequate thickness and is free from pinholes and the direct measurement of adhesion shall be checked by the removal of a small section of the coating. The Contractor shall supply all instruments and apparatus required for carrying out such tests required by the Employer.

### 4.9.8 Fusion-bonded Epoxy Powder Coatings

All fabricated steel pipe work and other Plant where specified, shall have a lining and coating, not less than 250 microns thick, of 100% solids, thermosetting fusion-bonded, dry power epoxy coating. All grit and dust shall be removed and coating shall be started before formation of visible oxidation of the surface. The metal shall be pre-heated to a temperature recommended by the manufacturer and the epoxy powder applied by immersion in a fluidized bed, after which excess powder shall be removed. The powder shall be allowed to flow out completely before curing. The thickness of the coating, including any repaired areas, shall be checked with a calibrated tester. Spark testing, for pinholes, voids, contamination, cracks and damaged areas, shall use a high-voltage spark generator. Repairs due to coating imperfections or damage shall be done using a brush-applied compatible two-pack liquid epoxy compound. The area to be repaired shall be cleaned to remove dirt, grease, scale and damaged coating, which shall be feathered. Pinhole surface preparation is not required other than removal of detrimental contaminants which could impair the adhesion of the repair material. The surface coating shall be applied by an approved applicator. GRP covers and guards shall be pigmented to give the finished colour without painting.

## 4.10 Water works Finish

A high standard of finish, defined as "Waterworks finish" is required for all Plant as detailed below.

**Welding and flame cutting**

A smooth neat finish, by careful grinding if necessary is required on all exterior welding

and flame cutting. All plates and bars used in fabrication shall have smooth surfaces with no pitting or deep slag inclusions

**Castings**

Casting surfaces shall be smooth and free from surface blowholes. Stock castings shall be specially selected with this in mind. All castings shall be shot blasted before machining.

**Covers**

All covers shall be firmly fixed. Weld mesh shall sit square in its frame. Where panels are placed next to each other the patterns shall line up.

**Flanges and beadings**

All bolt holes shall be spot faced parallel with the mating face for good seating of nuts and bolt heads. Surplus jointing shall be removed from mating faces and peripheries.

**Items to be chromium plated**

Name plates, instruction plates, rotation arrows, indicators and pointers, small bore pipework, oil level gauges and fittings, small valves (including air valves), plugs and grease nipples, which are sited in architecturally finished areas of the station and as selected by the Employer's Representative, shall be chromium plated. Damage to chromium plating shall be made good. All pipes and fittings etc. shall be fitted in a straight, neat symmetrical manner so as to present a pleasing appearance.

**External screws, Bolt Heads, nuts and washers**

These shall be chromium plated, sherardized or made in stainless steel.

**Gauges**

All indicating gauges fitted to any machine assembly shall be of similar appearance and grouped together to present a pleasing aspect. They shall all have chromium plated cases, bezels, cocks and fittings.

## 4.11 Other Items and Ancillary Mechanical Units

All other mechanical equipments shall be as per the relevant IS codes

# 5. Part 5 - Electrical System General and Particular Specifications

## 5.1 General

The scope of work includes design, equipment selection, manufacture, inspection at Bidder's or his Sub-Bidder's works, supply, installation (including storing, unloading and transferring the material / equipment to Bidder's storage area, maintaining equipment / material in safe custody and assembling the elements of the equipment and installing at the place of work), testing and commissioning of the plant equipment/ electrical system on 'turnkey' basis. After successful commissioning and trial run of the plant, it should be handed over to the Chandigarh Administration/MCC/CSCL or their representative. The Bidder shall submit their design calculations/ drawings based on 'Design criteria for electrical equipment/ system' for Chandigarh Administration/MCC/CSCL or their representative's review and approval. These specification covers, 11 kV, 33kV switchboard, 3.3 kV MV Switch Boards, LV switchboards, LV energy efficient motors, MV/ LV soft starters, LV capacitors, HV,MV, and LV power cables and control cables, DC supply system and other allied equipment, etc. along with the specifications for workmanship, laying cables, lighting system, earthing systems, lightning protection etc. for all the WWTPS in Chandigarh. It shall be the responsibility of the Bidder to design the electrical system based on the selection of the mechanical equipment.

The Bidder shall make his own estimate of sizes, ratings and quantities for 33kV/ 0.415kV, 11kV/0.415kV system, equipment, all plant items and miscellaneous systems such as earthing, lightning protection, lighting, etc. for WWTPs. It should be clearly understood that the Contract will be on 'turnkey' basis and no variation will be allowed for items of works not foreseen or omitted by the Bidder at the bidding stage, except where specifically indicated in the bid documents.

All equipment offered shall comply with the requirements specified in the latest editions of applicable Indian/ International Standards and shall also comply with the good engineering practices.

Bidder shall design the electrical system on the basis of 'Design Criteria' and to be submitted for Chandigarh Administration/MCC/CSCL or their representative's approval. Bidder shall incorporate any changes/ suggestions in the drawings to suit site conditions and design criteria and standard engineering practice and resubmit for approval to Chandigarh Administration/MCC/CSCL or their representative.

The contractor or hired subcontractor shall possess/arrange the valid electrical contractor's license of appropriate class from the concerned statutory bodies governing the area of work place which they have to submit before starting the electrical work at project site. The contractor shall fully comply with the relevant statutory rules and regulations.

All type (as applicable), routine and acceptance tests shall be conducted in the presence of

Chandigarh Administration/MCC/CSCL or their representative / Third Party Inspector on all the equipment as per latest applicable IS/IEC at no extra cost. Typical type test reports for other equipment shall be submitted by the Bidder for approval by Chandigarh Administration/MCC/CSCL or their representative.

All commissioning tests shall be carried out in the presence of Chandigarh Administration/MCC/CSCL or their representative and approval for the same shall be obtained before commissioning and installation. All test reports shall be properly maintained by the Bidder duly approved by the statutory bodies and shall be handed over to the Chandigarh Administration/MCC/CSCL or their representative after completion of the job. All instrument and accessories required for testing and commissioning of the equipment specified herein shall be provided by the Bidder at no extra cost to the Chandigarh Administration/MCC/CSCL or their representative.

Liaison with Electricity Department Chandigarh and other Government organization/ statutory bodies for obtaining Power supply/ other clearance shall be Bidder's scope. After completion of installation work, the Bidder shall arrange for inspection and obtain approval from the concerned statutory bodies. Any fees that are to be paid to such statutory bodies for testing, inspection or calibration shall be paid by the Bidder. Any modification / revision in the equipment / installation of equipment as required by the statutory bodies shall be carried out by the Bidder. All such costs / fees for revisions / modifications shall be deemed to be included in the prices of supply, installation, testing and commissioning of equipment as quoted by the Bidder.

### 5.1.1 Power Supply Information

Available and proposed power supplies are as follows:

**Introduction**

This chapter details the specific requirements of electrical works provided for the plant.
Operating Voltages and Frequencies

**HV System**

Voltage : 33kV nominal, 36kV/ highest
Frequency : 50Hz
Connection : 3 phase, 3 wire
33 kV/11 kV system maximum fault Level (25 kA/26.2 kA at 33 kV/11 kV)

**MV System**

Voltage : 3.3 kV nominal, 3.6kV highest
Frequency : 50 Hz
Connection : 3 phase, 3 wire
3.3 kV system maximum fault Level: 150 MVA (16 kA)
System Earthing : Neutral Grounding Resistance (NGR)

**LV System**

| | |
|---|---|
| Voltage | : 415 V nominal |
| Frequency | : 50Hz |
| Connection | : 4wire |
| System Earthing | : Solidly earthed |

415 V Maximum fault level: 50 kA r.m.s maximum

**Control voltage** – Instrumentation Power Supply, AC control, Lighting & space heating

| | | |
|---|---|---|
| Voltage | 110 V | 240 V |
| Phases | 1 | 1 |
| Frequency | 50 Hz | 50 Hz |

DC control voltage (for 33 kV switchgear and LV ACBs in Main LT Panel)

| | |
|---|---|
| Voltage | 110 VDC |
| Wires/Earthing | 2 wire /unearthed |

All equipment shall have rated withstand capacity based on above criteria.

### 5.1.2 Design Criteria for Electrical Equipment/ System

The Design Criteria described below covers the electrical equipment/system for the proposed WWTPs under the Project.

**General Power Distribution**

**Scheme Estimation of Load**

The following assumptions have been be made to arrive at the estimated load of the different sites.

a) Load Factor
   - i) Motor : 0.9 (or actual)
   - ii) Auxiliary load, valve motors, etc. : 0.9
   - iii) Lightingload : 1.0

b) DiversityFactor
   - i) Motor : 1.0
   - ii) Auxiliary load, valve motors, etc. : 1.5
   - iii) Lighting load : 1.2

c) Power factor of Motors : As per Manufacturer's Catalogue

d) EfficiencyofMotors : As per Manufacturer's Catalogue (Energy efficienteff3)

(Energy efficient, high performance motors (eff3 category) shall be provided for optimum utilization of energy).

e) Protections

The following protections are proposed for various switchboards, transformers, motors and other plant feeders.

1) 33kVSwitchboard

i) IDMT over current and earth fault protection forincomers
ii) IDMT and instantaneous over current and earth fault protection for outgoing transformer feeders

2) LV switchboard

i) Over current, short circuit and earth fault protection on ACBs/MCCBs

3) Motors

i) Overload protection by thermal (bimetal) relays in all the three phases to trip with single phase preventer (SPP) and short circuit protection in all the three phases through motor protection circuit breakers/ MCCBs Alternatively, microprocessor based motor protection relay shall also be used.

ii) Thermal, locked rotor, short circuit, negative sequence, under voltage, over voltage and earth fault for each motor feeder of rating 90kW and above.

f) Metering

The following metering shall be provided.

1) 11/33kV Switchboard
Multifunction meter (for incomer) containing-

i) Ammeter
ii) Voltmeter
iii) kW meter
iv) Frequency meter
v) Power factor meter
vi) Kilo watt hour meter
vii) KvAr meter
viii) kVA meter

For outgoing feeder Ammeter with selector switch

2) LV Incomers

i) Ammeters with selector switch
ii) Voltmeter with selector switch
iii) kW meter
iv) Power factor meter

v) Kilowatt-hour meter
vi) Frequency meter

3) LV Outgoing Feeders
i) Ammeter with ammeter selector switch

Multifunction meter shall be equipped with interfacing capability for RS-485 port.

g) Indicating Lamps

The following indication shall be provided:

1) 11/33 kV Incomer, Bus Coupler and Outgoing feeders

i) Circuit breaker ON, OFF and TRIP, spring charged, control supply healthy and trip circuit healthy (Mains ON (R,Y,B) indication for incomer only)

2) LV Incomers

i) Mains ON (red, yellow and blue)

3) Motor Feeders

i) Motor ON, OFF and Trip indication (Red, green and Amber)
ii) Motor ON, OFF and Trip indication (Red, green and Amber), control supply healthy and trip circuit healthy for breaker feeder.

All electrical equipment will be rated for 500 C design ambient temperatures.

All power cables shall be sized based on continuous current capacity, permissible voltage drop and short circuit current rating. The voltage drop shall be limited to 3 % at rated equipment current rating.

The other rating factors for variation in ground temperature, variation in ambient air temperature, grouping of cables, depth of laying, etc. shall also be considered for cable sizing.

The illumination levels proposed for various areas are as follows:

| **Area** | **Illumination level(Lux)** |
|---|---|
| Pump House | 250 |
| Office/Conference Room | 400 |
| Switchboard Room | 250 |
| All other indoor areas | 150 |
| Outdoor plant area and Road | 10 – 20 |

LED type luminaries shall be used for office/ all indoor areas. Decorative fixtures/ receptacles shall be used for office areas and industrial type fixtures/ receptacles shall be used for remaining areas.

Street/ area lighting shall be controlled by time switch/ photocell for automatic switching of luminaries. Emergency light shall be provided for safe evacuation of the people in case of fire or panic (blackout, total power failure, etc.) Emergency lighting shall be automatically switched ON when mains power supply fails.

The values of fault level for designing the electrical system shall be based on transformer capacity, its impedance and system fault level. Fault clearing time for sizing of earth conductor will be taken as one second.

The material of earthing conductor shall be hot dip Galvanized Steel. All connections between the earth conductors buried in earth/concrete and between earth conductor and earth leads shall be of welded type. While sizing the buried earth conductor, a corrosion allowance of at least 20% shall be taken. Plant earthing system shall be designed such that the overall earthing grid resistance is maximum one ohm.
Main earthing conductors outside and inside the building shall be planned in such a manner that various equipment is connected to earthing system by two connections in a reliable manner.

### 5.1.3 System Description and scope

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 standards of engineering and shall comply to all currently applicable standards, regulations and safety codes.

The scope of electrical works covers design, engineering, supply, erection, testing and commissioning of all the WWTPs in Chandigarh. All the electrical equipment of existing WWTPs shall be replaced by suitable capacity of new items. Sufficient details by way of clause no. 5.2 for dismantling & installation items such as HT/LT Switchgears ,cables, lighting fixtures, lighting DBs, cable trays etc. have been furnished. It is the intent of this specification to make the electrical systems for the plant suitable for receiving and utilizing in-house gas generated power in the plant.

All the electrical installation pertaining to the plants, therefore, are included in the scope of the present contract. Single Line Diagram related to HT distribution systems of the plant and concept Single Line Diagram for 415 V Switchgear are to be got approved as a concept scheme. The Bidder shall develop his own SLD based on his load list and submit the same along with his offer. 100% stand by Transformers shall be considered for the power distribution system.

The scope also includes cabling, lighting, earthing and lightning protection installation for all the three phases of the plant. A complete electrical Load List comprising process loads and other loads shall be furnished by the Bidder along with his Bid. The contractor shall work out the details based on his equipment's power consumption. The execution should take care of I.E. rules, Electricity Board's requirement and other local authorities and site condition.

It shall be the contractual responsibility of the contractor to obtain approval of drawings, design electrical installation and test certificates from Chief Electrical inspector to Government (CEIG) and any other statutory bodies. Necessary official procedural support as well as technical required in obtaining the approval shall be provided by the purchaser/engineer.

**Design Criteria for STP**

All electrical equipment shall be rated for $50^0$C design ambient temperatures. The installation shall generally conform to Indian Standards / IEC.

The following factors shall be considered for proper selection of electrical apparatus or equipment for areas where flammable gas or vapors may rise.

a) Area classification

The classification of area shall be as per IS 5571 & IS 5572, based on the degree of probability with which explosive concentrations of combustible gas or vapour may arise in installations in terms of both the frequency of occurrence and probable duration of existence on each occasion.

(i) Zone 0 – In which an explosive gas/air mixture is continuously present or present for long periods.

(ii) Zone 1 – In which an explosive gas/air mixture is likely to occur in normal operation.

(iii) Zone 2 – In which an explosive gas/air mixture is not likely to occur in normal operation and if it occurs, it will exist only for short periods.

b) Gas Group Classification

The characteristics of the gas or vapour involved in relation to Igniting current or minimum ignition energy in case of installations of intrinsically safe apparatus or maximum experimental safe gap data in case of installations for flame proof enclosures as per IS 2148.

c) Temperature Classification

The Ignition temperature of the gas or vapour involved, or the lowest value of ignition

temperature if more than one combustible material is present.

The maximum temperature of any unprotected surface of electrical equipment shall not exceed the Ignition temperature of gas or vapour. For electrical apparatus, no margin of safety need be applied between maximum surface temperature and ignition temperature. The Ignition temperature of combustible gases and vapours are measured in accordance with the test method prescribed in IS 7820.

d) Environmental conditions in which the apparatus is installed. Apparatus and its component parts shall be constructed so as to guard against electrical and mechanical failures in the intended conditions of use.

The selection of type of protection of electrical equipment for the different zones of Hazardous areas shall be made in accordance to Clause 6, Table -1 of IS 5571.
All electrical equipment installed in hazardous areas shall confirm to selection of equipment and installation guidelines of IS 5571.

The major items of work for the electrical works will be as tender:

**Dismantled Equipment/installation**

All the dismantled equipment shall be properly packed suitable for transport and storage for a long time, transported to and stored at designated store as desired by CSCL.

## 5.2 SCOPE OF WORK FOR WWTPs

### 5.2.1 ALL XLPE CABLES

Dismantling of existing cables after the new plants have been made functional.

**Scope of work: -**

i) Supply, laying, testing and commission of adequate size and length of cables, Aluminum conductor, XLPE insulated, GI strip armoured cables replacing the cables wherever required by new cables according to systems as per the bidder's design in line with the specifications.

ii) Supply and installation of cable termination kits, heat shrinkable type, for the cables to be laid new as mentioned above.

### 5.2.2 SWITCH BOARDS:

i) Dismantling of existing switch/panel board after the new plants have been made functional.

ii) Providing the required switch/panel board of appropriate size and capacity as per the design requirement of each STP based on the power arrangement already available at

site in case all the plants except 2 MLD Sukhna plant.

iii) In case of Sukhna plant new connection is required to be taken based on the power requirement of the plant and the site to be allocated by the Chandigarh Administration from the nearest available source.

### 5.2.3 11/0.433 KV, TRANSFORMERS

The rating of transformer shall be decided by Contractor as per their own design.

### 5.2.4 415 V, TPN, ALUMINUM BUS DUCTS

**Scope of work:-**

i) Dismantling of existing Aluminum bus ducts if any after the new plants have been made functional.

ii) Supply, installation, testing and commissioning of 415 V,TPN Aluminium conductor Bus duct of adequate rating, nos., and length comprising with bends, flexible and steels for support of bus duct .

### 5.2.5 LV SWITCHBOARS

All above LV Switchboards shall be transported at designated store as desired by CSCL.

### 5.2.6 STARTERS

**Scope of work:-**

1. Installation, Testing and commissioning of Local Push Button Stations mounted near to all the proposed motors. The starters for all the motors shall be housed inside the MV/LV switchboards installed at various locations for all the plants.

### 5.2.7 415V AUTOMATIC POWER FACTOR CORRECTION EQUIPMENT

Automatic power factor correction equipment shall be in the scope of work for all the plants.

### 5.2.8 ELECTRICAL MOTORS

**Scope of work:-**

Electric motors to be used in the STPs shall be of Eff3 class provided with Class F Insulation with temperature rise limited to that of Class B insulation.

### 5.2.9 LIGHTING SYSTEM

1. Dismantle existing Lighting Panels and lighting DBs wherever required

All the dismantled equipment shall be transported to and stored at designated storeas desired by CSCL.

**Scope of work:-**

1. Supply, installation, testing and commissioning of lighting Panels/DBs at the various locations of sewage treatment plant. The Lighting Panel/ DBs shall have suitable nos. and ratings of incoming and outgoing MCBs as per the required ratings.
2. Supply and installation & testing /commissioning of suitable type of LED lighting fixtures for offices/all indoor illumination as per the required lux level calculations in line with specifications.
3. Supply, installation & testing /commissioning of LED light fixtures for Pump Houses as per the required calculations in line with specifications.
4. Supply, installation & testing /commissioning of 90W/120W LED Street light fixtures for road lighting as per the required calculations in line with specifications.
5. Supply, installation & testing /commissioning of Flood light fixtures with suitable 120W/160W LED light fixtures for area lighting as per the required calculations in line with specifications.
6. Supply, installation & testing /commissioning of High Mast Lighting system with suitable LED light fixtures as per the required quantity and calculations in line with specifications
7. Supply, installation & testing /commissioning of 30W/60W, flameproof type well glass lighting fixtures for hazardous area with LED lighting fixtures as per the required calculations in line with specifications.
8. Supply, installation complete with foundation & testing /commissioning of solar lighting fixtures with LED lamps for external/road lighting.

All the lighting works and fixtures shall be in line with the specifications.

### 5.2.10 CABLE TRAYS

**Scope of work:-** Supply and installation of 600,450,300,150 Wide FRP cable trays shall be supplied as per the requirements in line with the specifications for all plants. All the cables shall be dressed properly with nylon cord to the satisfaction of Engineer-in-Charge.

### 5.2.11 LT CABLES

All the existing LT cables are in physically bad conditions and most of the cables are required to be replaced and all the dismantled cables shall be recovered after excavation, wound on Bidder supplied wooden drums, transported to and stored at designated store as desired by CSCL.

**Scope of work:-**

Supply, laying , testing and commission of LT Power and Control cables of 1100 V of adequate size and length required for the proposed driven equipment, Aluminum conductor, XLPE insulated, armoured and also replacing some of the existing cables wherever required according to the bidder's design in line with the specifications.

### 5.2.12 BATTERY, BATTERY CHARGER AND DC DISTRIBUTION BOARD

**Scope of work:-**

1. Supply, Installation, Testing and commissioning of 110 V DC Ni-Cad battery and Battery charger at S/S-1 along with distribution board required to control of all 11/ 33kV and 415V circuit breakers.
2. Supply, Installation, Testing and commissioning of 110 V DC Ni-Cad battery and Battery charger at S/S-2 along with distribution board required to control of all 11/33kV and 415 V circuit breakers. AH capacity of the battery shall be as per the specifications

3. Supply, Installation, Testing and commissioning of 110 V DC Ni-Cad battery and Battery charger at S/S-3 along with distribution board required to control of all 33kV and 415V circuit breakers. AH capacity of the battery shall be as per the specifications.

4. Supply, Installation, Testing and commissioning of 110 V DC Ni-Cad battery and Battery charger at S/S-4 along with distribution board required to control of all 33kV and 415 V circuit breakers. AH capacity of the battery shall be as per the specifications

### 5.2.13 EARTHING SYSTEM

**Scope of work:-**

Earthing materials viz. earthing conductor's earth pits etc. as required for newly supplied Switchgear, motors and other electrical equipment shall be supplied by the Bidder. Guidelines for selection of sizes are furnished in the specification for the plants separately.

### 5.2.14 UNITS OF MEASUREMENT

Metric units of measurement (System International) shall be used in all Contract documentation. Angular measurement shall be in degrees with 90 degrees comprising one right angle.

### 5.2.15 REFERENCE STANDARDS

All equipment / systems supplied under this Contract shall conform to the latest editions of

the International Electro-technical Commission (IEC) Standards or equivalent Indian Standards or other International Standards, provided they promise to confirm equal or superior performance. If standards other than IEC are referred, then the Bidder shall enclose English Version of the standard with the bid.

### 5.2.16 INSPECTION AND TESTING AT MANUFACTURER'S WORKS AND DISPATCH

The Bidder will follow the approved QA/QC Plan for the Inspection and Testing of Equipment at Manufacturer's Works and Dispatch.

### 5.2.17 CONSTRUCTION POWER SUPPLY

Contractor has to make his own arrangements for construction power supply from Electricity Department Chandigarh authorities. However, upon request of the Bidder, if Chandigarh Administration/MCC/CSCL or their representative agrees to provide the construction power supply then it is the responsibility of the Bidder to connect his equipment at the point of supply and pay the requisite charges / fees to the Chandigarh Administration/MCC/CSCL or their representative as per the prevalent rates of BSES.
All power and lighting circuits shall be constructed with due regard for personnel safety and shall comply with recognized codes of practice and local regulations. All circuits shall be fitted with earth leakage systems.

## 5.3 SPECIFICATION OF ELECTRICAL EQUIPMENTS

### 5.3.1 POWER TRANSFORMERS

#### 5.3.1.1 Standards

Transformers and its accessories shall comply with the following International Standards, including those referred to therein.

IEC 60076, 60214, 60296 / IS 2026, IS 335 / BS 148, 171

The technical parameters of transformers shall be as below:

| **Description** | **Unit** | **Particulars** |
|---|---|---|
| **General** | | |
| Quantity required | | As per requirement |
| Installation (Indoor / Outdoor) | | Indoor |
| **Ratings** | | |

| | | |
|---|---|---|
| Rated power | | |
| (*) Contractor shall submit their design calculation for rating of each equipment for Chandigarh Administration/MCC/CSCL or their representative for approval. | kVA | * |
| No load voltage Primary | kV | |
| Secondary | kV | |
| Number of phases | | 3 |
| Rated frequency | Hz | 50 |
| Impedance voltage | % | As per IEC/BIS |
| Vector group | | Dyn11 |
| Winding material | | Electric Grade Copper |
| Type of cooling | | ONAN |
| **System Voltage** | | |
| Nominal system voltage Primary | kV | |
| **Description** | **Unit** | **Particulars** |
| Secondary | kV | |
| Highest system voltage - Primary | kV | |
| - Secondary | kV | |
| **Transformer Secondary Neutral Earthing** | | Effectively earthed |
| **Insulation Withstand** | | |
| Rated lightning impulse withstand voltage | kV (peak) | |
| - Secondary | kV (rms) | |
| **Temperature Rise** | | |
| Reference design ambient | $^0$C | |
| Temperature rise over design ambient temperature of 50$^0$C | | |
| - Average winding temperature rise (by resistance measurement) | $^0$C | |
| - Top oil temperature rise (by thermometer) | $^0$C | |
| **Tap Changing Gear** | | |

| | | |
|---|---|---|
| Type of tap changer | | ON LOAD TAP CHANGER (OLTC) |
| Tapping range | % | ±% |
| Tapping steps | % | |
| **Bushings** | | |
| Rated voltage – Primary | kV | |
| – Secondary | kV | |
| One minute power frequency withstand voltage (dry and wet) – Primary | kV (rms) | |
| - Secondary (Line and Neutral) | kV (rms) | |
| Rated lightning impulse withstand voltage | kV (peak) | |
| Nominal creepage distance | mm/kV | |
| **Terminal Connections** | | |
| Primary line end | | Cable box |
| Secondary line end | | Cable box/Bus Duct |
| Secondary neutral end | | One bushing each inside and outside cable box |
| Type of wheels | | Plain – Bi-directional |
| **Cable Sizes:-** | | |

| **Description** | **Unit** | **Particulars** |
|---|---|---|
| Primary | | kV (*) sq.mm. Aluminium, XLPE, armoured cables |
| Secondary | | kV (*)sq.mm Aluminium , XLPE, armoured cables/ Bus Ducts. |
| Accessories | | OTI, WTI, MOG, Buchholz relay, Pressure relief valve, conservator. |

(*) Values to be ascertained by the Contractor after Submitting design calculations subject to approval.

### 5.3.1.2 Design Features

a) Transformers shall be suitable for indoor duty and shall be installed inside closed

room. It shall be rated for satisfactory operation at $50^0$C design ambient temperature. Transformer shall be designed for over- fluxing withstands capability of 110% continuous, 125% for at least 1 minute and 140% for 5seconds.

b) If the measured loss (load / no load or both) of the transformers is found to exceed the guaranteed loss figure, (with due consideration for tolerance, if any, indicated in the bid), the contractor shall be penalized on the basis of following for each kilowatt or part there of that exceeds the guaranteed loss. The bidder shall propose very low loss transformer with high efficiency.

c) Penalty in Rupees Per Kilowatt of Excess no Load Loss:

$$= \frac{(T.E + A)\,(1 + r)\,n - 1}{r\,(1 + r)\,n}$$

d) Penalty in Rupees Per Kilowatt of Excess Load Loss:

$$\frac{(T.E.LLF + A)\,(1 + r)^{n} - 1}{r\,(1 + r)^{n}}$$

Where

T - Number of hours for which transformer will be in service per year – 8400 hours.

E - Energy charge / kwh as per current power distribution agency **tariff** . n

-Life of the transformer to be taken as per CPHEEO manual.

A - Maximum demand charge / KW / Annum as per current power distribution agency tariff.

r - Rate of interest –10%.

LF - Loadfactor $= \frac{\text{Annual energyKW}}{\text{Maximum demand in KW} * 8760\ \text{LLF}}$ -

Load loss factor $= 0.2\ LF + 0.8\ LF^2$

TF - Transformer Factor $= \frac{(\text{Maximum demand in KVA})^2}{(\text{Rated KVA of transformer})^2}$

e) The individual Transformer KVA rating shall be designed considering maximum 80%

loading on the transformer at full load with a power factor of 0.8. Both the transformers should be suitable for parallel operation.

f) Voltage regulation of Transformer should be ≤ 5% at starting of largest motor at 0.8 power factor .

### 5.3.1.3 Accessories and Fittings

Each main power transformer shall have the following fittings and accessories including but not limited to:

a) A conservator of sufficient volume with
   i. oil level gauge with potential free contacts for initiating alarm for low oillevel
   ii. weather-proof dehydrating breathers for both compartments with activated alumina or silica gel as the dehydratingbreather
   iii. Shut off valves
   iv. Filling plug and drain valves

   The conservator shall be designed to maintain an oil seal up to a temperature of $100^0$ C.

b) Gas and oil actuated Buchholz relay with
   i. necessary shut off valves
   ii. Test cock with pipe connections for sampling
   iii. Potential free contacts for initiation of alarm in case of slow gas formation and trip in case of fast oil and gas surges

c) Dial type thermometer with
   i. maximum temperature indicator and its resetting device
   ii. Potential free contacts for initiating alarm on high temperature and trip on very high temperature

d) Winding temperature indicator with
   i. necessary sensing, compensating and calibrating devices
   ii. Potential free contacts for initiating alarm on high temperature and trip on very high temperature
   iii. WTI transmitter for remote indication on remote tap changing panel if required

e) Detachable type of radiators including but not limited to:
   i. Shut-off valves and blanking plates on transformer tank at each point of connection of inlet and out let header
   ii. Top and bottom shut-off valves and blanking plate on each radiator

iii. Lifting lugs
iv. Top oil filling plug, 19 mm size
v. Air release plug at top
vi. Oil drain plug at bottom, 19 mm size
vii. Earthing terminals

f) Pressure relief device for transformer tank

g) Weather - proof marshaling box mounted on transformer tank

h) Name plate, rating plate and Diagram plate

i) Valves and plugs as below:

i. Drain valve
ii. Filter valve
iii. Oil sampling valves at top and bottom
iv. Valves between radiators and tank (in case of detachable radiators)
v. Air release plug
vi. Twin outlets (with plug) for applying vacuum with attachments.

j) Earthing pads of copper or non-corrodible material for transformer tank (2 places) and radiator banks

k) Inspection manholes as required

l) Lifting arrangement for

i. fully assembled transformer
ii. Core and coil
iii. Tank

m) Hauling eyes on each face of the transformer

n) Bi-directional flanged wheels

o) Anti-earthquake clamping devices

p) Jacking pads

Each auxiliary transformer shall have the following fittings and accessories including, but not limited to:

a) Conservator with oil level gauge

b) Dehydrating silica gel breather

c) Oil temperature indicator

d) Thermometer pocket

e) Explosion vent diaphragm / pressure relief valve

f) Sampling and drainage valves

g) A plug or blank flange at the top for connecting valve for filtration

h) Two earthing terminals

i) Rating plate (Name plate and diagram plate)

j) Lifting lugs

k) Removable plain rollers

l) Adequate number of air vents for relieving trapped air during oil filling and during maintenance.

m) Accessories for clamping the wheel to the foundation channel in order to withstand earthquake forces.

### 5.3.1.4 Windings

The windings shall be of electrical grade copper.

Materials used in insulation and assembly shall be insoluble, non-catalytic and chemically inactive in the hot transformer oil and shall not soften or otherwise be affected under operating conditions. Windings and insulation shall be so arranged that free circulation of oil is possible between coils, between windings, and between winding and core.

Leads from winding to the terminal board and bushings shall be rigidly supported to prevent injury from vibration. Guide tubes shall be used where practicable.

Windings shall be subjected to shrinking and seasoning processes so that no further shrinkage occurs during service. Adjustable devices shall be provided to take up possible shrinkage in service. High voltage end - windings shall be suitably braced to withstand short circuit stresses.

### 5.3.1.5 Core

The magnetic circuit shall be constructed from high grade, cold rolled, non-ageing, grain oriented silicon steel laminations. Each sheet shall have an insulating coating resistant to the action of hot oil. Each lamination shall be coated with insulation which is unaffected by the temperature attained by the transformer during service.

The insulation structure for the core to bolts and core to clamp plates shall be such as to withstand appropriate dielectric test. All steel sections used for supporting the core shall be thoroughly shot or sand blasted after cutting, drilling and welding. Core laminations shall be annealed and burrs removed after cutting. Cut edges shall be insulated. The framework and clamping arrangements of core and coil shall be securely earthed inside the tank by a copper strap connected to the tank. The core clamping structure shall be designed to minimize eddy current loss. The core shall be provided with lugs suitable for lifting the complete core and coil assembly. The framework and clamping arrangements shall be securelyearthed.

The core and coil assembly shall be dried out and impregnated under vacuum.

### 5.3.1.6 Tank

The transformer tank shall be made from high-grade sheet steel, suitably reinforced by stiffeners made of structural steel sections. All seams, flanges, lifting lugs, braces, and other parts attached to the tank shall be welded. The interior of the tank shall be cleaned by shot blasting and painted with two coats of heat resistant, oil insoluble paint. Adequately sized manholes shall be provided for ease of inspection and maintenance. Steel bolts and nuts exposed to atmosphere, shall be galvanized.

Tank together with radiators, conservator, bushings and other fittings shall be designed to withstand without permanent distortion the following conditions:

a) Full vacuum of 760 mm of Hg for filling with oil under vacuum

b) Internal gas pressure of 0.35 kg/cm² with oil at operating level

Tank shall be provided with a pressure release device, which shall operate at a pressure below the test pressure for the tank and radiators. The device shall be provided with a device visible from ground to indicate operation. An equalizer pipe connecting the pressure relief device to the conservator shall be supplied. The device shall be provided with potential free contacts for alarm and tripping. Alternatively, a separate pressure relay shall be provided for this purpose.

The tank cover shall be bolted type and not welded, sealed type. The tank cover shall be removable and shall be suitably sloped so that it does not retain rainwater.

### 5.3.1.7 Radiators

Radiators shall be designed to withstand the vacuum pressure conditions specified for the

tank. They shall be so designed as to completely drain oil into the soak pit and to prevent formation of gas pockets when the tank is being filled.

Transformers of rating above 1500 kVA shall be equipped with detachable or separately mounted radiator banks. Radiators for the main transformers shall be with bolted and gasket flange connections. Transformers of rating 1500 kVA and below shall be provided with fixed type radiators. Fins of the radiators shall not have sharp edges and shall be rounded in shape.

When transformers are provided with separately mounted radiators, flexible joints shall be provided on the main oil pipes connecting the transformer tank to the radiator banks, to reduce vibration and facilitate erection and dismantling. The interconnecting pipes shall be provided with drain plug and air release vents.

### 5.3.1.8 Off-circuit tap changer for Auxiliary Transformer-- if applicable

Off circuit tap changer shall be provided for auxiliary transformers. It shall comprise

a) Operating handle or wheel accessible from ground level

b) Tap position indicator

c) Padlocking arrangement with padlock.

### 5.3.1.9 Marshalling Box

The marshalling box shall be tank mounted, weather proof, vermin proof, dust proof, sheet steel (2 mm thick), enclosed and with hinged door having padlock. Door and gland plate shall be fitted with neoprene gaskets. Bottom shall be at least 600 mm from grade level. Top surface shall be sloped. The degree of protection shall beIP65.

Contacts / terminals of electrical devices / relays, etc. mounted on the transformer shall be wired to the marshalling box. Interconnecting wires between the marshalling box and the accessories / devices shall be either PVC insulated wires in GI conduits or PVC insulated, armoured cables together with provision of double compression type, brass cable glands at the marshalling box. The above mentioned cables as well as terminating the cables shall be the Contractor's responsibility.

All contacts for alarm, trip and indication circuits shall each be electrically free, designed for the auxiliary DC supply of 110 V and brought out to separate terminals in the marshalling box. Terminals shall be rated for 10 A. Disconnecting / shorting type terminal block shall be used for CT circuits.

In case of main transformers, provision for remote annunciation shall be provided with two changeover contacts for alarm condition and two changeover contacts for trip condition for each of the following conditions including but not limited to:

a) Buchholzalarm

b) Buchholz Trip

c) Oil Temperature high

d) Oil Temperature very high

e) Oil level low

f) Pressure relief device operated

g) Winding temperature high

h) Winding temperature very high

i) Conservator oil level low

### 5.3.1.10 Cable Terminations

Cable boxes shall have sufficient space for segregating the cable cores and for adequate clearance in air between bare conductors at the terminals. Cable boxes shall be complete with necessary glands, lugs and armour grips.

Air filled cable boxes shall be of adequate dimensions and designed in such a manner that they can be opened for inspection without disturbing the gland plate or incoming cable. Disconnecting chamber shall be provided for disconnecting and moving away the main transformer, without removing the cables or the cable box. Provision shall be made for earthing the body of each cable box.

### 5.3.1.11 Tests

All tests required by the specification including repeated tests and inspection that may be necessary owing to the failure to meet any tests specified, shall be carried out at the Contractor's expense.

The following tests shall be carried out on the assembled transformer during inspection at the manufacturer’s works.

a) Temperature rise test on one transformer

b) Measurement of resistance of windings at principal and extreme taps

c) Ratio at each tap, polarity and phase relationships

d) Measurement of impedance voltage at principal and extremetaps

e) Measurement of no load current and no load losses at rated frequency and at both the rated voltage and 110 % rated voltage

f) Measurement of efficiency and regulation at ½, ¾ and ful load

g) Measurement of insulation resistance

h) Induced over voltage withstand test

i) Separate source voltage with stand test

j) Magnetic balance test

k) Test on OLTC

Type test certificates shall be provided for verification. Whenever two nos. or more identical transformers are being offered, type tests on one of them shall be carried out, including heat run test.

All auxiliaries and accessories such as temperature indicators, Buchholz and pressure relays shall be tested as per the applicable standards and test certificates shall be furnished to the Employer's Representative for approval.

### 5.3.1.12 Rejection

The Employer may reject the transformer if anyone of the following conditions arises during testing:

a) Any of the quantities / parameters of transformers subject to tolerances are outside the tolerances given in the applicable standards or such tolerance as guaranteed in the Contractor's bid.

b) Voltage ratio at no load not within the limits of tolerance over the guaranteed value.

c) No Load and Load losses exceeding the guaranteed loss value by more than 15%

d) Impedance voltage at principal tapping not within the limits of tolerance over the guaranteed value.

e) Winding and / or top oil temperature rise exceeds the specified / guaranteed value; and

f) Transformer fails to withstand any of the dielectric tests.

Additional tests shall be conducted to locate the failure and after rectification, all tests shall be repeated to prove that the rebuilt transformer meets the specification in all respects, all at the Contractor's expense.

CSCL reserves the right to have the transformer replaced or repaired by the Contractor within reasonable period to Employer's satisfaction at no extra cost to the Employer. The Contractor shall also bear the costs, including but not limited to, incurred by the Employer in re-inspection / re-testing such as travel and incidental expense, etc. The Contractor shall note that any delay in completion time due to such repair / replacement shall be subject to liquidated damages as specified in the Conditions of Contract.

### 5.3.2 SWITCHBOARD

MV indoor VCB switchboard shall comply with the following Standards, including those referred to therein.

The technical parameters of HV switchboards shall be as below:

HV/MV Switchboard

| **Description** | **Unit** | **Particulars** |
|---|---|---|
| **General** | | |
| Type | | Metal enclosed, compartmentalized, draw-out type |
| Rated voltage, no. of phases and rated frequency | kV / - / Hz | ____kVkV 3 Phase, 50Hz |
| System neutral earthing | | Effectively Earthed |
| **Rated Insulation Levels** | | |
| - Rated short duration power frequency withstand voltage | kV (rms) | |
| - Rated lightning impulse withstand voltage | kV (peak) | |
| Rated normal current of bus bars under design ambient temperature of $50^0$C and material of busbar | A / - | (*),Aluminium - suitable for 100% load including future loads |
| Rated short-time withstand current and time | kA (rms) / sec | ___kA for 1 sec |
| Dynamic rating | kA (peak) | ____ |
| **Constructional Requirements** | | |
| Minimum thickness of sheet steel in mm Cold rolled (Frame/Enclosure/Covers) | mm | Frame – 2.0<br>Doors/Covers – 2.0 |

| | | |
|---|---|---|
| Degree of protection of enclosure | | IP-4X |
| Color finish shade | | |
| - Interior | | Glossy White |

| **Description** | **Unit** | **Particulars** |
|---|---|---|
| - Exterior | | Light Grey Semi Glossy |
| Cable connection | | Bottom entry and exit |
| **Circuit Breakers** | | |
| Type | | Vacuum |
| Rated current inside the cubicle under design ambient temperature at 50°C | A | (*) – (Breakers shall be rated for final ratings of motors in STP) |
| Rated operating sequence | | O–3 Min–CO-3 Min-CO |
| Rated short time breaking current | kA (rms) | |
| Rated short time making current | kA (peak) | |
| Rated short-time withstand current and time | kA (rms) / sec | ___kA for 1 sec |
| Rated peak withstand current | kA (peak) | ____ |
| Min. no. of auxiliary contacts | | 6 NO + 6 NC after internal use by manufacturer |
| Type of operating mechanism | | |
| - Normal | | Spring charging for closing and tripping |
| - Emergency | | Manual and Spring charged for closing and tripping |
| Auxiliary control voltage | | |
| - Closing coil / Tripping coil | V | ____V DC |
| - Spring charging motor | V | ___V DC |
| - Space heater and lighting | V | ____V AC |
| Earthing switch | | Required |
| **Current and Voltage Transformers** | | |
| Details of ratio, taps, burden, accuracy | | As per Single Line Diagram (*) |
| **Protective Relays** | | |
| Type | | Numerical (Microprocessor based) |
| Auxiliary supply | V | 110V DC |
| Details of protective relays | | As per Single Line Diagram |
| **Switch-Disconnector** | | |

| | | |
|---|---|---|
| Rated current under design ambient temperature of 50°C | A | (*) |
| Rated making current | kA (peak) | 40/65 |
| Rated peak withstand capacity | kA (peak) | 40/65 |
| Rated short-time withstand current and time | kA (rms) / sec | ___ kA for 1 sec |
| **Insulation levels** | | |
| Rated lightning impulse withstand voltage | | |
| - Across the isolating distance | kV (peak) | ___ |
| - Phase to phase, between phases and across open switching devices | kV (peak) | ___ |
| Rated short duration power frequency withstand voltage | | |
| - Across the isolating distance | kV(rms) | ___ |
| - Phase to phase, between phases and across open switching devices | kV(rms) | ____ |

| **Description** | **Unit** | **Particulars** |
|---|---|---|
| Operating mechanism | | |
| - Closing and opening | | Spring charged |
| - Control voltage | V | 110V DC |
| Earthing switch | | Required |
| **HV Fuses** | | |
| Application | | Indoor |
| Type | | HRC |
| Rated current | A | (*) |
| Rated voltage | kV | ___ |
| Rated breaking capacity | kA (rms) | ___ |

(*) Value to be ascertained by the Bidder after submitting design calculations subject to approval.

### 5.3.2.1 Circuit Breaker

Circuit breakers shall vacuum type. Circuit breaker along with its operating mechanism shall be mounted on a wheeled carriage moving on guides, designed to align correctly and allow easy movement. Plugs and sockets for power circuits shall be silver faced and shall be insulated with suitable insulating material shrouds. All corresponding components of circuit breaker cubicles of same rating shall be interchangeable with oneanother.

There shall be 'Service', 'Test' 'Fully withdrawn' positions for the breakers. In the 'Test' position the circuit breaker shall be capable of being tested for operation without energizing the power circuits, i.e. the control circuits shall remain undisturbed while the power contacts shall remain disconnected. Separate limit switches, each having a minimum of 2 'NO' + 2

'NC' contacts, shall be provided for both 'Service' and 'Test' positions of the circuit breakers for future SCADA.
Electrical tripping shall be performed by shunt trip coils. "Local / Remote" selector switch lockable in "Local" position shall be provided on the cubicle door. `Red' and `Green' indicating lamps shall be provided on cubicle door to indicate breaker close and open positions. Breaker "Service" and "Test" positions shall be indicated by separate indicating lamps on the cubicle door, in case mechanical indication of "Service" and "Test" positions are not available on the cubicle door.

Connection of the control / interlocking circuits between the fixed portion of the cubicle and the breaker carriage shall be preferably by means of plug socket arrangement.

### 5.3.2.2 Operating Mechanism Control

a) Circuit breakers shall be operated by a motor spring charging type of mechanism. The mechanism shall be complete with motor, opening spring, closing spring and all accessories to make the mechanism a complete operatingunit

b) Operating mechanism shall normally be operated from the breaker cubicle itself.

c) The tripping spring shall be charged by the closing action, to enable quick tripping. Closing of the circuit breaker shall automatically initiate recharging of the springs to enable the mechanism to be ready for the next closing stroke. Charging time for the springs shall not exceed 30 seconds. It shall be possible to manually charge the springs in an emergency. Transfer from motor to manual charging shall automatically disconnect the charging motor. All operating mechanisms shall be provided with "ON" - "OFF" mechanical indication. The charging mechanism shall be provided with mechanical indicators to show "charged" and "discharged" conditions of the spring. Failure of any spring, vibration or mechanical shock shall not cause tripping or closing of the circuit breaker.

d) Only one closing operation of the circuit breaker shall result from each closing impulse (manual or electrical), even if the breaker trips while the control device (manual or electrical) is being held in the "close" position.

e) The circuit breaker mechanism shall make one complete closing operation, once the push button (PB) or control switch has been operated and the first device in the control scheme has responded, even though the PB or control switch is released before the closing operation is complete, subject to the condition that there is no counter- impulse for tripping.

f) Means shall be provided to manually open and close the breakers slowly, when the operating power is not available, for maintenance and adjustments. A local manual trip device shall also be provided on the operating mechanism.

g) Circuit breaker control shall be on 110 V DC. Closing coils and other auxiliary devices shall operate satisfactorily at all voltages between 85-110 % of the control voltage. Trip coils shall operate satisfactorily between 70 -110 % the rated control voltage.

h) Provision for remote control shall be provided .

### 5.3.2.3 Safety Interlocks and Features

a) Withdrawal or engagement of a circuit breaker / switch disconnector shall not be possible unless it is in the open position.

b) Operation of a circuit breaker / switch disconnector shall not be possible unless it is in service position, withdrawn to test position or fully drawn out. It shall not be possible to close the circuit breaker electrically in the service position, without completing the auxiliary circuit between the fixed and moving portions.

c) Circuit breaker / switch disconnector cubicles shall be provided with safety shutters operated automatically by the movement of the circuit breaker / switch disconnector carriage to cover the stationary isolated contacts when the breaker / switch disconnector is withdrawn. Padlocking facilities shall be provided for locking the shutters positively in the closed position. It shall, however, be possible to open the shutters intentionally against spring pressure for testing purposes.

d) The circuit breaker / switch disconnector carriage shall be earthed before the circuit breaker / switch disconnector reaches the test position from fully withdrawn position. In case of breakers / switch disconnector with automatic disconnecting type of auxiliary disconnects, the carriage shall be earthed before the auxiliary disconnects are made and the carriage earthing shall break only after the auxiliary disconnects break.

e) Caution nameplate, “Caution Live Terminals” shall be provided at all points where the terminals are likely to remain live and isolation is possible only at remote end, i.e. incomer to the switchboard. Suitable interlock shall be wired for the purpose.

### 5.3.2.4 Current and Voltage Transformers

CTs and VTs shall have polarity marks indelibly marked on each transformer and at the associated terminal block. Facility shall be provided for short-circuiting and earthing the CT secondary at the terminal blocks.

CT shall be able to withstand the thermal and mechanical stresses resulting from the maximum short circuit current. Core laminations shall be of high grade silicon steel.

VTs shall be of the single phase type and mounted on a draw out trolley. VTs shall be protected on their primary and secondary sides by current limiting fuses with interrupting ratings corresponding to breaker rating. It shall be possible to replace the secondary fuses safely when the switchboard is energized. Alternatively, MCB having auxiliary contact shall be provided. Primary side fuses shall be replaceable only in the de-energized position.

Secondary winding of voltage transformer (VT) shall be rated for a three phase line to line voltage of 110 V.
Identification labels giving type, ratio, output and serial numbers shall be provided for CTs and VTs.

### 5.3.2.5 Relays

Protection relays shall be Numerical (microprocessor based) type. Relays shall have interfacing facilities to communicate data to SCADA system.

All relays shall be enclosed in rectangular shaped, dustproof cases and shall be suitable for flush mounting.

All relays shall be accessible from the front for setting and resetting. Access to setting devices shall be possible only after the front covers of the relays are removed.
All protective relays shall be of the draw-out type and shall be provided with operation indicators visible from the front.

### 5.3.2.6 Over Current / Earth Fault Protection

a) This relay shall be of the multi-characteristics type which has a flexible mode selection facility so that it is possible to select one mode for the over current elements and another for the earth fault element.
b) Phase current range shall cover at least 50-300% of ‘In’ in steps of not more than 10% while the earth current range shall cover at least 5-100% of ‘In’ in steps of not more than5%.

c) The time setting range of the definite time mode shall not be less than 5 seconds in steps of 0.1 secondeach.

d) The time multiplier setting for the inverse time-current characteristic modes shall have a range not less than 0.05- 1.6 in steps of0.05.

e) Over current and earth fault relays shall have separate timers and operation indicators.

f) The high set element shall have a range of 2 - 15 times the nominal current in steps of ‘In’ and shall be of low transient overreach, with a tripping time of less than 25 ms and possible to be selected on "blocked" position. Reset time shall be not more than 50 ms

for both elements.

g) The relays that are installed on the transformer neutral side shall be of single phase version, but they shall have the same characteristics as the phase side relays.

### 5.3.2.7 Restricted Earth Fault Protection

a) The restricted earth fault relay shall be operated from a completely separate core of line and neutral current transformers. The dedicated CTs shall be of class PS and have the same magnetization characteristics with a knee 'emf' value higher than the highest possible setting of the relay. Intermediate CTs for ratio correction are not acceptable. CT sizing shall be matched with the requirements of the relay.

b) For this protection, 1-phase high impedance relay shall be provided and all the aspects regarding stability of the protection, dimensioning of current transformer, considering the peak short circuit current, etc. and all the auxiliary equipment such as non-linear VDR resistor for voltage limiting, filter for harmonics and DC component suppression and variable shunt resistor for sensitivity adjustment, if required, shall be provided.

c) The stability of this protection against out-zone faults shall be confirmed. A calculation to show the proper selection of the relay up to the maximum short circuit of the switchboard shall be submitted.

### 5.3.2.8 Under Voltage Relays

a) Suitable voltage operated relays for sensing loss of voltage shall be provided. The relay shall have a drop off to pick up ratio of the order 90%. The relays shall be fast operating type and shall be fitted with operation indication. The indication shall come on drop off or loss of voltage.

b) Additional potential free contacts for all the relay outputs i.e. trip as well as alarm signals shall be provided for connection to future SCADA.

### 5.3.2.9 Motor Protection Relay

a) It shall be designed to protect the motor against thermal overload, locked rotor, over current and earth fault protection, under voltage, over voltage, phase reversal and negative sequence.

b) Thermal setting range shall cover at least 50% to 200% of 'In' in steps of not more than 5 % of 'In'.

c) Phase current range shall cover at least 5-200% of 'In' in steps of not more than 1% while the earth current range shall cover at least 1-100% of 'In' in steps of not more

than 5%.

### 5.3.2.10 Auxiliary Relays and Timers

a) Following auxiliary relays shall be provided on each breaker cubicle:

i. Trip circuit supervision relay
ii. Anti- pumping relay

b) Hand reset type lockout (tripping) relays and timers shall be provided as required in addition to the protection relays given in the single line diagram.

c) Auxiliary relays and timers shall be rated to operate satisfactorily between 70 % and 110 % of the rated voltage.

d) Voltage operated relays with sufficient contacts to initiate tripping, alarm, annunciation for various trip functions like Buchholz relay operation. Each relay shall have four (4) pairs of self- reset contacts except for Buchholz and "PRD" trip which shall have hand-reset contact. The relays shall have hand-reset operation indicators.

e) Voltage operated relays with sufficient contacts to initiate alarm and data logging for various alarm functions for transformers, etc. shall be provided. Each relay shall have four (4) normally open self-reset contacts. The auxiliary relay for Buchholz alarm shall be slugged to have delay on drop off at 100 ms. The relays shall have hand reset operation indicator.

### 5.3.2.11 Switch Disconnectors and Fuses

Switch disconnectors when switched, shall be of the load break, fault make, grouping operated type. For use on 3-phase systems, the switches shall be of the triple pole type with a link for neutral connection.

Switch disconnectors shall be of the heavy duty, quick make and quick break type. It shall be electrically and manually operated. Their contacts shall be silver plated, and contact springs shall be of stainless steel. Their handles shall have provision for locking in both fully open and fully closed positions. Mechanical ‘ON-OFF’ indication shall beprovided.

For combination units of switch disconnector and fuses, the following interlocks shall be incorporated:

a) The fuses should not be accessible unless the switch disconnector is in fully open condition.

b) It should not be possible to close the switch disconnector when the fuse cover is open, but an authorized person may override the interlock and operate the switch disconnector.

After such an operation, the cover shall be prevented from closing if the switch disconnector is left in the "ON" position.

All fuses shall be of the HRC cartridge type in accordance with IEC 60269 mounted on plug-in type of fuse bases. Fuses shall be provided with visible indicators to show that they have operated. Current vs. time characteristics of all types of fuses shall be furnished to the Chandigarh Administration/MCC/CSCL or their representative.

Fuses and links functionally associated with the same circuit shall be mounted side by side. An adequate number of spare fuse cartridges of each rating shall be supplied and fitted in clips inside the panel.

### 5.3.2.12 Constructional Features of Switchboard

Switchboard design shall comprise metal enclosed, fully compartmental and draw out execution having separate sections for each circuit. Compartments with doors for access to operating mechanism shall be so arranged as not to expose high Voltage circuits. Switchboard cubicle shall be provided with hinged door on the front with facility for locking doorhandle.

Switchboard shall be dust and vermin-proof and shall have a degree of protection of enclosure of IP 4X.

All removable covers shall be gasketed all around with neoprene or superior gaskets.

Instruments, relays and control devices shall be flush-mounted on hinged door of the metering compartment located in the front portion of cubicle. The metering compartment shall be properly shielded to prevent mal-operation of electronic equipment such as numerical / static relays due to electro-magnetic fields. Separate signal earth shall be provided for such devices, if necessary.

Each switchboard cubicle shall be fitted with a label on the front and rear of the cubicle. Each switchboard shall also be fitted with label indicating the switchboard designation, rating and duty. Each relay, instrument, switch, fuse and other devices shall be provided with separate label.

Sheet steel used for fabrication of switchboards, control cabinets, marshalling boxes, etc shall be cold rolled.

All panels, cabinets, kiosks and boards shall comprise rigid welded structural frames made of structural steel sections or of pressed and formed cold rolled sheet steel of thickness not less than 2 mm. The frames shall be enclosed by sheet steel of at least 2 mm thickness.

Stiffeners shall be provided wherever necessary.

All doors, removable covers, gland plates, etc. shall be of at least 2 mm thickness and shall be gasketed all-round the perimeter.

All doors shall be supported by strong hinges of the disappearing or internal type and braced in such a manner as to ensure freedom from sagging, bending and general distortion of panel or hinged parts.

All floor mounted panels / boards shall be provided with a channel base frame. It shall be possible to extend the switchboard on both sides.
The fully draw-out modules shall have all the circuit components mounted on withdrawable type steel chassis. All power and control connections shall be of the draw out type. It shall be possible to withdraw the chassis mounted circuit components without disconnecting any connections. All draw- out contacts shall be of silver plated copper.

In case of circuit breaker compartments, suitable barriers shall be provided between breaker and all control, protective and indication circuit equipment including instrument transformers such that no live parts are accessible. External cable connections shall be through separate cable compartments for power and control cables.

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

After isolation of the power and control connections of a circuit, it shall be possible to carry out maintenance in a compartment safely, with the bus bars and adjacent circuits alive.

### 5.3.2.13 Earthing

A copper earthing bus shall be provided and extended throughout the length of the switchboard. It shall be bolted to the framework of each unit and brazed to each breaker earthing contact bar. It shall be located at the bottom of the board.
The earth bus shall have sufficient cross section to carry the momentary short circuit and short time fault current for at least 1 second or higher as specified, without exceeding maximum allowable temperature rise. The earth bus shall be properly supported to withstand stresses induced by the momentary short circuit current.

Suitable clamp type terminals at each end of the earth bus shall be provided to suit the size of the earthing conductors.

Bolted joints, slices, tap, etc. to the earth bus shall be made with at least two bolts.

Positive earthing of circuit breaker frame shall be maintained when it is in the connected position and in all other positions whilst the auxiliary circuits are not totally disconnected.

Hinged doors shall be earthed through flexible earthing braid of adequate cross section.

All non-current carrying metal work of the switchboard shall be effectively bonded to the earth bus.

Positive connection of the frames of all the equipment mounted in the switchboard to the earth busbar shall be maintained through insulated conductors of size equal to the earth busbar or the load current carrying conductor, whichever is smaller.

All instrument and relay cases shall be connected to earth busbar by means of 1100V grade, green colored, PVC insulated, stranded, tinned copper, 2.5 sq. mm conductor looped through each of the earth terminals.

### 5.3.2.14 Circuit / Busbar Earthing Facility

It shall be possible to connect each circuit or set of 3 phase bus bars of the switchboard to earth through earthing switches.

Earthing switches / earthing devices shall be mechanically interlocked with the associated breakers / switch disconnector to prevent accidental earthing of live circuit or bus bars.

In case the earthing facility comprises earthing trucks to be inserted in place of circuit breakers, separate earthing trucks shall be supplied for each type / size of breaker.

The earthing facilities proposed to be provided by the Bidder shall be clearly detailed in the Bid and shall be subject to Chandigarh Administration/MCC/CSCL or their representative's approval.

Auxiliary contacts (min. 2 NO + 2 NC) shall be provided on each earth switch / earthing device and shall be wired to the terminal block for interlocking purpose.

### 5.3.2.15 Annunciators

Annunciators shall be of facia type with translucent plastic window for each alarm point. Annunciator facia plates shall be engraved in block lettering with respective alarm inscriptions. The inscriptions shall be clearly readable and visible when the respective facia light is lighted.

Each annunciation window shall be provided with two lamps to provide redundancy against lamp failure. Lamps shall be replaceable from the front. Lamps shall be of clustered LED type.

All facia annunciator points shall be suitable to accept external contacts of either 'NO' or 'NC' self or hand reset type for initiating the annunciation sequence. Annunciators shall be suitable for accepting fleeting faults of duration as less as 15 millisecond.

For static annunciator schemes, special precaution shall be taken by the Bidder to ensure that spurious alarm conditions do not appear due to influence of external magnetic fields on the annunciator wiring and switching disturbances from the neighboring circuits within the panels / desks.

A "Lamp Test" push button shall be provided for each individual panel's group of annunciators to limit the sudden drain on the battery.

Provision of testing facilities for flasher and audible alarm circuits of annunciators is desirable. The Bidder shall give the details of the offered scheme.

Annunciators shall have following features:

a) Suitable for annunciating subsequent faults immediately after the sound cancel of the previous fault.

b) During lamp test, if a fault occurs, the corresponding lamp circuit shall be automatically disconnected from the "lamp test" circuit and shall start flashing.

c) Designed to prevent mal-operation of the scheme or sequence when the push buttons are pressed incorrectly or in the wrong order.

d) "Alarm Supply Failure" Alarm scheme similar to the normal annunciation sequence, but shall operate on a different DC supply or on AC auxiliary supply.

### 5.3.2.16 Instruments

All electrical instruments and meters shall comply with IEC 60051, 61010 and IS 722, 1248.

All indicating and recording instruments shall be flush mounted in dust proof cases complying with IEC 60068 and dimensions to IEC 61554. All digital instruments shall have interface facilities to communicate data to SCADA system.

### 5.3.2.17 Indicating Instruments

a) Electrical indicating instruments shall be 96 or 110 mm square with 2400 scale. Taut band type of instruments is preferred. Taut band moving coil instruments for use on AC systems shall incorporate built-in transducers.

b) Instrument dials shall be white with black numbers and lettering. A red line shall be drawn on each scale to represent rated conditions.

c) Normal maximum meter reading shall be of the order of 60 % normal full scale deflection. Ammeters for motor feeders shall have suppressed scale to show current from full load up to six times the full load current.

d) Instruments shall have accuracy class of 1.0 or better. The design of the scales shall be such that it can read to a resolution corresponding to 50% of the accuracy class index.

e) Ammeters and current coils of Watt meters and Voltmeters shall continuously withstand 120% of rated current and 10 times the rated current for 0.5 sec., without loss of accuracy. Voltmeters and potential coils of Watt meters and Varmeters shall withstand 120% of rated voltage continuously and twice the rated voltage for 0.5 sec. without loss of accuracy.

Alternatively, instruments can be electronic / digital type with LCD display. These instruments should have high performance ratio and can be equipped with digital output (for alarms) or with interfacing facilities for communication and remote reading of parameters.

### 5.3.2.18 Metering instruments

a) Watt-hour meters shall be of the induction type and shall be provided with reverse running stops.

b) Watt-hour and Varhour meters shall be of the three phase two element type of accuracy class 1.0, suitable for measurement of unbalanced loads in three phase three wire circuits.

c) Watt-hour and Varhour meters shall be suitable for operation from the secondary of CTs and VTs. They shall be provided with a separate 3 phase 4 wire type test blocks for the testing of the meters without disturbing the CT and VT secondary connections.

d) Meters shall have digital or cyclometer type of registers. They shall read kWh, kVARh or MWh, MVARh as the case may be without the use of additional multiplying factors. Multiplying factors if unavoidable shall be multiples of 10 (ten). Number of digits provided shall be adequate to cover at least 1000 hrs. of operation.

e) Alternatively, instruments can be electronic / digital type with LCD display. These instruments should have high performance ratio and can be equipped with digital output (for alarms) or with interfacing facilities for communication and remote reading of parameters.

### 5.3.2.19 Control and Selector Switches

Control and instrument switches shall be rotary type, provided with escutcheon plates clearly marked to show operating position and suitable for semi-flush mounting with only the switch front plate and operating handle projecting out. The connections shall be from the back. The contact assembly at the back of the switch shall be enclosed in dust tight removable covers.

The control switches shall be 3 position, spring return to neutral type. They shall be provided with contacts to close in 'normal after close' and 'normal after trip' position. Each switch shall have external red and green indicating lamps, (except when discrepancy type switches are called for). In addition, a semaphore indicator shall be provided for earthing switch.

Contacts of the switches shall be spring assisted and contact faces shall be of silver / silver alloy. Springs shall not be used as current carrying parts. Contact rating and configurations of the switches shall be adequate for the functions desired.

Instrument selector switches shall be of the maintained (stay-put) type. Ammeter selector switches shall have make-before-break type contacts so as to prevent open circuiting of CT secondary when changing the position of the switch.

Lockable type switches, which can be locked in a particular position, shall be provided, if required. Emergency stop buttons, if any, shall incorporate 'stay-put' features with independent reset facilities.

### 5.3.2.20 Indicating Lamps / Pilot Lights

Indicating lamp shall be of the double contact, bayonet cap type rated for operation at either 230 V AC or at the specified DC system voltage as applicable. Lamps shall be provided with translucent lamp covers.

Clustered LED type lamps shall be provided Lenses shall be glass or plastic in standard colors, red, green, blue, white and amber, in accordance with IEC 60073.

Bulbs and lenses shall be interchangeable and easily replaceable from the front of the panel. Tools, if any, which are required for replacing the bulbs and lenses, shall also be included in the scope of supply.

Miniature pilot lamps may be provided with plastic marking plate contained inside square (or rectangular) front lens to provide indication of legend or symbols engraved on the marking plate.

The basis of colors shall be as follows:

Red : Flow ofenergy.
Green : No flow ofenergy.
White : Supervision of power available, relay coil healthy,etc.
Amber: Disagreement with original condition, 'abnormal' conditionor 'sequence–on'condition.

### 5.3.2.21 Push Buttons

Push buttons shall be of momentary contact type with rear terminal connections. The color of the push button actuator shall be red for 'OPEN / STOP' and green for 'CLOSE / START' and for other applications shall be as per specified requirements. The push button knob shall be suitably shrouded to prevent inadvertent operation. The push buttons shall be provided with integral inscription plates engraved with their designation.

All push buttons shall have independent, potential free, 2NO + 2NC contacts. The contact faces shall be of silver / silver alloy. The contacts shall be rated 10A and capable of breaking inductive load of 1A at 110V DC and 5A at 110VAC.

### 5.3.2.22 Space Heaters

Adequately rated anti-condensation space heaters shall be provided for each switchboard / cubicle. Space heater shall be of the industrial strip continuous duty type, rated for operation on a 230 V, 1 phase, 50 Hz, AC system.

Space heater shall be provided with a single pole MCB with overload and short circuit release, a neutral link and a thermostat to cut off the heaters at 350 C.

### 5.3.2.23 Cubicle Lighting / Receptacle

Each cubicle shall be provided with interior lighting by means of 18 W fluorescent tube lighting fixture. An MCB shall be provided for the lighting circuit. The lighting fixture shall be suitable for operation from a 230 V, 1 ph, 50 Hz, AC supply.

A 230 V, 1 phase, AC receptacle (socket) plug point shall be provided in the interior of each panel with an MCB.

### 5.3.2.24 Power and Control Cable Terminations

Terminals for power connections shall be complete with adequate phase segregating insulating barriers, shrouds and suitable crimping type of lugs for terminating the cables.

Double compression type glands with armour and bonding clamps for the termination of all solid dielectric multicore cables shall be provided. They shall be designed to secure the armour wires to provide electrical continuity between the armour and the threaded fixing component of the gland and to provide watertight seals between the cable outer sheath and gland and between the inner sheath and threaded fixing component. The gland shall preferably project above the gland plate to avoid entry of moisture.

Earthing connectors between cable armour and earth shall be routed outside the cable gland in an approved manner. Gland insulation shall be capable of withstanding test for appropriate higM Voltage for one minute.

Cable terminations for HV / MV cables shall be heat / cold shrinkable type. Adequately sized shrouds/ bolts shall be provided at connections to completely cover the terminations.

Where core-balance type current transformers are provided on the feeder cables for earth fault protection, glands for cables shall be insulated from earth in an approved manner.

### 5.3.2.25 Wiring for Control and Protective Circuits

All low voltage wiring for control, protection and indication circuits shall be carried out with 1100 V grade, PVC insulated cable with stranded, tinned copper conductor of minimum 1.5 sq. mm size. The size of conductor for CT circuits shall be minimum 2.5 sq. mm.

All wiring shall be run on the sides of panels and shall be neatly bunched and cleated without affecting access to equipment mounted in the panel.

The wiring shall be bound and supported by clamping, roughing or lacing. Spiral wrapping will not be accepted. Wire ways shall not be more than 50% full. Adequate slack wire shall be provided to allow for one re stripping and reconnection at the end of each wire. When screened cables or wires are necessary, an insulating sheath shall be included.

Wiring and supports shall be of fire resistant material.
Wiring shall only be jointed or teed at terminals. Terminals of the clamp type shall not have more than two wires connected.

### 5.3.2.26 Terminations and Ferrules

Engraved core identification ferrules, marked to correspond with the wiring diagram, shall be fitted to each wire and each core of multicore cables terminated on the panels.

Moisture and oil resisting insulating material shall be used. The ferrules shall be of the interlocking type and shall grip the insulation firmly without falling off when the wire is removed.

All wires forming part of a tripping circuit shall be distinctively marked.

Spare auxiliary contacts of electrical equipment shall be wired to terminal blocks.

### 5.3.2.27 Control Wiring Terminal Blocks

Terminal blocks shall be of 1000 V grade and stud type. Brass stud of at least 6 mm dia. with fine threads shall be used and securely locked within the mounting base to prevent turning. Each terminal shall comprise two threaded studs, with a link between them, washers, and matching nuts and locknuts for each stud. Connections to the terminals shall be at the front.

Terminals shall be numbered for identification, grouped according to function. Engraved ‘black on- white’ labels shall be provided on the terminal blocks describing the function of the circuit.

Terminals for circuits with Voltage exceeding 110 V shall be shrouded. Terminal blocks at different voltages shall be segregated into groups and distinctively labeled.

Terminals used for connecting current transformer secondary leads shall be ‘disconnecting and shorting’ type with a facility for earthing the secondary.

Terminal blocks shall be arranged with 100 mm clearance, between any two sets. Separate terminal stems shall be provided for internal and external wiring respectively.

All wiring shall be terminated on terminal blocks, using crimping type lugs or claw type of terminations.

### 5.3.2.28 Electronic Equipment

Electronic equipment shall be capable of withstanding randomly phased transient over voltages of either polarity on the power supply or interruptions of the power supply without damage or impairment to the equipment's subsequent performance. In the case of controls, no mal-operation shall occur.

Where manufacturers require that electronic equipment supplied under this Contract should not be subjected to insulation resistance tests ('Meggering'), suitable warning notices shall be provided and installed in appropriate locations. When specified by manufacturers, separate shield / signal earthing shall be provided.

It shall be possible to remove / replace cards from / to electronic equipment without damage and without interfering with the operation of the rest of the equipment or system. If necessary, consideration should be given to switching off the supplies locally to a card to prevent inadvertent interference to the equipment or system during removing / replacing a card.

Electronic equipment shall not use local internal batteries unless the approval of the Chandigarh Administration/MCC/CSCL or their representative's Representative has been obtained. Where approval is given, batteries used inside equipment shall be of the totally sealed, leak proof type.

### 5.3.2.29 Interference

a) Self-Generated Interference
Equipment shall not generate any type of interference at a level, which could be detrimental to the performance of any other equipment / component or which could cause annoyance or discomfort to personnel.
The earthing and cabling arrangements shall be such that detrimental interference is not generated.

b) External Interference
In the presence of interference expected in substation environments, the design of the equipment shall be such that no damage occurs and performance is maintained to the requirements of the individual specifications.

c) Spark Quenching
Spark quenching devices shall be fitted wherever necessary to ensure continued satisfactory operation of contacts and prevent mal-operation of electronic devices.

d) Noise and Vibration
The acoustical noise levels and / or vibration produced by the equipment in operation shall be as low as is reasonably practicable for the type of equipment concerned and shall be agreed with the Chandigarh Administration/MCC/CSCL or their representative 's Representative.

### 5.3.2.30 Setting-Up and Maintenance Facilities

All equipment shall be provided with sufficient easily accessible test points to facilitate setting-up and fault location together with maintenance aids such as extension boards, jumper leads and special maintenance tools.

Pin or terminal numbering of all cards in all crates shall be consistently uniform throughout. Power supplies shall use the same pin positions on all cards in an equipment or system.

### 5.3.2.31 Loose Equipment

Special connecting leads, extension boards and any special item required for calibration or maintenance purposes, together with the mating half of all necessary connectors shall be supplied.

### 5.3.2.32 Printed Circuit Boards

Printed circuit boards shall be epoxy glass fabric boards to comply with IEC - 60321 suitable for use in hot humid climates. Printed circuit boards may be single-sided, double-sided ormulti-layer.

Printed boards shall, in general, comply with IEC 60326. They shall not bow perceptibly when they are mounted in their shelves or racks. Means shall be provided to prevent boards being plugged into the wrong sockets and the plugging in / out action shall be arranged in a positive manner.

An approved protective coat shall be applied to the printed circuit side of the board to protect against tracking, tarnishing and general deterioration due to moisture and deposition of dust. The coating shall not have any adverse reaction with any other material or components used and shall be suitable for use under tropical conditions. When boards are repaired in the field it shall be possible to apply (or 'touch up') such a finish by simple convenient means.

### 5.3.2.33 Component Identification

a) A component reference number shall be marked adjacent to each component. Where this is impossible, components shall be identifiable from the layout drawings provided.

b) The following shall be marked in all instances:

i. Fuses
The rating and the circuit identification of each fuse shall be marked adjacent to the fuse base.

ii. Control, Protection and Indication Devices
The function of each control, protection and indication device shall be marked.

The caption and its arrangement shall be subject to the approval of the Chandigarh Administration/MCC/CSCL or their representative's Representative.

iii. Preset Controls

The circuit reference and if possible, the function shall be marked adjacent to each preset control in a position where it will be clearly visible while the adjustment is being made.

iv. Connectors

The diagram reference number shall be marked on or adjacent to each connector.

c) Test points shall be individually marked with the diagram reference number.

d) The polarity of any polarized devices (e.g. diodes) shall be marked.

### 5.3.2.34 Test Terminal Blocks

Test terminal blocks, if any, shall be provided for secondary injection and testing of relays. A suitable metering block shall be provided where specified for the connection of a portable precision instrument to be operated when required for specific plant testing purposes.

### 5.3.2.35 Tests

The following routine tests shall be carried out on the assembled switchboard / panel during inspection at the manufacturer's works in addition to other tests as per applicable standards.

(i) Primary injection tests to ensure correct ratios and polarity of current and voltage transformers and of the current operated protection relays and direct acting coils, over their full range of settings.

(ii) Balance earth fault stability test by primary current injection. Care must be taken to reproduce accurately the burdens of interconnecting cables. A further test to ensure correct polarity must be made after assembly.

(iii) Tests on auxiliary relays at normal operating voltages by operation of associated remote relays.

(iv) Correct operation of sequencing and control circuits at normal operating voltages by operation of local control switches, and simulation of operation from remote control positions.

(v) Carry out functionality tests, check interfacing status contacts and instrumentation.

(vi) Checking of Differential protection relay.

(vii) One minute power-frequency voltage dry withstand tests on the main circuits

(viii) One minute power-frequency voltage dry withstand tests on auxiliary circuits

(ix) Insulation resistance tests

All circuit breakers shall be subject to the following tests:

(i) Routine tests including HV pressure test, millivolt drop tests and mechanical tests.

(ii) To ensure the operation of the dc closing coil and satisfactory closing of the circuit breaker with the voltage of the coil down to 80% of its rated voltage, and that mal- operation does not occur with a voltage on the coil of 120% of its rated voltage.

(iii) Interchangeability of withdraw able identically equipped circuit breakers, and checking of all mechanical and electrical interlocks.

Type test figures for heat test runs performed on identical panel types shall be made available.

### 5.3.2.36 MOTORS

All motors shall be of premium efficiency as per IS 12615:2011motors and also comply with IEC 60034, 60072/ IS 325, 4691, 6362,4029,12065, 12075, including standards referred to therein.

The technical parameters of main

The technical parameters of motors shall be as below :

| **Description** | **Unit** | **Particulars** |
|---|---|---|
| Type | | Squirrel cage Induction motor (TEFC) |
| Rating | kW | (*) |
| Rated voltage | kV | |
| Type of mounting | | Vertical / Horizontal (As required) |
| Duty type | | Continuous (S1) |
| Efficiency Class | | Eff3 |
| Description | Unit | Particulars |
| Method of starting | | By variable speed drive (For Blower/compressor motors and other drives required by process) Direct online- for motors up to 5.5kW Star-Delta (Close transition type)–Formotors 7.5 kW and up to 37 kW Soft Starter – For motors 45 kW andabove. |
| Type of system earthing | | Effectively earthed |
| Class of insulation | | F |
| Design ambient temperature | C | |
| Limits of temperature rise of winding | | |
| - Determination by resistance method | C | |
| - Determination by ETD method | C | |
| Location | | Indoor/Outdoor |
| Degree of Protection | | IP55 |

| | | |
|---|---|---|
| Cooling designation | | IC411 |
| External cable details | | 0.4 / 1 kV, 3C(#) x (*) Aluminum, XLPE, armoured |
| Space heater for motor | | Required for rating 30kW and above |

(*) Value to be ascertained by the Bidder after submitting design calculations subject to approval. (#) 4C cable of appropriate size shall be used for VFD operated motors.
The LV motors shall be of the totally enclosed fan cooled type, with degree of protection for enclosure of IP 55 and shall be suitable for continuous operation and direct-on-line starting, unless otherwise specified.

They shall be suitable in all respects for service in extreme climatic conditions. Main conductor and slot insulation shall be non-hygroscopic and in accordance with Class F of IEC 60085.

Motors shall be capable of operating continuously at rated output at any frequency between 49 and 51 Hz and at any voltage within + 10% of the nominal value. Motors shall be designed to be operated for a period of not less than five minutes at a voltage of 20% below the nominal value and at normal frequency without injurious overheating.

The starting current at rated voltage when started direct-on-line shall not exceed 6 times the rated full load current. When started with soft starter it should be 2.5 to 3 times the rated full load current. The motor characteristics shall be coordinated with soft starter manufacturer.

All bearings shall be fitted with oil or grease lubricators. Vertical shaft motors shall have thrust bearings.

All terminals shall be of the stud type of adequate size for the particular duty, marked in accordance with an approved standard and enclosed in a weatherproof box.

All terminal boxes shall be fitted with an approved sealing chamber, conduit entry or adapter plate, as required, together with the necessary fittings to suit the type of cable specified.

The power rating of the motors shall be larger of the following:

a) 115% of the power input to the pump at duty point at a speed corresponding to a frequency of 50Hz.

b) 110% of the maximum power absorbed by pump during entire range of operation/.

Motors shall be capable of starting and accelerating the load with the applicable method of starting, without exceeding permissible winding temperatures, when the supply voltage is 80% of the rated voltage.

Motors shall be capable of satisfactory operation at a supply voltage of 80% of the rated voltage for 5 minutes, commencing from hot condition.

The locked rotor withstand time under hot conditions at 110% rated voltage shall be more than the starting time at minimum permissible voltage by at least two seconds or 15% of the accelerating time, whichever is greater. The locked rotor current of motors shall not exceed 600% of full load current of motor, which is inclusive of 20% tolerance.
Motors when started with the drive imposing its full starting torque under the specified supply voltage variations shall be capable of withstanding at least two successive starts from cold conditions and one start from hot condition without injurious heating of windings. The motors shall also be suitable for three equally spread starts per hour under the above referred supply conditions.

In case of motors started by soft starters, the three phases shall be segregated by metal barriers within both line and neutral side terminal boxes. The two terminal boxes shall be on opposite sides.

The earthing pad shall be of non-corrodible metal, welded / brazed at two locations on opposite sides. The pad size shall be 75x65x25 mm with two holes drilled at 40 mm centers, tapped and provided with suitable bolts and washers for connecting the earthing strip.

Motors rated 30 kW and above shall have space heaters suitable for 230 V, single phase 50 Hz AC supply. These shall be placed in easily accessible positions in the lower part of motor frame. Provision shall be made to measure temperature of bearing by inserting hand held temperature measuring device. Thermistors shall be provided for Flame proof motor.

Motors shall have drain plugs so located that they will drain water, resulting from condensation or other causes from all pockets in the motor casing.

Pockets shall be provided in the motor bearing housings for insertion of portable instrument probes for measuring bearing temperature. One portable hand held instrument per pumping station shall be provided for measuring motor bearing temperature. The same instrument shall also be used to measure the pump bearing temperature.

### 5.3.2.37 Insulation

Any joints in the motor insulation such as at coil connections or between slot and winding sections, shall have strength equivalent to that of slot sections of the coil. The insulation shall be given tropical and fungicidal treatment for successful operation of the motor in extreme climate. The motors shall be provided with class F insulation with temperature rise limited to that of class B insulation.

### 5.3.2.38 Constructional Features

The motor construction shall be suitable for easy disassembly and re-assembly. The enclosure shall be sturdy and shall permit easy removal of any part of the motor for inspection and repair.

Motors weighing more than 25 kg shall be provided with eyebolts, lugs or other means to facilitate safe lifting.

The rotor bars shall not be insulated in the slot portion between the inner core laminations for squirrel cage motors.

### 5.3.2.39 Terminal Box

Terminal boxes shall be of weather proof construction designed for outdoor service. To eliminate entry of dust and water, gaskets of neoprene or equivalent approved shall be provided at cover joints and between box and motor frame. It shall be suitable for bottom entry of cables. It shall be suitable of being turned through 3600 in steps of900.
The terminals shall be of stud type with necessary plain washers, spring washers and check nuts. They shall be designed for rated current carrying capacity and shall ensure ample phase to phase and phase to earth clearances. Suitable cable glands and lugs shall be supplied to match specified cables.

### 5.3.2.40 Accessories

Two independent earthing points shall be provided on opposite sides of the motor for bolted connections. These earthing points shall be in addition to earthing stud provided in the terminal box.

### 5.3.2.41 Tests

Motors shall be subject to routine tests which shall also include the following:

- Insulation resistance
- Measurement of winding resistance
- high voltage test
- no load / full load tests to determine efficiency, power-factor and slip
- momentary overload test
- test for noise levels of motor
- test for vibration severity of motor
- over speed test
- locked rotor reading of voltage, current and power input at a reduced voltage.

Type test certificates for test runs performed on identical motors (below 11 kW rating) shall be made available. Whenever two nos. or more identical motors (above 11 kW rating) are being offered, type tests on one of them shall be carried out, including heat run test.

### 5.3.3 SOFT STARTERS FOR LV MOTORS

The soft starters shall comply with the requirements of IEC 60034, 60947 and IS 325 including those standards referred to therein.

#### 5.3.3.1 Constructional and Performance Features

Motor soft starters shall be switched or electronic type.

Soft starter panel shall be indoor, metal clad with separate metal enclosed compartments for

a) Control, metering and current transformers for differential protection, if specified
b) DOL bypass arrangement
c) Bus bars
d) Power cable terminations
e) Push buttons with indicating lamps.

Soft starter shall achieve smooth starting by torque control for gradual acceleration of the drive thus preventing jerks and extending the life of equipment.

Starting current shall be limited to 2.5 to 3 times the rated current of the motor. The soft starter manufacturer shall co-ordinate with motor manufacturer for this purpose.

Separate removable gland plates shall be provided for power and control cables.
Each cubicle shall be fitted with a label in the front and rear of the cubicle, indicating the panel designation, rating and duty. Each relay, instrument, switch, fuse and other devices shall be provided with separate labels.

Necessary wiring diagram shall be provided considering starting interlock, trip circuit, starting and running mode signal.

It shall be possible to manually start the motor locally from the starter panel or in Auto mode through PLC.

#### 5.3.3.2 Main Bus Bars

Bus bars shall be fully insulated by encapsulation in epoxy resin /shrinkable PVC Sleeve, with moulded caps protecting all joints. Bus bars shall be supported on insulators capable of

withstanding dynamic stresses due to short circuit. Bus bars shall be of Aluminium conductor (Copper is not recommended in sewage corrosive atmosphere as it oxidized.)

#### 5.3.3.3 Earthing

A copper earthing bus shall be provided at the bottom and extended throughout the length of the panel. It shall be bolted / welded to the framework. All non-current carrying metal work of the panel shall be effectively bonded to the earth bus. Hinged doors shall be earthed through flexible earthing braid.

#### 5.3.3.4 Panel Accessories and Wiring

Panel shall be supplied completely wired internally up to equipment and terminal blocks and ready for the external cable connections at the terminal blocks. Inter panel wiring between compartment of the same panel shall be provided.

All auxiliary wiring shall be carried out with 1100 volts grade, single core, stranded copper conductor with PVC insulation. The sizes of wire shall be not less than 1.5 sq. mm.

Terminal blocks shall be of stud type, 10 A rated, complete with insulated barriers. Terminal blocks for CTs shall be provided with test links and isolating facilities.

All spare contacts and terminals of cubicle mounted equipment and devices shall be wired to terminal blocks.
Accuracy class for indicating instruments shall be 1.0 or better. Instruments shall be 110 mm square, 240° scale for flush mounting with only flanges projecting.

Push buttons shall be provided with inscription plates engraved with their functions. Indicating lamps shall be of clustered LED type.

Space heaters of adequate capacity shall be provided inside each panel. They shall be suitable for 230 V, 1 ph, 50 Hz supply. They shall be complete with MCB and thermostat.

Each panel shall be provided with 230 Volts, 1 phase, 50 Hz, 5 A, 3 pin receptacle with MCB located in a convenient position. An interior illuminating lamp together with the operating door switch and protective MCBs shall be provided.

The DC and AC auxiliary supply shall be distributed inside the panel with necessary isolating arrangements at the point of entry and with sub-circuit MCBs as required.

#### 5.3.3.5 Tests

Each unit of soft starter shall be tested at the manufacturer's work. Test result must satisfy all the characteristics during starting and acceleration against their quoted values during bidding.

### 5.3.4 CAPACITORS AND APFC PANEL

Capacitors shall comply with IEC 60871 and IS 5553, 13925 including those standards referred to therein.

The technical parameters of capacitors shall be as given below:

**LV Capacitors and Control Panel**

| Description | Unit | Particulars |
|---|---|---|
| **Capacitor Bank** | | |
| Application | | Power factor improvement |
| Arrangement | | Automatic Power Factor Correction (APFC) |
| Description | Unit | Particulars |
| Type of insulation | | Polypropylene (APP) / Mixed Dielectric (MD) |
| Rated output | kVAR | (*) |
| Rated voltage | V | 415 |
| Rated frequency and no. of phases | Hz / - | 50, 3 Phase |
| Capacitor bank connection | | Delta |
| Type of mounting and location | | Floor mounted and Indoor |
| Design ambient temperature | ¡C | 50 |
| Type of switching | | Automatic |
| Control supply | | 110V DC/AC |
| No. of steps for control | Nos. | Minimum 8 |
| Degree of protection of enclosure | | IP4X |
| Color finish shade | | Light Grey Semi Glossy |
| Type of APFC relay | | Microprocessor based automatic power- factor correction relay (maximum setting 0.99 lag) |

(*) Value to be ascertained by the Bidder after submitting design calculations subject to approval.

MV capacitors shall be provided for connection across MV motor terminals while LV capacitors with APFC relay and a panel shall be provided for connection to LV switchboard bus, where specified.

#### 5.3.4.1 Design Criteria

- MV capacitors – Capacitor rating shall be such that capacitor current is less than 90% of the magnetizing current of the motor or for improvement of rated motor power

factor to 0.98, whichever is lesser.

- LV capacitors – Rated for improvement of power factor on LV side to0.98

### 5.3.4.2 General

The capacitor bank shall be complete with all parts that are necessary or essential for efficient operation. Such parts shall be deemed to be within the scope of supply whether specifically mentioned or not. It shall be complete with the required capacitors along with the supporting post insulators, steel rack assembly, aluminium bus bars, connecting strips, foundation channels, fuses, fuse clips, etc. The steel rack assembly shall be hot dip galvanized.

The capacitor bank shall 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 assembly of the banks shall be such that it provides sufficient ventilation for each unit.

Each capacitor case and the cubicle shall be earthed to a separate earth bus.
Capacitors shall be of polypropylene type. 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.

Each capacitor unit / bank shall be fitted with a directly connected, continuously rated, low loss discharge device, if required, to discharge the capacitors to reduce the voltage to 50 volts within one minute upon disconnection.

### 5.3.4.3 Unit Protection

Each capacitor unit shall be individually protected by a HRC fuse suitably rated for load current and interrupting capacity, so that only the faulty capacitor unit will be disconnected without causing the bank to be disconnected. An operated fuse shall give visual indication so that it may be detected during periodic inspection. The fuse breaking time shall co-ordinate with the pressure built up within the unit to avoid explosion. Mounting of the individual fuse should be internal to the capacitor case.

### 5.3.4.4 Capacitor (APFC) Control Panel for LV Application

APFC microprocessor based relay shall automatically switch ON / OFF the capacitor banks to attain the value of ‘pf’ close to the set value. Switching shall follow first in first out

(FIFO) method to ensure uniform use of all capacitor banks. At least eight steps shall be provided for switching. Harmonic filter (inbuilt with APFC panel) shall be provided to restrict Total Harmonic Distortion (THD) to 3% or less.

Capacitor and capacitor control shall be housed in a metal enclosed cubicle. Capacitor shall be housed in the lower compartment and capacitor control unit at the top compartment, the two compartments being segregated.

The cubicle shall be fabricated out of 2 mm thick cold rolled sheet steel and shall of a degree of protection of IP 4X (for Capacitor Panel IP 4X is applicable as cut out for fan for heat dissipation). The panel shall be of indoor type and shall consist of:

a) Isolating MCCB
b) Contactors with over load element
c) Relays responsive to current / voltage / kVAR / pf for automatic switching
d) Sequencing devices, timers and auxiliary relays for automatic sequential switching of capacitor units in and out of circuit
e) Auto-manual selector switch
f) Microprocessor based Automatic Power Factor Correction (APFC)Relay
g) Push button for opening and closing the power circuit
h) Red and Green lamps for capacitors ON / OFF indication
i) Protective relays to protect the healthy capacitor units when one unit fails in a series connection
j) Space heater and cubicle lighting

### 5.3.4.5 Tests and Test Reports

Capacitors shall be subjected to routine tests as per IS: 13925. Test for capacitor losses shall also be carried out on one capacitor bank of each type ordered.

In addition to the above, the capacitor units shall be subjected to the following tests:

1. Load test at 110% rated voltage at an ambient of 45 to 50 C for a period of 8 hours or more.
2. Leak proof ness test-initially after impregnation and total sealing, each capacitor shall be heated up to 80o C to 110 o C for a few minutes. After the load test each capacitor unit shall be carefully inspected for leakage.

Type tests shall be carried out as per IS: 13925 on capacitors above 1000V rating of identical design. Certificates of type tests carried out in the last three years for similar capacitor units shall be furnished.

## 5.3.5 HV AND LV CABLES

HV / LV Cables shall comply with the following International Standards, including those referred to therein.

IEC 60183, 60227, 60502, 60885 and IS 7098, 5831, 8130, 1554, 10810.

The technical parameters of cables shall be as given below:

| Description | Unit | Particulars |
|---|---|---|
| **MV XLPE Power Cables** | | |
| Rated voltage U / Uo (Um) | kV | 18 / 30 (36) and 3.6 / 6 / (7.2) |
| Material of conductor | | Aluminum (stranded) |
| Cross-sectional area | | (*) |
| Type of insulation | | XLPE |
| Inner sheath | | Extruded |
| Outer sheath | | Extruded |
| Conductor and insulation screening | | Required |
| Material of armour | | Galvanized Steel (Aluminum for single core cable) |
| **LV Power, Control and Lighting Cables** | | |
| Rated voltage U / Uo (Um) | kV | 0.6 / 1 (1.2) |
| Material of conductor | | Aluminum for Power and Tinned Copper for Control cable (stranded) |
| Cross-sectional area | | (*) |
| Type of insulation | | XLPE for power and PVC for control cables |
| Inner sheath | | Extruded |
| Outer sheath | | Extruded |
| Material of armour | | Galvanized Steel (Aluminum for single core cable) |
| Cable Protection | | Compound of outer sheath of all HV/LV cables shall contain suitable chemicals for preventing attack by rodents. |

(*) Value to be ascertained by the Bidder after submitting design calculations subject to approval.

### 5.3.5.1 Voltage Drops

5.3.5.1.1 The maximum voltage drops in various sections of the electrical system under steady state conditions at full load shall be within the limits stated in the followingtable:

| Sr. No. | SYSTEM ELEMENT | MAXIMUM PERMISSIBLE VOLTAGE |
|---|---|---|

| | | **DROP** |
|---|---|---|
| a) | Bus duct or cable between transformer secondary and MV Switchboard or PCC/PMCC | 0.5% |
| b) | Cable between PCC/PMCC and MCC or auxiliary switch board<br>i) MCC/Auxiliary Switchboard near PCC/PMCC<br>ii) MCC/Auxiliary Switchboard situated remote from PCC/PMCC | <br>0.5%<br>1 to 1.5% |
| c) | Cables between MV Switchboard and MV Motor | 2% |
| d) | Cable between PCC/PMCC and motor (Running) | 2.5% |
| e) | Cable between MCC (situated near PCC/PMCC) and motors | 2.5% |
| f) | Cable between MCC (situated remote from PCC/PMCC) and motors | 3% |
| g) | Cable between Auxiliary Switchboard & Lighting Panel | 1 to 1.5% |
| h) | Circuit between lighting panels and lighting points | 4% |
| i) | DC Supply Circuit (Electrical Controls) | 5% |
| j) | DCDB to Control Room | 2% |
| k) | UPS outgoing circuit | 5% |

5.3.5.1.2 The maximum voltage drop at various buses during start-up of large motor and / or motor reacceleration conditions shall be within the limits stated below:

| **Sr. No.** | **SYSTEM ELEMENT** | **OPERATING CONDITION** | **MAXIMUM PERMISSIBLE VOLTAGE DROP** |
|---|---|---|---|
| a) | At the bus bars of the worst affected Switchboard | Start-up of the large HV/MV motor with other loads on the bus or reacceleration of a group of HV motors (simultaneous start-up or group reacceleration of MV motors isnot envisaged) | 15% |
| b) | At the bus bars of the worst affected LV Switchboard (PCC/PMCC/MCC) | Startup of large LV motor with other loads on the bus, or reacceleration of a group of LV motors. | 10% |
| c) | Cables between HV/MV Switchboard & Motor | Motor start-up or reacceleration | 5% |

| | | | |
|---|---|---|---|
| d) | Cables between LV switchboard (PCC/PMCC/MCC) & motor | Motor start-up or reacceleration | 15% |

**NOTES:**

a) The voltage available at the motor terminals during start-up must be sufficient to ensure positive starting or reacceleration of the motor (even with the motor fully loaded, if required), without causing any damage to the motor.

For high voltage motors, the voltage available at the motor terminals must not be less than 80% of the rated value during start-up or reacceleration.

### 5.3.5.2 Installation

a) In air or buried in ground
b) Depth of laying in ground 1000 mm for directly buried HV / MV cables and 750 mm for LV cables
c) In conduit: space factor not more than 40 % (ratio of total cable area to internal conduit area)
d) In trays: single layer with spacing of one diameter for HV / MV and main LV cables and touching for small LV cables

Control cables shall be 2C, 4C, 7C, 12C and 19C type. Minimum size of conductor for control cables shall be 2.5 sq.mm. copper.

All power cables shall be sized based on continuous current capacity, maximum permissible voltage drop of 2.5% and rated short circuit current withstand. In addition, rating factors for variation in ground/air temperature, grouping of cables, depth of laying, number of racks, etc. shall be considered for cable sizing.

### 5.3.5.3 Tests

All HV, and LV cables shall be subject to routine tests in accordance with the relevant Indian Standard Specifications.

Test certificates shall be provided against each drum and/or cable length.

The tests carried out on every cable length and / or drum at manufacturer's premises shall

include following tests as applicable but not limited to:

- High Voltage dc insulation pressure test, between cores, each core to earth, metallic sheath or armour as applicable;
- Insulation resistance test;
- Core continuity and identification;
- Conductor resistance test
- Elongation test
- Smoke density test
- HCl gas generation test
- Anti rodent test (Presence of lead)

### 5.3.6 LV INDOOR SWITCHBOARD

LV indoor switchboard and its components shall comply with the following International Standards, including those referred to therein.

IEC 60269, 60947, 61459, 60529 and IS 4237, 8623, 1248, 722, 2705, 3156, 10118, 11353, 13947

The technical parameters of LV switchboard shall be as given below:

| Description | Unit | Particulars |
|---|---|---|
| **General** | | |
| Rated voltage, no. of phase and rated frequency s | V / - / Hz | 415V, 3, 50Hz |
| System neutral earthing | | Effectively Earthed |
| Rated short duration power frequency withstand voltage | | |
| - Power circuit | kV (rms) | |
| - Control circuit | kV (rms) | |
| Rated normal current of bus bars under design ambient temperature of 50°C and material of busbar | A / - | (*), Aluminum |
| Rated short-time withstand current and time | kA (rms) / sec | 45* kA for 1 sec (Min) |
| **Constructional Requirements** | | |
| Thickness of sheet steel in mm Cold rolled (Frame/Enclosure/Covers) | mm | Frame – 2.0<br>Doors/Covers – 2.0 |
| Degree of protection of enclosure | | IP-5X, Form-4 enclosure |

| | | |
|---|---|---|
| Color finish shade | | |
| - Interior | | Glossy White |
| - Exterior | | Light Grey |
| Cable connection | | Bottom entry and exit |
| **Circuit Breakers** | | |
| Type | | Air |
| Rated current inside the cubicle under design ambient temperature at 50°C | A | (*) |
| Rated operating sequence | | O–3 Min–CO-3 Min-CO |
| Rated short-time withstand current and time | kA (rms)/ sec | 45(*) /1 sec |
| Min. no. of auxiliary contacts | | 6 NO + 6 NC after internal use by manufacturer |
| Type of operating mechanism | | |
| - Normal | | Spring charging for closing and trippin g |
| - Emergency | | Manual and Spring charge for closing and tripping d |
| Auxiliary control voltage | | |
| - Closing coil / Tripping coil | V | 110V DC |
| - Spring charging motor | V | 110V DC |
| Description | Unit | Particulars |
| - Space heater and lighting | V | 230V AC |
| Earthing switch | | Required |
| Current and Voltage Transformers | | |
| Details of ratio, taps, burden, accuracy | | As per Single Line Diagram (*) |
| Protective Relays | | |
| Type | | Numerical (Microprocessor based) |
| Auxiliary supply | V | 110V DC |
| Details of protective relays | | As per Single Line Diagram |
| **Moulded Case Circuit Breakers** | | |
| Type | | Moulded Case (microprocessor based) |
| Rated current when installed within cubicle under design ambient temperature of $50^0$C | A | As required (*) |
| Rated short-time withstand current | kA (rms) | 45* kA |
| **Miniature Circuit Breakers** | | |
| Type | | Miniature |
| Rated current when installed within cubicle under design ambient temperature of $50^0$C | A | (*) |
| Rated short-time withstand current | kA (rms) | 10 |
| **Motor Starters and Contactors** | | |

| | | |
|---|---|---|
| Type | | Soft Starter/Variable Frequency Drive/ Star-Delta / Direct-on line |
| Rated current | A | (*) |
| Rated voltage of coil | V | 230V AC / 110V DC |
| Utilization category | | AC-3 |

(*) Value to be ascertained by the Bidder after submitting design calculations subject to approval.

These cover the main switchboard and distribution boards. The distribution board shall be of floor / wall mounting type. Entry for incoming and outgoing cables shall be from bottom. Bus bars shall be of aluminium . Degree of protection of the panel shall be IP5X.

The board shall be provided with circuits as required, ammeter with ammeter selector switch and voltmeter with Voltmeter selector switch. Bidder shall furnish proposed single line diagram of the board along with the Bid.

Incoming and outgoing circuit shall be protected by suitably rated ACBs/MCCBs.

The switchboard and its components shall be subjected to tests as per the applicable standards.

The current rating of outgoing feeders of any switchboard shall not be less than 10% of that of the incoming feeder. Deviation from this requirement shall be subject to the approval of the Chandigarh Administration/MCC/CSCL or their representative's Representative.

### 5.3.6.1 BusBars

The phase and neutral bus bars shall be of rating indicated in the corresponding single line diagram. Bus bars shall be of aluminium and shall be provided with minimum clearances as per standards.

All bus bars and bus taps shall be insulated with close fitting sleeve of hard, smooth, dust and dirt free, heat shrunk PVC insulation of high dielectric strength, to provide a permanent non-ageing and non-tracking protection, impervious to water, tropical conditions and fungi. The insulation shall be non-inflammable and self-extinguishing type and in fast colors to indicate phases. The dielectric strength and properties shall hold good for the temperature range of 0 to 95 degree centigrade. If the insulating sleeve is not colored, bus bars shall be color coded with colored PVC tape at suitable intervals.

Bus bar joints, if any, shall be of the bolted type with minimum 4 bolts. Spring washers shall be provided to ensure good contact at the joints. Bus bars shall be thoroughly cleaned at the joints and suitable contact grease shall be applied just before making a joint.

Direct access to, or accidental contact with bus bars and primary connections shall not be

possible. All apertures and slots shall be protected by baffles to prevent accidental shorting of bus bars due to insertion of maintenance tools.

Sequence of red, yellow and blue phases and neutral for four-pole equipment shall be left to right and top to bottom, for horizontal and vertical layouts respectively.

#### 5.3.6.2 Moulded Case Circuit Breaker (MCCB)

MCCBs shall be of the air break, quick make, quick break and trip free type and shall be totally enclosed in a heat resistant, moulded, insulating material housing.

MCCBs shall have an ultimate short circuit capacity not less than the prospective short circuit current at the point of installation.

MCCBs shall have a service short circuit breaking capacity equal to the ultimate short-circuits capacity.

Each pole of MCCB shall be fitted with microprocessor based protection for over current, earth fault and short circuit (L-S-I-G). Such protection system shall be fully self-contained, needing no separate power supply. The elements shall be adjustable. Adjustments shall be made simultaneously on all poles from a common facility.

Motor protection circuit breaker (MPCB) shall be used for motor feeder instead of MCCBs.

#### 5.3.6.3 Miniature Circuit Breaker (MCB)

Miniature circuit breakers shall be of the thermal and magnetic tripping type, and comply with IEC 60898 and IEC 60947-2.

MCB shall be hand operated, air break, quick make, quick break type.

Operating mechanisms shall be mechanically trip-free from the operating knob to prevent the contacts being held closed under overload or short-circuit conditions.

Each pole shall be fitted with a bi-metallic element for overload protection and a magnetic element for short-circuit protection. Multiple pole MCBs shall be mechanically linked such that tripping of one pole simultaneously trips all the other poles. For motor feeders, MCB shall have type C characteristics.

The short circuit rating shall be not less than that of the system to which they are connected with a minimum of 10 kA.

#### 5.3.6.4 CONTACTORS AND STARTERS

The power contactors used in the switchboard shall be of air break, single throw, triple pole, and electromagnetic type. Contactors shall be suitable for uninterrupted duty and rated for Class AC3 duty in accordance with IEC 60947-4.

Operating coils of all contactors shall be suitable for operation on 230 V, single phase, 50 Hz supply. Contactors shall be provided with at least two pairs of NO and NC auxiliary contacts.

Contactors shall not drop out at voltages down to 70 % of coil rated voltage. All motor contactors and their associated apparatus must be designed to operate for a period of not less than 5 minutes at a voltage of 20% below the nominal value and at normal frequency without injurious overheating.

Contactors shall be provided with a three element, positive acting, ambient temperature compensated, time lagged, hand reset type thermal overload relay with adjustable settings. The hand reset button shall be flush with the front door of the control module, and shall be suitable for resetting the overload relay with the module door closed. Relays shall be either direct connected or CT operated. Overload relay and reset button shall be independent of the "Start" and "Stop" push buttons. All contactors shall all be provided with single phasing preventer (SPP).

Motor starters shall be complete with auxiliary relays, timers and necessary indications.

Starters shall be of the electrically held-in type with integral “start” and “stop” push buttons mounted externally on the door, with integral interlocked isolators. Where required, auxiliary switches shall be included for the operation of “red” and “green” indicating lights in remote instrument panels.

For details of other equipment/ accessories of LV switchboard (e.g. circuit breaker, current and voltage transformer, relay, constructional features of switchboard, earthing, annunciator, indicating and measuring instrument, control and selector switch, indicating lamp, push button, space heater, cubicle lighting/ receptacles, power and control cable termination, wiring, terminal blocks, etc), refer specification of HV switchboard.

### 5.3.6.5 TESTS

The following routine tests shall be carried out on the assembled switchboard / panel during inspection at the manufacturer’s works in addition to other tests as per applicable standards.

(i) Primary injection tests to ensure correct ratios and polarity of current and voltage transformers and of the current operated protection relays and direct acting coils, over

their full range of settings.

(ii) Balance earth fault stability test by primary current injection. Care must be taken to reproduce accurately the burdens of interconnecting cables. A further test to ensure correct polarity must be made after assembly.

(iii) Tests on auxiliary relays at normal operating voltages by operation of associated remote relays.

(iv) Correct operation of sequencing and control circuits at normal operating voltages by operation of local control switches, and simulation of operation from remote control positions.

(v) Carry out functionality tests, check interfacing status contacts and instrumentation.

(vi) Checking of Differential protection relay.

(vii) One minute power-frequency voltage dry withstand tests on the main circuits

(viii) One minute power-frequency voltage dry withstand tests on auxiliary circuits

(ix) Insulation resistance tests

All circuit breakers shall be subject to the following tests:

(i) Routine tests including HV pressure test, millivolt drop tests and mechanical tests.

(ii) To ensure the operation of the dc closing coil and satisfactory closing of the circuit breaker with the voltage of the coil down to 80% of its rated voltage, and that mal-operation does not occur with a voltage on the coil of 120% of its rated voltage.

(iii) Interchangeability of with draw able identically equipped circuit breakers, and checking of all mechanical and electrical interlocks.

Type test figures for heat test runs performed on identical panel types shall be made available.

### 5.3.7 DC EQUIPMENT

DC equipment shall comply with IEC 60896 including those standards referred to therein

#### 5.3.7.1 Requirements

Following items shall be covered in the Contract:

a) One no. 110 V Nickel Cadmium type Battery (Minimum capacity of Battery –300AH)

b) Two nos. Float-cum-boost chargers for 110 V batteries

c) DC distribution board.

All connections between battery, battery chargers and DC distribution board shall be designed for effective segregation between positive and negative leads.

#### 5.3.7.2 110 V Battery

Battery offered shall be Nickel Cadmium (Ni-Cd) type. Nickel hydroxide and Cadmium

hydroxide shall be used for positive and negative electrode respectively. Aqueous solution of Potassium hydroxide with small quantities of lithium hydroxide shall be used as electrolyte. It shall be used only for ion transfer and shall not chemically change during charging/ discharging.

The containers shall be transparent and preferably be made of toughened glass or plastic and provided with acid level indicator.

The battery shall be rated on 5-hour basis and for the specified ambient temperature. The battery shall have maximum recharge time of 8 hours. The batteries shall be sized for a backup of 2 hours, in case of power failure. The ampere-hour capacity shall be selected to cater to all the emergency loads, operation of control gear, indication lamps, annunciation panels, emergency lighting, incoming breaker(s) spring charging currents, short time loads etc. A margin of about 25% shall be taken to cater to the contingencies.

Terminal posts shall be designed to accommodate external bolted connection conveniently and positively. Each terminal post shall have two bolt holes of the same diameter, preferably at right angles to each other. The bottom hole shall be used to terminate the inter-cell connection. The top hole shall be left for external terminal connections. Bolts, heads and nuts, except seal nuts, shall be hexagonal and shall be lead covered. The junction between terminal posts and cover, and between cover and container shall be so sealed as to prevent any seepage of electrolyte.

Required quantity of electrolyte for first filling with 10% extra shall be supplied in non-returnable containers.

Each battery shall be complete with following accessories, as applicable, that include, but are not limited to:

a) Battery racks
b) Porcelain insulators, rubber pads, etc.
c) Set of inter-cell, inter-tier and inter-bank connectors as required for the complete installation.
d) Electrolyte for first filling + 10% extra. Accessories for testing and maintenance

| | | | |
|---|---|---|---|
| i. | One | - | -3, 0, +3 volts DC voltmeter with built-in discharging resistor and suitable leads for measuring cell voltage. |
| ii. | One | - | Filler hole thermometer fitted with plug and cap and having specific gravity correction scale. |
| iii. | Three | - | Pocket thermometers |
| iv | Two | - | Cell lifting straps |
| v | One se t Eachof | - | Terminals and cable boxes with glands for connecting cable as required.<br>Spare connectors<br>Spare vent plugs<br>Spare nuts and |

| | | | |
|---|---|---|---|
| | | | bolts<br>Suitable set of spanners |

Each battery shall be mounted in a manner that permits easy accessibility to any cell. The racks shall be suitable for fixing on flat concrete floor. The complete racks shall be suitable for bolting end to end.

It shall be the responsibility of the Bidder to provide batteries of adequate capacities to meet specified requirements pertaining to control, indication, annunciation, etc. and emergency lighting. For computing battery capacity, it shall be assumed that the battery is fully charged at the beginning of loading cycle and is discharged to a voltage of 1.2 volts per cell at the end of the loading cycle.

Emergency lighting load shall be considered as 10 % of total lighting load of the plant including internal & external lighting. Emergency lighting shall be applicable for all vital locations like substation, Administrative building, Control room, Pump Houses, Laboratory, Gas engine room etc. For external lighting/Road lighting /Area lighting emergency lighting fixtures shall also be considered to overcome the interruption in movement of persons and vehicles.

The battery shall have minimal difference (approx. 0.3 V per cell) between float and boost charging voltages.

### 5.3.7.3 Battery Charger (110 V)

The float-cum-boost type battery charger shall comprise silicon controlled rectifiers (SCRs) connected in a full wave bridge circuit.

Each battery charger shall be suitable for float charging the battery under normal conditions and boost charging the battery when it has discharged during service conditions. The changeover from float to boost mode and vice versa shall be automatic.
The rectifier transformer shall be dry type and double wound with required number of taps.

The DC output voltage during float charging shall be stabilized within + 1% of the set DC

bus voltage for AC input voltage variation of +10%, frequency variation of + 5% and DC load variation from 0 - 100%. The voltage regulation shall be achieved by a constant voltage regulator having fast response SCR control. The ripple content shall be within 1% of DC output nominal voltage with battery disconnected and shall be designed to have voltage regulation of 1%. Also in any mode of operation, the maximum harmonics in the charger output shall not exceed 5%.The setting of the output DC bus voltage shall be adjustable between + 10% of nominal rated voltage. There shall be provision for manual control if auto mode fails. Line surge suppressers shall be provided.

For boost charging the discharged battery after a mains failure, the rectifier shall charge the battery at high rate limited to the maximum boost charging voltage. The boost charging shall come on only when selected for boost mode manually. In auto control, the DC output current shall be stabilized within +2% for AC input voltage and frequency variation of + 10% and + 5% respectively. There shall be provision for manual control if auto-mode fails. Boost charging time for charging the battery to full capacity from fully discharged condition shall not exceed 8hours.

In the float charging mode, the charger shall be designed for supplying:

a) The DC loads of control, indication and annunciation circuits that remain energized during normal operation and the momentary closing and trip coil loads of circuit breakers, vacuum contactors; and
b) The float charging current of the battery.
c) 25% margin over the above load

Battery charging equipment complete with all accessories shall be housed in a free standing sheet steel cubicle having degree of protection of IP 4X. Sheet steel used for construction shall be 1.6 or 2 mm thick. The units shall be wired using 1100 V grade, PVC insulated, stranded copper conductor cables.

Each battery charger shall be provided with accessories that include, but not limited to the following:

a) Silicon controlled rectifiers connected in full wave bridge circuit with ripple control devices and transient suppression network.
b) Double wound dry type transformer with taps
c) Automatic voltage regulator unit with manual / auto control switch
d) Coarse and fine control potentiometers for manual control
e) Selector switch for mode of charging i.e. float charging / boost charging
f) Off-load tap changing switch for changing the taps of the transformer
g) DC voltmeter with fuses and a three position selector switch
h) DC ammeter with shunt

i) AC ammeter with selector switch for incoming AC power
j) AC voltmeter with selector switch for incoming AC power
k) MCB for incoming AC supply along with surge suppressers
l) Switch-fuse / MCB on DC output side with kick fuses and alarm contacts
m) Voltage dropping diodes in load circuit during boost charging mode
n) DC under voltage relay and earth fault relay
o) AC / DC switching relays for alarm and indication circuits including buzzer
p) Cubicle space heater suitable for 230 V AC, 1 ph, 50 Hz supply, with MCB and thermostat
q) 230 V AC compact fluorescent lamp fixture for internal lighting with MCB

Each battery charger shall be provided with the following alarms /indications:

a) AC and DC supply 'ON'
b) AC and DC supply fail
c) Modes of charging
d) Over voltage
e) Under voltage on DC side
f) Earth fault on DC side
g) AC / DC MCB trip

The Bidder shall include in the bid, detailed AC and DC scheme for battery charger offered.

### 5.3.7.4 110 V DC Distribution Board (DB)

The distribution board shall be of floor mounting design. Entry for incoming and outgoing cables shall be from the bottom. Bus bars shall be of aluminum or copper.

Incomers, bus coupler and outgoing circuits shall be controlled by suitably rated double pole MCBs type suitable for DC application. Bidder shall furnish proposed single line diagram of the board along with the Bid.

Constructional features, pre-treatment, painting and other aspects shall comply with the specifications for LV switchboard. DCDB shall have 10% spare feeder for owner use in future.

Aluminium earth busbar of suitable size shall be provided along the length of the DB at the bottom. Two nos. earthing terminals shall be provided on the external face of the board for connection to the earthing grid.

### 5.3.7.5 Tests

The batteries, chargers and distribution boards and their components shall be subjected to

routine/ acceptance tests as per the applicable standards. For battery, following tests are also to be carried out:

- Capacity test
- Test for voltage charging and discharging
- Ampere-hour and watt-hour efficiency test

Certificates of type tests carried out on similar equipment shall be furnished.

### 5.3.8 VARIABLE FREQUENCY DRIVES (VFD)

#### 5.3.8.1 General

AC induction motor shall be coupled with a Frequency drive of rating commensurate with the rated motor. The Frequency drives shall be of Current Source Inverter Pulse Width Modulated (CSIPWM) with latest version, which performs precise speed and torque control of standard squirrel cage motors with optimum efficiency. Each drive must have a soft starting feature and a bypass arrangement for DOL starting of motors. All frequency dives shall be suitable for data connectivity with PLC/SCADA system and shall have suitable for data connectivity with PLC/SCADA system and shall have communication port and protocol compatible to PLC. The drives must be easily programmable. The drives shall be provided with surge protection, programmable lockable code. The Frequency drive shall have following characteristics:

- Accurate open loop torque control
- Torque step rise time typically less than 5ms
- Speed control inaccuracy typically 0.1% to 0.5% of nominal speed
- 150% overload capacity for 60second

Total Harmonic distortion shall comply with the provisions of IEEE 519. Necessary metering, self- diagnostic arrangement (including display and alarm facilities) shall be provided for local/ remote monitoring.

#### 5.3.8.2 Technical Parameters

| **Main connection** | | |
|---|---|---|
| Voltage | : | 3 phase, 415 +/- 10 % permitted tolerance |
| Frequency | : | 45 to 65 Hz, maximum rate of change 17%/s |
| Imbalance | : | Max. +/- 3% of nominal phase to phase input voltage |
| Fundamental Power factor | : | 0.97 (at nominal load) |
| **Motor connection** | | |
| Voltage | : | 3 phase, from 0 to applied incoming supply voltage, 3-phase |

| | | |
|---|---|---|
| | | symmetrical |
| Output Frequency | : | 0 to 250 Hz |
| Frequency Resolution | : | 0.01 Hz |
| Continuous Current | : | 1.0 * I2N(normal use) |
| Short Term Overload Capacity (1min./10min) | : | I2max = 1.1 * I2N |
| Field Weakening point | : | 8 to 300 Hz |
| Acceleration Time | : | 0 to 1800 sec |
| Deceleration Time | : | 0 to 1800 sec |
| Efficiency | : | Min. 97% at nominal power level |
| Environment limits | | |
| Ambient temperature | : | 0 to 45 deg. Cent. |
| **General Standard Control Connections or as per Process Requirement** | | |
| • 3 programmable differential analogue inputs (1 voltage signal, 2 current signals) | | |
| • 7 programmable digital inputs | | |
| • 2 programmable analogues outputs (current signal) | | |
| • 3 programmable digital outputs ( from Crelays) | | |
| • Optional analogue and digital extension modules can be added as well as a wide range of field bus adapters. | | |
| **Protection** | | |
| • Over current | | |
| • Short circuit at start-up | | |
| • Input phase loss | | |
| • Output phase loss | | |
| • Motor over load | | |
| • Earth fault | | |
| • Overvoltage | | |
| • Under voltage | | |
| • Over temperature | | |
| • Motor stall | | |
| **Application macros** | | |
| The features a selection of built-in, pre-programmed application macros for configuration of inputs,<br>outputs, signal processing and other parameters. It shall have interfacing facilities to communicate data to SCADA system. These include: | | |
| • FACTORY SETTING for basic industrial applications | | |
| • HAND/AUTO CONTROL for local and remote operation | | |
| • PID CONTROL for closed loop processes | | |
| • TORQUE CONTROL for process where torque control is required. | | |
| • SEQUENTIAL CONTROL for processes where torque control is required. | | |
| • USER MACRO 1 and 2 for user's own parameter setting | | |
| • Comprehensive testing and diagnostic function | | |

#### 5.3.8.3 Tests

Each unit of Variable frequency drive shall be tested at the manufacturer's work. Test result must satisfy the efficiencies on various loads and at different frequency levels against their quoted values during bidding.

### 5.3.9 LIGHTING SYSTEM EQUIPMENT

Lighting system shall comply with the following International Standards, including those referred to therein IEC 60083, 60598, 60669, 60884, 60906 and 60947. However at least 50% of street lighting shall be solar based as per specifications given below:

**SOLAR STREET LIGHTING SYSTEM**

A standalone solar photovoltaic street lighting system (SLS) shall be an outdoor lighting unit used for illuminating a street or an open area. The Solar Street Lighting System shall consist of solar photovoltaic (SPV) module, a luminaire, storage battery, control electronics, inter-connecting wires/cables, module mounting pole including hardware and battery box. The luminaire shall be based on LED which emits light when electric current passes through it. The luminaire shall be mounted on the pole at a suitable angle to maximize illumination on the ground. The PV module shall be placed at the top of the pole at an angle facing south so that it receives solar radiation throughout the day, without any shadow falling on it. A battery is placed in a box attached to the pole.

Electricity generated by the PV module charges the battery during the day time which powers the luminaire from dusk to dawn. The system lights at dusk and switches off at dawn automatically. Bidder can consider suitably rated PV module for requirement of the light fixture wattage selected based on the requirement of illumination level required.

Nos. of poles and type of fixture will be arrived based on the lux level specified for street lighting elsewhere.

**BROAD PERFORMANCE SPECIFICATIONS**

| | |
|---|---|
| PV Module | 74 Wp under STC or as required |
| Battery | Lead acid Tubular Flooded or Tubular GEL / VRLA , 12V-75 AH @ C/10 |
| Light Source | Compact Fluorescent Lamp of 11 Watt |
| Mounting of light | Minimum 4 meter pole mounted |
| Electronics Efficiency | Minimum 85% total |
| Inverter | Quasi sine wave or sine wave type |
| Duty Cycle | Dusk to dawn |

| | |
|---|---|
| Autonomy | 3 days or Minimum 42 operating hours per permissible discharge |

**TECHNICAL DETAILS**

**PV MODULE**

i. Indigenously manufactured PV module shall be used.
ii. The PV module shall have crystalline silicon solar cells and shall have a certificate of testing conforming to IEC 61215 Edition II /BIS 14286 from an NABL or IECQ accredited Laboratory.
iii. The power output of the module(s) under STC shall be a minimum of 74 Wp at a load voltage* of 16.4 ± 0.2 V. Either two modules of minimum 37 Wp output each or one module of 74 Wp output shall be used.
iv. The open circuit voltage* of the PV modules under STC shall be at least 21.0 Volts.
v. The module efficiency shall not be less than 14 %.
vi. The terminal box on the module shall have a provision for opening it for replacing the cable, if required.
vii. A distinctive serial number starting with NSM will be engraved on the frame of the module or screen printed on the tedlar sheet of the module.

*The load voltage and Voc conditions of the PV modules shall not be applicable for the system having MPPT based charge controller.

**BATTERY**

i. Lead Acid, tubular positive plate flooded electrolyte or Gel / VRLA Type.
ii. The battery will have a minimum rating of 12V, 75 Ah at C/10 discharge rate.
iii. 75 % of the rated capacity of the battery shall be between fully charged and load cut off conditions.
iv. Battery should conform to the latest BIS/ International standards.

**LIGHT SOURCE**

i. The lamp shall be suitably rated LED light fixtures.
ii. The lamp shall be housed in an assembly suitable for outdoor use, with a reflector on its back. No blackening or reduction in the lumen output by more than 10%, shall be observed after 1000 ON/OFF cycles - two minutes ON followed by four minutes OFF is one cycle.

**ELECTRONICS**

i. The total electronic efficiency shall be at least 85%.
ii. The inverter shall be of quasi sine wave/ sine wave type, with frequency in the range of 20 - 30 KHz.
iii. Electronics shall operate at 12V and should have temperature compensation for proper charging of the battery throughout the year
iv. .No load current shall be of less than 20 mA.

v. The PV module itself shall be used to sense the ambient light level for switching ON and OFF the lamp.
vi. The PCB containing the electronics shall be capable of solder free installation and replacement.
vii. Necessary lengths of wires/cables, switches suitable for DC use and fuses shall be provided

**ELECTRONIC PROTECTIONS**

i. Adequate protection shall be incorporated under "No Load" conditions e.g. when the lamp is removed and the system is switched ON.
ii. The system shall have protection against battery overcharge and deep discharge conditions.
iii. Fuse shall be provided to protect against short circuit conditions.
iv. Protection for reverse flow of current through the PV module(s) shall be provided.
v. Electronics shall have temperature compensation for proper charging of the battery throughout the year.
vi. Adequate protection shall be provided against battery reverse polarity.
vii. Load reconnect shall be provided at 80% of the battery capacity status.

**MECHANICAL COMPONENTS**

i. A corrosion resistant metallic frame structure shall be fixed on the pole to hold the SPV module.
ii. The frame structure shall have provision to adjust its angle of inclination to the horizontal between 0 and 45, so that the module can be oriented at the specified tilt angle.
iii. The pole shall be made of Galvanized Iron (GI) pipe.
iv. The height of the pole shall be 4 meters above the ground level, after grouting and final installation
v. The pole shall have the provision to hold the luminaire.
vi. The lamp housing shall be of water proof and shall be painted with a corrosion resistant paint.
vii. A vented, acid proof and corrosion resistant metallic box with a locking arrangement for outdoor use shall be provided for housing the battery.

**INDICATORS**

i. The system shall have two indicators, green and red.
ii. The green indicator shall indicate the charging under progress and shall glow only when the charging is taking place. It shall stop glowing when the battery shall be of fully charged.
iii. Red indicator shall indicate the battery "Load Cut Off" condition.

**QUALITY AND WARRANTY**

i. All the components and parts used in the solar street lighting systems shall conform to the latest BIS or IEC specifications, wherever such specifications are available and applicable.
ii. The street lighting system including the battery will be warranted for period of five years from the date of supply.
iii. The PV module(s) will be warranted for a minimum period of 25 year from the date of supply. The PV modules must be warranted for their output peak watt capacity, which shall not be less than 90% at the end of Ten (10) years and 80% at the end of Twenty five (25) years.
iv. The Warranty Card to be supplied with the system must contain the details of the system.

**OPERATION AND MAINTENANCE MANUAL**

An Operation, Instruction and Maintenance Manual, in English and the local language, shall be provided with the Solar Street Lighting System. The following minimum details must be provided in the Manual:

- Basic principles of Photovoltaic.
- A small write-up (with a block diagram) on Solar Street Lighting System - its
- components, PV module, battery, electronics and luminaire and expected
- Performance.
- Type, Model number, Voltage & capacity of the battery, used in the system.
- The make and wattage of the CFL used in the lighting system.
- About Charging and Significance of indicators.
- Clear instructions about erection of pole and mounting of PV module (s) and
- Lamp housing assembly on the pole.
- Clear instructions on regular maintenance and troubleshooting of the Solar

**General Requirements**

Lighting system equipment shall cover lighting panels, lighting fixtures, switches, receptacles with switches, for outdoor lighting - lighting masts, street lighting poles, etc.

Normal and emergency lighting for indoor and outdoor areas shall be provided.
Supply for emergency lighting shall be derived from 110 V DC distribution board to be provided under this Contract. The Bidder shall provide emergency lighting in the vital installation including pump house, switchboard room, office building, administration areas, etc. Minimum 10% of the total normal lighting fixtures shall be emergency type.

Galvanized conduits shall be used for all exposed wiring and black enameled MS conduit shall be Chandigarh Administration/MCC/CSCL or their representative d for all concealed wiring. Minimum size of conduit shall be 20 mm / 25mm for exposed / concealed conduits respectively. Wiring inside the pump house, switchboard room and other areas shall be concealed type.

Wires used for conduit wiring of lighting fixtures / ceiling fans and receptacles shall be 250/440V grade, PVC insulated, single core, stranded copper conductor wires of sizes not less than 2.5 sq. mm and 4 sq. mm respectively. Wires shall conform to IS standards. Three individual wires with proper color coding (P-N-E) shall be used for wiring and no joint in wires between conduit is allowed. 3 core x 2.5 sq. mm. copper cables shall be used for circuiting of peripheral lighting.

### 5.3.9.1 Lighting Panels

Lighting panels shall be of wall mounting type and fabricated out of 1.6 mm. thick cold rolled sheet steel. lncomer circuit shall be controlled by a switch disconnector with a link in the neutral circuit. Outgoing circuits shall be controlled by single pole MCBs of minimum 10A rating and a link in the neutral circuit. TPN MCB shall be provided for street lighting/ area lighting purposes. Breaking capacity of MCBs shall not be less than 10 kA. Residual circuit breakers (RCCBs) shall be used on all lighting and receptacle circuits.

It shall be possible to terminate incoming and outgoing circuits from top and bottom. Knock-out for cable / conduit entries for all the circuits shall be provided. Separate circuits shall be provided for control of lighting fixtures and receptacles. Each phase shall have at least one spare circuit.

The panel shall be provided with 3 phase and neutral copper busbar adequately rated to cater to the requirement of all the outgoing circuits. Two earthing terminals shall be provided external to the panels for terminating the external earthing conductor.

The panel shall be internally wired using color coded, stranded copper conductor, PVC insulated wires of 1100 V grade.

The panels shall have hinged door, gasketed all round and provided with handle lock. Operation of incomer switch or MCBs shall be possible without opening the door.

Detailed specification of lighting panel and its accessories (e.g. busbar, MCB, indicating instrument, indicating lamp, etc.) are described at MV and LV switchboard.

### 5.3.9.2 Lighting Fixtures and its Accessories

Lighting fixtures for illumination of outdoor and indoor areas shall be supplied. Fixtures for outdoor installation shall be of weatherproof design with degree of protection of IP65. The fixtures shall be suitable for operation on a nominal supply of 240 V, single phase, 50 Hz, AC with a voltage variation of + 10 %.

Fixtures shall be complete with internal wiring, lamp, capacitor, starter, holder, ballast, reflector, louvres / perspex, etc. as required for their satisfactory operation. Fixtures shall be energy efficient and ballast shall be electronic low loss type. All indoor lighting fixture for office and control room shall be decorative type and for remaining areas it shall be industrial type.

Lamp holders for shall be of the spring loaded, low contact resistance, bi-pin rotor type, resistant to wear and suitable for operation at the specified temperature, without deterioration in insulation value, contact resistance or lamp holding quality. Bidder shall use LED lamp in suitable fixtures at all location of the plant.
Lighting fixture reflectors shall generally be manufactured from steel or aluminum sheet of not less than 20 SWG thicknesses. Each fixture shall be complete with a four way terminal block for connection and looping of incoming and outgoing cables. Each terminal shall be able to accept two
2.5 mm2 copper stranded conductors. Each lighting fixture shall be provided with an earthing terminal suitable for connecting 16 SWG copper stranded conductor. All metal or metal enclosed parts of the housing shall be bonded and connected to the earth terminal to ensure satisfactory earthing continuity throughout the fixture. All reflectors and louvers shall be finished to the same standard as the fixture housing.

The enamel finish shall have a minimum thickness of 2 mils for outside surface and 1.5 mils for inside surfaces. The finish shall be non-porous and free from blemishes, blisters, and fading.

Size of wire chosen shall be such as to limit the voltage drop to within 3 %. Minimum area of conductor shall be 1.5 sq mm stranded copper for lighting and 2.5 sq mm / 4 sq mm for 5A / 15A receptacle circuits respectively, and current density shall not exceed 2.5 A/sq mm. Generally, not more than 8 to 10 lighting points shall be wired in one circuit. For calculating connected loads of various circuits, a multiplying factor of 1.25 shall be assumed on the rated lamp wattage for sodium vapour and fluorescent lamp fixtures to take into account the losses in the ballast. A loading of 100 watts and 500 watts shall be assumed for each, single-phase 5 amps and 15 amps receptacles respectively. Wires belonging to different phases shall not be run in the same conduit. However, more than one circuit on the same phase can be run in the same conduit. For every phase wire, a separate neutral wire shall be run. Neutral wire for different phases shall not be looped.

The following types of fixtures shall be considered for various areas. The construction features are indicative. Equivalent or superior feature is acceptable.

**Flood lighting fixtures** – Energy saving, environmental friendly, long life, exclusive innovative die- cast aluminium IP-65 flood light with high power LEDs as light source. Type Turbo LED flood light with 120W/160W LED fixtures.

**High Mast Lighting-** 18 Mtrs. High Mast Lights with suitably rated LED lighting fixtures.

**Gate post lights -** Post top lantern fitting with LED lamp shall be used.

**Indoor Areas –** LED Light fixtures shall be used. These fixtures shall be used in switchboard room offices and pump houses and other areas. Where false ceiling is provided, fixtures shall be suitable for recessed mounting. For non-false ceiling office areas, decorative type fixtures shall be used.

**Outdoor Areas**- Suitable type of fixtures with LED lamps shall be considered.

**Street Lighting**- Energy saving, environmental friendly, long life, exclusive innovative die-cast aluminium IP-65 street light with high power LEDs as light source. Suitable LED Street light with 90W/120W LED fixtures shall be used.

Suitable type and rating of solar operated lighting fixtures with LED lamps shall also be used. System shall be hybrid type to facilitate the charging facility at the event of non-sunny days.

1200mm sweep ceiling fans shall be provided in areas such as offices, etc. as per design requirement. Adequate ventilation arrangements shall be made for enclosed areas where ceiling fans are not proposed to be installed or cannot be provided. Power supply for the ceiling fans shall be derived from lighting circuits. Ceiling fans shall be complete with all accessories. Regulators shall be electronic (triac)type.

The work shall comprise wiring in heavy gauge (minimum 16 SWG) GI conduits, fixed and supported at intervals of 300 mm on walls, ceiling etc.; installation of light control switches and receptacles housed in GS boxes; earthing with 16 SWG copper wire run along the conduit and clamped to it at every 300 mm; and termination of cables/wires at lighting panels, light control switches, receptacles, lighting fixtures etc., as required. The minimum size of conduit shall be 20 mm. Space factor (ratio of total wire area to internal conduit area) shall be 40 %. Concealed conducting shall be provided to all building / office areas. For pump house area, the Bidder shall adopt surface conducting also.

**Receptacles and Switches** – It shall be weather-proof for outdoor application. For Pump-house area and Switchgear room, industrial type receptacles with switch shall be provided. For Office areas, it shall be decorative type. 3 phase welding receptacles shall also be provided as per requirement.

Types of fixtures proposed by the Bidder for various areas shall be subject to Chandigarh Administration/MCC/CSCL or their representative's representative approval.

The lighting poles for streetlights shall be of tubular / swaged type steel poles, circular in construction. The steel poles shall be coated with bituminous preservative paint on the inside as well as embedded outside surface. Exposed outside surface of the steel poles shall

be painted with one coat of red lead oxide primer. After completion of installation, two coats of aluminum paint shall be applied. The supply of poles shall be complete with fixing bracket, necessary pipe reducer for fixing the fitting and also include the necessary associated pole mounted junction boxes. 2 nos. studs shall be provided on the pole for earthing. The lighting poles shall have an end cap with brackets for mounting lamps (of suitable wattage) in weatherproof fittings, cut-off type or semi- cut off type luminaries. The brackets shall be welded to the pole and shall ensure an suitable overhang depending on height of the pole.

Junction boxes with terminals shall be supplied for branching and terminating the lighting cables, weatherproof and suitable for usage in outdoor areas. The junction boxes shall be dust and vermin proof and shall be fabricated from 2 mm CRCA sheet steel and shall be complete with removable cover plate with gaskets, two earthing terminals each with nut, bolt and washer. The Bidder shall provide support arrangement (through 25 x 4 mm GI flat U clamp) for proper fixing of the junction box to the pole.

The boxes shall be hot dipped galvanized / painted with on shop coat of red oxide zinc chromate primer followed by a finishing coat of paint. Suitable rubber gaskets shall be provided on the doors of the junction boxes. The junction boxes shall have a locking facility, suitable to be opened by a common panel key for all the junction boxes. The boxes shall have provision for mounting on the poles. Suitable knockouts for the entry for cable / conduit entry shall be provided with terminal blocks, HRC fuses etc.

The terminal blocks shall be mounted securely on brackets welded to the back sheet of the box. The terminals shall be 1.1kV grade, one piece construction complete with barriers, galvanized nuts, bolts, washers and provided with identification strips of PVC. The terminals shall be made of copper alloy and shall be of box clamp type. Double compression brass glands shall be provided for entry / exit of the cables into the junction box.

### 5.3.9.3 Illumination Levels

Lighting system shall be designed to achieve the average maintained levels of illumination as indicated below. The Bidder shall be required to measure the actual levels and carry out necessary modifications to accomplish specified levels. It is to be noted that the values measured after installation will exceed those specified due to inclusion of light loss factor in the calculation. Measurement shall be carried out after 100 burning hours.

a) Pump House : 200 lux
b) Office / Conference Room : 400lux
c) Switchboard Room / PLC room: 250 lux and main indoor areas
d) All other indoor areas : 150 lux
e) Outdoor plant/ Street lighting : 10 – 20lux

The illumination system shall be so designed that the uniformity factor is of acceptable level and that the glare is within limits. The ratio of maximum to minimum illumination levels shall not exceed 20 in outdoor area.

The following values of 'light loss factor' shall be considered for design:

a) Indoor air-conditioned area: 0.8

b) Other indoor areas :0.7

c) Outdoor area :0.6

The Bidder shall furnish detailed design calculations, uniformity factors, ratio of maximum to minimum illumination levels, ratio of average to minimum illumination levels, glare values, etc. for approval. Detailed characteristics of various types of fixtures including photometric curves and tables shall also be furnished for review.

### 5.3.9.4 Receptacles with Switches

Adequate number of receptacles of 6A, 16A and 32A rating with MCBs suitable for operation on 230 V AC, 1 phase, 50 Hz supply shall be provided as detailed below:

a) Decorative and industrial type shall be proposed in relevant areas.
b) Receptacles proposed for outdoor installation shall be of weatherproof design of degree of protectionIP65.
c) Single phase receptacle shall be provided with a switch / MCB of the same current rating, housed in the same enclosure. Three phase receptacles shall be associated with a MCB of the same rating, housed in the same enclosure. The number, type, rating and location of receptacle shall be subject to approval of the Chandigarh Administration/MCC/CSCL or their representative's Representative.

### 5.3.9.5 Switches

Decorative / industrial type switches of 6A / 16A rating shall be provided for all indoor areas. Switches shall be provided to control a group of lighting fixtures in various areas. Switches shall be housed in galvanized steel boxes.

### 5.3.9.6 Water Coolers General

Water cooler shall conform to IS 1475/78 with latest amendment suitable for operation on 230 volts
±10%, 50 cycle's single phase AC supply. It shall be supplied with hermetically sealed type suction cooled compressor with overload protection conforming to IS 10167. It shall have cooling capacity of 40 liters per hour with storage capacity as 80 liters.

Water coolers shall be required for site office. Two nos. water coolers shall be installed and make them in operation.

#### 5.3.9.7 Tests

Lighting panels, fixtures, receptacles and other accessories shall be subjected to routine and acceptance tests as per the applicable standards.

### 5.3.10 CABLING SYSTEM INSTALLATION

**General**

The scope shall cover, in addition to supply, complete installation of plant items and accessories as indicated in various parts of the specification. Requirements / guidelines / information / parameters / instructions, etc. specified in this section shall apply to all the sections.

Installation work pertaining to plant items and systems such as cabling, lighting, earthing and lightning protection systems, etc. shall comply with the applicable standards, safety codes,etc.

Installation shall be carried out strictly in accordance with the approved drawings. Changes, modifications, if any, required to suit site conditions, shall be carried out only with the prior approval of the Chandigarh Administration/MCC/CSCL or their representative's Representative. All such changes shall be incorporated in the "As built" drawings to be furnished by the Bidder.

All tools, brazing equipment, crane, scaffolding, rigging materials, ladders, consumables, hardware, etc. required for installation shall be provided by the Bidder.

It shall be the responsibility of the Bidder to engage Specialist Engineers from his Sub-Bidders / Manufacturers to supervise installation work for plant items such as switchboard, motors, etc. where felt essential. Such services shall be arranged by the Bidder at no extra cost to the Chandigarh Administration/MCC/CSCL or their representative.

It shall be the responsibility of the Bidder to obtain approval / clearance, if any, from local statutory authorities, for conducting any work for completed installation.

The Bidder shall ensure that all plant under erection as well as the work area and the project site are kept clean to the satisfaction of the Chandigarh Administration/MCC/CSCL or their representative. In case the Chandigarh Administration/MCC/CSCL or their representative is not satisfied about the cleanliness, he will have the right to carry out the cleaning operations. Expenditure incurred by him in this regard will be to the Bidder's account. Packing cases and packing material, except for spares shall be cleared from sites.

In order to avoid hazards to personnel moving around the equipment, which is kept charged after installation before commissioning, such equipment shall be cordoned off by suitable barriers to prevent accidental injury.

Switchboard shall be installed on finished surfaces. Proper aligning, joining of various vertical shipping sections, busbar connections, inter panel wiring, etc. will be the responsibility of the Bidder. The Bidder shall take utmost care in handling instruments, relays and other delicate mechanisms. Wherever the instruments and relays are supplied separately, they shall be installed only after the erection of switchboards is complete.

### 5.3.10.1 Cabling System

All apparatus, connections and cable work shall be designed and arranged to minimize risk of fire and any damage, which might be caused in the event of a fire.

Cables shall be laid directly buried in earth, on cable trays in built-up trenches, in conduits / pipes along walls / structures / foundations / ceilings, etc. wherever required as per direction of engineer in charge. Cables from substation to various MCCs, PDB, and other LT Panels shall be laid in RCC cable trench on the trays .Trench shall be covered with RCC slab after finishing the cable laying work. The Bidder's scope of work includes unloading, excavation, laying, backfilling, fixing, bending and terminating the cables. The Bidder shall supply the necessary material and accessories required for installation and termination of the cables which shall include but not be limited to items such as glands, lugs, terminating accessories, hardware, consumables, saddles / spacers, GI conduits / pipes, cable identification tags, protective bricks, civil materials, etc.

### 5.3.10.2 Buried Cables

Cable installation in outdoor areas shall be carried out in directly buried cable trenches. Stabilized thermal backfilling shall be used for directly buried cables. Cabling from trenches up to junction box / equipment, etc. shall be carried out in GI conduit / pipes of class B. Provision of GI pipe sleeves in trench wall shall be the Bidder's responsibility. Where cables cross roads or water / sewage pipes, the Bidder shall provide rows of 150 mm diameter GI pipes in a concrete block for passage of cables. Bidder shall also lay spare pipes for future use. Alternatively, Bidder shall provide concrete cable duct for road crossing. LV cables shall be buried at a depth of minimum 750 mm while HV and MV cables shall be buried at a depth of minimum 1000 mm. For road crossings, the pipe for the cables shall be buried at not less than one meter depth.

Directly buried cables shall be laid on a 75 mm thick riddled and compacted earth bed. The cables shall then be covered on top and at their side with riddled earth to a depth of about

150mm. This shall then be gently pulled down to a depth of about 100 mm above the top of uppermost cable to provide bedding for the protective concrete cable covers, which shall be placed centrally over the cables. The protective cable covers shall be of reinforced concrete. The RCC covers shall have one hole at each end to tie them to each other with GI wires to prevent displacement. The trench should be then backfilled with the excavated soil and well rammed in successive layers of not more than 300 mm thick, with the trenches being watered to improve consolidation, wherever necessary. To allow for subsidence, a crown of earth not less than 50 mm in the center and tapering towards the sides of the trench should be provided.

All cables to be routed along any particular route shall be laid at one time to avoid repeated excavation, etc. Each cable shall be tagged with numbers. The tag shall be of aluminum with the number punched on it and securely attached to the cable / conduits by not less than two turns of 20 SWG GI wire. Cable tags shall be of rectangular shape for power cables and of circular shape for control cables. Cables tags shall be provided on all cables at each end, on both sides of wall / floor crossings, on each duct / conduit entry, at each bend/ corner and at every thirty (30) meters in cables trench / tray racks on straight run.

Where groups of HV, LV and control cables are to be laid along the same route in the same trench, suitable nonmetallic barriers/bricks to segregate them physically shall be provided. When power cables are laid in the proximity of communication cables, minimum horizontal and vertical separation of 300 mm shall be maintained. Power and communication cables shall, as far as possible, should not cross at right angles to each other.

### 5.3.10.3 Cables in Trays

Cables in trays shall be cleated individually or in a group using GI saddles. Interval for cleating shall not exceed 1500 mm.

In case of laying on cable trays / racks, power and control cables shall be laid in separate cable trays, the order of laying of various cables being as given below:

a) HV cables on top tiers
b) LV cables on subsequent tiers
c) Control, instrumentation and other service cables in bottom-most cable tier.

Ladder type FRP cable trays and painted rack support shall be installed in cable trenches for power cables. Perforated trays shall be used for control and instrumentation cables. Embedded flats for fixing cable tray supports shall be provided in cable trenches to support the cable trays during civil works. Where such flats cannot be used, the fixing of cable trays shall be done using anchor fasteners. All cable trays shall be earthed at a regular interval.

The cable trays shall be complete with all necessary coupler plates, elbows, tees, bends,

reducers, stiffeners and other accessories and hardware. Cable trays and accessories such as tees, elbows, reducer, etc. shall be fabricated out of minimum 2 mm thick sheet of hot dip galvanized sheet except for trays of width 300 mm and lower for which 16 G GS sheet is acceptable. Bends, tees, etc. shall be supplied or fabricated at site, as required. Cable tray supports such as angles, channels, etc. shall be of galvanized steel. Galvanizing thickness shall be not less than 85 micron.

### 5.3.10.4 Cable Pulling

The cables shall be laid in built-up trenches, directly buried in ground, or on cable trays, vertical raceways, clamped on structures / walls / ceiling, pulled through pipes and conduits, etc. The scope of cable installation shall include excavation and backfilling (in case of buried cable trench), laying, pulling of cables, proper dressing of cables on cable trays, racks, vertical raceways and supply and installation of cable tags, saddles, spacers and nylon cord for tying as required. The cost of supplying covers for cable route / joint markers, supply of sand and cover plates are included in the scope of the Bidder.

Standard cable grips and reels shall be utilized for cable pulling. If unduly difficult pulling occurs, the Bidder shall check the pull required and suspend pulling until further procedure has been approved by the Chandigarh Administration/MCC/CSCL or their representative's Representative. The maximum pull tension shall not exceed the recommended value for the cable measured by the tension dynamometer. In general, any lubricant that does not injure the overall covering and does not set up undesirable conditions of electrostatic stress or electrostatic charge may be used to assist in the pulling of insulated cables in conduit / pipes and ducts.

After pulling the cable, the Bidder shall record cable identification with date pulled neatly with waterproof ink in linen tags / aluminum tag and shall securely attach such identification tags. Identification tags shall be attached to each end of each cable with non-corrosive wire. The wire must be non-ferrous material on single conductor power cable. Tags would further be required at intervals on long runs of cables on cable trays and in pull boxes. Cable and joint markers and RCC warning covers shall be provided wherever required.

Each cable shall be pulled into the particular conduit / pipe and shall be taken from the particular reel designated for the run. In hand holes, pull boxes or junction boxes having any dimension over 1000 mm, all conductors shall be cabled and / or racked in an approved manner. Care shall be taken to avoid sharp bending or kinking cables, damaging insulation or stressing cable beyond manufacturer's recommendations in pulling. Cable shall be protected at all times from mechanical injury and from absorption of moisture at unprotected ends. The bending radii for various types of cables shall not be less than 12/15 times the overall diameter of the cable for armored cables and 15/20 times the overall

diameter of the cable for unarmored cables.

Cables on cable racks and in conduits / pipes shall be formed to avoid bearing against edges of trays, racks, conduit / pipes or their supports upon entering or leaving racks or conduit / pipes.

Cables splices shall not be used except where permitted by the Chandigarh Administration/MCC/CSCL or their representative's Representative. Splices shall be made by Bidder for each type of wire or cable in accordance with the instructions issued by cable manufacturers and the Chandigarh Administration/MCC/CSCL or their representative's Representative.

Before splicing, insulated cables shall have conductor insulation stepped and bound or penciled for recommended distance back from splices to provide a long leakage path. After splicing, insulation equal to that on the spliced conductors shall be applied at each splice.

At cable terminal points, where the conductor and cable insulation will be terminated, terminations shall be made in a neat, skillful and approved manner by specially trained staff. Terminations shall be made by the Bidder for each type of wire or cable in accordance with instructions issued by cable manufacturers and / or the Chandigarh Administration/MCC/CSCL or their representative's Representative.

Control cable termination shall be made in accordance with wiring diagrams, using proper color codes for the various control circuit.

When control cables are to be fanned out and corded together with a cord, the Bidder shall make connections to terminal blocks, and test the equipment for proper operation before cables are corded together. If there is any doubt about correctness of connection, the Bidder shall make a temporary connection with sufficient length of cable so that the cable can be switched to another terminal without splicing. After correct connections are established, cables shall be cut to their correct lengths, connected to terminals in the specified manner, and corded together where necessary to hold them in place in a skillful manner. Jointing of cables shall be in accordance with relevant Standards and manufacturer's instructions. Materials and tools required for cable jointing work shall be supplied by the Bidder. Cables shall be firmly clamped on either side of a ‘straight through joint’ at a distance of not more than 300 mm away from the joints. Identification tags shall be provided at each joint at all cable terminations.

Where cables pass through floor or wall openings or other partitions, suitable bushes / pipe sleeves of GI shall be provided by the Bidder. The Bidder shall seal the cables at the bushes

/ pipe sleeves using fire resistant material.

Cable seals shall be examined to ascertain if they are intact and that cable ends are not damaged. If the seals are found to be broken, the cable ends shall not be jointed until after due examination and testing under supervision of the Chandigarh Administration/MCC/CSCL or their representative's Representative. Before joining is commenced, insulation resistance of both sections of cables to be jointed shall be checked by megger.

In case of motor cables, after installation and alignment of motors, the Bidder shall complete the conduit / pipe installation, including a section of flexible conduit / pipe between motor terminal box and trench / tray, if necessary. The Bidder shall install and connect the power, control and heater supply cables as per equipment manufacturer's drawings / instructions. The Bidder shall be responsible for correct phasing of the motor power connection and shall interchange connections at the motor terminal box, if necessary, after each motor is test run.

Connections to recording instruments float switches, level electrodes, limit switches, pressure switches, thermocouples, thermostats and other miscellaneous equipment shall be done as per manufacturer's drawings and instructions.

In each cable run, some extra length shall be kept at a suitable point to enable one or two straight- through joints to be made, should the cable develop fault at a later date.

### 5.3.10.5 Conduits / Pipes

Where cable trench is not available, cables shall be laid in GI conduits / pipes routed along walls / columns / beams / steel structures or buried in concrete slabs, etc. to suit site conditions. GI conduits shall be Class C type. Supply and installation of GI conduits / pipes, their accessories such as bends, tees, couplers, etc., saddles, spacers, junction / marshalling boxes and GI hardware required for installation shall be included in the Bidder's scope. Interval between supports shall not exceed 500mm. For multiple cables, maximum utilization factor (ratio of total wire area to internal conduit area) shall be 50% of the conduit area.

Non-metallic conduits / pipes shall be used for single core cables of a 3 phase circuits.

### 5.3.10.6 Junction Boxes / Marshalling Boxes

Junction boxes / marshalling boxes shall be hot-dip galvanized, weather proof with IP 55 degree of protection and shall be provided with cable glands for incoming and outgoing cables. The boxes shall be fabricated from 1.6 mm thick sheet steel and galvanized. The boxes shall be suitable for mounting on walls / columns / steel structures, etc. and shall be supplied with mounting accessories. The front covers of the boxes shall be removable and provided with gaskets. All the terminals shall be complete with insulated barriers, terminal

studs, washers, nuts, etc. The boxes shall be effectively earthed.

### 5.3.10.7 Fire Proof Sealing (FPS) System

Fire proof sealing system shall be provided and shall consist of

a) Fire-stops / fire-seals for sealing of cable / cable tray and conduit / pipe penetrations, both horizontal and vertical, through brick or RCC walls / floors, to prevent the spread of fire from one area to other areas by fire-resistant barriers.

The FPS system shall also include all the necessary accessories and equipment required for supporting, holding in position, fixing and installation of the fire-stop.

The FPS system shall comply in all respects with the requirements of the codes and standards mentioned herein IEC-111 and IEC-112.

### 5.3.10.8 Fire Stop / Seal

The FPS system adopted for cables or cable trays penetrating through walls and floor openings, or cables passing through embedded conduits / pipes / pipe-sleeves, constitutes a `fire stop / seal', which is meant to prevent spreading of fire between areas separated by fire-resistant barriers.

#### 5.3.10.8.1 Performance Requirements

Requirement of fire stops

(i) The material, design and construction of the fire stops shall be such as to provide a fire-rating of 120 minutes for a fire on any side and meet all requirements listed in this specification and the relevant codes and standards.
(ii) The materials used in the fire stops shall be non-hygroscopic, compatible with the type of cables.
(iii) The fire stops shall be suitable for retrofitting of cables through the penetration seal without disturbing the sealing of the cables already existing.

#### 5.3.10.8.2 Application of Fire Proof Sealing System

a) Fire stops

Fire stops shall be provided for cable penetration openings listed below

i. The passage of cables / cable trays pipe sleeves / embedded conduits through walls / floors.
ii. Vertical raceways, if any, which carry cables between successive floors, through openings provided in the RCC floor slab, shall be sealed by fire stops at each floor level.
iii. Cable entry through openings in floor slabs.

Bidder shall furnish the test certificates for the fire stops after award of Contract for

Chandigarh Administration/MCC/CSCL or their representative for review. If the certificates are not satisfactory, all the tests shall be conducted free of cost. The offered system i.e. fire stops and fire breaks shall be identical (or better) with the system which is successfully type tested for the specified rating i.e. the composition density of the material, thickness of coating in case of fire breaks and any other properties of the material / system offered shall be identical or better than the tested system and shall be subject to Chandigarh Administration/MCC/CSCL or their representative approval.

#### 5.3.10.8.3 Performance Tests:

a) The fire stops shall be subjected to the following type tests:
   i. Fire Rating Test
   ii. Hose Stream Test
b) Type tests shall be conducted on different fire stop test specimens described above as per IEEE-634. The sizes of the fire stop test specimens shall be similar to the largest of the sizes being used in the plant.
c) Preconditioning of fire stop test specimens
   Before conducting the Fire Rating and Hose Stream tests, each test specimen shall be preconditioned for thermal ageing, water immersion and vibration.
d) Test on Fire Stops
   During the Fire Rating test, the transmission of heat through the cable penetration fire stop shall not raise the temperature on its unexposed surface above the self-ignition temperature of the outer cable covering, the cable penetration fire stop material, or material in contact with the cable penetration fire stop, with a maximum temperature limit on the unexposed surface of $200^0$C.

### 5.3.11 EARTHING AND LIGHTNING PROTECTION SYSTEM

#### 5.3.11.1 EARTHING

Earthing and lightning protection system shall comply with the following International Standards, including those referred to therein.

ANSI / IEEE Std. 80 and 142, IEC 61024, and IS 2309, 3043.

The scope includes measurement of electrical soil resistivity (during dry season) at site, supply of earthing conductors, earth electrode pits, lightning protection system and their installation including associated civil work as per the specifications and approved drawings, to the satisfaction of the Chandigarh Administration/MCC/CSCL or their representative 's Representative. The scope of works shall also comprise designing the earthing and lightning protection systems as per the applicable standards and specific design basis listed below:

a) Average value of soil resistivity as measured for different electrode spacing, at site.

(from 2 to 100 Meter or more in steps of 5, 10 Meter. At least 20 nos. readings shall be taken over the plant area, each in two different directions)

b) Permissible values of step and touch potentials based on weight of human being as 70 kg and Earth fault current of 40 kA for 1seconds
c) Gravel with surface resistivity of 3000ohm-m
d) Depth of burial of earth conductors of 600 mm below ground level
e) Ground resistance with only electrodes of maximum 1ohm.
f) Ground resistance of earthing grid of maximum 1ohm
g) Corrosion allowance of at least 20%
h) Earthing conductor material shall be minimum 20 mm diameter and 3 m long GI Pipe.

Earthing system design and calculations shall be subject to Chandigarh Administration/MCC/CSCL or their representative's approval.

Earthing and lightning protection system shall be provided to ensure equipment safety, personnel safety and to facilitate designed operation of protective devices during earth fault conditions in the associated system.

The Bidder shall install bare earth conductors as required for the system and individual equipment earthing. All the work such as cutting, bending, supporting, drilling, brazing / soldering/welding, clamping, bolting and connections to structures, equipment frames, terminals or other devices shall be in the Bidder's scope. All hardware and consumables such as fixing cleats / clamps, anchor fasteners, lugs, bolts, nuts, washers, brazing electrodes, flux, bituminous compound, anti-corrosive paint, etc. as required for the complete work shall be included by the Bidder.

Tap connections (earthing leads) of more than 500 mm long, from main earthing grid to equipment shall be embedded in the floor by the Bidder together with associated civil work such as chipping / chasing, concreting and surfacing, etc. The concrete cover over the conductor shall not be less than 50 mm.

The scope of installation of earth conductors in outdoor areas, buried in ground shall include excavation in earth up to 600 mm depth and 400mm width, laying of conductor at 600 mm depth, brazing as required of main grid conductor joints as well as riser's up to 500 mm above ground at required locations and backfilling. Backfilling material to be placed over buried conductor shall be free from stones and other mixtures. Backfill shall be placed in layers of 150 mm, uniformly spread along the trench and compacted. If the excavated soil is found unsuitable for backfilling, the Bidder shall arrange for suitable material from outside. Earthing conductors in outdoor areas shall be laid 1500mm away from buildings. The scope of installation of earth conductors in outdoor areas buried in ground, shall include excavation of earth up to 600 mm depth, brazing / welding of main grid conductor, joints as well as risers of length 500 mm above ground at required locations and then backfilling.

Wherever earthing conductor crosses underground service duct and pipes, it shall be laid 300 mm below them. If the distance is less than 300 mm, the earthing conductor shall be bonded to such service ducts /pipes.

The scope of installation of electrodes shall include installation of electrodes in constructed earth pits, and connecting to main buried earth grids. The scope of work shall include excavation, construction of the earth pits including all materials required for treatment (salt, charcoal, chemicals, etc.), placing the electrode and connecting to main earth grid conductors.

The work of embedment of earthing conductor in RCC floors / walls along with provision of earth plate inserts / pads / earth risers shall be done by the Bidder preferably before the floors / columns / walls are cast. The embedded conductors shall be connected to reinforcing rods wherever necessary.

The scope of installation of earthing leads to the equipment and risers on steel structures / walls shall include laying the conductors, brazing / cleating at specified intervals, brazing to the main earth grids, risers, bolting at equipment terminals and coating brazed joints by bituminous paint.

Earthing and lightning protection system conductors along their run on walls / columns, etc. shall be cleated at an interval of 750 mm.

Main earthing conductor shall be buried below the trench at crossing points.

Metallic frames of all electrical equipment shall be earthed by two separate and distinct leads and then connected with earthing system.

Neutral of a transformer shall be earthed to two separate earth electrode pit by two separate earth leads.

Crane rails shall be connected to the earthing system.

An earthing mat shall be provided under the operating handle of the disconnector. Operating handle of the disconnector and the supporting structure shall be bonded together by a flexible connection and connected to earth grid.

Metal pipes and cable conduits shall be effectively bonded and earthed by earthing clamps efficiently fastened to the conduit at both ends.

Neutral connection shall never be used for equipment earthing.

A separate earth electrode shall be provided for each lightning arrester and for each lightning conductor down comer.

Cable sheaths and screen shall be bonded to the earthing system.

Armour of multicore cables shall be bonded to earthing system at both ends, while that of single core cables shall be earthed at source end only. The size of conductor for bonding shall be appropriate with the system fault current.

Conduits, fixtures, junction boxes, etc. shall be bonded to the earthing system by 16 SWG diameter copper wire looped from lighting panel earth bus onwards. Outdoor lighting poles, junction boxes, etc. shall be earthed by 12 SWG copper wires.

Street light pole and junction box shall be earthed with 12 SWG tapped off from the 25x3 mm GI earthing conductor to be laid along the street lighting cable.

All metallic parts such as transformer, fence, gate, etc. shall be properly earthed.

Wherever earthing conductor passes through walls, galvanized steel pipe sleeves shall be provided for the passage of earthing conductor. The pipe ends shall be sealed by the Bidder, by suitable water- proof compound. Water stops shall be provided wherever earthing conductor enters the building from outside below ground level.

All connections in the main earth conductors buried in earth / concrete shall be brazed type. Connections between main earthing conductor and earth leads shall also be of brazed type. Connection between earth leads and equipment shall be by two bolts.

### 5.3.11.2 LIGHTNING PROTECTION SYSTEM

Lightning system confirm to the specification laid down in

1. IS 2309 Protection of Buildings and allied structures against Lightning.
2. NFPA 780-Standard for the installation of Lightning protection system, National Fire protectionAssociation-2000.
3. UL96- Lightning Protection components.
4. UL96A-Installation Requirement for Lightning protection system
5. IS/IEC 62305-1:20110-Protection against Lightning
6. IS/IEC 62305-2:20110-Protection against Lightning
7. IS/IEC 62305-3:20110-Protection against Lightning
8. IS/IEC 623054:20110-Protection against Lightning

**SYSTEM DESCRIPTION**

Conductor system protects structures consisting of air terminals on roofs, bonding of structure and other metal objects, grounding electrodes and inters connecting conductors. Lightning system includes:-

1. Air terminals and Inter connecting conductors
2. Grounding and equipotential bonding for lightning protection.
3. Down conductors
4. Joints and bonds
5. Testing Joints
6. Earth termination sand
7. Earth Electrode.

Installation of lightning conductors on the roof of buildings shall include laying, anchoring, fastening and cleating of horizontal conductors, grouting of vertical rods wherever

necessary, laying, fastening / cleating / brazing of the down comers on the walls / columns of the building and connection to the test links to be provided above ground level.

Lightning protection system down-conductors shall not be connected to the conductors of safety earthing system above ground level. The lightning protection system for the structures shall be installed by forming a grid of exposed continuous earth conductors and taking down-comers along the walls/supports of the structure and terminating the same at earth pits. A separate earth electrode shall be provided for each lightning arrester and for each lightning conductor down comer. The lightning protection system earth pits shall be inter-connected to form the safety earthing grid provided for the building / structure. The safety earthing grid shall be connected to the mains grid of the switch yard.

The lightning protection air termination rods and / or horizontal air termination conductors shall be fixed in a firm manner. The necessary accessories such as cleats, clamps, brazing materials, bolts, nuts, shall be supplied by Bidder.

Air termination systems shall be connected to earthing system by down conductors. There shall not be any sharp bends, turns and kinks in the down conductors.

All joints in the down conductors shall be of brazed type. All metallic structure within 1 meter of down conductors shall be bonded to lightning protection system.

Every down conductor shall be provided with a ‘test link’ mounted on wall / column at about 1000 mm above ground level housed in a 16 SWG GS enclosure. The test joint shall be directly connected to the earth electrode.

The lightning protection system shall not be in direct contact with underground metallic service ducts, cables, cable conduits and metal enclosures of electrical equipment. However, all metal projections, railings, vents, tanks, etc. above the roof shall be bonded together to form a part of roof grid.

Lightning protection system down conductors shall not be connected to other earthing conductors above ground level. In addition, no intermediate earthing connection shall be made to lightning arresters and transformer, who’s earthing leads, shall be directly connected to electrode pit.

**LIGHTNING PROTECTION UNIT (LPU)/SURGR DIVERTER**

Suitable rating and type of surge diverter shall be provided when earth pits of lightning system to be connected to main earth grid. Lighting protection unit shall also be connected to each of HT/ LT Panel to protect the panel against lightning.

### 5.3.11.3 Earth Electrodes and Pit

Treated earth pits shall comprise of treatment material such as salt and charcoal or any other conductivity enhancing compound. Treatment material placed around the electrode shall be finely graded, free from stones and other harmful mixtures. Backfill shall be placed in 150 mm thick uniformly spread and compacted layers. If excavated soil is found unsuitable for backfilling, the Bidder shall arrange for a suitable soil from outside.

Earth electrodes shall be fabricated from minimum 20 mm diameter, 3m long, copper rod or 40 mm diameter, 3m long GI pipe. The minimum spacing between adjacent electrodes shall be 6 m. Design and constructional details of electrode pit shall be subject to the Chandigarh Administration/MCC/CSCL or their representative's Representative approval.

Electrodes shall, as far as practicable, be embedded below permanent moisture level.
Test pits with concrete covers shall be provided for periodic testing of earth resistance. Installation of electrodes in test pits shall be suitable for watering. The necessary materials required for installation of test pits shall be supplied and installed by Bidder. The installation work shall also include civil works such as excavation / drilling and connection to main earth grid. Earth electrode pit marker shall be provided.

Treated earth pits shall be treated with suitable treatment material mentioned above, if average electrical resistivity of soil is more than 20 ohm meter.
Minimum conductor size for connections to various equipment shall be as per the table as follows, however sizes of earthing conductor and nos. of earthing pits will be selected based on the soil resistivity report of the site, approved earthing system design:

| Equipment | Rating KW | Conductor Size |
|---|---|---|
| Motors | Up to 11 kW<br>11 kW up to 22 kW<br>22 kW up to 37.5 kW<br>37.5 kW to 90 kW<br>90 kW to 200 kW<br>Above 200 kW | 8 SWG GI wire<br>4 SWG GI wire<br>25 x 3 mm GIflat<br>25 x 6 mm GIflat<br>40 x 6 mm GIflat<br>50 x 10 mm GI flat |
| PCC | | 50 x 6 mm GI flat |
| PDB | | 50 x 6 mm GI flat |
| DG and other panel | | 50 x 6 mm GI flat |
| Local control station, street light pole and its junction box | | 8 SWG GI wire |
| All switchyard equipment | | As Calculated |
| Main earth grid | | As Calculated |
| Lighting Panel | | 25 x 3 mm GI flat |
| Down conductors for lightning | | 35x3 mm GI Strip |

| | | |
|---|---|---|
| Indoor fixtures | | 14 SWG GI wire |

All paint, scale etc. shall be removed before earthing connections are to be made. Anchor bolts or fixing bolts shall not be used for earthing connections.

### 5.3.12 NONSEGREGATED PHASE BUS DUCT

**SPECIFICATIONS FOR ALUMINIUM CONDUCTOR NON-SEGREGATED PHASE BUSDUCT**

1. This specification covers the requirements of 3 phases 415 V, 50 Hz, 50KA continuous rated, Aluminium TPN bus with enclosure suitable for indoor / outdoor type. The bus – duct shall be designed for continuous current ratings and fora maximum temperature rise of 40°Cover an ambient temperature of45°C.

2. The bus – bars shall be of hard drawn high conductivity electrolytic grade aluminium flats of electrical grade 63401-WP as per IS: 5082. The bus- bars shall be of uniform cross section along its entire length. No tapering of the bus bars' cross-section is allowed.

3. The enclosure of bus – duct shall be of 14 SWG sheet steel of minimum thickness of 2 mm bolted on to an angle iron / structural steel framework. The bus duct shall be painted after suitable pre-treatment of all structural steel and plates with anti-corrosive epoxy base primer paint & two coats of anti-corrosive epoxy base paint externally with a colour of pebble / flint gray shade RAL7032and dried in an oven. The enclosure shall conform to IP: 55 for outdoor and IP: 54 for indoor, as per Indian Standards. Inner surface of the bus – duct shall be coated in the rubber paint.

4. The bare bus-bars shall be provided with a coat of Matt finish.

5. The joints in the bus-bars shall be of the bolted type and it shall be ensured that the following precautions are observed.

   (i) The contact pressure must be ample and this shall be maintained during the time the panel is in service.

   (ii) The surfaces of the conductors must be clean.

   (iii) With flat conductors, the overlap should be equal to or greater than the width of the bars or ten times the thickness of the bar whichever is greater.

   (iv) The joints shall be treated by the application of joint compound to render the joint moisture-proof.

   (v) For the joints use of bolts of cadmium plated high-tension MS bolts having

expansion characteristics due to temperature change similar to the conductor may be used with steel nuts.

(vi) Smearing the surfaces with oxide inhibiting grease just prior to making the joint in order to preserve the efficiency of the joints. Minimum phase and earth clearance required shall be maintained at joints. The joints shall be thoroughly shrouded.

6. The bus bar arrangement shall generally conform to IS: 5578 and IS: 11353. The bus – duct shall be also supplied with suitable earth bus running all along the length of the bus – duct made of copper strips. Current density at any part shall not exceed prescribed limits. Two copper flats of same phase shall be stacked together or the spacing between them shall be maximum of the thickness of one conductor.

7. The bus bars shall be phase identified by colour, at intervals. Colour code shall be RED, YELLOW and BLUE for phase and BLACK for the neutral bus – bar.

8. Bus – bars shall be supported on tough, non-hygroscope8. Bus – bars shall be supported on tough, non-hygroscopic, resin bonded self-extinguishing fire retardant insulators preferably of SMC / DMC with ribbed construction to prevent tracking due to dust paths. Bus-bars and supports shall withstand the maximum stresses that are induced in the event of. The short-circuit currents being as specified. The bus-bar support shall be at a minimum interval of 500mm.

9. The bus- bars shall be supplied with flexible expansion joints at both the ends and also at bends. The supports and expansion arrangement shall be so chosen to avoid undue stress to the bus – bars, supports and end connections.

10. Dust excluding gaskets of neoprene shall be used for enclosures to ensure water and dust tightness. The duct shall be (mostly) suitable for outdoor installation. Minimum two numbers of space heater switch thermostats shall be provided to prevent moisture condensation and maintain cubicle temperature 5 Deg. C above the ambient.

11. The clearance between the individual bare phase power bus-bars and between the phase and earth bus –bars in air shall be not less than 25 mm and 19 mm respectively.

12. Drain points shall be provided at the bottom of the bus – duct, at suitable locations. The bus-duct shall be provided with silica gel breathers, in all sections.

13. Bus duct joints shall be covered with encapsulated PVC sleeves. Phase cross over shall be provided wherever required.

14. Fire proof sealing shall be provided wherever bus ducts enter/exit the wall of substation building.

15. Joints of bus ducts shall be covered with pvc caps.

16. Phase cross over shall be considered wherever required in the route length of bus ducts.

### 5.3.13 FIELD PUSH BUTTON STATIONS

1. 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 and rules.

   The design and workmanship shall be in accordance with best engineering practices as applicable to industrial electrical enclosure.

2. **CONSTRUCTION**
   Industrial Local Control Station enclosure shall be Cast Aluminium LM6 alloy or FRP enclosure having minimum 3 mm thickness.

   The enclosure shall be weather proof, IP-55 suitable for outdoor installation. Local control stations for use in hazardous areas shall be Ex-d protection, suitable for gases such as methane (CH4), CO, CO2 and H2S and shall be suitable for zone-1application. These shall be CMRS certified. All mating surfaces of industrial LCS shall be with continuous non-deteriorating type special rubber gasket/neoprene gaskets. An additional 2mm thick Aluminium canopy shall be provided to give adequate protection against weather.

3. **CABLE ENTRIES**
   Two threaded entries shall be of 20 mm shall be provided on each Local Control Stations at the bottom for fixing the cable glands. Metallic/rubber plug shall be provided for sealing one of the cable entry.

4. **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.

5. **WIRING**
   All internal wiring up to the terminal block in the Local Control Station shall be carried out with 1.5 sq.mm stranded copper conductors. Wires shall be PVC insulated type 650/1100V grade. The wire shall be terminated with crimping type lugs only and shall be provided with ferrules at both the ends.

6. **PAINTING**

The Local Control 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 paint shall be 631 of IS5.

## 7. NAME PLATE

Each LCS shall be provided with name plate. Name Plate shall be made from rear engraved, Perspex with letters of size minimum 6 mm on black backgrounds. All name plates shall be identical in size and shall be fixed with screws on the cover.

## 8. COMPONENT SPECIFICATIONS

### a. PUSHBUTTON

Each push button shall be provided with 1NO+1NC contacts, each rated to carry, make and break 10A at 240 V AC.

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 totally shrouded type to prevent accidental start of the motor.

### b. TERMINALBLOCK

Voltage grade of terminal block shall be 660V. Current rating, their size and make shall be as per the requirement specified. Two nos. spare terminals shall be provided in each local control station.

**9. DRAWING DATA AND MANUALS**

The various drawing and documents to be submitted with offer and after placement of order shall be as per attached schedule. Before starting manufacture of the equipment, the manufacturer shall take the approval of design drawings from the engineer.

**10. INSPECTION & TESTING**

The LCS shall be routine tested at manufacturer's works in the presence of purchaser/his representative before dispatch to site.

**11. SPECIFIC TECHNICAL PARTICULARS**

| S.NO. | DESCRIPTIONS | DETAILS |
|---|---|---|
| 1 | Material of Enclosure | Die Cast Aluminium alloy LM6/FRP |
| 2 | PUSH BUTTONS | Make |
| 3 | Actuator | GREEN for START and RED for STOP |
| 4 | TYPE | Spring return for START and mushroom headed stay put for STOP |
| 5 | Standard to which equipments confirm | IS 8623 & IS 4237 |
| 6 | **Terminal Block** | |
| 6.1 | Type | Clip-on |
| 6.2 | Size | 2.5 sq.mm |
| 6.3 | Voltage Grade | 660V |
| 6.4 | Current Rating | 10A |
| 7 | **Internal Wiring** | |
| 7.1 | Size | 1.5 sq. mm Stranded copper conductor. |

### 5.3.14 SILENT TYPE DG SET WITH AMF PANEL.

The contractor shall provide the required nos. of DG sets of suitable capacity to cater auxiliary loads of gas engines and Bio gas power plant auxiliary loads for starting of bio gas engines. The DG set shall be equipped with automatic starter and automatic change over switch in case of power failure. The contractor shall lay separate feeder line from automatic change over switch of DG set to respective units where consistent power supply is required.

The detailed scope of supply, installation, testing and commissioning includes the following.

(i) AMF controlled silent type Diesel Generating set of required capacity at 0.8

power factordeveloping415volts+/-5%,3phase4wiresystem,required

(ii)Necessary set of piping required for lub. oil system, fuel system, circulating water system for radiator and exhaust piping.

(iii) Necessary flexible connections to be inserted in water circulation, lub, oil, fuel and exhaust piping system.

(iv) Necessary lead acid battery for starting including cable work.

(v) Necessary winterization system scheme.

(vi) Necessary set of foundation bolts and suitable vibration isolation mountings.

(vii) Necessary cable work between control panel and the alternator both power and control as per detailed specification.

STARTING SYSTEM:-

Thisshallcompriseofnecessarysetofheavydutybatteries24V.D.C.orassuitable,starter motor axial type gear to match with the toothed ring on the fly wheel. A bimetallic relay protection to protect the starter motor from excessively long cranking runs suitable integrated with the engine protection system shall be included within the scope of work. Battery capacity shall be suitable for meeting the needs of the starting system as well as the requirements of control panel, indications and auxiliaries etc. The scope shall cover all cabling, terminals including initial charging etc.

BATTERY CHARGER:-

The battery charger shall be suitable to charge required numbers of batteries of 12 volts- 25 plates 180 AH capacity each at 24 volts complete with, transformer, rectifier, charge rate selector switch, indicating ammeter & voltmeter etc.

SILENCERS:-Residential silencer suitable for indoor mounting shall be provided.

INSTRUMENTATION:-

Engine instrumentation shall be centralized on an instrumentation panel. The instrument panel shall be resilient, mounted on the engine and shall have the following mounting:

(i) Cooling water temperature indicator.

(ii) Lub. Oil pressure indicator.

ENGINE PROTECTION AND SWITCHING DEVICES:-

Following protection and equipment shall be provided.

(i) Low lubricating oil pressure.

(ii) High cooling water temperature.

(iii) Over speed shutdown.

(iv) Switching and protection equipment for engine auxiliaries such as motor, Jacket water heater, etc. as applicable shall be included.

OPERATION DEVICES:-

A set of operation devices shall be incorporated in the front of panel as under:

(a) MASTER ENGINE CONTROLSWITCH:-

This shall cut off in OFF position, D.C. control supply to entire panel thus preventing startup of engine due to any cause. However, battery charger, lamp test button for testing the healthiness of indication lamps, D.C. voltmeter / ammeter etc. shall be operative. It shall be feasible to lock the switch in off position for maintenance and shut down purposes.

(b) Operation selector switch OFF/AUTO/manual/test position.
(c) Voltmeter, frequency meter, selector switch.
(d) Ammeter with selector switch.
(e) Relays, contactors, timers, circuit breakers as required.
(f) Auto/manual statics selector.
(g) Necessary battery charger with boost/trickle selector D.C. voltmeter and D.C. Ammeter with lamp indications for healthy mains boost charge and float charges.
(h) Compatibility with 'Building Management System' *BMS): PLC compatibility and required nos. of input/output terminals points should be provided in the AMF control panel.

TESTS ON GENERATING SETS:-

Tests shall cover the following-

(a) Routine tests as per standards at manufactures works.

(b) Insulation resistance tests.

(c) Operation checks

FABRICATION &DESIGN

A. The firm must furnish a copy norm as below:-

-- Exhaust norms of engine offered shall be minimum euro-II/ bharat-III

-- Acoustic Enclosure type test

The test must be carried out through a test lab., which is accredited by CPCB for this purpose.

B. The acoustic enclosure shall be as per standard design of D.G. set OEA/OEM and shall also confirm requirement of bye-laws of CPCB. Sound level when measured at a distance of 1mtr.should not exceeds 75db. Adequate illumination inside the enclosure shall beprovided.

**NOTES**:-Bidder shall alternatively consider

1. Clean gas holder for 15 minute capacity to black start of gas engines.
2. Suitably rated UPS of motor duty to cater the auxiliary services load of gas engines.
3. Diesel Generated power shall also be used for gas flare and water sprinkler system to be used for horticulture.

### 5.3.15 SUBSTATION DESIGN

**5.3.15.1** The sub-stations shall be located in a safe area close to the load center

**5.3.15.2** HV/MV sub-stations & MCC rooms shall be elevated at least by 1 Mtr. by compacting the soil so that the bottom of the cable trench within sub-station is above the surrounding grade level.

**5.3.15.3** A separate entry of 3 m x 3 m with rolling shutter shall be provided for drawing in all equipment for erection. The main entry for operating personnel shall be preferably provided with double door system. The Sub-station shall also have an emergency door opening outwards.

**5.3.15.4** For attending sub-stations, an operator's room shall be provided. An annunciation panel to monitor the switchgear located in the sub-station shall be installed in the operator's room.

**5.3.15.5** Sub-station wall adjacent to the transformer bays shall be 355 mm thick in case of brick construction or 230 mm thick in case of RCC construction.

**5.3.15.6** Sub-station building shall be without any columns within the switchgear room to ensure optimum space utilization.

**5.3.15.7** Battery banks shall be located in a separate adequately ventilated room in the sub-station buildings, along with the necessary exhaust system and water connection with sink. Floor of the battery room and walls up to 1.0 m height shall have acid / alkaline resistant protective material coating / tilling. Light fittings in this room shall be chemical resistant type.

The battery rooms shall be provided with minimum two exhaust fans and louvered opening in opposite wall/door.

**5.3.15.8** UPS system and other power electronics equipment e.g. variable speed drive panels shall be located in air-conditioned room.

**5.3.15.9** Sub-station shall have fire fighting equipment, first aid boxes and other safety equipment as per statutory requirements. Mats of required voltage rating shall be provided in front o switchboards.

**5.3.15.10** Equipment like transformers, neutral grounding resistors, reactors and HV capacitor banks shall be located in bays adjacent to the sub-station building. All bays shall have well drained floor, surfaced with gravel or other suitable material. Each bay shall be provided with 2.5m high removable chain link fence with a lockable gate at the open side. Partition walls between transformer bays and the ends of the last bay shall be of fire proof type and shall extend at least 600 mm above the height of the equipment. Height of the bay shall be decided so as to facilitate maintenance and easy removal of equipment and requirements of natural ventilation.

**5.3.15.11** Oil immersed transformers with oil capacity exceeding 2000 liters shall be provided with a soak pit of sufficient capacity to take the whole of the oil of the equipment. Where oil capacity of transformers exceeds 9000 liters, provision shall be made to drain away the oil to a separate waste oil tank/pit located away through suitable drainpipes of 150 mm or 200 mm in diameter. Fixed fire extinguishing system shall be provided for all oil-filled transformers having oil content more than 2000 liters.

**5.3.15.12** One set of accessories consisting of cell testing voltmeter, spanner, face shield, PVC apron, rubber gloves etc. shall be provided in each battery room.

**5.3.15.13** The substation building shall be sized to take care of present and future needs and to maintain adequate clearances between equipment for ease of maintenance.

The following minimum clearances around various equipment shall be

maintained.

| | | |
|---|---|---|
| a) | Front clearance for HV/MV switchboard | 2500 MM |
| b) | Front clearance for all other switch- Boards/panels | 2000 MM |
| a) | Rear clearance for panels having Maintenance access from front only | Less than 200mm or more than 750 mm |
| b) | Rear clearance for panels requiring Maintenance from rear | 1500 mm (HVSWBDs) 1000 mm (MVSWBDs) |
| c) | Side clearance between two switch- Boards or from nearest obstruction | 1500 mm (but not less than twice The width of each panel) |
| f) | All around clearance for transformers/NGR | 1000 mm |
| g) | All around clearance for capacitor bank/ series reactor | 1000 mm |
| h) | Battery rack to wall clearance for | |
| | - Single row, single/double tier<br>- Double row, single tier<br>- Double row, double tier | 100 mm<br>100mm<br>750mm |
| i) | Battery rack-to-rack clearance | 750 mm |
| j) | Head room clearance below bus ducts for Any other overhead equipment | 2000 mm |
| k) | Front clearance for wall mounted equipment | 1000 mm |
| l) | Front clearance for operation station/ Annunciation/control panel | 2500 mm |

**5.3.15.14** Vertical clearance above the top of the highest equipment shall be minimum 1500 mm measured from bottom of roof slab and minimum 500 mm measured from the bottom of the lowest roof beam. However for the areas with false ceiling, minimum clearance of 750 mm shall be provided between false ceiling & top of any equipment.

**5.3.15.15** All substations, UPS rooms, battery charger/battery rooms shall be provided with at least 25% space for future expansion.

**5.3.15.16** The DG sets shall be preferably located in a separate building other than the substation, in a safe area to reduce noise level in substation. However in case the same is located in the substation building, the DG set foundation shall be structurally delinked from the slab/floor of the rest of the substation building. Exhaust of diesel engine shall be kept away from the process/hydrocarbon handling areas and diesel day oil tanks shall be located outside the DG room. Suitable ventilation system shall be provided to avoid heat accumulation in the DG room.

### 5.3.16 PRELIMINARY DETAILS TO BE SUBMITTED WITH BID:-

1. Filled in Datasheets
2. Electrical Load List
3. Transformer capacity sizing calculation
4. APFC sizing calculation
5. Battery & Battery charger sizing calculation
6. Guaranteed losses of transformers
7. Single Line Diagram for HT & LT Power Distribution
8. List of Electricals
9. Instrument Index
10. Control system architecture
11. Control room layout

### 5.3.17 SPECIFIC SPECIFICATION–ELECTRICAL&INSTRUMENTATION WORK

### 5.3.18 General

1. Incomers of LT switchgear panels shall have four poles. Each MCC Panels shall have two incomers, one bus coupler and required numbers of outgoing feeders as per system requirement. Minimum one no. of each type and rating or 20% of the outgoing feeders shall be considered as spare feeder in each LT Panels. Feeders rated 630A and above shall be Air circuit Breaker, up to 400A MCCB, 63A and below shall be MCB. MPCB of adequate rating and KA capacity shall be used for motors rated up to 3.7Kw.
2. Incomer rating of LT Panels /MCCs shall be selected considering total running load + 50% standby feeders load+ 10% spares feeder's load and additional 10% margin on the sum of above.
3. Any fees paid to statutory body for testing, inspection of installed electrical equipment will be reimbursed later by CSCL against document any evidence.
4. Minimum size of power cable shall be 2.5 sq. mm copper conductor or 6 sq.mm Aluminium conductor cable. Control cable shall be 2.5 sq.mm copper conductor cable.

5. HT panel shall be suitable for 33KV, (25 KA for 1 Sec). There will be two Incoming source on dual circuit at one place at substation of proposed 128 MGD STP and further subdivided to.
   (i) Substation-S/S-1 carrying the load for Primary Treatment, Sludge Thickening, Miscellaneous & gas handling System.
   (ii) Substation-S/S-II near Biological Treatment
   (iii) Substation-S/S-III near Tertiary system.
   (iv) Substation-S/S-IV for Effluent Pumping Station.
6. DC system equipment (comprising batteries, Battery charger & DC distribution board) with adequate capacity shall be proposed for protection / control circuits and other vital devices of each substation. DC system, Calculation of DC Battery size, DC battery charger, should be attached with thebid.
7. All the protection relay of 11/33 kV kV HT panel shall be of microprocessor based except master tripping relay and check supervision relay.
8. No any other/ authorized manufacturers shall be considered for panel manufacture ring. Only approved vendors will be acceptable. In case of non-response/regret from approved vendors, approval of additional vendors shall be initiated.
9. Delivery time of any equipment shall not be more than six months before the date of installation.
10. The Control system and instrumentation for the plant shall be provided as per typical control system architecture attached with this tender.
11. Height of operating switch for LT switchgear panels should not be more than 1800mm and should not be less than 300mm.
12. Suitable arrangement of power requirement for starting the bio gas engines and gas flare during the mains power failure shall also be considered.
13. Power generated from bio gas engines should be synchronized to mains power atS/S-II

### 5.3.19 Transformer

Transformer ratings shall be considered based on the total load (Motor load+ Lighting load+ HVAC load). In addition to that 10% margin shall be considered for contingency load.

Transformer should not be loaded more than 80% of the rated capacity.

Voltage regulation during starting of largest motor at last should not be more than 5% at 0.8 power factors and 100% load.

### 5.3.20 Motor

All the motors shall be squirrel cage Induction motor with TEFC enclosure, premium efficiency and for continuous duty. For hazardous area Flame Proof motors shall be considered.

Starting of motors shall be considered as follows:-

Motors rated up to 5.5 Kw ---------- DOL Starter

Motor rated 7.5 Kw and above up to 37 Kw -- Star/Delta Starter

Motors rated 45 Kw and above---------- Soft Starters

All motors above 100HP/75KW shall be provided with RTD's (at least two RTD's per winding) earth leakage protection, comprehensive micro process Based protection having locked current /over load, negative phase sequence relay, under load, over current, earth fault, start nos., transit currents etc. Variable Frequency Drives as per process requirement.

**Margin in Brake Kilowatts(BKW)**

Motor kW shall be selected based on the table as given below:-

TABLE—MARGIN FOR MOTOR RATINGS

| Required BKW of Pump/ Drives | Multiplying Factor to decide Motor rating |
|---|---|
| Up to 1.5 | 1.5 |
| Above 1.5 to 3.7 | 1.4 |
| Above 3.7 to 7.5 | 1.3 |
| Above 7.5 to 15 | 1.2 |
| Above 15 to 75 | 1.15 |
| Above 75 kW | 1.1 |

**Capacitors**

APFC Panel with ALL Polypropylene (APP)/Mixed Dielectric (MD) type capacitor bank shall be considered to improve power factor of the entire plant up to 0.98 or better.

Additional capacitors shall also be considered on each side of bus coupler to compensate the power factor due to Transformers impedances.

Suitably rated reactor shall also be considered with Capacitor banks.

Impact of over voltage shall also be considered in sizing of capacitor.

**Lighting**

20 Mtrs. Height high masts with LED lamps shall be considered (Minimum-16 Nos.) for area lighting based on the lux level as 50 Lux shall be considered.

In addition to high mast lighting, solar operated LED lighting shall also be considered for shadow areas.

Hybrid type solar operated lights shall be considered to facilitate the charging during non- sunny days.

**Earthing**

Entire earthing system for existing STP has to be dismantled and the material to be stored in designated store as desired by CSCL.

Adequate nos. of earth pits and earthing conductor have to be considered to achieve the earthing resistance lower than one ohm.

Earthing system design has to be made based on the soil resistivity data of the site.

Size of the earthing conductor shall be considered to withstand the stress of fault Current for one second. However minimum size will be as specified elsewhere in the tender.

**Cable Tray**

Cable tray shall be of FRP having minimum thickness of 3mm. Size of cable tray shall be selected considering 20% extra space for owner's use.

**Cable laying**

RCC cable trenches of adequate size shall be used for cable laying between Electric substation and various LT panels located at different location of the plant. Cable shall be laid on trays inside the cable trenches.

Minimum 400 mm space shall be considered for movement of a person during maintenance of cables inside the cable trench.

Cable trenches shall be covered with rcc cover after completion of installation of cables.

Cable trenches shall have slope for draining the accumulated water during rainy season.

The accumulated water inside the trench shall be drained or pumped to plant drainage system.

**Power Distribution Scheme**

Block Diagram of power distribution system for the entire plant shall be displayed in the substation, preferably in wooden frame with glass cover.

**Telecommunication System**

Telecommunication system with EPBX shall be provided. Telephone sets will be provided for major areas of the plant such as—

i) Substations
ii) Administrative Building
iii) Control Room
iv) All Pump Houses
v) Security Room
vi) Gas Engine's Room

**Public Addressing System**

A centralized amplifier based system that's been designed to provide voice paging and to broadcast alarm tone during emergencies.

The system can transmit alarm tone and routine voice messages, from a central location, to all or selected areas of the facility, in a reliable and safe manner, by the use of loud speakers.

**Power Factor Penalty:-**

Whenever the average power factor is less than 0.98, penal charges shall be levied at the rate of the following percentages of the amount of the monthly bill including energy charges, reliability charges, FAC, and Fixed/Demand Charges, but excluding Taxes and duties:

| Sr. No. | Range of Power Factor | Power Factor Level | Penalty |
|---|---|---|---|
| 1 | 0.975 to 0.980 | 0.98 | 0% |
| 2 | 0.965 to 0.974 | 0.97 | 0.5% |
| 3 | 0.955 to 0.964 | 0.96 | 1.0% |
| 4 | 0.945 to 0.954 | 0.95 | 1.5% |
| 5 | 0.935 to 0.944 | 0.94 | 2.0% |
| 6 | 0.925 to 0.934 | 0.93 | 2.5% |
| 7 | 0.915 to 0.924 | 0.92 | 3% |
| 8 | 0.905 to 0.914 | 0.91 | 4% |
| 9 | 0.895 to 0.904 | 0.90 | 5% |
| 10 | 0.885 to 0.894 | 0.89 | 6% |
| 11 | 0.875 to 0.884 | 0.88 | 7% |
| 12 | 0.865 to 0.874 | 0.87 | 8% |
| 13 | 0.855 to 0.864 | 0.86 | 9% |
| 14 | 0.845 to 0.854 | 0.85 | 10% |

**Note:** P.F. to be measured /computed up to 3 decimals, after universal rounding off.

# Part 6 -Instrumentation Specifications

## 6.1 General

CSCL Invited to install latest technology with compatible automation system having fully automatic process control, ON LINE to monitor and control the WWTPs from a single location using a common SCADA control room for each WWTP. Typical control system architecture is enclosed with bid which is to be strictly followed by bidder / contractor while designing the control system and instrumentation. The plant data collected through online monitoring of water quality and flow shall be displayed locally where the instrument is installed and also transferred to the PLC / SCADA control room. The data shall also be made available via the internet to various statutory bodies / locations.

The bidder shall provide, install, test and commission all instruments (online and laboratory) and local panels required for proper operation of the works. Details of instruments associated with the actual waste water treatment processes are in some instance given in the relevant sections of the specification. The bidders are advised to diligently go through the complete tender document and quote instruments accordingly. The bidder shall include in their bid a list of instruments / devices showing compliance to agencies such as ISO, BIS, EPA, etc. as applicable.

The instrument proposed for each application shall be of reputed make with latest technology and that which in the opinion of the contractor and the manufacturer is most appropriate subject to CSCL approval. In addition to the above criteria, the instruments offered shall be of approved make of CSCL and the selection of instruments shall minimize the quantity and multiplicity of spares required to facilitate ease of maintenance and servicing.

## 6.2 Objective

Using the latest technology for ON LINE monitoring and control of various parameters CSCL hopes to achieve following aim:

- Improvement in effluent quality
- Proper monitoring and correction
- Lesser manpower
- Generation of all faults and trends
- Correct display of input raw material and output treated effluent
- Long term historical storage of process data
- Analysis and graphical plots of historical data
- Prevention maintenance management
- Inventory control
- Maintain plant operation summaries
- Improve plant efficiency and increase the plant life
- Maintain records of pumping through flow meters
- Maintain record of quantity of gas generated and power generated

## 6.3 Scope

This part covers the general requirements for the design, supply, installation, inspection and testing of the instrumentation and automation solution proposed for flow measurement, monitoring of water quality and control of all the plants.
Integration of complete proposed system (i.e., PLC and SCADA including APIs) with ICCC (Integrated Command and Control Center) as proposed by CSCL under ICT (Pan City) components.

### 6.3.1 Reference Standards

Unless otherwise approved, instrumentation shall comply with relevant quality standards test procedures and codes of practice collectively referred to as Reference Standards including those listed below in accordance with the requirements detailed elsewhere in this specification. IEC 60381-1:1982 Analogue signals for process control systems.

Specification for direct current signals:

- IEC 60947-4-1:2000 Specification for low-voltage switchgear and Control Gear. Contactors and motor-starters. Electromechanical contactors and motor-starters.
- IEC 60947-4-2:1999 Specification for low-voltage switchgear and Control Gear. Contactors and motor-starters. A.C. semiconductor motor controllers and starters.
- IEC 60947-4-3:1999 Specification for low-voltage switchgear and Control Gear. Contactors and motor-starters. Contactors and motor-starters. AC semiconductor controllers and contactors for non-motor loads.
- IEC 60770-1:1999 Transmitters for use in industrial-process control systems. Methods for performance evaluation.
- BS ISO 1217:1996 Displacement compressors. Acceptance tests.
- ISO 2112:1990 Specification for amino plastic moulding materials.
- ISO 6817:1997 Measurement of conductive liquid flow in closed conduits. Method using electromagnetic flow meters.
- BS EN 837-1:1998 Pressure gauges. Bourdon tube pressure gauges. Dimensions, metrology, requirements and testing.
- BS EN 1057:1996 Copper and copper alloys. Seamless, round copper tubes for water and gas in sanitary and heating applications.
- BS EN 1092-1:2002 Flanges and their joints. Circular flanges for pipes, valves, fittings and accessories, PN designated. Steel flanges.
- BS EN 1563:1997 Founding. Spheroidal graphite cast iron.
- BS EN 60529:1992 Specification for degrees of protection provided by enclosures (IP code).
- BS EN 60534-1:1993 Industrial-process control valves. Industrial-process control valves. Control valve terminology and general considerations.
- BS EN 60546-1:1993 Controllers with analogue signals for use in industrial-process control systems. Controllers with analogue signals for use in industrial-process control systems. Methods for evaluating performance.
- BS EN 60584-2:1993 Thermocouples. Tolerances.
- BS EN 60654:1998 Operating conditions for industrial-process measurement and control equipment. All relevant parts.
- BS EN 60751:1996 Industrial platinum resistance thermometer sensors.

- BS EN 60873:1993 Methods of evaluating the performance of electrical and pneumatic analogue chart recorders for use in industrial-process control systems.
- BS EN 61000-6:2001 Electromagnetic compatibility (EMC). Generic standards. Emission standard for industrial environments.
- BS 89:1990 Direct acting indicating analogue electrical measuring instruments and their accessories. All parts.
- BS 90:1975 Specification for direct-acting electrical recording instruments and their accessories.
- BS 476 Fire tests on building materials and structures. All parts.
- BS 1042-1.4:1992 Measurement of fluid flow in closed conduits. Pressure differential devices. Guide to the use of devices specified in Sections 1.1 and 1.2.
- BS 1041-2.1:1985 Code for temperature measurement. Expansion thermometers. Guide to selection and use of liquid-in-glass thermometers.
- BS 1041-2.2:1989 Code for temperature measurement. Expansion thermometers. Guide to selection and use of dial-type expansion thermometers.
- BS 1041-3:1989 Temperature measurement. Guide to selection and use of industrial resistance thermometers.
- BS 1041-4:1992 Temperature measurement. Guide to the selection and use of thermocouples.
- BS 1042-1.4:1992 Measurement of fluid flow in closed conduits. Pressure differential devices. Guide to the use of devices specified in Sections 1.1 and 1.2.
- BS 1123-1:1987 Safety valves, gauges and fusible plugs for compressed air or inert gas installations. Code of practice for installation.
- BS 1203:2001 Hot-setting phenolic and amino plastic wood adhesives. Classification and test method.
- BS 1553-1:1977 Specification for graphical symbols for general engineering. Piping systems and plant.
- BS 1571-2:1975 Specification for testing of positive displacement compressors and exhausters. Methods for simplified acceptance testing for air compressors and exhausters.
- BS 1646-1:1979 Symbolic representation for process measurement control functions and instrumentation. Basic requirements.
- BS 1646-2:1983 Symbolic representation for process measurement control functions and instrumentation. Specification for additional basic requirements.
- BS 1646-3:1984 Symbolic representation for process measurement control functions and instrumentation. Specification for detailed symbols for instrument interconnection diagrams.
- BS 1646-4:1984 Symbolic representation for process measurement control functions and instrumentation. Specification for basic symbols for process computer, interface and shared display/control functions.
- BS 1794:1952 Specification for chart ranges for temperature recording instruments.
- BS 2765:1969 Specification for dimensions of temperature detecting elements and corresponding pockets.
- BS 3680 Measurement of liquid flow in open channels. All relevant parts.

- BS 3693:1992 Recommendations for design of scales and indexes on analogue indicating instruments.
- BS 4675-2:1978 Mechanical vibration in rotating machinery. Requirements for instruments for measuring vibration severity.
- BS 4999-142:1987 General requirements for rotating electrical machines. Specification for mechanical performance: vibration.
- BS 5169:1992 Specification for fusion welded steel air receivers.
- BS 5728-3:1997 Measurement of flow of cold potable water in closed conduits. Methods for determining principal characteristics of single mechanical water meters (including test equipment).
- BS 6004:2000 Electric cables. PVC insulated, non-armoured cables for voltages up to and including 450/750 V, for electric power, lighting and internal wiring.
- BS 6739:1986 Code of practice for instrumentation in process control systems: installation design and practice.
- BS 7671:2001 Requirements for electrical installations. IEE Wiring Regulations. Sixteenth edition. Instrument Society of American Standards and Recommended Practices:
- S 5.1 Instrumentation symbols and identification
- S 5.4 Instrument loop diagrams
- S 7.3 Quality standard for instrument air
- RP 16.1 Terminology, dimensions and safety practices for indicating variable 2, 3 area meters
- RP 16.4 Nomenclature and terminology for extension-type variable-area meters (rota meters)
- RP 16.5 Installation, operation, maintenance instructions for glass tube variable area meters (rota meters)
- RP 16.6 Methods and equipment for calibration of variable area meters (rota meters)
- RP 18.1 Specifications and guides for the use of general purpose enunciators
- S 26 Dynamic response testing of process control instrumentation
- RP 31.1 Specification, installation and calibration of turbine flow meters
- S 37.1 Electrical transducer nomenclature and terminology
- S 37.3 Specifications and tests for strain gauge pressure transducers
- S 50.1 Compatibility of analogue signals for electronic industrial process instruments
- S 51.1 Process instrumentation terminology
- RP 60.08 Electrical Guide for Control Centres

### 6.3.2 Statement of Compliance

The Contractor shall provide a list of the reference standards used and shall provide a compliance/non-compliance statement for all the online and lab instruments proposed.

All standards which the Contractor intends to use but which are not referenced herein shall be submitted to the Engineer for consent before any design against that standard proceeds. Installation works shall comply with all relevant local Indian Regulations including the Code of Practice for Electrical Wiring Installations – IS 732.

### 6.3.3. Submissions by Contractor

General
The Contractor shall make submissions to the Engineer of all design drawings and schedules relating to instrumentation and control equipment and systems provided under this Contract. These submissions shall include, where relevant, the following:

Functional Design Specification

The Contractor shall submit a complete functional design specification (FDS) for approval by the Engineer. This document shall serve as the primary mechanism by which the Engineer may confirm that the Contractor possesses an accurate understanding of the system and its control requirements. The Contractor is encouraged to obtain clarifications and to suggest refinements to the control descriptions contained in this Specification. The FDS shall comprise an overall description of the plant, its functioning and control, and a detailed description of each section of the control system covering modes of operation, manual overrides, set-point and parameter selection and adjustment. The detailed description shall include a step-by-step control description which defines the function of each piece of equipment and each control action and interlock, including details of the program in each programmable item. The format of the program details may be chosen by the Contractor, however it is suggested that this format be chosen to satisfy the requirements of the software design documentation, if applicable, as described elsewhere.

The FDS shall describe the 'fail-safe' features incorporated into the design for the event of failure of a plant item or system, or loss of an input signal affecting a control loop or process sequence.

The FDS shall describe control actions taken and monitoring functions which remain available during a power failure, and any automatic controls or sequencing which take place during system start-up and shut-down.

The FDS shall be presented in a clear and precise manner and shall include figures or drawings where appropriate. The Contractor shall submit and obtain approval of the FDS from the Engineer before beginning the detailed control system design. The contractor should take note of the importance of this obligation.

Drawings and Schedules

Process and instrumentation diagram which shall comply with BS 1646 (all parts) and BS 1553-1:1977.

General arrangement drawings of field-mounted instruments showing installation details.

General arrangement drawings of instrument and control panels, fully-dimensioned in plan and elevation views, showing foundation and fixing details, access doors, clearances, cable-entry positions, weight and lifting arrangement.
Layout drawings of panel fascias showing instruments, controls and details of all labels.
Layout drawings of panel interior showing equipment, terminal blocks and cable ways.

Annunciator arrangement and engraving details.
Internal circuit and wiring diagrams for instrument and control panels.

Schematic control diagrams.
Instrument loop diagrams.
Instrument wiring and piping diagrams.
Interconnection wiring diagrams.
Cable block diagrams, drawings and schedules.
Instrument system and panel power distribution diagrams.
Programmable-device functional design specifications which shall include hardware details, logic flow charts, ladder diagrams and program listings.

Schedules of inputs to and outputs from programmable controllers and telemetry outstations.
Labelling schedules.
Comprehensive testing schedules for all off-site, on-site, pre-commissioning and commissioning tests and take-over tests.

All other drawings necessary for the provision of ducts, openings, trenches, fixing holes for panels and the like and for the complete understanding of the operation, maintenance and extension of the system including any required for the Purchaser to dismantle, repair, maintain, modify or extend the Plant during the O&M period.

Data and Calculations

- Manufacturer's catalogues and data sheets
- Calculations to support control system design
- Specification for protective coatings and painting

Certificates

- Manufacturer's works tests
- Pre-installation checks
- Pressure-testing schedules
- Instrument loop test check sheets
- Installed instrument performance tests
- System tests
- Statutory certificates of compliance (such as hazardous area equipment)

Operation and Maintenance Instructions

Composite manual describing the functional and operation of each piece of equipment.

Composite manual for testing and servicing every system and individual item.

### 6.4 Basic Features

Each instrumentation system shall be designed, manufactured and installed to achieve the following basic requirements:

Basic Requirements

- To maintain the highest standards of availability, reliability and accuracy and to give clear warnings of any deterioration in performance
- To suit the abilities of the staff who will:
  i) Use the systems
  ii) Service the systems
- To measure, indicate, process, store and control the relevant parameters, as specified
- To give clear warnings of dangerous and other abnormal conditions and to initiate plant safety procedures, shutdowns and corrective measures as specified to assure the safety of 'operations and maintenance' personnel and that of the plant and to store and collate the data, as required
- To derive, present and utilize, as required, such additional data to facilitate:
  (i) The most efficient operation of the plant
  (ii) The routine maintenance of the plant

## 6.5 Design Requirements for Control And Instrumentation Systems (C&I)

The instrumentation, control and automation installations shall fully comply with design standards, regulations and the material and workmanship requirements of the Specification. The instrumentation control and automation systems shall comply with the relevant Indian Standards being practiced as per the industry norms. All consumable items and spare parts shall be readily available within India.

All equipment and materials incorporated in the system shall be selected, designed and rated to operate under the defined performance duties and specified site conditions and to maintain a high level of operational reliability. The instrumentation control and monitoring system equipment and materials shall have an operational life of not less than 15 years.

Unless otherwise specified, all functions shall be transmitted electrically and all analogue signal- transmission systems shall be in accordance with IEC 60381-1:1982 or equivalent and shall use a signal of 4mA to 20mA dc. Where possible, measuring systems shall be designed so that any necessary power supply is taken from the appropriate instrument panel. Transmitting devices shall have integral indicators to monitor the output signal or connections suitable for use with a portable test meter, and shall be capable of meeting the performance requirements specified in the appropriate part of IEC 60770-1:1999 or equivalent. Equipment mounted in enclosures shall be suitable for continuous operation at the maximum internal temperature possible in service, due account being taken of internally-generated heat and heat dissipated by other plant. All components shall be rated adequately and circuits shall be designed so that change of component characteristics within the manufacturers' tolerances shall not affect the performance of plant. All equipment shall be designed to operate without forced (or fan) cooling.

All measuring instruments shall have zero and span adjustment. Instruments not mounted in panels shall be supplied complete with all brackets, stands, supporting steelwork and weatherproof enclosures (separate from the instrument cases) necessary for securing them in their working positions and affording complete protection at all times including periods of servicing, adjustment, calibration and maintenance. The installation arrangements for meters measuring conductivity, pH, and dissolved oxygen, and ionic concentration shall include a sample bench and other facilities for operating portable test meters. Each installation shall incorporate a valve and pipework for obtaining a sample representative of the fluid at the position of the permanent meter tundish and drain. If the measuring and sampling points are remote from each other, the test and sample facilities shall be provided at both points. Sample transport times shall be minimized by provision of a bypass and drain with control and isolating valves and a local flow meter to enable the correct sample flow to be adjusted. An automatic portable sampler shall be provided for collecting and transporting the samples from the sampling locations to the laboratory.

### 6.5.1. Instrument Design Criteria

The design criteria to be applied to instrumentation system shall be as follows:

- Instrumentation & Control (I&C) systems shall be selected, designed, manufactured, installed, tested and rated to operate under the defined performance duties and specified site conditions and to maintain a high level of operational reliability. Instruments mounted in field and on panels shall be suitable for continuous real time operation. All electronic components shall be adequately rated and circuits shall be designed so that change of component characteristics shall not affect the plant operation.
- All I&C equipment shall be new, of proven design, reputed make and have data logging facility. Unless otherwise specified, all instruments shall be tropicalized. The outdoor equipment shall be designed to withstand tropical rain and shall be suitable for the worst environmental operating conditions. Wherever necessary space heaters, heat dissipaters, dust and weather proof cabinets shall be provided. Instruments offered shall be complete with all the necessary mounting accessories & safety features.
- No custom made hybrid type IC's [Integrated Circuits] shall be used in any circuit in instrumentation and control equipment. Any hybrid circuits or sealed modules or devices which do not have alternative manufacturer shall be disclosed in the Bid by Contractor, so that such devices can be included as component spares in sufficient quantity in advance and shall be deemed to be included in the bid price.
- Instruments and loggers provided shall be able to carry out continuous real time monitoring and logging of selected water quality parameters.
- All instrumentation shall be suitable for continuous real time operation and be powered through the UPS.
- As far as possible and depending upon the location and availability of wireless services (GPRS / GSM, etc.), all transmitting instruments and data loggers shall be of wireless type. In case of non-feasibility, the output of the transmitting instruments shall be 4-20 mA / 0-10V DC linear having two wire system.
- After a power failure, when power supply resumes, the instruments and associated equipment shall start working automatically.

- Unless otherwise specified, thenormal working range of all indicating instruments shall be between 25% and 80% of the full scale range.
- The field instruments i.e. the instruments mounted outside the control panel shall be mounted at a convenient height of approximately 1.2 m above grade platform.
- Unless otherwise stated, field mounted electrical and electronic instruments shall be weatherproof to IP-65 or better.
- The instruments shall be designed to work at the ambient conditions of temperature, humidity, and contamination that may prevail at site. The instruments shall be given enough protection against corrosion. All wetted parts of instrument sensors shall be non - corrosive and suitable for use within sewerage environment.
- The performance of all instruments shall be unaffected for the ±10% variation in supply voltage and ±5% variation in frequency simultaneously.
- Unless otherwise specified, double compression glands shall be used forglanding the cable in field instruments and instrument control panel.
- All digital outputs shall be volt free.
- All probe type analyzers should be IP68 rated.
- All displays shall be of the digital type with no moving parts and should utilize back lit liquid crystal diode LCD/ LED technology.
- Instrumentation shall utilize solid state electronic technology and avoid the use where practical of any moving parts.
- Minimum maintenance requirements. The instruments selected shall be rugged and not require any consumables / filling solutions. Systems should be able to work with minimum power requirements.
- Lockable enclosure shall be provided for all the field mounted instruments.
- All the instruments and cabinets shall have tag plates / name plates permanently attached tothem.
- All instruments to be used or installed within a corrosive sewerage environment shall be Explosion Proof or Intrinsically Safe.
- The data obtained from the online quality monitoring system shall be conveyed back via suitable communications protocol, to web servers hosted by a service provider. The service provider shall have the data storage capacity for next 15 years. At the service provider end, it is desirable to have functionality for viewing, processing, calculation, analysis and graphical display of data. There should be an option to customize the functionality and make it user specific for client employees.
- Unless otherwise specified, all continuous online monitoring instruments shall be plug and play type.

Instrumentation system shall be provided to monitor the field parameters to meet the process requirements shall be considered as per following table: -

**Table-1**

| Sr. No. | LOCATIONS | ONLINE INSTRUMENTS |
|---|---|---|
| | | 1. Area VelocityFlowmeter<br>2. Differential LevelTransmitter |

| | | |
|---|---|---|
| 1. | Head Works | 3. TSSAnalyzer<br>4. BOD/CODAnalyzer<br>5. AmmoniaAnalyzer<br>6. Oil & Greaseanalyzer<br>7. pHAnalyzer<br>8. Total Nitrogen Analyzer |
| 2. | Primary Clarifier, if applicable | 1. TSSAnalyzer<br>2. Sludge Blanket/ Sludge densityindicator<br>3. Magnetic Flowmeter in Sludge Withdrawal Line |
| 3. | Biological Reactor | DO and ORP Analyzer |
| 4. | Secondary Clarifier, if applicable | 1. BODAnalyzer<br>2. TSSAnalyzer<br>3. Sludge Blanket/ Sludge densityindicator<br>4. Magnetic Flowmeter in Sludge Withdrawal Line |
| 5. | Sludge Thickener | 1. Magnetic Flowmeter in Sludge Withdrawal Line<br>2. Sludge Blanket/ Sludge densityindicator |
| 6. | Treated Effluent | 1. pHAnalyzer<br>2. TSSAnalyzer<br>3. Indicative COD/BODAnalyzer<br>4. AmmoniaAnalyzer<br>5. PhosphorousAnalyzer<br>6. Area Velocity Flowmeter<br>7. Total Nitrogen Analyzer |
| 7. | Digester | 1.Temperature Transmitter 2. pH Analyzer<br>3.GasFlow Indicator |
| 8. | Primary Sludge Pumps Header Line | Electro Magnetic Flowmeter |
| 9. | Return Sludge Pumps Header Line | Electro Magnetic Flowmeter |
| 10. | WAS Header Line | Electro Magnetic Flowmeter |
| 11. | Air Flowing to Biological Reactor | Orifice type Flow meter<br>Pressure Switch<br>Pressure Transmitter |
| 12. | Bio Gas line feeding to Gas Engine | Gas Flowmeter (Ultrasonic type)<br>Calorific Value Measurement<br>CO2, CH4 & H2S Gas Concentration |
| 13. | All Sumps & Tanks | Ultrasonic Level Transmitters<br>Magnetic Type Level Gauge (For Tanks only) |
| 14. | Pressure Transmitter | Delivery Header Line of Pumps |
| 15. | Pressure Gauges | Delivery Line of each Pump |

**Note:** - Above listed instruments are minimum, however any extra instruments if required to meetthe process requirements shall be considered in the scope of work.

Online instrument system shall have the ranges listed in “Table 2” below:

**Table 2**

**Online Instrument Range**

| Sl. No. | Parameter | Required Range(s) |
|---|---|---|
| 1. | Online Continuous Dissolved Oxygen Measuring System – DO Analyzer | 0 – 20 mg/l |
| 2. | Ultrasonic Level Measurement | As required at site |
| 3. | Ultrasonic Differential Level Measurement | As required at site |
| 4. | Ultrasonic Open Channel Flow Measurement at Parshall Flume | 5 mtrs |
| 5. | Gas Flow meter (Ultrasonic Flow Measurement System) | 0 – 3000 Normal $m^3$/hr |
| 6. | Pressure Transmitter | As required at site |
| 7. | Continuous Online Total Suspended Solids Analyzer – TSS Analyzer | 0 –5000 mg/l |
| 8. | Continuous Online pH Measuring System | 0 – 14 pH |
| 10 | Biochemical Oxygen Demand Analyzer - BOD Analyzer | 0 – 500 mg/l |
| 11. | Chemical Oxygen Demand Analyzer - COD Analyzer | 0 – 500 mg/l |
| 12. | Measurement of $CO_2$, $CH_4$ and $H_2S$ Gas Concentration | 0 – 100% |
| 13. | Electro-Magnetic Flow Meter | As required at site |
| 14. | Online Gas Calorific Value Measurement | 6000 Kcalorie/$m^3$ |
| 15. | Total Phosphorus | 0 – 10 mg/l |
| 16. | Oil In Water | 0 – 15 ppm |
| 17. | Total Nitrogen Analyzer | 0-30 mg/l |

### 6.6 Laboratory – Laboratory Instruments and Sampling System

The laboratory shall be housed within the administrative building and shall be equipped with instruments, equipment, chemicals and other infrastructure that is necessary to perform the routine analysis for the parameters as detailed in "Table 2". The equipment shall be supplied with all the accessories that are necessary to make the equipment functional for analyzing parameters and generating daily reports. In addition to these, contractor shall also provide necessary chemicals, glassware and reagents required for sample testing in the laboratory along with calibration standards / solutions for calibrating the instruments.

The quality of the sewage entering, passing and leaving the treatment plant shall be monitored via online monitoring equipment as well as manual sampling systems and tested daily, at least from the following parameters:

**Table 3**

**Parameters**

| Sl. No. | Parameter |
|---|---|
| 1. | $BOD_5$ or $BOD_3$ |
| 2. | pH |

| | |
|---|---|
| 3. | SS |
| 4. | Temp |
| 5. | COD |
| 6. | TOC |
| 7. | Ammonia |
| 8. | Total Phosphorous |
| 9. | Acidity, Alkalinity |
| 10. | Ammonical Nitrogen |
| 11. | Total Nitrogen |
| 12. | MLSS/MLVSS |
| 13. | Dissolved Oxygen |
| 14. | SVI |
| 15. | Total Hardness, Calcium Hardness |
| 16. | Gas Analysis |
| 17. | Calorific Value Monitoring |
| 18. | Volatile Suspended Solids |
| 19. | Total Solids, Volatile Solids |
| 20. | Specific Gravity |
| 21. | Moisture Content |
| 22. | Total Coliform |
| 23. | Faecal Coliform |
| 24. | Total Dissolved Solids |
| 25. | Bacteria, Escherichia Coli |
| 26. | Oil & Grease |

Three nos. portable samplers shall be provided to collect composite samples for monitoring from

Inlet chamber for raw sewage At the outlet of clarifying units At the outlet of Tertiary effluent

The laboratory shall have the equipment, storage space and chemicals for all the chemical and bacteriological routine analyses. The area of laboratory shall be sufficient with sufficient length of working platforms and adequate no. of sinks. Area of laboratory shall be defined by bidder as per the requirement but not less than specified in the bid document. At least the following equipment and all required laboratory chemicals / reagents given in Table 3 are to be provided by the contractor within the scope of work and have to be replenished by him till the end of the O&M Period.

All lab based test instruments results shall be stored automatically and transferred to the PLC as well as web servers on real time basis for control and report applications.

| **Sl. No.** | **Description** |
|---|---|
| 1. | Single / Multi parameter meter for pH, Conductivity, DO, Ammonia and Phosphate |
| 2. | Mains operated pH meter completed with one calomel electrode and glass electrode |

| | |
|---|---|
| 3. | UV / VIS Spectrophotometer |
| 4. | Water bath with 6 to 8 concentric holes and discs, electrically heated |
| 5. | Hot plates – 25cm |
| 6. | Ultrapure Water Plant / Distillation |
| 7. | Conductivity with TDS meter |
| 8. | Refrigerator (280 litres capacity) double door / cooling cabinet for sample preservation |
| 9. | Muffle furnace |
| 10. | Electronic Burettes and Dispensers |
| 11. | Magnetic stirrer |
| 12. | Analytical balance (Electronic) with weight box – Resolution up to 4 decimal places |
| 13. | Jar-Test apparatus – 6 Stirrers |
| 14. | Centrifuge |
| 15. | Flame photometer with gas cylinder |
| 16. | Fume cupboard |
| 17. | Field Test kit for cations and anions |
| 18. | Depth Sampler |
| 19. | Total Organic Carbon Analyser |
| 20. | Sieve shaker with standard sieves and two pan balance weighing up to 200gm samples |
| 21. | Hot Air Oven |
| 22. | Autoclave |
| 23. | Binocular microscope |
| 24. | Automatic Portable Sampler |
| 25. | Pipette Box (Stainless Steel) |
| 26. | Wooden Racks/Aluminium Racks |
| 27. | Wire Baskets |
| 28. | Cotton/ Aluminium Foils |
| 29. | Burners (Bunsen) With Pilot Lamp |
| 30. | Suction Flask (1 Litre Cap) |
| 31. | Suction Pump |
| 32. | Sampling Bottles |
| 33. | Measuring Cylinders (1000 Ml, 500 Ml, 200 Ml, 100 Ml, 50 Ml, 25 Ml) |
| 34. | Vacuum pump |
| 35. | Soxhlet extraction unit |
| 36. | Kjeldhal digestion unit |
| 37. | Weighing Balance (max 10kg) |
| 38. | Laminar Air Flow chamber |
| 39. | M. Endo Broth (dehydrated) |
| 40. | Lactose or Lauryl Tryptose broth |
| 41. | Mac Conkey broth |
| 42. | Brilliant Green Bile Lactose Broth |

| | |
|---|---|
| 43. | Total Plate Count Agar |
| 44. | Peptone / Triyptone Water |
| 45. | BOD Analysis: Incubator, Reagents, etc. |
| 46. | COD Analysis: COD Reactor – 15 Vials, Reagents, etc. |
| 47. | Filtration assembly for suspended solids |
| 48. | Incubator 44°C (Water/Air-Jacketed) |

## 6.7 Online Instruments Specifications

The bidder shall provide duly filled data sheets for all the instruments as per the "Technical Specifications" format used for individual instruments given below. The data sheets should also comply and include other important information as detailed under respective heads. The completed data sheets would be submitted by the bidder as part of the technical bid.

### 6.7.1. Pressure Measuring System

#### 6.7.1.1. Pressure Gauges

**1.** Pressure gauges shall be of chemically sealed diaphragm type as per requirement and shall be provided in the delivery headers of all pumps, blowers and compressor.

Pressure gauges shall be suitable for sewerage/ sewerage gas application.

**2.** Specification

a) Pressure gauges shall comply with IS 36241 BS 1780. For arduous duty where the gauge is subject to pressure pulsations and/or vibration, it shall be provided with a glycerin filled dial.
b) The internal parts of pressure gauge shall be of stainless steel material. For other fluids an appropriate non- corrosive diaphragm material shall be used.
c) The minimum diameter for round pressure gauges shall be 150 mm unless specified.
d) The accuracy of pressure gauges shall be ± I% over the operating range. The zero and span of pressure gauge shall not change by more than ±0.1 % of the span per deg.c change in ambient temperature. The gauges shall be of precision type.
e) Pressure gauge shall be provided in the delivery headers of all pumps, blowers and compressor and at location shown in P and I drawings.
f) Type shall be Bourdon (SS316)
g) Accuracy shall be ± I % of full scale
h) Dial size shall be 150 mm
i) Glass shall be Shatterproof
j) 25% above maximum pressure shall be considered for over range protection.
k) Flanged bottom entry connection shall be provided
l) Housing material shall be Die cast aluminum
m) Wetted parts shall be SS 316
n) Additional Accessories like Snubber, isolation valve and ·drain valve, Impulse tubing and fittings and Diaphragm seal shall be provided.
o) Case of the pressure gauge shall be SS3 l 6

p) Window material shall be Shatter proof glass
q) Pointer travel shall conform to Not less than 200 deg and not more than 270 deg

**Pressure Switch**

The pressure switch shall be suitable for humid and H2S laden atmosphere. It should have scaled adjustment knob to enable the adjustment of trip and reset pressure without the use of a screwdriver.

It should be adjustable pressure switch for monitoring over pressure (5mbar to 12 mbar), vacuum (-5 down to-700mbar) or differential pressure (5 to 50 mbar) of liquid, gas and aggressive media.

**Technical Specifications**

| | | |
|---|---|---|
| Application | : | For monitoring over pressure |
| Temperature Range | : | -2 to C |
| Diaphragm material | : | Silicon, FKM, EPDM |
| Electrical Rating | : | 6A/220V AC, 2A/24V DC |
| Contacts plating | : | silver |
| Arrangement of Contacts | : | 1 C/O contact |
| CE conformity | : | ATEX Certification |
| Damping | : | Restrictors alternatively with 0.3/0.5/0.8 mm diameter. |
| Accessories | : | Mounting brackets and protection caps with IP-54 |
| Mounting Position | : | As per site requirement |
| Connection | : | Threaded or Tube connection |

**Pressure Transmitter**

Pressure measuring system shall measure pressure and transmit signal proportional to pressure. The system shall consist of a combined pressure transducer and transmitter, digital panel indicator, connecting pipe work, diaphragm seal and valves. Pressure measuring system shall be rugged in construction and shall be capable for with standing surge pressures likely to occur in the monitored system. Pressure transmitters shall have over range protection up to 1.5 times the maximum line pressure and shall be capable of withstanding full line pressure on any side with the other side vented to atmosphere without damage or effect on the calibration. No plastic material shall be used in their construction. Internal parts shall be of stainless steel, bronze or approved corrosion-resistant material. Where necessary, a special diaphragm shall be used to segregate the corrosive fluid media. In ammonia applications, the diaphragm shall be in stainless steel.

The zero and span of a pressure transmitter shall not change by more than ±0.1% of the span per °C change in ambient temperature. After application for 10 minutes of pressure at 130% of maximum pressure, the change in zero and span shall not exceed ±0.1% of the span. Pressure transmitters shall be protected to BS EN 60529:1992, IP 65 standard or higher. For transmitters installed in locations liable to flooding or underwater applications, they shall be to IP 68 standard and shall operate up to a maximum submergence of 20 meters of water.

**Technical Specifications**

| | | |
|---|---|---|
| Parts | : | Transmitter and communicator |
| Type | : | Electronic variable capacitance; two-wire transmitter |
| Application | : | H2S laden atmosphere and other poisonous gases,Corrosive Waste Water Environment |
| Safety | : | Explosion Proof or Intrinsically Safe |
| Range | : | As required at site |
| Accuracy | : | ± 0.25% of span or better |
| Humidity | : | 0 to 100% relative humidity |
| Damping | : | Fluid or electronic type with adjustment |
| Indicator | : | LCD with LED backlighting |
| Materials | : | Wetted parts including process flanges and drain / vent valves, Type 316 stainless steel unless otherwise specified |
| Wetted O-Rings | : | Glass filled TFE, graphite filled PTFE, or Viton,unless otherwise specified |
| Fill Fluid | : | Silicone |
| Output | : | 4-20mA DC output proportional to the pressure range |
| Mounting | : | Pipe or wall as specified. Provide stainless steel brackets with stainless steel bolts |
| Housing | : | Modular with separate compartments for electronics and field wiring termination. Epoxy coated aluminium, unless otherwise specified |
| Power Supply | : | 230 V AC ± 10%, 50 Hz |
| Operating Temperature: | | 0 to 50°C |
| Communication Protocol: | | Open Protocol like MODBUS, PROFIBUS, etc. |

**Level Measuring System**

**Level Gauges (Magnetic Type)**

Magnetic type level gauges shall be used. It consists of a chamber, a magnet equipped float which rises and lowers with the fluid level, and an indicator which is mounted to the chamber.

The indicator houses a column of small flags which indicate the level of the fluid in the chamber, based on the position of the float. As the fluid level rises and lowers, the float rises and lowers as well, and the flags are tripped from one orientation to the other; typically, the red side indicates the liquid level and the silver side indicates the vapor space.

As the float rises and falls with the process level, tripping the flags, it also stimulates any attached transmitters and switches, providing a signal back to the control system.

The indicators contain flags made of aluminium coated with paint, which can withstand high temperatures. The flags are assembled so that the components are prevented from separating, for example due to vibration in the application.

The standard flag color is red, which is the universal color of warning and stands out in an industrial environment, making sure the level in the vessel is highly visible.

**Technical Specifications**

| | | |
|---|---|---|
| Float Cage Material | : | PP |
| Wetted Part Material | : | PP |
| Indicator Housing | : | Aluminium |
| Process Connection Orientation | : | Side Flanged |
| Process Connection Material | : | PP |
| Process Connection Size & Rating | : | 40 NB, ANSI B16.5,150#,FF |
| Visibility | : | 100% |
| C-C Distance | : | As per Process requirement |
| Float Material | : | PP |
| Display | : | Bicolor Rotating Flappers (Red & white) |
| Flapper MOC | : | SS304 |
| Scale MOC | : | SS-304 |
| Graduations | : | 10mm |
| Instrument Range | : | Equal to C-C distance |
| Fasteners | : | ASTM193 Gr.B7/A194 Gr.2H |
| Gasket | : | Viton |
| Vent Plug | : | 1/2” NPT Vent with Plug |
| Drain Valve | : | ½” NPT Ball Valve |

**Ultrasonic Level Transmitter**

Ultrasonic level measuring devices applied for liquid level measurement shall comprise of level sensor / transducer, level transmitter, digital level indicator / remote indicator, control unit and any other items required to complete the level measuring system.

The transducer shall be suitable for flange or bracket mounting as required. To reduce the effect of sewage turbulence in wet wells / tanks, averaging facility should be provided in the transmitter unit for providing steady readings.

The design and application of the ultrasonic level measuring system shall take into account the vessel / sump / wet well / channel construction, the material, size, shape, environment, process fluid or material, the presence of foam, granules, size etc.

In case of ultrasonic level sensor, the installation shall avoid any degradation of instrument performance due to spurious reflections, absorption, sound velocity variations, sensor detection area, temperature fluctuations, specific gravity changes and condensation. For applications where spurious reflections are unavoidable the control unit shall be provided with facilities for spurious reflection rejection. If turbulence exists, shielding, stilling tubes or other measures shall be provided to avoid effects on the measurement.

**TechnicalSpecifications**

| | | |
|---|---|---|
| Measuring Principal | : | Ultrasonic |
| Application | : | H2S laden atmosphere and other poisonous gases, Corrosive Waste Water Environment |
| Safety | : | Explosion Proof or Intrinsically Safe |
| Range | : | As required at site |
| Accuracy | : | ± 0.25% of measured value or better |
| Resolution | : | 2mm or 0.2 percent of range, whichever is greater |
| Blanking Distance | : | As short as 0.3 meters |
| Beam Angle | : | 12 degrees or less |
| Temperature compensation | : | Integral Mounting |
| a.) Sensor | : | Flange or bracket |
| b.) Transmitter / Controller | : | Wall, Panel, Pole Protection Category |
| a.) Sensor | : | IP-68 |
| b.) Transmitter / Controller | : | IP-66 (NEMA 4X) |
| Transmitter / Controller Type | : | Microprocessor Based |
| Diagnostic | : | Inbuilt |
| Display | : | LCD with LED backlighting |
| Power Supply | : | 230 V AC ± 10%, 50 Hz |
| Analog Output | : | Isolated 4 – 20mA |
| Relay Contacts | : | Minimum of 3 SPDT contacts |
| Zero & Span | : | Field Adjustable |
| Operating Temperature | : | 0 to 50°C |
| Communication Protocol | : | Open Protocol like MODBUS, PROFIBUS, etc. |
| Sensor Cable | : | Integral to sensor |
| Cable Length | : | As per site requirement |

**Ultrasonic Differential Level Measurement**

The ultrasonic type differential level measuring system shall consist of ultrasonic type level sensors on upstream and downstream of screens, differential level computer / transmitter and indicator. The flow computer / transmitter shall be microprocessor based and shall have facility for programming (i.e. adjustment of set points) while the sensor shall be capable of adjustable datum setting facilities.

The differential level control shall be done by two ultrasonic sensors, one before and one after the screen to sense the differential level through the screen and give a signal to the control to start the screens operation as soon as a pre-set differential level is reached. After receiving the level signal the control shall start and operate the screen as long as the pre-set level difference appears.

**Technical Specifications**

| | | |
|---|---|---|
| Measuring Principal | : | Ultrasonic |
| Application | : | H2S laden atmosphere and other poisonous gases, Corrosive Waste Water Environment |
| Safety | : | Explosion Proof or Intrinsically Safe |

| | | |
|---|---|---|
| Range | : | As required at site |
| Accuracy | : | ± 0.25% of measured value or better |
| Resolution | : | 2mm or 0.2 percent of range, whichever is greater |
| Blanking Distance | : | As short as 0.3 meters |
| Beam Angle | : | 12 degrees or less |
| Temperature compensation | : | Inbuilt |
| Mounting | | |
| a.) Sensor | : | Flange or bracket |
| b.) Transmitter / Controller | : | Wall, Panel, Pole Protection Category |
| a.) Sensor | : | IP-68 |
| b.) Transmitter / Controller | : | IP-66 (NEMA 4X) |
| Transmitter / Controller Type | : | Microprocessor Based |
| Diagnostic | : | Inbuilt |
| Display | : | LCD with LED backlighting |
| Power Supply | : | 230 V AC ± 10%, 50 Hz |
| Analog Output | : | Isolated 4 – 20mA |
| Relay Contacts | : | Minimum of 3 SPDT contacts |
| Zero & Span | : | Field Adjustable |
| Operating Temperature | : | 0 to 50°C |
| Communication Protocol | : | Open Protocol like MODBUS, PROFIBUS, etc. |
| Sensor Cable | : | Integral to sensor |
| Cable Length | : | As per site requirement |

**Flow Measuring System**

**Ultrasonic Flowmeter**

The flow meter should employ ultrasonic principle to measure level and level to flow conversion should be inbuilt in the unit. Ultrasonic flow measuring system shall consist of flow sensor

/ transducer, flow computer and flow transmitter. The flow transmitter shall be coupled with an ultrasonic level sensor for emitting and receiving ultrasonic waves and signal conditioning & flow compounding unit. The unit shall be suitable for installation in corrosive environment and shall be unaffected by H2S laden atmosphere.

Flow transducers shall be rugged in construction and shall be suitable for continuous operation. Flow transducers shall have waterproof construction and shall be suitable for installation in underground/ above ground pipeline.

The design and application of ultrasonic level meter shall take into account the channel construction, the material size, shape, environment, process fluid or material, the presence of foam granules, size etc. To avoid the effects of disturbances in the velocity profile, a straight and uninterrupted run, upstream as well as downstream from the location of the flow sensor shall be provided in accordance with the requirements of the flow meter manufacturer.

The flow transmitter shall be suitable for field mounting and shall accept an input from the flow sensor. It shall process the input signal and provide isolated 4-20mA/0-10VDC output proportional to flow rate. The flow range shall be adjustable.

Flow measurement shall not be affected by physical properties of waste water viz., temperature, pressure, viscosity, density etc., within given limits. The system should have inbuilt temperature sensor for automatic compensation for changes in air temperature to ensure measurement accuracy. Contractor shall provide additional compensating electronic circuits if required. The installation shall avoid any degradation of performance from spurious reflections, absorption, sound velocity variations, sensor detection area, temperature fluctuation, specific gravity changes and condensation. For application where spurious reflections are unavoidable the control unit shall be provided with facilities for spurious reflection rejection. The structure required for supporting the level sensor, platform, railings etc. shall be in the contractor's scope.

**Technical Specifications**

| | | |
|---|---|---|
| Measuring Principal | : | Ultrasonic |
| Application | : | H2S laden atmosphere and other poisonous gases, Corrosive Waste Water Environment |
| Safety | : | Explosion Proof or Intrinsically Safe |
| Range | : | 2 Meters |
| Accuracy | : | ± 0.5% of measured value or better Mounting |
| a.) Sensor | : | Installation in open channel (above Parshall Flume) |
| b.) Transmitter / Controller | : | Wall, Panel, Pole |
| Protection Category | | |
| a.) Sensor | : | IP-65 |
| b.) Transmitter / Controller | : | IP-66 (NEMA 4X) |
| Transmitter / Controller Type | : | Microprocessor Based |
| Diagnostic | : | Inbuilt |
| Display | : | LCD with LED backlighting |
| Power Supply | : | 230 V AC ± 10%, 50 Hz |
| Analog Output | : | Isolated 4 – 20mA |
| Relay Contacts | : | Minimum of 3 SPDT contacts |
| Zero & Span | : | Field Adjustable |
| Operating Temperature | : | 0 to 50°C |
| Temperature Compensation | : | Inbuilt temperature sensors for automatic compensation for changes in air temperature |
| Communication Protocol | : | Open Protocol like MODBUS, PROFIBUS, etc. |
| Sensor Cable | : | Integral to sensor |
| Cable Length | : | As per site requirement |

**Velocity Flowmeter**

The flowmeter shall be designed for open channel flow monitoring applications. The meter can calculate flow using standard open channel level to flow and area velocity conversions, as well as user- defined equations, level to area data points, or level to flow data points, depending on the application need.

The Flowmeter has unique features for data integrity. It logs key events such as changes in calibration and power changes to validate data accuracy. Data can be easily reviewed to detect any type of data alteration.

**Standard Features**

- 485 Modbus Input
- RS-585 Modbus output
- Multiple parameter data logging
- Program & Summary Reports
- Data Integrity Verification

**Applications**

Flow measurement

**Options and Accessories**

- Analog output card
- Battery Backup Power
- Mechanical Totalizer
- Advanced Cellular and Ethernet communication option
- Mounting Hardware

**Technical Specifications**

| | | |
|---|---|---|
| Materials | : | Polyphenylene Oxide PPO |
| Enclosure | : | NEMA 4X/IP66 |
| Power required | : | 100 to 220V AC, 50 Hz |
| Cable entry | : | Standard ¾" NPT conduit |
| Flow measurement | : | Area Velocity Technology |
| Inputs | : | Analogue In |
| Setup | : | Front Panel Key Board, Remote Cellular or Ethernet |
| Flow conversion | : | Area Velocity |
| Data Retrieval | : | USB Drive, remote cellular or Ethernet |
| Outputs | : | Modbus, Analog |
| **Sensor** | | |
| Materials | : | Epoxy, chlorinated PC, SST, Cable-UV-Rated PVC |
| Temperature Range | : | 0 to 70°C |
| Velocity Measurement Range | : | -1.5 to 6.1 m/s |
| Velocity Measurement | : | Bi-directional |

| | | |
|---|---|---|
| Velocity Accuracy | : | +/- 0.03 m/s |
| Minimum Depth | : | 25 mm |
| Level Measurement Range | : | 0.01 to 3.05m |
| Level Accuracy | : | +/- 0.10% Full Scale |

**Electromagnetic Flowmeter**

Flow meters shall operate on the electromagnetic induction principle and shall consist of a measuring sensor and measuring transmitter complying with ISO 6817:1997. Measuring sensors shall have a full bore stainless steel metering tube and non-conductive, abrasion-resistant lining to suit the fluid being metered. The lining of material can be of PTFE or polyurethane. No rubber lining will be allowed. The flow meter shall have flanged connection. Measuring sensors shall have factory-sealed power and signal cables. Unless otherwise specified, the cable lengths shall be sufficient to permit termination external to the chamber, either at a junction box or at the measuring transmitter. Remote flow indicator cum integrator shall be provided on the control panel.

Measuring sensors installed within a chamber shall be suitable for indefinite submersion under a head of water equal to the chamber depth or 3 meters whichever is the greater. Measuring sensors shall be installed on a steel cradle or concrete plinth with upstream and downstream straight pipe lengths not less than those recommended by the manufacturer. When fitted in lined non-metallic or internally- coated pipe work, measuring sensors shall have an earthing electrode or corrosion-resistant earthing rings. To ensure full electromagnetic compatibility the flow tube flanges and transmitter housing shall be connected earth.

Measuring sensors shall be bonded by tinned copper braid links at each end to the adjacent pipe work to ensure a good connection between the body and the metered liquid. Measuring sensors installed in a catholic protected pipeline shall have isolation and bonding in accordance with therecommendations of the manufacturer. The measuring transmitter shall provide a precise current input to the field winding of the measuring sensor and shall convert the resultant signal from the electrodes to analogue and pulse outputs in accordance with IEC 60381-1:1982. The signal processing facilities of the converter shall ensure that the output signals are unaffected by interfering voltages, stratified flow, changes in fluid electrical conductivity within the limit stated, non-homogeneity of the fluid and the presence of ferrous particles. The zero and output signals shall be unaffected by partly-fouled electrodes.

The following measuring transmitter features shall be provided as a minimum; additional requirements may be stated elsewhere in the Specification: -

<u>Measuring Transmitter Features:</u>

- Pulsed D.C. field excitation
- Scaled pulse output for integration counter drive
- Capability of bi-directional measurement with differing forward and reverse ranges and with local and remote indication of flow reversal

- Contact operation at a programmable measured value
- Integral display of flow and integrated quantity
- Galvanic isolation between each output circuit and between the electrode circuit and output circuit
- Output circuit isolation from earth within the instrument but suitable for earthing at any point in the external circuit
- Key entry for basic parameters
- Commissioning and re-scaling to require no special programming knowledge
- Adjustable low flow cut-off

Self-diagnosis

- Continuously adjustable velocity and flow range settings
- Terminals accommodated in a compartment separate from electronic components
- Outputs including: analogue - 4-20mA
- Pulse - two programmable outputs
- Alarms - two outputs programmable for high/low
- Flow, polarity, forward/reverse, instrument fault, liquid sensing fault condition including partially empty pipe

**Technical Specifications**

| | | |
|---|---|---|
| Measuring Principal | : | Electromagnetic |
| Type | : | Pulsed DC |
| Application : | | H2S laden atmosphere and other poisonous gases, Corrosive Waste Water Environment |
| Safety | : | Explosion Proof or Intrinsically Safe |
| Metering Tube | : | SS 304 |
| Sensor Housing | : | SS 304 fully welded |
| Connection / Junction Box | : | SS 304 |
| Lining Material | : | PTFE/Polyurethane |
| Range | : | As per site requirement |
| Accuracy | : | ± 0.5% of flow rate at maximum mean velocity of 1.5 to 3.0 m/sec |
| Electrode Type: | | Flush or bullet nose as recommended by the Manufacturer |
| Earthing Ring/Electrode Material | : | Type 316 stainless steel |

Protection Category

| | | |
|---|---|---|
| a.) Sensor | : | IP-68 |
| b.) Transmitter / Controller | : | IP-65 |
| Transmitter / Controller Type | : | Microprocessor Based |
| Display | : | Indicating and totalizing |
| a.) Indicator | : | Digital 16-character display |
| b.) Totalizer | : | Digital 16-character display |

| | | |
|---|---|---|
| Mounting | : | Pipe, wall, panel |
| Diagnostic | : | Inbuilt |
| Power Supply | : | 230 V AC ± 10%, 50 Hz |
| Analog Output | : | Isolated 4 – 20mA / 0-10VDC output based on the flow rate |
| Zero & Span | : | Field Adjustable |
| Turndown Ratio | : | Minimum of 10 to 1 when flow velocity at minimumflow is at least 0.3 meters per second |
| Zero Stability Feature | : | Required to eliminate the need to stop flow tocheck zero alignment |
| Pressure Loss | : | Very Low |
| Removable Electrodes | : | Required |
| Flange Material | : | Carbon steel, Epoxy Coated |
| Empty Pipe Detection | : | Inbuilt |
| Operating Temperature | : | 0 to 50°C |
| Temperature Compensation | : | Inbuilt temperature sensors for automaticcompensation for changes in air temperature |
| Communication Protocol | : | Open Protocol like MODBUS, PROFIBUS, etc. |

**DPT (orifice Type Flowmeter)**

Differential pressure flowmeters, also known as DP flowmeters, create a cross sectional change in the flow tube, which causes the velocity of the flowing fluid to change. A change in velocity occurswhenever there is a change in flow cross-section; i.e., with a decrease in velocity, an increase in pressure occurs. Differential pressure flowmeters can be used as liquid flowmeters or gas flowmeters.

Flat metal plate with an opening in the plate, installed perpendicular to the flowing stream in a circular pipe. As the flowing fluid passes through the orifice, the restriction causes an increase in velocity and decrease in pressure. A differential pressure transmitter is used to measure pressure between the orifice and the pipe flow stream. There is always a permanent pressure loss. No dirty liquids allowed. Orifice differential pressure flowmeters can be constructed to measure gas, liquid or steam. Orifice plates are primary flow elements which measure flow as a function of differential pressure.

**Technical Specifications**

| | | |
|---|---|---|
| Application | : | Fluids (Air Blowers outlet) |
| Orifice assembly | : | 316L SS |
| Stem and Manifold | : | 316L SS |
| Transmitter Sensing House | : | 304 L SS |
| Process Isolating Diaphragms Seal | : | PTFE |
| Process Connection | : | ASME B16.5 (ANSI) Class 150,300) |
| Type of Transmitter | : | Two Wire |
| Input Supply | : | 24 V DC |
| Out Put | : | 4 to 20mA (Isolated) HART |

| | | |
|---|---|---|
| Accuracy | : | + 1.5% |
| Range ability | : | + 0.1% |
| Zero & Span Adjustment | : | Available |
| Sensing Element | : | Membrane |
| Sensing Element Material | : | 316L SS |
| Wetted O'ring Material | : | FKM Viton |
| Process Connection | : | ½' (M) Adaptor |
| Fill Fluid | : | Silicon |
| Mounting | : | 2" Pipe Mpounting |
| Enclosure Material | : | Die Cast Aluminium with protective powder coating on polyester based. |
| Enclosure Protection Class | : | IP66 |
| Cable Entry | : | ½"(NPT)F |
| Display | : | Digital 7 Segment Back lit LCD Display |
| Area Classification | : | Safe |
| Alarm Contact (Upper Limit & Lower Limit) | : | Required |

**Gas Flowmeter (Ultrasonic Type)**

Ultrasonic measurement system dedicated for process gas flow application shall be used for measuring the gas flowing in bio gas lines.

**Technical Specifications**

**A. Measuring System**

| | | |
|---|---|---|
| Area Classification | : | Hazardous |
| Measuring Principle | : | Ultrasonic Transit Time |
| Application | : | Flow Measurement of bio gas |

**B. Design**

| | | |
|---|---|---|
| Features | : | 1 or 2 path all welded flow sensor with o-ring fitted with titanium transducers. |
| Modular Cons Construction | : | The measurement system consists of a measuring sensor and a signal converter. |
| Measuring Range | : | -30 to +30 m/s |

**Signal Converter**

| | | |
|---|---|---|
| Inputs/Outputs | : | Current, pulse, frequency and/or status output, limit switch and/or control input. |
| Self-Diagnostics | : | Integrated verification, diagnosis function: flowmeter, process measured value, bar graph. |
| Communication interfaces | : | Modbus, HART, FF |

**Display**

| | | |
|---|---|---|
| Graphic display | : | LC display, backlit white. |
| Operator input elements | : | 4 optical keys for operator control of signal converter without opening the housing |
| Remote Control | : | All DTM's and drivers will be available at internet homepage of the manufacturer. |
| Accuracy | : | +/- 2% of actual measured value. |
| Repeatability | : | <+/- 0. 2% |

**Materials**

| | | |
|---|---|---|
| Sensor | : | NACE MR175/103 |
| Transducer | : | Titanium grade 29 |
| Transducer Holder | : | 316LSS |
| Transducer O-ring | : | Standard: FKM/FPM |
| Coating | : | Polyurethane |
| Converter housing | : | Die-cast aluminium, polyurethane coated |
| Power Supply | : | 22oV AC/24V DC |
| Signal Cable | : | Shielded cable with 2 triax cores |
| Cable entries | : | ½" NPT |

**Temperature Monitoring Instrument**

**Temperature Transmitter**

Temperature Transmitter shall have a sensor usually RTD (Resistance Temperature Detector) that collects the data about temperature from a particular source and converts the data into understandable form for a device or an observer. RTD sensor is one of the most accurate sensors. In resistance temperature detector resistance is proportional to temperature. The sensor is made from platinum, nickel and copper metals. It requires an external current source to function properly.

The technique used to measure temperature by RTD shall be two wire in which current is forced through RTD to measure the resulting voltage.

**Technical Specifications**

| | | |
|---|---|---|
| Area Classification | : | Safe & Hazardous |
| Type | : | Two Wire |
| RTD Type Supported | : | Yes |
| Power Supply | : | 24 V DC |
| Output | : | 4-20mA, HART, Isolated |
| Accuracy | : | + 0.2% |
| Instrument Range | : | As Required |
| Calibration Range | : | as Required |
| Mounting | : | 2" Pipe Mounting |
| RTD Cable Connection | : | ½" NPT(F) |
| Enclosure Material | : | Aluminium, Polyester Powder Coated |
| Enclosure Protection Class | : | IP66 |

| | | |
|---|---|---|
| Electrical Connection | : | ½" NPTF |
| Display | : | LCD, Local Indicator |
| Certification | : | ATEX Certification |

**Quality Monitoring instruments (Analyzers)**

**DO Analyzer**

DO Analyzers shall be installed to continually record the dissolved oxygen level at every grid within each aeration basin. The primary sensing device used for the dissolved oxygen level measurement, shall be a sensing probe mounted within the aeration basin and connected to a controller for displaying and transmitting the results

**Technical Specifications**

| | | |
|---|---|---|
| Measuring Principal | : | Optical |
| Application : | | H2S laden atmosphere and other poisonous gases, Corrosive Waste Water Environment |
| Safety | : | Explosion Proof or Intrinsically Safe |
| Range | : | 0 to 20.0 ppm, 0 to 20.0 mg/L |
| Accuracy | : | ± 0.5% or better |
| Repeatability | : | ±0.5% of span |
| Sensitivity | : | ±0.5% of span |
| Pressure Limit | : | 4 - 6 bar |
| Temperature Indication | : | Inbuilt |
| Calibration Method : | | Air Calibration: One point, 100% water saturated air;Sample Calibration: Comparison to standard instrument, or comparison to Winkler Titration method |
| Cleaning : | | Air Blast Unit. Probe should be able to function with cleaning unit attached to it |
| Mounting | | |
| a.) Sensor | : | Inside aeration basin at each grid |
| b.) Transmitter / Controller | : | Wall, Panel, Pole |
| Protection Category | | |
| a.) Sensor | : | IP-68 for Sensor |
| b.) Transmitter / Controller | : | IP-66 (NEMA 4X) |
| Transmitter / Controller Type | : | Microprocessor Based |
| Diagnostic | : | Inbuilt |
| Display | : | LCD with LED backlighting |
| Power Supply | : | 230 V AC ± 10%, 50 Hz |
| Analog Output | : | Isolated 4 – 20mA |
| Relay Contacts | : | Minimum of 2 SPDT contacts |
| Operating Temperature | : | 0 to 50°C |
| Communication Protocol | : | Open Protocol like MODBUS, PROFIBUS, etc. |
| Sensor Cable | : | Integral to sensor |

| | | |
|---|---|---|
| Cable Length | : | As per site requirement |

**TSS Analyzer**

**Technical Specifications**

| | | |
|---|---|---|
| Measuring Principal | : | Optical |
| Application : | | H2S laden atmosphere and other poisonous gases, Corrosive Waste Water Environment |
| Safety | : | Explosion Proof or Intrinsically Safe |
| Range | : | 0 – 50 mg/l, 0 - 1000 mg/l, 0 – 5000 mg/l |
| Accuracy | : | <5% of reading or better |
| Pressure Limit | : | 6 bar |
| Flow Rate | : | Maximum 3m per second |
| Temperature Indication | : | Inbuilt |
| Calibration Method | : | Single point or two point |
| Sensor Cleaning | : | Inbuilt |
| Mounting | | |
| a.) Sensor | : | Inside pipe / channel / tank |
| b.) Transmitter / Controller | : | Wall, Panel, Pole |
| Protection Category | | |
| a.) Sensor | : | IP-68 for Sensor |
| b.) Transmitter / Controller | : | IP-66 (NEMA 4X) |
| Transmitter / Controller Type | : | Microprocessor Based |
| Diagnostic | : | Inbuilt |
| Display | : | LCD with LED backlighting |
| Power Supply | : | 230 V AC ± 10%, 50 Hz |
| Analog Output | : | Isolated 4 – 20mA |
| Relay Contacts | : | Minimum of 2 SPDT contacts |
| Operating Temperature | : | 0 to 50°C |
| Communication Protocol | : | Open Protocol like MODBUS, PROFIBUS, etc. |
| Sensor Cable | : | Integral to sensor |
| Cable Length | : | As per site requirement |

**pH Analyzer**

**Technical Specifications**

| | | |
|---|---|---|
| Measuring Principal | : | Combination / Differential Electrode |
| Application : | | H2S laden atmosphere and other poisonous gases, Corrosive Waste Water Environment |
| Safety | : | Explosion Proof or Intrinsically Safe |
| Range | : | 0 - 12 pH |
| Accuracy | : | ±0.02 pH or better |
| Repeatability | : | ±0.05 pH |
| Sensitivity | : | ±0.01 pH |
| Pressure Limit | : | 4 - 6 bar |

| | | |
|---|---|---|
| Flow Rate | : | Maximum 3m per second |
| Temperature Indication | : | Inbuilt |
| Temperature Compensation | : | Inbuilt automatic temperature compensation |
| Temperature Accuracy | : | ±0.5 °C |
| Calibration Method | : | Two point automatic, one point automatic, two point manual, one point manual |
| Mounting | | |
| a.) Sensor | : | Inside pipe / channel / tank |
| b.) Transmitter / Controller | : | Wall, Panel, Pole |
| Protection Category | | |
| For Transmitter / Controller | : | IP-66 (NEMA 4X) |
| Transmitter / Controller Type | : | Microprocessor Based |
| Diagnostic | : | Inbuilt |
| Display | : | LCD with LED backlighting |
| Power Supply | : | 230 V AC ± 10%, 50 Hz |
| Analog Output | : | Isolated 4 – 20mA |
| Relay Contacts | : | Minimum of 2 SPDT contacts |
| Operating Temperature | : | 0 to 50°C |
| Communication Protocol | : | Open Protocol like MODBUS, PROFIBUS, etc. |
| Sensor Cable | : | Integral to sensor |
| Cable Length | : | As per site requirement |
| Sensor Cleaning | : | Inbuilt (Air &Water ) |

**Ammonia Analyzer**

**Technical Specifications**

| | | |
|---|---|---|
| Application | : | H2S laden atmosphere and other poisonous gases, Corrosive Waste Water Environment |
| Safety | : | Explosion Proof or Intrinsically Safe |
| Range | : | 0 – 5 mg/l, 0 - 50 mg/l |
| Accuracy | : | 3% ±1mg/l or better |
| Repeatability | : | 2% ±1mg/l or better |
| Flow Rate | : | Maximum 20 L/h |
| Cleaning | : | Automatic |
| Mounting | | |
| a.) Analyzer | : | Wall, Panel |
| b.) Transmitter / Controller | : | Wall, Panel, Pole |
| Protection Category | | |
| a.) Analyzer | : | IP-55 or better |
| b.) Transmitter / Controller | : | IP-66 or better |
| Transmitter / Controller Type | : | Microprocessor Based |
| Diagnostic | : | Inbuilt |
| Display | : | LCD with LED backlighting |
| Power Supply | : | 230 V AC ± 10%, 50 Hz |
| Analog Output | : | Isolated 4 – 20mA |

| | | |
|---|---|---|
| Relay Contacts | : | Minimum of 2 SPDT contacts |
| Operating Temperature | : | 0 to 50°C |
| Communication Protocol | : | Open Protocol like MODBUS, PROFIBUS, etc. |
| Cable Length | : | As per site requirement |

**BOD Analyzer**

**Technical Specifications**

| | | |
|---|---|---|
| Measuring Principle | : | UV Absorption |
| Application : | | H2S laden atmosphere and other poisonous gases, Corrosive Waste Water Environment |
| Safety | : | Explosion Proof or Intrinsically Safe |
| Range | : | 0 – 50 mg/l, 0 - 500 mg/l |
| Accuracy | : | ± 5% or better |
| Compensation | : | 550 nm |
| Sample pH | : | 4.5 to 9 pH |
| Pressure Limit | : | 0.5 bar |
| Cleaning | : | Automatic Mounting |
| a.) Sensor | : | Inside pipe / channel / tank |
| b.) Transmitter / Controller | : | Wall, Panel, Pole |
| Protection Category | | |
| a.) Sensor | : | IP-68 |
| b.) Transmitter / Controller | : | IP-66 (NEMA 4X) |
| Transmitter / Controller Type | : | Microprocessor Based |
| Diagnostic | : | Inbuilt |
| Display | : | LCD with LED backlighting |
| Power Supply | : | 230 V AC ± 10%, 50 Hz |
| Analog Output | : | Isolated 4 – 20mA |
| Relay Contacts | : | Minimum of 2 SPDT contacts |
| Operating Temperature | : | 0 to 50°C |
| Communication Protocol | : | Open Protocol like MODBUS, PROFIBUS, etc. |
| Sensor Cable | : | Integral to sensor |
| Cable Length | : | As per site requirement |

**COD Analyzer**

**Technical Specifications**

| | | |
|---|---|---|
| Measuring Principle | : | UV Absorption |
| Application : | | H2S laden atmosphere and other poisonous gases, Corrosive Waste Water Environment |
| Safety | : | Explosion Proof or Intrinsically Safe |
| Range | : | 0 – 250 mg/l, 0 - 1000 mg/l |
| Accuracy | : | ± 5% or better |
| Compensation | : | 550 nm |
| Sample pH | : | 4.5 to 9 pH |

| | | |
|---|---|---|
| Pressure Limit | : | 0.5 bar |
| Cleaning | : | Automatic |
| Mounting | | |
| a.) Sensor | : | Inside pipe / channel / tank |
| b.) Transmitter / Controller | : | Wall, Panel, Pole |
| Protection Category | | |
| a.) Sensor | : | IP-55 or better |
| b.) Transmitter / Controller | : | IP-55 or better |
| Transmitter / Controller Type | : | Microprocessor Based |
| Diagnostic | : | Inbuilt |
| Display | : | LCD with LED backlighting |
| Power Supply | : | 230 V AC ± 10%, 50 Hz |
| Analog Output | : | Isolated 4 – 20mA |
| Relay Contacts | : | Minimum of 2 SPDT contacts |
| Operating Temperature | : | 0 to 50°C |
| Communication Protocol | : | Open Protocol like MODBUS, PROFIBUS, etc. |
| Sensor Cable | : | Integral to sensor |
| Cable Length | : | As per site requirement |

**Total Phosphorus Analyzer**

**Technical Specifications**

| | | |
|---|---|---|
| Measuring Principle | : | Photometric |
| Application | : | H2S laden atmosphere and other poisonous gases, Corrosive Waste Water Environment |
| Safety | : | Explosion Proof or Intrinsically Safe |
| Range | : | 0 - 10 mg/l |
| Accuracy | : | 2% of the measured value + 0.05 mg/L or better |
| Repeatability | : | 2% of the measured value + 0.05 mg/L |
| Flow Rate | : | Maximum 20 L/h |
| Sample pH | : | 5 to 9 pH |
| Pressure Limit | : | 0.05 bar |
| Mounting | | |
| a.) Analyzer | : | Wall, Panel |
| b.) Transmitter / Controller | : | Wall, Panel, Pole |
| Protection Category | | |
| a.) Analyzer | : | IP-55 or better |
| b.) Transmitter / Controller | : | IP-55 or better |
| Transmitter / Controller Type | : | Microprocessor Based |
| Diagnostic | : | Inbuilt |
| Display | : | LCD with LED backlighting |
| Power Supply | : | 230 V AC ± 10%, 50 Hz |
| Analog Output | : | Isolated 4 – 20mA |
| Relay Contacts | : | Minimum of 2 SPDT contacts |
| Operating Temperature | : | 0 to 50°C |

| | | |
|---|---|---|
| Communication Protocol | : | Open Protocol like MODBUS, PROFIBUS, etc. |
| Cable Length | : | As per site requirement |

**Oil In Water Analyzer**

**Technical Specifications**

| | | |
|---|---|---|
| Measuring Principle | : | UV Fluorescence / Laser Induced Fluorescence |
| Application : | | H2S laden atmosphere and other poisonous gases, Corrosive Waste Water Environment |
| Safety | : | Explosion Proof or Intrinsically Safe |
| Range | : | 0 – 15 ppm |
| Accuracy | : | ± 5% or better |
| Cleaning | : | Automatic |
| Analyzer Type | : | Panel Type / Sensor (Probe Type) |
| **Mounting** | | |
| a.) Panel Type | : | Wall Mounted |
| b.) Sensor (Probe Type) | : | Inside pipe / channel / tank |
| c.) Transmitter / Controller | : | Wall, Panel, Pole |
| Protection Category | | |
| a.) Sensor | : | IP-68 |
| b.) Transmitter / Controller | : | IP-66 (NEMA 4X) |
| Transmitter / Controller Type | : | Microprocessor Based |
| Diagnostic | : | Inbuilt |
| Display | : | LCD with LED backlighting |
| Power Supply | : | 230 V AC ± 10%, 50 Hz |
| Analog Output | : | Isolated 4 – 20mA |
| Relay Contacts | : | Minimum of 2 SPDT contacts |
| Operating Temperature | : | 0 to 50°C |
| Communication Protocol | : | Open Protocol like MODBUS, PROFIBUS, etc. |
| Sensor Cable | : | Integral to sensor |
| Cable Length | : | As per site requirement |
| Sensor Cleaning | : | Inbuilt (Air &Water) |

## 6.8 Surge Protection Devices

Surge protection devices (SPDs) shall be suitable for withstanding the surge arising out of high energy static discharge / lighting strikes and protect the instrument to which it is connected against damage. SPDs shall provide protection through the use of quick acting semiconductors like Tranzorb, zener diodes, varistors and an automatic disconnect and reset circuit. SPDs shall be passive and shall require negligible power for operation. During the occurrence of a surge it shall clamp on the allowable voltage and pass the excess voltage to the ground. The SPD shall be self-resetting to minimize the down time of the measurement loop.

SPDs shall be provided to protect devices transmitting and receiving analogue and digital signals derived from field devices located outdoors.

The surge protection device shall be rated for surge rating of 10kA.

Two numbers of surge protection devices (SPDs) shall be provided for each signal and power loop for field instruments located out-doors. One SPD shall be provided in the field near transmitter and the other SPD of the loop shall be mounted in the control panel/ console.

SPDs shall also be provided in the 240 V AC incoming power supply to panels/ consoles. Surge protection devices (SPDs) shall be suitable for withstanding the surge arising out of high energy static discharge I lightning discharges and protect the instrument to which it is connected against damage. SPDs shall provide protection through the use of quick acting semiconductors like Tranzorb, zener diodes; varistors and an automatic disconnect and reset circuit. SPDs shall be passive and shall require negligible power for operation. During the occurrence of a surge it shall clamp on the allowable voltage and pass the excess voltage to the ground. The SPD shall be self- resetting to minimize the down time of the measurement loop.

SPDs shall have a weather proof casing and shall be suitable for field/back of panel mounting. There should be total isolation between input, output and ground terminals. The rating and type of SPDs shall be as per the instrument manufacturer's recommendation and shall be subject to Employer's representative's approval.

### 6.9 Cabinets for Field Instruments

Wall mounted cabinets shall be provided for enclosing transducer unit and associated accessories which are mounted outside the main control panel. The cabinet shall be of die-cast aluminium/FRP enclosure for field instruments provided not less than IP-65 protection and shall be lockable. The cabinet shall have facilities for earthing. A steel plate shall be provided inside the cabinet for mounting instrument and accessories.

### 6.10 Panel Details

**Cabinet / Enclosure for Instruments**

Enclosures shall be any form of board, cabinet, panel, desk, box or case used to protect, contain or group instrumentation, telemetry or control equipment. Cabinets shall be fabricated from cold rolled steel with powder coating sheet of minimum 2 mm thick and shall be suitable for wall mounting or pedestal mounting as required. A steel plate/pipe, as per the requirement, shall be provided in the cabinet for mounting the instrument and accessories. The cabinet shall be properly painted from inside and outside and shall have built in locking facility. The cabinet shall also be earthed properly. All equipment in or on enclosures shall be arranged logically and, as far as possible, symmetrically, with projections kept to a minimum. Each enclosure shall be designed on ergonomic principles and shall permit in-situ and safe access for any normal adjustment, maintenance and servicing. The tops of plant-mounted enclosures shall be sloped downwards from front to rear.

The minimum degree of protection shall be IP 54 for indoor locations and enclosures for use outside buildings or in places where splashing may occur shall have a minimum rating of protection to BS EN 60529:1992, IP 65 and have tops which project sufficiently to protect the vertical faces of the enclosure and any component mounted thereon from splashing, inclement weather and direct sunlight. Also, when enclosures for use outside buildings are located where exposure to direct sunlight will give rise to high top-panel surface temperatures such that the internal temperature rises above themanufacturer's recommendation (normally 4 °), the enclosure shall include a sun shield fitted to the top of the enclosure and should have sufficient air ventilation for heat dissipation.

Fixing arrangements for surface-mounting enclosures shall be external to the enclosure and shall ensure that the rear face of the enclosure is not in contact with the surface to which it is fixed. Enclosures shall have hinged access doors, fitted with recessed lockable handles. Doors shall be of rigid construction and provided with close-fitting flexible seals in recesses to prevent the ingress of liquids, moisture, dust and vermin. Hinges shall be of the lift-off pattern and one hinge shall engage before the other for ease of fitting. Wherever necessary, removable access covers secured by quick- release fasteners shall be provided to ensure ease of maintenance for all installed apparatus. Mounting plates, brackets and racks shall be provided for all other internal equipment which shall be hinged or otherwise arranged with quick-release fasteners or captive screws to give quick and easy access to equipment, securing screws, terminals and wiring.

Enclosures for two or more devices with electrical circuits shall have gland plates and terminal blocks as specified elsewhere. Each enclosure shall be designed for the safe testing and servicing of equipment with the power on. Each part which may be live under any circumstances shall be so covered or shielded as to prevent inadvertent contact.

**Panel Design and Construction**

Unless otherwise specified, all instrument panels, instrument cubicles, control panels, control consoles and desks, associated equipment and terminal racks, telemetry and electronic equipment racks and the like shall be free-standing, floor-mounted units and shall conform to the requirements of this part and will hereafter be referred to as panels. The design and dimensions of control consoles and desks shall be determined according to their intended function but shall be in accordance with the requirements of the Specification drawings. The height shall not exceed 1400mm above the finished floor level.

Unless otherwise specified or shown in the Specification drawings, the height of panels shall be not greater than 2130mm overall (excluding lifting devices) above finished floor level. Front-of-panel instruments and controls shall be mounted so that the height of their centers above the floor shall be generally between 1800mm and 900mm for indicators, 1400mm and 900mm for recorders and process controllers, 2000mm and 750mm for alarm facias and signal lamps and 1500mm and 750mm for manual controls. Controls, switches and push-buttons shall be positioned below or adjacent to any associated reading instrument. Panels for use in locations such as pumping stations and machinery rooms shall have anti-vibration mountings. The clearance between the extremities of apparatus mounted on the internal walls shall allow safe and unobstructed access to all terminals and to parts requiring maintenance. Panel layout drawings shall normally include a list of all instruments, accessories and

components contained therein. If the drawings have insufficient space for the list, a separate schedule of instruments, accessories and components shall be provided and the panel drawing shall contain a cross reference to the contents list and an indication of the panel location of each item on the list.

**Panels – Major**

Panels shall be constructed generally as specified in the preceding clause and as shown in the Specification drawings. Panel material shall be prime-quality, cold-rolled and annealed mild steel or zinc-coated mild steel sheet, suitably braced and stiffened as necessary with flat bar or angle to form a rigid structure.

Panel fronts shall be flat and free from bow or ripple. Exterior corners and edges shall be rounded or welded and ground to give a smooth overall appearance. Flanged edges shall be straight and smooth.

Materials shall be chosen with due regard to the panel size, number of cut-outs, instrument weight and position of center of gravity and method of fabrication, with the following:

- minimum thicknesses except where otherwise shown in the Specification drawings
- instrument bearing surfaces, gland plates and pneumatic distribution plates: 3mm
- internal mounting plates: 3mm
- doors, covers and filler panels: 2mm

No design involving the use of externally-visible assembly or fixing bolts and screws nor any design resulting in dust or water-collecting crevices will be accepted. Stiffeners and supporting frameworks shall be provided where necessary inside panels. Framework shall be hinged or fixed, suitable for the installation of instruments, components and internal equipment for which it is provided and located to give easy access to adjacent equipment.

When a panel is constructed in sections, the sections shall be designed for ease of assembly during installation and, in any case, shall not exceed 2m in length. All necessary nuts, bolts, washers and the like shall be supplied and included in the same shipment as the relevant sections. Sections exceeding 1m in length shall be provided with double doors. Unless otherwise shown in the Specification drawings, each panel shall be mounted on a self-draining base frame fabricated from 150mm deep, steel channel section which shall be drilled or provided with clamps for bolting to the floor. The base frame shall be set back from the panel front face to give a toe space of not less than 25mm. The outside of the base frame shall be covered with an approved kicking strip.

Ceiling and other filler panels shall be fabricated from sheet steel and adequately stiffened. Each section shall have 50mm returned edges along all four sides and shall be braced to the main steelwork of the panel. A chequered-plate floor shall be provided inside and above the level of the base frame, having openings suitable for the bottom entry of cables when applicable. Sufficient removable undrilled gland plates, in sections convenient for handling, shall be fitted close to the appropriate terminal blocks and not less than 230mm above the panel floor or not less than 230mm below the panel top. The gland plates shall have removable side covers giving access to both sides of the gland plate and ensuring vermin-

proof and dust-proof construction. Gland plates of a surface-mounted enclosure may form a part of the base or top. Panels containing pneumatic or other instruments using a fluid as the transmission medium shall have distribution plates with bulkhead unions for the termination of internal and external pipework.

All doors shall open outwards and all doors in one panel assembly shall use the same lock and key combination. Panel design shall ensure adequate ventilation and air circulation without permitting the entry of vermin or dust. Panels installed in control rooms or other clean condition areas shall have louvres to allow air circulation. Temporary closures shall be provided to prevent the entry of dust and vermin during transit and installation. After commissioning has been completed, all entries except air- circulation louvres shall be sealed.

No equipment other than front-of-panel items shall be mounted on panel wall surfaces. If electrical and non-electrical instruments are mounted in the same panel, the panel shall be subdivided internally to separate the electrical and non-electrical sections. All connections shall be arranged to ensure that no accidental damage to cabling or electrical components can occur in the event of failure of any non- electrical component or connection. Provision shall be made for safe and easy handling during transit and installation. If lifting eyes are provided, they shall be reversible and panel tops shall be reinforced where necessary.

Where equipment is specified to be installed at a future date, space shall be allocated, and cutouts with removable masking plates, brackets, supports, wiring, terminals and piping and the like shall beprovided. Panels shall be finish-coated at the place of manufacture before commencing the installation of apparatus and other fittings.

**Panels – Minor**

Panels for installation on the Plant which contain relatively few items of equipment, or where so specified elsewhere, shall be classed as minor panels and shall be constructed generally as specified in the preceding clause and comply with this Clause. Panels shall be fabricated from sheet steel or other approved material less than 2.5mm thick suitably braced to form a robust and rigid structure. Exterior corners and edges shall be rounded to give a smooth overall appearance and assembly bolts; screws or rivets shall not be visible on the front face.

The design shall be such as to ensure adequate ventilation and air circulation where required, without permitting the entry of vermin. Openings for cables shall be made vermin-proof. Doors shall be hinged and shall be provided with close-fitting flexible seals in recesses to prevent the ingress of liquids, moisture, dust and vermin. Unless otherwise specified, panels shall be suitable for floor mounting and shall not exceed 2130mm in height. Where surface mounted panels are provided, the fixing shall prevent the ingress of moisture and the rear of the enclosure shall be not less than 10mm from the wall.

Lifting eyebolts shall be removed, issued to the Purchaser and subsequently replaced with bolts after installation. Panels shall be extensible, and symmetrically arranged as far as possible with projections kept to a minimum. Where two or more panels are fitted together, they shall form a flush-fronted continuous panel of uniform height. Front door and top cover dimensions shall match. Instruments, relays, and control devices shall be mounted at a height not more than 2000mm and not less than 300mm from floor level.

The arrangement of equipment within each enclosure shall be such as to permit easy access for installation and maintenance. No instruments, relays or other components shall be mounted on rear access doors or removable covers.

**Panels – Composite**

In situations where space limitations preclude the use of separate instrumentation, control and automation (ICA) and switchgear panels and, at the sole discretion of the Engineer, ICA equipment may be combined within a single enclosure subject to the following conditions:

Enclosure

- The observance of all other clauses herein relating to enclosures, mounting boards and minor panels.
- The written assurance of each supplier of ICA equipment that the proximity of the switchgear will have no detrimental effect on the life or performance of any ICA component
- The total segregation of ICA equipment and switchgear including the glanding and termination facilities.
- The absence of any voltage exceeding 250V ac or 50V dc from any compartment containing ICA equipment.
- The use of the full height of the panel (excluding the busbar chamber and cable space) for any ICA equipment compartment.

**Panels - Glass Reinforced Plastic (GRP)**

Any panel required to be installed outside buildings shall, unless otherwise approved by the Engineer, be manufactured from double-skin, resin-bonded fiberglass, with a totally encapsulated infill of rigid weatherproof and ‘boil proof’ plywood to BS 12 3:2 1 between the two skins to provide a rigid and vandal-proof enclosure. The environmental rating shall be IP 65 or better.

For any application in a non-temperate climate or where so specified elsewhere, the roof section shall be sloping and have a totally-encapsulated infill of end-grain balsa instead of plywood. Box-section steel shall be encapsulated into door edges and door frames. Door locks, handles and hinges shall be of a high tensile strength, non-corroding alloy with stainless steel pins and through fixing bolts. Large plane surfaces shall have adequate reinforcing to ensure rigidity.

The doors shall be complete with latching handles and locks. All door catches and locks shall latch onto steel-reinforced surfaces. Threaded studs shall be incorporated into the design of the panel for the mounting of sub frames within the panel. Any panel drilled to provide fixings for internal equipment will not be accepted. Each cubicle shall be provided with a floor or deck with a removable gland plate for cable entry.

The laminate material shall have flame-retardant characteristics in compliance with BS 476 Class 2, and shall retain ‘stability, integrity and insulation’ for 3 minutes. olour-impregnated gel coats backed by coloured resin shall be used to ensure maintenance free and ‘colour-fast’

finishes. The external finish colour shall be advised by the Engineer and the internal finish colour shall be white. The fronts of externally-visible instruments and windows shall be of glass. An air-gap of 100mm shall be provided between the top surface of the panel and its protective canopy. All internal equipment shall be mounted on supports built into the fiberglass structure. Fixing bolts through the skin will not be accepted.

**Panel Protection**

Adequate facilities for isolation and protection by miniature circuit breaker or fuse for each instrumentation and control circuit and sub-circuit shall be provided and shall be so arranged that any interruption causes minimum disruption of plant, operates the appropriate alarm and cannot result in any unsafe operating condition. All fuses shall be of the cartridge pattern and main fuses shall be of the high rupturing capacity type. Fuse and solid-link carriers and bases shall be of plastic-moulded insulating material of an approved make. Ceramic materials will not be accepted. Live connections shall be efficiently shrouded and it shall be possible to change fuses with power on without danger of contact with live metal. The fuses shall be rated to give maximum protection to the equipment in circuit and the rating shall be permanently inscribed on the fuse label and on the fuse carrier.

Unless necessary for the protection of particular equipment, miniature circuit breakers used for individual circuits in a panel or control desk shall not trip on over-voltage or under-voltage. Bases for solid links shall not be interchangeable with those for fuses. Fuses and links in the same circuit shall be mounted opposite each other in separate adjacent rows and shall not alternate in the same row. At least 10% and not less than two unallocated miniature circuit breakers or fuses and links shall be provided in each panel distribution board. Miniature circuit breakers and fuses of similar size and rating shall be of the same make and type. At least 10%, and not less than two, spare fuses and links of each rating shall be provided and fitted in clips inside the panel.

Each instrument requiring a power supply shall be individually wired and protected so that, in the event of a failure in one circuit, the remainder is unaffected. Power supply circuits shall be of sufficient rating that any protective device may operate without reducing the voltage at the terminals of any other component to an unacceptable level. Remote alarms shall be operated on failure of theelectrical supply to a panel or to any internal sub-circuit. Clearly identifiable, switched socket outlets of 15A minimum rating to comply with IS 4615, supplied at the main cabinet operating voltages shall be fitted within the panel at the rate of one for each operating voltage per meter of panel length; for a panel whose length is less than one meter, one switched socket outlet for each main operating voltage shall be provided. Suitable socket outlets for portable tools and hand lamps shall be provided as specified elsewhere.

**Panel Isolation**

Clearly-labelled isolating circuit breakers shall be provided for each incoming power supply. Switches shall be of the quick make-and-break type with spring-loaded contacts that close

fully without requiring full operation of the handle. The handle and cover shall be interlocked so that the handle cannot be operated when the cover is open and the cover cannot be opened unless the switch is in the 'off' position. The 'on' and 'off' positions of each switch shall be indicated clearly.

Circuit breakers for panel power supplies shall be mounted near an access point and in positions where they may be operated easily from a standing position. Plug-in isolating links or devices of an approved type shall be provided in any circuit that may still be alive when the power supply isolators are in the 'off' position, as, for example, in circuits controlling equipment whose power supply is independent of the panel. Such links or devices shall be properly screened and, if not incorporated in or adjacent to their associated outgoing terminals, shall be labelled with suitable warning notices. Any item of panel equipment to which panel internal wiring is connected with a plug and socket instead of terminals shall be wired in flexible cable of adequate rating between the 'free' plug and a socket mounted adjacent to the device. The power supply connector shall be a socket.

**Panel Terminal Blocks**

External wiring for panel power supplies shall be terminated on the appropriate isolator. Signal cables from strain gauges, analyzers, resistance thermometers, re-transmitting slide wires and thermocouples may be terminated at their appropriate instruments. A terminal block shall be provided as the interface between the corresponding conductors of each internal and external wire and each internal and external connection except those listed above. The terminal blocks shall be mounted vertically where possible and not nearer than 230mm to the floor or less than 230mm from an incoming cable gland.

Terminal block rows shall be spaced apart by not less than 150mm and arranged to permit convenient access to wires and terminals and to enable ferrule numbers to be read without difficulty. Other circuits shall be grouped on the terminal blocks according to the classification given in the clause for 'Panel internal wiring' which shall be clearly marked along the corresponding section of each terminal board. Groups of different voltages on the same board shall be separated by insulated barriers.

All connections shall be made from the front of terminal blocks and no live metal shall be exposed at the back. All terminal blocks shall be of the type which clamps the wire securely and without damage between two plates by means of a captive screw and which permits removal of any terminal without disturbance to adjacent terminals. Pinch-screw type terminal blocks will not be accepted. Terminal moldings shall be in melamine to ISO 2112:1990, polyamide or equivalent. Terminal rails shall be hot-dip galvanized. Current bars between the two connection points of each terminal block shall be of copper or brass with tin/lead alloy plating. All steel parts shall be zinc-plated and passivated with a yellow chromate layer.

Terminal blocks for input and output analogue signals and for circuits containing volt-free contacts internal or external to the cabinet shall be of the Klippon type SAKC or equivalent which permit the connection of a test millimeter or continuity meter without disconnecting any wiring. Terminal blocksfor power supplies for equipment external to the panel shall permit the isolation of the item of external equipment without affecting the operation of any other circuit within or outside the panel.

No more than one core of external cables or one internal wire shall be connected to any terminal. If terminal blocks are used as common points for two or more circuits, individual terminals with the appropriate number of permanent cross-connections shall be provided. The lengths of exposed cable cores shall be sufficient to reach any terminal in the appropriate row or rows. The cores shall be formed into a neat loom and a separate loom shall be provided for each cable. Identification ferrules as specified in the clause for 'Panel wiring identification and termination' shall be fitted on each core of all external cables and on each internal wire. The size of the terminals shall be appropriate to the size and rating of the cable cores which will be connected to them but shall not be smaller than Klippon type SAK2.5 or equivalent unless otherwise agreed with the Engineer.

Each row of terminal blocks shall contain at least 25% spare terminals over the number required for terminating all cores of external cables in that row. Unless otherwise specified or shown in the Specification drawings, each external cable shall contain at least 20% spare circuits, with a minimum of one spare circuit. Terminal blocks shall be numbered consecutively in a sequence different from that used for identifying wiring. The terminal numbers, voltage grouping and terminal board layout shall correspond precisely with wiring diagrams so that quick and accurate identification of wiring can be made. All the terminal boards shall be provided with covers of transparent insulating material that does not sustain combustion and shall be sectionalized where possible to give access to groups of terminals without uncovering all boards. Terminals which may be live when the panel is isolated from its main supplies shall be suitably labelled to minimize the risk of accidental contact.

**Panel Internal Wiring**

Panel circuits shall be segregated into the following categories: -

Group 1: Power control and very-high-level signal wiring (above 50V):

- AC power supplies
- DC power supplies
- DC current signals above 50mA (such as CT circuits)
- AC voltage and control signals above 50V (such as PT circuits)

Group 2: High-level signal wiring (6V to 50V dc):

- Signals from conventional electronic transmitters and controllers (such as 4mA to 20mA)
- Circuits to alarm enunciators and other solid-state devices (excluding those in categories 2.1, 2.5, 3.1, 3.2 and 3.3)
- Digital signals
- Emergency shut-down and tripping circuits
- On / Off control circuits
- Intrinsically safe circuits
- Speech-frequency circuits

Group 3: Low-level signal wiring (5V dc and below):

- Signals from thermocouples

- Signals from resistance thermometers and re-transmitting slide-wires
- Signals from analytical equipment and strain gauges

*For Group 3 wiring, internal connections to the instruments shall be made by one of the following methods:*

- The twisted, screened conductors of the external cable shall be led direct to their appropriate instruments via ducting systems installed for this purpose during construction of the panel.
- The conductors of the external cables shall be terminated on terminals segregated from all other categories and the connections to the appropriate instruments shall be made using twisted pairs with individual screening installed for this purpose during construction of the panel.

Internal wiring for all circuits in Group 2 except those sharing a common connection shall be multi- stranded, twisted pair, 0.75mm² minimum copper conductors with HPDE or PVC insulated cable of adequate grade and rating in accordance with BS 6004:2000. Wiring for circuits in other Groups or sharing a common connection shall be run in stranded, 1.0mm² minimum copper conductors with 250V grade, PVC-insulated cable of adequate grade and rating. Wiring sheath colours shall be black for ac circuits, and grey for dc circuits (excluding thermocouple circuits) and blue for Group 2.6 circuits. Circuits supplied at 240V, between 240V and 110V dc shall also be physically segregated from each other and from other circuits. Access to wiring and components of circuits having voltages exceeding 240V shall not be possible unless and until the circuit has been isolated.

Separate ducts, trunking, cable looms, tray work and the like shall be provided within the panel for each category with at least 150mm between parallel paths of Group 1 and those of any other Group. Intrinsically-safe circuits and their terminals shall be segregated from other circuits and terminals. All wiring shall be neatly and securely fixed by insulated cleats, bunched and secured by approved plastic strapping or run in approved insulated wiring trunking or non-corrodible flexible tubing. Not more than 75% of the capacity of trunking, ducts, looming, or tubing shall be used. Insulated earth wiring shall be so arranged that access to any equipment or connection point or the removal of any item of equipment is unimpeded. Wiring for future equipment shall be secured and terminated on terminal blocks. Lacing for wiring looms shall be of rot-proof cord or plastic strips. Inter-section wiring in multi-section cabinets shall be via a terminal block in each section.

**Panel Wiring Identification And Termination**

Identification ferrules shall be fitted at both ends of each wire. The numbers or letters used shall correspond with the appropriate wiring diagram. The ferrules shall be of plastic insulating material with permanent black characters on a colour-coded background for numbers and on a white background for letters, unaffected by oil or water. They shall be so arranged that they can be read logically from left to right when viewed normally. The system of wire identification shall be such that wires in the same circuit on opposite sides of a terminal shall have the same reference, and this system shall be continued through all

external cabling. Terminal ferrules (spade, tongue, crimped connections) shall be provided on each conductor.

**Panel Earthing**

A continuous copper earth bar of not less than 25mm % 6mm cross section shall run the full length of each panel and shall be securely fixed and bonded electrically to the main frame. The cable gland- plates and the earth bar shall be provided with suitable brass terminals of not less than 6mm diameter for connecting the metal cladding or armouring of all incoming and outgoing cables to the station earthing system.

A second continuous copper earth bar of not less than 25mm % 6mm cross section, electrically isolated from the steelwork of the panel and metal cladding and armouring of cables, shall be provided for earthing the signal earth connection of each instrumentation and control device and the screen(s) of each instrument cable not earthed elsewhere to the station instrumentation earth plate. The earth bar shall have sufficient brass terminals as specified above for each instrumentation and control device and the screen of every shielded cable plus 25% spare terminals. In multi-section panels, each earth bar shall be electrically bonded to the corresponding bars in the adjacent section(s). Instrumentation and instrument cable screen earthing shall comply with BS 6739: 1986, Section 10, unless otherwise stated in this clause.

**Panel Heating**

Each panel shall have one or more thermostatically-controlled tubular or ribbed panel heaters to prevent condensation and assist ventilation and which shall be adequate for ambient temperatures down to 5°C. The heater rating shall not exceed 0.2W/mm and the surface temperature of any part which could be contacted accidentally shall not exceed 60°C. Heaters shall be so situated that no deterioration can be caused to any equipment or wiring in the panel. The heating circuits shall be switched and fused independently of the instrumentation and control equipment and manually controlled by an enclosed switch mounted in an accessible position within the panel. Thermostats shall be mounted remote from the heaters and other sources of heat and shall be fully adjustable over a range of not less than 0°C to 50°C.

Thermostats shall cut out each heater when the internal temperature of the panel exceeds a preset value; differential thermostats shall be used to maintain the panel internal temperature at a pre-set value above the external ambient temperature. If the permanent power supply is not available at the time of installation of the panel and condensation is detected, a temporary power supply shall be connected to the panel of sufficient rating to operate the heaters.

**Panel Lighting**

Each panel shall be adequately illuminated internally, as evenly and as free from dazzle as possible, by fixed fluorescent lighting controlled from totally-enclosed light switches and by totally-enclosed door-operated switches positioned so as not to interfere with access. There shall also be one installed inspection lamp per three meters of panel length or part thereof with adequate flexible connection cable to reach any point in the panel. The control switch for an inspection lamp shall form part of the lamp assembly. Lighting circuits shall be fused

independently of any instrumentation and control circuit and designed to allow lamps to be replaced safely and shall be fed from a distribution board and circuit breaker connected on the live side of the main panel ac supply circuit breaker.

**Panel Ventilation**

Each panel shall be provided with ventilation fans as required to ensure that equipment within the panel is maintained within manufacturer's recommendations, with due regard to the environment in which the panel will be mounted. Fans shall be controlled by a suitably labeled enclosed switch mounted internally in an accessible position. Fans shall be mounted with their axes horizontal and shall be arranged to draw clean air into the panel. Air entries shall have filters which can be renewed from outside the panel and shall be designed to prevent the entry of rain, spray, injurious fluids, sand or dust.

**Panel Piping and Tubing**

Panels containing equipment using a supply of compressed air shall have a common air pressure- reducing station with duplicate pressure-reducing valves and filters. The pressure reducing stationshall also include isolating valves upstream and downstream of each filter/reducing-valve set, pressure-relief valve, pressure indicator and low-pressure alarm unit for the low-pressure header and a pressure indicator for the high-pressure pipework. The pressure-reducing station components shall be mounted in a clear space inside the panel, supported on a suitable framework between the lower horizontal row of instruments and the main low-pressure header.

All piping, fittings and valves downstream of the pressure-reducing station shall be of brass, copper or plastic. PTFE tape shall not be used downstream of the main filters. The low-pressure header shall be brass and shall be near the panel floor with drain valves and tundishes piped to a drain. Branch air headers shall be of brass (15mm diameter minimum) and shall run vertically from the header to the instrument. The low pressure header and each branch shall have a 6mm minimum, non-ferrous shut- off valve for each instrument requiring an air supply and a compression coupling for each air-purge connection. At least 10% spare connections for possible future instruments shall be provided in each panel section. Any header dismantled before shipment shall have brass unions or flanges at each panel-section junction.

Panel-mounted instruments shall be piped to bulkhead fittings on a gland plate during assembly at the manufacturer's works. Piping shall be colour-coded in accordance with Recommended Practice ISA−RP 7.2 issued by the Instrument Society of America and shall be segregated from wiring so that any leakage is harmless. Each panel-mounted pressure gauge shall have a stainless steel flush- mounted shut-off and fine-regulating valve mounted vertically below. A drip tray shall be provided below each row of gauges. Exhaust and de-pressurizing pipework shall be routed out of the panel.

**Panel Labels**

Labels shall be provided for every panel to describe the duty or otherwise identify the panel and its sections and every instrument, component and item of equipment mounted internally

and externally. Where applicable, front-of-panel labels shall be as shown in the Specification drawings. Wording shall be clear, concise and unambiguous and shall be subject to review by the Engineer before manufacture. Each label shall be permanently secured to the surface near the item to which it refers. Externally-fitted labels shall be of perspex or other approved transparent plastic, with letters and numbers rear-engraved and filled with black. The rear surface of each perspex label shall be finished with a coat of paint of the same colour as the panel external finish. Instrument duty labels fitted externally shall be below the item to which they refer. Embossed tape or similar adhesive labels will not be approved.

Laminated materials or rear-engraved and filled plastic shall be used for internally-fitted labels, which shall be white with engraved black letters. Labels conforming to the requirements of the preceding paragraphs or other approved means shall be provided:

Labels

- To describe or identify circuits or circuit components
- To identify DC polarity
- To warn or remind about dangerous or potentially-dangerous circumstances
- Wherever elsewhere specified

Unless otherwise specified, all engraving shall be in plain block letters, 4mm high. The minimum practicable number of different sizes shall be used. Manufacturers' nameplates shall not be fitted on panel external surfaces.

**Panel Finish**

For control and instrument panels, desks and cubicles a hard, smooth, durable finish, free of blemishes, shall be provided. Before painting, all external welds and any rough areas shall besmoothed, and all surfaces shall be thoroughly cleaned and free from scale, contaminates, corrosion or grease. If rust-proof or Zintec steel has not been used in the construction, the panel shall be treated with a passivating agent such as phosphoric acid. All internal surfaces shall have a minimum of three coats of paint of which the first shall be an approved ant rusting priming coat and the final coat shall be opaque gloss white enamel. All external surfaces shall have not less than five coats of paint of which the first shall be an approved etch priming coat, and the second and third suitable undercoats, all of which shall be rubbed smooth when dry before application of the next coat. The undercoats shall be easily distinguished in shade or colour from the priming and finishing coats. The two final coats shall be of stove enamel paint, gloss or semi-matt finish, to a colour and finish to be advised by the Engineer. Stoving shall be carried out in accordance with the recommendation of the paint manufacturer. The overall dry film thickness (DFT) shall be between 85 and 120 microns. Nuts, bolts, washers and other fixing devices which may have to be removed for transit or maintenance purposes shall be galvanized or otherwise finished to an approved standard. A 500ml tin of matching touch-up paint shall be provided and packed with each panel. The colour of glass reinforced plastic panels shall be to the approval of the Engineer.

## 6.11 Recording Equipment

### Chart Recorders

Chart recorders shall be microprocessor-controlled or have auto-balancing potentiometric movements and conform with BS 90:1975 where applicable and shall be able to pass each test specified in BS EN 60873:1993 or equivalent standard. Recording instruments shall have an accuracy of +/-0.5% full- scale deflection or better. The operating temperature range shall be 0°C to 50°C. The recorder shall be equipped with indicating scales and pointers for each measured variable. The pen and a reasonable length of chart shall be visible without opening the case. Strip-chart recorders shall be electrically driven and have monthly or fanfold charts of not less than 100mm width which shall advance at a minimum of three selectable rates, including 20mm per hour.

Recorder inks and inking systems shall be suitable for use both in highly-humid conditions and in air- conditioning. Inks of differing colours shall be used for recording two or more quantities on the same chart. Each recorder chassis shall be easily withdrawable from its housing for chart changing without interrupting its circuits. Recorder scales and charts shall be in accordance with BS 1794:1952 and BS 3693:1992 or equivalent as applicable. Single-pen recorders used for more than one measurement shall have rotary-switch selectors with plates engraved to show the density of the selected measurement.

### Electrical Indicators and Integrators

Indicators for use with analogue signal-transmission systems shall comply with BS 89:1990 or equivalent and have an accuracy class index of 1.0. Indicator movements shall be critically damped (dead-beat). Indicators for use on more than one circuit shall have rotary switches to select the circuit, with engraved plates to show the circuit selected. Indicators shall have circular scales or shall be of the vertical edgewise type and shall be designed to avoid parallax error. Scales shall be clearly marked in SI units and shall comply with BS 3693:1992 or equivalent. All instruments mounted on one panel or board, or in adjacent groupings, shall have similar styles of figures and letters. Dials shall be white with black scales and lettering not subject to fading.

The material for scales shall be such that no peeling or discoloration will take place with age under any environmental conditions. Major scale marks and numerals shall be of the same size and thickness and shall be separated by not more than twenty-five minor marks. Pointers shall taper to the width of the scale marks. Integrators shall be of the multi-digit cyclometer type. Integrators operating in conjunction with an electromagnetic or ultrasonic flow meter shall use the pulse output from theflow transmitter. Any integrator operating from a device without a pulse output shall have an integral or separate current-to-pulse converter with sufficient adjustment of the pulse rate to avoid the use of any multiplying factor except in integer power of 10. Each integrator shall incorporate an adjustable limiter whereby any input below a pre-set value is inoperative. Unless otherwise specified, integrators shall have a minimum of eight digits with a decimal point where applicable.

**Alarm System**

Alarms shall be initiated by the opening or closing of volt-free contacts which shall remain unchanged throughout the periods in which the alarm conditions exit. Alarm circuits shall be capable of conversion from open-healthy to open-alarm or vice versa by a simple modification after installation requiring no additional parts or special equipment.

Each alarm shall initiate the operation of both visual and audible devices. The sound intensity of each audible device shall be suitable for the maximum sound level of its environment.

Audible devices in the same room or area shall have distinguishable sounds and adjustable sound levels.

**Matrix Type Alarm Annunciators**

The alarm annunciator shall be microprocessor based, modular, split type unit with alarm windows mounted on the front door and electronic modules inside the panel. The weather protection class for alarm annunciator shall be IP-54 of IS 13947, Part-I.

Each alarm shall initiate a visible and audible indication of the specified condition. Unless otherwise specified, alarm indicators shall be grouped together in annunciator units each having at least 20% spare ways. Alarm indicator lamps (Cluster LED type) shall have transparent screens engraved with legends approved by the Project Implementation Unit of CSCLDEL (PIU). The legend area of each indication shall not exceed 40mm high and 75mm wide.

When any alarm condition occurs, a condition device common to an alarm annunciator system shall sound and the appropriate indicator shall flash on and off. The flashing rate shall not be less than 2 Hz and shall not exceed 5 Hz. On pressing an accept pushbutton, the audible device shall be silenced and the flashing light shall become steady. The alarm indicator shall remain illuminated until the alarm condition ceases and a reset pushbutton has been operated.

The operation or acceptance of one alarm shall not inhibit the operation of the audible device or the flashing of the appropriate alarm indicator if a further alarm condition occurs.

At unmanned locations alarms operated on two or more annunciators shall require acceptance at each annunciator.

Alarms shall be accepted automatically and the appropriate audible device silenced after an adjustable period of 1 to 5 minutes.

An integral ‘test’ pushbutton shall be provided to illuminate each lamp in the appropriate group and to operate the audible device but shall not cause a spurious alarm condition on any other annunciator.

Alarm circuitry shall be arranged so that spurious or transient alarm states persisting for less than 0.5 seconds do not initiate any action.

Alarm annunciator / indicator legends or labels shall be arranged with three lines of text as follows:

- Top Line: Location; example: Sludge Blanket Level
- Middle line: parameter; LEVEL
- Bottom line: status. HIGH

**Push-Buttons and Indicator Lights**

Push-buttons in control circuits shall have shrouds, guards or other suitable means for preventing inadvertent operation. Status-indicator lights shall be of the high-intensity LED type. Indicator lights shall be of a design which allows easy LED replacement from the front. Indicator lights shall be easily visible above the ambient light level when viewed from within an included angle of 120 degrees. LEDs shall be chosen to ensure clear discrimination between the energized and de-energized states and to ensure an average working life of not less than 3 hours. A 'lamp-test' push-button shall be provided for each group of indicator lights. The colours of push-buttons and indicator lights on instrument panels shall be as follows:

INDICATOR LIGHTS ON INSTRUMENT PANELS

| | | |
|---|---|---|
| Duty Push button | - | Signal lamp |
| Start or on (energize) | - | Green |
| Stop or off (de-energize) | - | Red |
| Open valve | - | Black* |
| Close valve | - | Black* |
| Accept | - | Black |
| Lamp test | - | Black |
| Reset | - | Black |
| Motor running (energized) | - | Red |
| Motor stopped (de-energized) | - | Green |
| Valve open | - | Red |
| Valve closed | - | Green |
| Urgent alarm | - | Red |
| Non-urgent alarm | - | Yellow |
| Plant healthy or ready for use | - | White |

***Panel-mounted push-buttons for valve operation shall be coloured black, unless otherwise agreed with the Engineer, with the duty clearly defined by legend on an associated label.***

**Analogue Signal Transmission**

Unless otherwise specified, analogue signal-transmission systems shall be in accordance with BS EN 60546-1:1993 and shall use a signal of 4mA to 20mA DC. Transmitting devices shall have integral indicators to monitor the output signal or connections suitable for use with a portable test meter. Transmitters shall be capable of meeting the performance requirements laid down in the appropriate part of IEC 60770-1:1999.

### Analogue Process Controllers

Analogue controllers shall use solid-state components and shall have outputs containing three terms with negligible interaction. The controller fascia shall have measured value, set value and outputindication, manual set-value and output controls, auto/manual switch for control mode and remote- local transfer switch for set-value control. Manual control stations shall have measured-value and set- value indication, local/remote switch and control available lamp indicator. Each controller shall have the means to restrict its output signal to a predetermined, fully adjustable band so that the regulating device is not moved to unsafe positions. The adjustment of these safe operating limits shall be by means of accessible, clearly marked, internal components. A continuously adjustable proportional band of not less than 5 to 500% shall be provided. Integral and derivative action times shall be adjustable over ranges which shall not be narrower than 6 seconds to 25 minutes and 0-to 10 minutes respectively. If the integral or derivative action times' adjustments are in steps, the ratio of successive steps shall not exceed 2. The controls used to set the P, I and D values may be at the front of the instrument or mounted internally in an accessible position.

Each controller shall be designed so that in the event of failure, it shall be possible to plug a portable manual station into the controller case and to control the regulating device manually. Controller design shall ensure automatic procedure-less, bump less transfer whenever the instrument is switched from "auto" to "manual" or vice versa. Controller action shall be adjustable from direct to reverse and vice versa by the operation of an internal switch. Analogue process controllers shall be capable of meeting the performance requirements laid down in the appropriate part of BS EN 60546-1:1993.

## 6.12 SCADA System

### General

The purpose of this document is to briefly describe the proposed Automation system (SCADA System) for CSCL. The SCADA shall monitor complete parameters of Plant including Mechanical Equipment (Pumps, Motors, Valves, etc.) Process Instruments and Power Network. The System should be such that it has feature as per generic requirements to enable the system for seamless integration with other SCADA System.

The SCADA System shall collect data of various Process instruments, Mechanical Equipment, MFM and I/Os through Communication Network. The System Architecture has been provided for reference purpose.

The System shall collect data through PLC under scope of supply. The field instruments (continuous monitoring online analyzers) can transfer data to Control Centre directly through wireless technology /optical fiber cable communication system, other equipment (pumps, motors, valves, etc.) data will report to remote PLC and PLC will report to Control Centre through fiber cable. The fiber cable will be laid across all location in Ring so that we can get redundant communication.

**Basic Requirements for the Control System**

This section summarizes the basic requirements for the control system, including the system's components, its open communication capabilities, its combined DCS functionality, and its scalable architecture.

**System Components**

The control system shall consist of a modular controller (including control, I/O, and communications functions), a peer to peer architecture, comprehensive process automation software (including configuration, documentation, operator interface, historian, and simulation software) and software modules that facilitate open systems connections.

The system shall include a full complement of modular supporting equipment (including mounting racks, power supplies, termination strips, equipment enclosures, prefabricated cables, furniture, etc.), all of which shall be designed to simplify construction and the overall engineering effort.

**Open Communications**

The control system shall be open to enable easy integration with OPC (OLE for Process Control) [where OLE stands for Object Linking and Embedding (OLE)] server so as to collect the data from the remote housing station.

The control system shall include features traditionally associated with both a programmable logic controller (such as logic processing, modular rugged hardware, and remote I/O architectures) and a distributed control system (such as continuous and complex control, advanced operator interfaces, sophisticated redundancy). These capabilities must seamlessly reside in one control system, without the use of special gateways or interfaces.

**Scope of Work**

The solution should meet the functionality as per requirements for connectivity of PLC, IP Camera etc. with Control Centre. The scope of supplies for the SCADA project shall be as detailed below and given in the System Architecture attached herewith (Refer Annexure-1A).

- Supply of Control Centre Hardware and Software for SCADA System
- Networking Equipment's (Router, Firewall etc.) for Control Centre.
- Interface / Integration of PLC Units with SCADA System.
- Integration of Field Instruments Hardware with Control Centre.
- Testing, Erection & Commissioning of supplied system.
- Training as per detailed Offer.

**Hardware Details**

This chapter contains a detailed configuration description of Automation System. The building sub-systems are:

- SCADA cum Communication Server
- User Interface subsystem like WS
- Video Projection System
- IP Camera
- Local Area Network subsystem like LAN switch, Router, Firewall
- 12 C Single Mode Fiber cable
- RTU/PLC,
- Peripheral subsystem

Each subsystem is built from hardware common components. All subsystems and hardware components are described below:

### 6.12.1. Subsystem Description

This section lists and describes the subsystems (associated hardware components) at each location.

**SCADA CUM COMMUNICATION SERVER, WEB SERVER, ISR SERVER**

| Qty | Hardware Component | Remarks |
|---|---|---|
| 1 | SCADA cum Communication Server | The interfaces for each server are connected to Ethernet networks to collect data from field. |
| 1 | WEB server | Interface with Internet to remote client |
| 1 | ISR server | Databases server with Oracle/SQL for Alarm and MIS Report |

**USER INTERFACE SUBSYSTEM**

| Qty | Hardware Component | Remarks |
|---|---|---|
| 2 | Workstation Console | The console is provided with 298782+ 2 TFT Monitor<br>The interface is connected to the Ethernet networks. |
| 1 | Remote access terminal | LAPTOP connected through a serial link and a modem. |

**LOCAL AREA NETWORK SUBSYSTEM**

| Qty | Hardware Component | Remarks |
|---|---|---|
| 1 | LANSwitch | Ethernet switch 14 ports (10/100 Base TX)+2 Fibre Port |
| 6 | Remote Location LAN switch | Ethernet switch 14 ports (10/100 Base TX)+2 Fibre Port |
| 1 | Router | 2 LAN+2 WAN, all are 10/100 with 2 V.35 Port |
| 2 | Firewall | 4LAN+2 WAN, all Wan are 10/100Mbps and LAN are 10/100/1000 Mbps |
| Lot | 12C Single Mode Fibre armored cable | For Connectivity |

### 6.12.2. Peripheral Subsystem

**PRINTERS**

| Qty | Hardware Component | Remarks |
|---|---|---|
| 1 | Laser Printer(Colour) | Each laser printer is connected to Ethernet network. |

**UPS**

| Qty | Hardware Component | Remarks |
|---|---|---|
| 1 | 10 KVA(Minimum) UPS for Control room Hardware | The UPS is designed for 10 KVA (Minimum) with two hours backup. |
| 1 | 3 KVA(Minimum) UPS at all Remote location | The UPS is designed for 3 KVA (Minimum) with two hours backup. |

**IP Camera**

| Qty | Hardware Component | Remarks |
|---|---|---|
| 1 | IPCamera | EachCameraisconnectedtoEthernetnetwork for Remote location surveillance of the completeWWTP |

**Video Projection System**

| Qty | Hardware Component | Remarks |
|---|---|---|
| 1 | Rear Projection one cube with controller | Each VPS is connected to Ethernet network. |

**Hardware Components Description for all 6 plants**

This section describes the common hardware components.

### 6.12.3. Communication cum SCADA Server, Web Server, ISR Server

Characteristics*

| | |
|---|---|
| Intel® Xeon® Quad-Core Processor E5606 2.13 GHz, 8MB L3 Cache | 1 |
| Integrated Two Broadcom dual-port Gigabit Ethernet with TOE enabled | 1 |
| 8GB Memory (4x2GB), 1333MHz, DDR3 RAM | 1 |
| 2nd Intel® Xeon® Quad-Core Processor E5606 2.13 GHz, 8MB L3 Cache | 1 |
| 300GB 15K RPM,6Gbps SAS 3.5 Hot Plug Hard Drive " With RAID5 | 3 |
| DVD+/-RW ROM, SATA, Internal for Ms 2008 R2 | 1 |
| High Output Power Supply, Redundant, 460W | 1 |

| | |
|---|---|
| Power Cord, GType, 230V (Nepal, Sri Lanka, India) | 2 |
| 2U Cable Management Arm | 1 |
| 2U Sliding Rail | 1 |
| Windows Server 2008 | 1 |

**The system (hardware, software, accessories, etc.) being provided during installation would be of latest configuration.*

### 6.12.4. Workstation Console Dual Monitor

| | |
|---|---|
| **Motherboard** | Intel® Xeon® Dual-Core Processor W3503 (2.40 GHz, 4 MB cache, 1066 MHz memory) |
| **Video Card** | ATI FirePro 2270 (512 MB ) |
| **RAM Memory** | 4GB (2x2GB) DDR3 SDRAM Memory, 1333MHz,ECC 1 |
| **HDD** | 500 GB SATA (7200 RPM) HDD |
| **Input Power Supply** | 220 to 240 VAC (+/- 10%), 50 Hz (+/- 2 Hz) |
| **Power Cord** | Indian Style |
| **CD Drive** | 16X DVD + /-RW Combo Drive |
| **Keyboard** | **USB Entry Keyboard** |
| **Mouse** | USB Optical Scroll Mouse (2 buttons) with Mouse Mat |
| **LAN(Ethernet port)** | Dual Broadcom RJ45 10/100/1000 BASE on board Ethernet NIC |
| **I/O Cards** | One serial RS-232 port, 4 USB port and one parallel port |
| **Indicator & Switch** | Power on/off x 1, HDD x 1. Power on/off x 1, System reset x 1 |

**The system (hardware, software, accessories, etc.) being provided during installation would be of latest configuration.*

### 6.12.5. Remote Access Terminal (1no.)

Characteristics*

**LAPTOP***

| | |
|---|---|
| **Processor** | 2nd generation Intel® ore™ i3-2350M processor (2.30 GHz, 1333, 3M cache) |
| **Operating System** | Genuine Windows® 7 Professional SP1 32bit (English) for India |
| **Display** | 14.0" HD WLED Anti-Glare (1366x768) |
| **Memory2** | 2GB2 DDR3 SDRAM at 1333MHz |
| **Hard Drive** | 320GB 5400RPM SATA Hard Drive |
| **Video Card** | Intel® HD Graphics/ Intel® HD Graphics 3000( It depends on processor selected) |

**The system (hardware, software, accessories, etc.) being provided during installation would be of latest configuration.*

### 6.12.6. LAN Switch

Characteristics*

| | |
|---|---|
| **Specification** | Managed Industrial Ethernet switch |
| **Ethernet Standards** | IEEE 802.3 for 10BaseT<br>IEEE 802.3u for 100BaseT(X) and<br>100BaseFX IEEE 802.3x for Flow Control |
| **Design Standard** | FCC Part 15, CISPR (EN55022) class A, Shock- IEC60068-2-27, Vibration-IEC60068-2-6, EN61000-4-2 (ESD), EN61000-4-3 (RS), EN61000-4-4 (EFT), EN61000-4-5 (Surge), EN61000-4-6 (CS), EN61000-4-8, EN61000-4-11 standards |
| **InputVoltage** | 9.6-60 VDC |
| **Operating Temperature:** | 0 to 60°C |
| **Ambient Relative Humidity:** | 5% to 95% Non-condensing |
| **Overload Current Protection** | Present |
| **Mounting** | DIN RailMounting |
| **No. of Ports** | 12 Nos. (10 CU + 2 FO) |
| **Interface** | |
| **Ethernet ports** | 10 no. RJ45 Ports with 10/100BaseT(X) auto negotiation speed, Full/Half duplex mode, and auto MDI/MDI-X connection |
| **Fiber Port** | Two 10/ 100BaseFX port SC Type Single-Mode, 1310 nm Supports Ring, and Self-Healing |

**The system (hardware, software, accessories, etc.) being provided during installation would be of latest configuration.*

### 6.12.7. Color Laser Printer

Characteristics*

| | |
|---|---|
| **Print speed** | Up to 12 & 8ppm |
| **Print quality** | Up to 600x600 dpi with HP Image REt 3600 |
| **(A4 Size, ready)** | 26/32 sec |
| **Print speed footnote** | Exact speed varies depending on the system configuration, software application, driver and document complexity. |
| **Memory, standard** | 128 MB, expandable to 384 MB |
| **Processor speed** | 600 MHz |
| **Duty cycle (monthly, A4)** | Up to 30000 pages |
| **Connectivity, standard** | Hi-Speed USB 2.0 port; built-in Fast Ethernet 10/100Base-TX |
| **Print technology** | In-line colour laser printing technology |
| **Print languages** | HP PCL 6, HP PCL 5c, HP Postscript level 3 emulation |
| **Paper trays, standard** | 2 |

| | |
|---|---|
| **Paper handling input, standard** | 150-sheet input tray |
| **Paper handling output, standard** | 150-sheet face-down output bin |
| **Power** | Input voltage 115 to 127 VAC (+/- 10%), 60 Hz (+/- 2 Hz), 12 A; 220 to 240 VAC (+/- 10%), 50 Hz (+/- 2 Hz), 6 A |
| **Power consumption** | 445 watts maximum (active), 18 watts maximum (ready), 6.7 watts maximum (sleep), 0.48 watts maximum (off) |
| **Media sizes supported** | Tray 1: A4, A5, A6, B5 (JIS), 10 x 15 cm, 16K, envelopes (ISO DL, ISO C5, ISO B5), post cards (Standard #10, JIS Single, JIS Double); Tray 2 : A4, A5, A6, B5 (JIS), 10 x 15 cm, 16K, envelopes (ISO DL, ISO C5, ISO B5), post cards (JIS Single, JISDouble) |
| **Media sizes, custom** | Tray 1: 76 x 127 to 216 x 356 mm; Tray 2 : 100 x 148 to 216 x 356 mm |
| **Media weight, supported** | Tray 1: 60 to 176 g/m² (up to 220 g/m² with HP laser glossy photo papers); tray 2, optional tray 3: 60 to 163 g/m² (up to 176 g/m² with postcards, up to 220 g/m² with HP laser glossy photo papers) |
| **Recommended operating** | 15 to 27° C |
| **Operating humidity range** | 20 to 70% RH |

**The system (hardware, software, accessories, etc.) being provided during installation would be of latest configuration.*

### 6.12.8. UPS (1 No.)

| | |
|---|---|
| **Technology** | Microprocessor based IGBT, High Frequency Switching Sinusoidal multiple PWM |
| **Rating** | 15 KVA (Minimum) |
| **Input** | 230 V AC, +10%, -15% |
| **Output** | 230 V AC |
| **Battery** | Sealed Maintenance Free Batteries, CSB / Panasonic / Global & Yuasa or eqvt |
| **Backup Hours** | 120 Minutes |

### 6.12.9. UPS (6 Nos. Tentative) or as per bidder design

Characteristics

| | |
|---|---|
| **Technology** | Microprocessor based IGBT, High Frequency Switching Sinusoidal multiple PWM |
| **Rating** | 3 KVA (Minimum) |
| **Input** | 230 V AC, +10%, -15% |
| **Output** | 230 V AC |
| **Battery** | Sealed Maintenance Free Batteries, CSB / Panasonic / Global & Yuasa or eqvt |
| **Backup Hours** | 120 Minutes |

### 6.12.10. Router (2 Nos.) or as per bidder design

Characteristics*

| | |
|---|---|
| **Memory** | RISC @ 533 MHz |
| | Flash Memory:256M Bytes |
| | SDRAM: 256M Bytes |
| **Interface** | 2 x 10/100/1000 Mbps Ethernet Port |
| | 2 Serial Ports (V.35) |
| | 2 X 10/100 Mbps WAN Interface |
| | 1 Console port |
| | 1 Auxiliary port |
| **Performance** | |
| Throughput | 300 Kpps (64-byte packets) |
| Routing table size | 30000 entries |
| **Network Management** | IMC - Intelligent Management Center; command-line interface; Web browser; SNMP Manager; Telnet; RMON1; FTP; IEEE 802.3 EthernetMIB |
| **Operating Temperature** | 0° to 40° C (32° to 104° F) (Relative Humidity: 5% to 90% non-condensing) |
| **Non-Operating Temperature** | -40° to 70° C (Relative Humidity: 5% to 90% non-condensing) |
| **Power** | 100-120/200-240 VAC |

**The system (hardware, software, accessories, etc.) being provided during installation would be of latest configuration.*

### 6.12.11. IP Camera (20 No. - Tentative): To cover all the units in the plant

Characteristics*

| **Camera** | |
|---|---|
| Sensor | 1/2.7” HD progressive scan MOS |
| Lens | C/CS mount lens |
| Auto Iris Type | DC drive |
| Illumination (low light sensitivity) | • olor: .2 lux atF1.2 |
| | • B/W: .lux atF1.2 |
| Pan and Tilt | Pan Range: 0 to 360°, Tilt Range: -90 to 40° |
| White Balance | ATW/AWB (range: 3200 to 10000°K) |
| Dynamic Range | • olor: 1dB |
| | • B/W: 11 dB |
| Auto Electronic Shutter | 1/30 to 1/25000 sec. |
| S/N Ratio | 50 dB (Gamma, Aperture, AGC OFF; DNR ON) |
| ICR Control | Auto (light sensor control) or DI control |
| DNR | Built-in DNR |
| WDR | Level 1-8/Off |
| AGC control | 2X, 4X, 8X, 16X, 32X, 64X |

| | |
|---|---|
| Flickerless Control | Indoor/Outdoor mode |
| Black Level Control | High/Medium/Low |
| Auto Exposure | Level ±5 |
| Image Rotation | Flip, Mirror, and 180° rotation |
| Image Setting | Manual tuning with saturation, sharpness, and contrast |
| **• Video** | |
| Video Compression | H.264 (ISO/IEC 14496-10) or MJPEG |
| Video Outputs | Ethernet |
| Video Streams | Up to 3 video streams (2 x H.264 and 1 x MJPEG) |
| | • Stream 1: H.264, 12 x resolution(max.) |
| | • Stream 2: H.264, 72 x 4 resolution(max.) |
| | • Stream 3: MJPEG, 72 x 4resolution(max.) |
| Video Resolution and FPS (frames per second) | Not less than 20 FPS in NTSC or PAL |
| **• Network** | |
| Protocols | TCP, UDP, HTTP, SMTP, FTP, Telnet, NTP, DNS, DHCP, UPnP, RTP, RTSP, ICMP, IGMPv3, QoS, SNMPv1/v2c/v3, DDNS, Modbus/TCP, 802.1X, SSH/SSL |
| Ethernet | 1 10/100BaseT(X) Ethernet port, RJ45 connector |
| **• SerialInterface** | |
| RS-485 | 1 half-duplex RS-485 |
| **• GPIO** | |
| Digital Input | 1, max. 8 mA |
| | • High: +13 V to +3V |
| | • Low: -30 V to +3V |
| Relay Output | 1, max. 24 VDC @ 1A |
| **• LEDIndicators** | |
| STAT | Indicates if the system is booted properly or not |
| Network | 10 Mbps or 100 Mbps |
| Power | Power on/off |
| **• LocalStorage** | |
| SD Socket | Standard SD socket (SDHC) |
| **• PowerRequirements** | |
| Input | Power Consumption: As per requirement |
| | • Redundant power inputs |
| | • 12/24 VD , 24 VA , or Power-over-Ethernet(IEEE 802.3af) |
| **• Physical Characteristics** | |
| Camera Body Housing | Metal, IP65 protection or better. In case camera body has lower IP rating, external housing providing IP65 rating or better should be used. |
| Installation | Wall mounting, pole mounting, corner mounting |
| Note | External housing and mounting accessories for PAN and TILT functionality (if not inbuilt) should be used. |
| **• Security** | |
| Password | User level password protection |
| Filtering | By IP address |

| | |
|---|---|
| Authentication | 802.1X |
| Encryption | HTTPS, SSH |
| **• Alarms** | |
| Video | Camera tamper, virtual fence, alert zone, missing object, unattended object |
| Video Motion Detection | 3 independently configurable motion areas |
| Scheduling | Daily repeat timing schedule |
| Imaging | JPEG snapshots for pre/trigger/post alarm images |
| Video Recording | Event recording and stored in the SD card |
| Email/FTP Messaging | Automatic transfer of stored images via email or FTP as event-triggered actions |
| Custom Alarms | HTTP event servers for setting customized alarm actions |
| Pre-alarm Buffer | 24 MB video buffer for JPEG snapshot images |
| **• Environmental Limits** | |
| Operating Temperature | 0 to 60°C (32 to 140°F) |
| Storage Temperature | 0 to 60°C (32 to 140°F) |
| Ambient Relative Humidity | 5 to 95% (non-condensing) |
| Environment | $H_2S$ laden atmosphere and other poisonous gases, Corrosive Waste Water Environment |

**The system (hardware, software, accessories, etc.) being provided during installation would be of latest configuration.*

### 6.12.12. Video Projection System (1 No.)

Characteristics*

| | |
|---|---|
| Resolution | SXGA+ |
| Individual Cube Size | 67" Diagonal |
| Image Size (mm) | 1361 x 1021 |
| Display Technology | DLP, single chip |
| Native Resolution | 1400 x 1050 pixels |
| Aspect Ratio | 4:03 |
| Screen to screen gap | Rear access: |
| | Adjustable up to 0.2 mm |
| DMD | .9 ” DMD 12 deg. |
| Light Source | LED - 1R1G1B - 12 sq mm each |
| Brightness | 650 Lumens |
| Luminance (Nits or cd/$m^2$) | Based on screen used, lamp mode and screen size |
| Brightness Uniformity | Greater than 90% |
| Screen Type | Fresnel/ Lenticular/Black Bead/Cross Prism (XPS) |
| Full Viewing Angle | 180 degrees |
| Colors | 16.7 million |
| Color Temperature Range | 3200K to 9300K |
| Color Temperature Range | 3200K to 9300K |
| LED Life (typical) | > 60,000 Hours |
| Inputs | RGBHV on BNC, Dsub -15, |

| | |
|---|---|
| | DVI-DX2, Composite video, (NTSC/PAL/SECAM) |
| | Component video HDTV, RS232C |
| Outputs | Video/DVI |
| Control | RS-232/IR, RS 422/IP |
| Voltage | AC100-240V @ 50/60 Hz |
| Power Consumption | ‹ 3W |
| | |
| Operating Temperature | 10-35°C |
| Operating Humidity | 10%~90% |
| Storage | -20 to 60°C |

**The system (hardware, software, accessories, etc.) being provided during installation would be of latest configuration.*

### 6.12.13. 12C Single Mode Fibre Cable

| | |
|---|---|
| Configuration | MULTITUBE DOUBLE SHEATH ARMOURED CABLE |
| Nos. of Core | 12 |
| Maximum Tensile Loading | 1361 x 1021 |
| Installation | 2700N |
| Long Term Installed | 900N |
| Operating Temperature | -30°C to +60°C |
| Normal Dia | 14.8 mm |
| Nominal weight | 200 KG/KM |
| Mode | Single Mode |
| Single mode Fiber: | (G.652.B) |

### 6.12.14. Server Panel

The equipment can be of **any Standard make which can comply with the following Standards:**

| Type | SERVER RACK 42U/600W/1000D |
|---|---|
| **Specification** | Captive Front Panel Hardware, Pkt of 20 |
| | Castors (Plain) |
| | Server Rack , 19"/42U |
| | consisting of High quality extruded Aluminium vertical profiles 4 Nos.Top and Bottom steel end |
| | frames with bottom Panel having gland plate for cable entry, Top cover with FHU provision, Side |
| | Panels with latches and venting slots at bottom 1/3 area and 2 pairs of 19" Mounting Angles |
| | Dimension: 2150 x 600W x 1000D Powder Coated BLACK |
| | Front CRCA steel single door with Perforation |
| | Rear CRCA steel single door with Perforation |
| | Component Shelf, Universal, 19"W/575mmD, Load cc 50 kg. |

| | |
|---|---|
| | Top Mounting, Fan Housing Unit with 4 fans 230 V / 90CFM |
| | Rotary Keyboard Tray with slides |
| | Castors (with brake) |
| | Earth Continuity straps (kit) |

### 6.12.15. PLC (1 No.)

The equipment should be of Reputable **make which can comply with the followings Standard:**

**1. Powerful Integrated Controller**

The controller shall consist of a family of intelligent integrated modules, with each performing a dedicated function. It shall have an integrated redundant interface for the I/O modules as well as redundant interface for the Human machine interface.

Additionally the controller should be able to able to communicate to its redundant pair directly preferably on a Passive backplane.

**2. Modular Architecture**

The modular approach shall enable a very small system to be installed with expansion to a very large system without changing the basic hardware or disrupting the architecture. A minimumof the following module types must be available: control modules, I/O modules, communications modules, computer modules, and power supply modules.

**3. Controller Packaging**

For installation flexibility and high reliability, controller hardware must be designed to withstand harsh conditions within industrial environments, such as heat, humidity, shock, vibration, and electrical surge and discharge.

**A. Module Hardware**

Module hardware must meet the following requirements:

- The modules shall be identical in appearance.
- All the module shall be housed in a powder coated metal case rack to prevent physical damage from handling or dust.
- All control and I/O modules shall be rated for operation within the following ranges: 0-50 Deg C and 5-95% relative humidity, non-condensing.
- I/O and power modules shall have circuitry to protect the system from electrical surge and discharge.

The modules shall comply with the following specifications:

**International Electro-technical Commission (IEC)**

- IEC 60751 (1983-01) Industrial platinum resistance thermometer sensors
- IEC 61000-4-2 (2001-04) Electromagnetic compatibility (EMC)- Part 4-2
- IEC 61000-4-3 (2002-03) Electromagnetic compatibility (EMC) - Part 4-3
- IEC 61000-4-4 (1995-01) Electromagnetic compatibility (EMC) - Part 4
- IEC 61158 (2000-08): Field-bus standard for use in industrial control systems - Part 2:
- IEC 61131-3 (1993-03) for Programmable controllers - Part 3

The modules shall comply with the following shock and vibration standards:

- Vibration: IEC 68-2-6, Fc: 10-50 Hz, 2g

**B. Module Racks**

The modules shall be grouped together in racks to form the control system. The racks shall provide the communications mechanism to fully integrate the modules and facilitate intercommunications between racks. A rack should hold approximately ten individual modules, with each slot identical and able to accept any module. Modules should be connected to the backplane using high quality, gold- plated, industry-grade pin connectors.

It shall be possible to remove and reinsert the modules under power with no damage to the rack or modules and without removing any external wiring or cables. The rack and modules shall provide a physical keying mechanism to prevent incorrect module insertion during system operation.

To simplify installation and maintenance, the module racks and modules shall be designed for front access only. All user functions, including diagnostics, field wiring, cable connections, switches and status indications, shall be available from the front of the rack.

**C. Power Supply**

Redundant Power supplies shall be available for card rack mounting to form as an integral part of the system. The module rack must provide two individual power supply buses that to be driven by two independent power sources for high availability placed in the rack in current sharing mode. Each module shall be capable of using power from any of the two buses.

**D. Enclosures**

The racks shall be mounted in an industrial enclosure with a front & rear -access design, with all frequently accessed items (such as modules, connectors, status indicators, switches, and termination assemblies) located in the front of the enclosure. For maximum flexibility, the enclosures shall be modular, with the ability to be stacked, joined side to side, or joined back to back. To provide the degree of environmental security required, enclosures shall be available in sealed and vented versions.
Enclosure shall be

(i) for Indoor IP 44 and ii) for Outdoor IP 65

**4. Control Module**

A control module shall provide process control functions. The control module should be used with dedicated I/O modules to read and control field signals. The module shall also be capable of operation independent of I/O modules, "supervising" operation of other control modules. In addition, the control module shall be capable of executing on a 5 millisecond resolution input-to-output when required by the application.

### A. Hardware

The control module shall consist of a single-slot module with a dedicated microprocessor. Memory should be battery-backed RAM so that the module retains its configuration and state information to optionally and automatically restart after a power failure without requiring its database to be downloaded. The minimum memory required is 16MB.

During a hot start, all variables can be selected as retain or non-retentive.

### B. Software

The control system must support a full complement of process control functions. It shall be possible to define these functions using a mix of function blocks, ladder logic diagrams, sequential function charts, and textual programming. Each of the four languages and their interaction within a configuration shall be based on the IEC 61131-3 standard. The languages shall be completely interchangeable and interactive, with a single control module's database capable of including any combination of the four languages.

## 5. Input / Output Devices

Input/output Modules shall be intelligent I/O modules. Each module should be able to communicate with the CPU in a dedicated fashion without requirement of any additional interfacing hardware so as to reduce the common cause of the Failure. Each module should have its own microprocessor to execute its input/output function, maintain ownership of its configured data, and perform module diagnostics.

All process I/O shall be electrically isolated from both computers common and communications common. Isolation shall meet be min 1500 VAC requirements. Modules shall automatically determine their physical address and report this information to the controller. No range jumpers or user- configurable physical address jumpers should be necessary.

All configurable data shall be set via software, with no hardware jumpers used. Configurable data should include Channel tag.

**All the I/O modules shall have max 8 channels for the Analog and 16 channels for the Digital modules. Special modules like Counter inputs shall monitor dry contact pulses with an input resolution of one Hz minimum.**

### A. Field Termination for I/O Modules

Each I/O module's field signals shall be wired into the system such that an I/O module can be removed at any time without disturbing the field wiring.

The field wiring should be separate from the I/O module(s). The extension from the module(s) shall be accomplished via a marshalled I/O cable assembly. This assembly should

be a multi-conductor cable that attaches to the module rack (and the back of the I/O module) on one end and a finished termination end.

The marshalled termination assemblies shall be DIN rail-mounted PCB-based fixtures that include terminal blocks and two receptacles for accepting the interconnect cable plug. These receptacles must be female to eliminate the possibility of power from the terminal block being exposed on pins.

## 6.13 System Communications

The communication networks in the system shall provide redundant, high-speed, secure controller information exchange via Ethernet TCP/IP. Communication between individual modules shall be viaredundant, local, independent buses that allow complete integration of the family of modules.

### 6.13.1. Module Communication Bus

All the communication to the I/Os in the DCS shall use a deterministic. This protocol must be compliant to IEC61158, and open. It shall be possible to connect a minimum of 100 nodes on a single network

The bus must be redundant. Minimum data transmission rate is 10 Mbps.

Communication on the expanded network shall be accomplished in a manner identical to that of local communication bus. The extension shall be transparent to the user, and no extra software configuration effort shall be required.

### 6.13.2. Configuration Software

The configuration software shall be portable. It shall run on a personal computer of the most current technology under Windows.

The software shall execute in the off-line mode when the computer is not attached to any controller hardware, allowing controller databases to be created, edited, and documented. When the computer is attached to the controller hardware via the networked or direct-connected PCs, the networked workstations, or by running in the industrial computer module, an on-line mode of operation shall be available to allow use of all off-line functions plus on-line troubleshooting tools. This software shall be able to be used to configure continuous, batch, and safety protection control strategy configurations from a single user console.

**IEC 61131-3**

The configuration software shall allow controller databases to be created using the following standard languages defined by the specification IEC 61131-3: function blocks, ladder logic, sequential function charts, and structured text.

### 6.13.3. Graphical Configuration and Documentation

Controller configuration should provide graphical configuration methods, with functions entered into a database using a point and click object-oriented routine. The resulting database

should be its own documentation because of the graphical appearance. Furthermore, the graphical database must be transferable directly to the controller as it exists, including all graphical information, with no compile routine necessary before transferring the database to the controller. The graphically configured database shall be stored and executed in the controller, and the controller-resident database shall be viewable graphically on-line and upload able to a PC or workstation without the need for storing the "source" database off-line.

**A. On-Line Tools**

The configuration software shall provide on-line tools that assist in troubleshooting control schemes. These tools must include on-line display of variables, the ability to force values and states, support for on-line database changes, and on-line real-time trending.

It should be possible to display variables' values and the status of ladder logic and SF elements while viewing an on-line controller database. The ladder logic and SFC element states shall be indicated using colors.

The configuration software shall provide the ability to write values, states, and modes to independent variables and elements in the controller. It shall also provide the ability to force non-independent variables and elements to a predetermined value, state, or mode.

During troubleshooting, the user shall have the ability to stop the controller and single-step its execution. This will provide a way to clearly understand complex configuration schemes and highly interactive logic that might need to be examined.

**B. Prebuilt Library of Functions**

The configuration software shall include a predefined library of control schemes. The library must include at least:

- Single PID loop with alarm
- Single PID loop with external setpoint and alarm
- Ratio control loop with alarm
- Cascade loop with alarm
- Primary control loop with alarm etc.

Separate, optional libraries should be available for specialized applications.

The configuration software shall also allow commonly used functions created by the user to be added to a library for future use.

**C. On-Line Help**

On-line help screens in the configuration software shall be available to assist while creating a database. The help screens shall include descriptions of every configuration element (e.g. each function block and ladder logic element).

**D. System Architecture**

A system architecture graphic depicting the hardware within the control system. This graphic should give status information for the modules in the system by using colors to indicate general health of the modules.

### 6.13.4. Windows Based Operator Software

The industrial-grade PC-based operator interface software shall be able to run on a personal computer of the most current technology under Windows. The software shall provide all standard operator functions, including process monitoring, alarm management, real-time and historical trends, reports, plus provide process graphic displays, an integrated historian, Internet enabler, batch manager and control simulator.

### 6.13.5. Reliability

The system must be designed for maximum reliability and minimal downtime. This should be achieved through a fault-tolerant design with minimal common cause failures and state-of-the-art redundancy schemes.

**Controller**

The controller must have a fault-tolerant design, with redundancy in the same model

**A. Standard Fault Tolerance**

The module communication bus and each I/O communication bus must be redundant. If one side of a redundant bus should fail, communications should continue, uninterrupted, on the remaining side of the bus.

The module rack shall provide two separate power supply modules, with each module capable of drawing power from any of the two.

**B. Redundancy**

Complete 1:1 redundancy needs to be quoted. The redundant control modules that share a single set of I/O, identical, standard hardware must be used for all redundancy schemes with option of duplication of control modules and I/O modules.

It must be possible to replace a failed component on-line, without removing power. Process control shall continue to be executed in the non-failed unit.

When a module is replaced, the new module must automatically initialize, receive the current database from the primary module, and pick up in synchronous execution as a secondary module in the redundant relationship. This should take place without user action for any of the steps.

### 6.13.6. Operator Interface

Window based operator interfaces need to be supplied such that the failure of one component, card, or module does not cause the operator to lose any portion of the process window.

### 6.13.7. System Architecture

The system should be capable of Remote I/O modules architecture at various remote locations near to the major equipment sensors to reduce the commissioning. There will be remote I/O module stations at various locations of the plant and connected to main PLC through OFC cable. Please refer the system architecture.

### 6.13.8. Features Required in SCADA System

The system will be based on latest version of SCADA system. The main SCADA system will be redundant. Based on application, servers are to be distributed with redundancy. For Cyber Security it is proposed that Security Solutions Shall be provided and separate DMZ zone be made so that outside intrusion can be minimized. Network monitoring system shall also be provided for monitoring of Network devices. SCADA system will have many extra features and the proposed system should support multiple PLC/ RTU Protocol like Modbus, Profibus, DNP (Serial/TCPIP), OPC etc.

## 6.14 Detailed Specification of SCADA System Components

### 6.14.1. Data Acquisition

The SCADA system shall perform data acquisition from PLC and field Equipments. PLC is to be located at each location of the plant. PLC communications with Control Centre shall utilize the Open protocol like Modbus, Profibus.

### 6.14.2. Data Exchange

The SCADA systems shall be able to exchange various types of data with the other application software using ActiveX Data Objects (ADO) or Dynamic Data Exchange (DDE).

### 6.14.3. Data Processing

a) Analog data

Analog data processing shall be performed according to the requirements listed below.

- Conversion to Engineering Units
- Reasonability Limits Checking
- Limit Monitoring

b) Digital/Status Input Data

The following status input data types shall be accommodated as a minimum: Two-state points: The following pairs of state names shall be provided:

(1) Open/Closed
(2) Tripped/Closed
(3) Alarm/Normal
(4) On/Off
(5) Auto/Manual

(6) Remote/Local

c) Calculated Data

It shall be possible to define the calculations on real-time data and historical data, periodically and on request. The results shall be incorporated into the database as calculated data available for display & report generation.

The user shall be able to define calculated analog values using database points as the arguments and mathematical functions as the operations. Functions such as addition, subtraction, multiplication, division, maximum value, minimum value, average, count, square root, exponentiation, trigonometric functions, logarithms and other statistical functions shall be provided.

The SCADA system shall be capable of analyzing the open/closed status of switching devices, such as Motor, PUMP etc. The configuration shall be updated whenever a switching device status change is detected.

### 6.14.4. Quality Codes

Quality codes indicate the presence of one or more factors that affect the validity of a data value. All quality codes that apply to a data value shall be maintained in the database for that data value. At least following quality codes shall be supported:

- Telemetry failure
- Delete from scan
- Limit violated
- Manually replaced
- Alarm inhibit
- Abnormal data

### 6.14.5. Sequence-Of-Events Recording

The Sequence-of-events (SOE) data is listing of status change events with time stamp. SOE data shall be collected by the SCADA system from PLCs. The description of each event shall include the database description name, device state, the date, and the time (to the nearest millisecond) of each event.

### 6.14.6. Supervisory Control

An authorized user of an SCADA system shall be able to control the operation of field devices connected to PLCs. A control action shall require a confirmation of selection prior to execution of control command.

The user shall be able to select and operate any controllable switching device. Controllable switching devices will be of like, Pump, Motor.

### 6.14.7. Information Storage and Retrieval

Information Storage and Retrieval (ISR) system shall collect and store analogue data (telemetered and calculated) periodically at every 5 minute (configurable) and status data by exception. Associated quality codes shall be included. It shall be possible to perform calculations on the stored data, and the results of these calculations shall be collected and stored. Other information such as alarms, events, SOE and reports shall also be stored. The data shall be stored on hard disc with date tag on daily basis for easy retrieval. Subsequently, the data shall be retrieved for analysis, display, trending, and report generation.

### 6.14.8. Extensive Use of Standard

The **SCADA Software** should be such that it uses an extensive use of standards, achieved by a corporate commitment to comply with all standards that are recognized on the SCADA market, and in particular:

- Intel (or compatible) based hardware;
- Operating system options of WNT 4.0, Windows 2000 or Windows 2003;
- Uses Microsoft Foundation Class (MFC) Object Oriented Database;
- Developed with Microsoft Developer's Studio;
- Installed using Microsoft Install Shield utilities;
- Component Based Architecture;
- Interfaced using Active X controls (OCX);
- TCP/IP for Local and Wide Area Networks (LAN & WAN) ;
- Web-enabled Operator Consoles;
- Control Center Application Programming Interface (CCAPI) Initiatives

### 6.14.9. System Sizing & Extensibility

The hardware and software openness of SCADA allows the customer to smoothly upgrade the proposed system with great facilities. Common upgrading needs include (but not limited to) the following items:

- Additional measurement points (analog and digital);
- Additional protocol-compliant IEDs;
- Additional protocol-compliant PLCs;
- Additional operator consoles;
- Additional printers;
- Connection to other SCADA centers

### 6.14.10. SCADA Interfaces

User interface and gateway services communicate with SCADA over the following interfaces:

- **OLE Automation Control Interface** - OLE Automation provides the easiest programming interface to SCADA. OLE automation client services may be built using Visual Basic or C++. The service may direct SCADA to add, delete, or modify SCADA

objects, may issue controls, and may retrieve measurement data. The OLE Automation interface may be distributed across CPUs, such that a service on one server uses SCADA running on another server;

- **Publisher/Subscriber Control Interface** - The publisher / subscriber interface allows for high performance data update and automatic refresh. This interface is based on TCP/IP sockets, and may run on the same server or between servers. This may be used directly from C++ or using custom OLE controls in Visual Basic;
- **Custom IT elementary Sink Interface** – The custom IT elemetrySink interface is used by gateway services for high performance data transfer. This interface works between two processes on the same server. This interface supports C++ programming.

## 6.15 Graphical User Interface (GUI)

The GUI shall operate within a window environment The system shall use displays which mimic the existing control panels so that the operators working in conventional control room environment are comfortable while working on the new system. Contractor shall develop control panel display generally similar to the one existing in conventional control room.

The GUI shall allow the personnel to monitor and control the equipment through the control panel displays and Tabular displays. The control panel displays shall be dynamically updated for measurands, device positions, annunciations. To have better visibility of control panels, it shall be possible to iconise each control panel separately. Operator shall select that icon to zoom/view that panel display & carry out operations such as alarm annunciation accept/reset, device close/open operations etc.

### 6.15.1. Trending

Trend displays shall enable the user to select real-time and historical data for trending on graphical displays and for tabular displays. It shall be possible to take print of these trends.

### 6.15.2. Alarms

Alarms are conditions that require user notification when detected. Audio, visual alarm shall be generated for all such conditions. It shall be possible to accept & reset all trip & non-trip alarm annunciation appearing on control panel facia from control panel display itself. Alarm annunciation on control panel shall have following characteristics:

| Condition | Facia | Sound |
|---|---|---|
| Alarm initiation by relay contact | Flashing Glow | On |
| Accept PB pressed | Steady Glow | Off |
| Reset | Off (if relay contact is reset)<br>Steady Glow (if relay contact is not reset) | Off |

Other alarm conditions shall be acknowledged from respective alarm list displays. Other alarm conditions shall include, but not be limited to the following:

(a) Telemetered or calculated value limit violations

(b) Un-commanded changes of a power system device state
(c) Data source communication errors resulting in loss of data
(d) SCADA hardware and software element failures.

The standard products for advanced alarm management shall also be provided. Regardless of the alarm management technique used, all alarm messages shall be recorded with time & date tag on auxiliary memory for review and printing on demand by the user.

Displays shall highlight alarm condition using a combination of colour, intensity, inverse video and blinking. Alarm messages shall be a single line of text describing the alarm that has occurred with date & time of occurrence.

#### 6.15.3. Events

Events are conditions or actions that shall be recorded by the SCADA system but do not require user action. Events shall be recorded in the form of an event message. The event message format shall be similar to the alarm message format. Events shall include but not limited to followings:

Values returning to normal from a limit violation state Device status change on manual operation.

#### 6.15.4. Hardcopy Printing of Display

A means shall be provided to produce a copy of a display. The display printout shall be initiated from user friendly push buttons/pull down menus. The options for printing mode shall include at least selection for orientation, background colour, page size, colour or black & white print and print preview. It shall also be possible to print selected portions of display and direct printing on any of the connected printer.

#### 6.15.5. Report Generation

The user shall be able to schedule periodic reports generation, direct a report to a display, print a report, and archive a report. Hardcopy report formats shall be handed over to contractor for generation of report formats in the system. It shall also be possible to define and generate the additional user configurable reports. The generation and printing of any report shall not effect normal scanning of data from PLC. The report scheduling display shall enable entry of the following parameters, with default values provided where appropriate:

(a) Report name
(b) Report destination (printer or archiving device)
(c) Time the system should produce the report.

### 6.16 SCADA System Access Security

A mechanism for defining and controlling user access to the SCADA system shall be provided.

### 6.16.1. Alarm Summary Displays

Displays that list or summarize all unacknowledged and acknowledged alarms shall be provided. The user shall be able to select between viewing alarms in chronological and reverse chronological order. The default shall be most recent alarms. The summary shall separate acknowledged and unacknowledged alarms. To facilitate identification of unacknowledged messages the time field shall blink or entire row shall blink. It shall be possible to sort alarms by user defined text, date, time.

### 6.16.2. Event Summary Displays

Event summary displays shall list the most recent events. The user shall be able to select between viewing events in chronological and reverse chronological order. The user shall be provided with a convenient and efficient means of selecting an event summary display. It shall be possible to sort events by user defined text, date, time.

### 6.16.3. Operating Information Summaries

The operating information summaries defined below shall be provided. Summary items will be listed in reverse chronological order with the most recent item shown on the first page. The user shall have the ability to sort summary items by device.

### 6.16.4. Abnormal Summary

The summary display shall list devices and values that are found to be abnormal, i.e., are not in their normal state. Telemetered, calculated, and manually entered status and data values shall be included.

### 6.16.5. Out-Of-Scan Summary

The out-of-scan summary display shall list device status and data values that are not currently being processed by the system.

### 6.16.6. Alarm Inhibit Summary

This display shall list devices and data values for which the user has suspended alarm processing.

### 6.16.7. Tag Summary

This display shall list and describe all active device tags.

### 6.16.8. Help Displays

Help displays shall be provided to aid the user in interpreting displayed information and to guide the user through a data entry or control procedure.

### 6.16.9. Alarm Beeper Services

The Alarm Beeper service audibly notifies the operator of recent alarms by playing a wave file. Wave files can be used to distinguish between Alarm priorities. All the Windows's wave files or customized wave files can be used.

### 6.16.10. Alarm Pager Services

The Alarm Pager service allows the user to configure the system to issue various pages in response to specified alarms.

### 6.16.11. 6.Training Of Owners Engineers

The contractor is required to provide in depth training to Owners engineers (10 Nos.) for 1 month on all aspects of the system being supplied. Training module shall be mutually discussed and finalized to cover Owner's personnel to operate, append, modify and troubleshoot the System effectively. All the documentation and write up material for trainees shall be provided by the contractor.

The vendor should conduct this training at his premises, before testing of the package start. The Bidder should devise an exhaustive training program.

## 6.17 Testing / Inspection

### 6.17.1. Test on Complete Control System

On completion, the functioning of the complete system shall be tested to demonstrate its correct operation in accordance with the Specification.

For control system testing, the contractor may provide temporary means to simulate operating conditions, but the system will not be finally accepted until correct operation has been demonstrated to the satisfaction of the Engineer when all the pumps are operating.

The system shall be shown to operate correctly whatever the selection of duty and standby equipment may be.

Conditions to be tested shall include:

- Normal automatic operation.
- Normal manual operation
- Emergency manual operation

### 6.17.2. Commissioning Tests

Correct operation of controllers shall be verified by observing that the final control element moves in the proper direction to correct the process variable as compared to the set point.

All logic sequences shall be verified to operate in accordance with the specifications.

All defects and malfunctions disclosed by test shall be corrected immediately. New parts and materials shall be used as required and approved and tests shall be repeated.

A report certifying completion of validation of each instrument system indicating calibration values, verification that the system performs as per requirements and any provisional settings made to devices shall be provided. A format for commissioning checklist to be provided for approval before performing the commissioning tests.

### 6.17.3. Final Operational Testing and Acceptance

Upon completion of instrument calibration and system validation, all systems shall be tested under process conditions.

The testing shall include, but not limited to all specified operational modes, taking process variables to their limits (simulated or process) to verify all alarms, failures, interlocks and operational interlocks between systems and / or mechanical equipment.

Any defects or malfunctions shall be immediately corrected using approved methods and materials and the tests shall then be repeated.

Upon completion of final operational testing, a report shall be submitted, indicating that the total control system provided meets all the functional requirements specified herein. This report shall be made in the format approved by the Engineer. The Engineer shall certify this report and it shall constitute final acceptance of the control system.

## 6.18 Commissioning

After completion of installation works the contractor shall arrange to carry out following checks/tests in the presence of CSCL representative / Engineer – in – charge.

### 6.18.1. Test on Control Panels and Switchboards

**Mechanical Completion Test**

(i) Check name plate details of every associated equipment according to specification
(ii) Check for physical damage
(iii) Check for tightness of all bolts, clamps and connecting terminals
(iv) Check earthing
(v) Switch developments
(vi) Each wire shall be traced by continuity tests and it should be made sure that the wiring is as per relevant drawings. All interconnections between panels/equipment shall be similarly checked.
(vii) All the wires should be meggered to earth

**Commissioning Tests**

(i) Checks on relays, functioning of relays, simulation of fault for testing
(ii) Checks on motors
(iii) Setting of relays, other alarm, tripping devices and interlocks as per scheme

(iv) Phase angle checks, measurement of magnitude and phase angle of current transformer secondary currents and potential transformer secondary voltage
(v) Functional checking of all power and control circuits e.g. closing, tripping, control, interlock, supervision and arm circuits including proper functioning of the components equipment. If inter locks are provided with other equipment, it shall be thoroughly tested.

### 6.18.2. Test of Relays

**Mechanical Completion Checks**

(i) Check name plate details according to specification
(ii) Check for any physical damage
(iii) Check internal wiring
(iv) Megger all terminals to body
(v) Megger AC to DC terminals

**Commissioning Checks**

(i) Check operating characteristics over the entire range by secondary injection
(ii) Check minimum pick up voltage
(iii) Check operation of electrical / Mechanical targets
(iv) Relay settings to be checked by injecting different values of current
(v) Setting of relays as per discrimination chart

**Miscellaneous**

Mechanical completion checks and commissioning tests on items not covered above, shall be carried out by the contractor as per the instructions of CSCL representative / Engineer - in – charge.

## 6.19 Uninterrupted Power Supply (UPS)

All the DDCs and control instrumentation should be powered through UPS. The Network Controllers and Operator workstation should also be powered through online UPS.

Bidder shall provide true ON Line 3 Phase UPS system with rated working load plus 100% standby with parallel redundant in a room. The UPS system shall be provided with necessary by pass arrangement. Each UPS shall have minimum 120 minutes' battery backup. The batteries shall be of maintenance free type.

All DC or AC voltage required for instrumentation system shall be derived within the control panels by providing a regulated DC power supply units or transformers. Inverter of small capacity sufficient to feed UPS, shall be supplied and installed along with control gear, changeover scheme and earthing and inverter shall have 4 hour back up.

## 6.20 CONTROL PHILOSOPHY General

### Control Philosophy

The treatment plant conceived is an auto control plant capable of Automatic Operation requiring minimal operator attention. The conceived Auto Control is as follows:

### Pumps Automation

Auto start / stop of the following pumps depending upon level in the tanks/ sumps

a. Auto start (timer control) of Primary sludge pumps pumping to sludge thickener
b. Auto start and stop of RAS sludge pumps as per the control logic of the Bidder
c. Auto start and stop of dilution water pumps as per the control logic of the Bidder
d. Manual start of digester feed pumps as per Bidder operation philosophy, with auto stop in case of any alarms
e. Manual Start of Sludge dewatering System, under operator supervision. , with Auto stop in case of low level in sludge storage sump
f. Manual start and stop of Treated water tanker filling pumps as per requirement
g. Auto start and stop of filtrate / centrate as per level in the sump

### Pressure Indication

All operating pumps will have pressure indication which will reflect on the panels.

### Flow Measurement

The flow meters will be area velocity flow meter & electromagnetic flow meter with local and remote indicators. There shall be online flow measurement at the following locations.

(a) Inlet chamber with area velocity flowmeter
(b) Excess Sludge from Primary clarifiers to Mechanical Thickener Sump
(c) Excess Sludge Secondary Bioreactors to Mechanical Thickener Sump
(d) Excess mixed (excess bio + primary) sludge feeding from Mechanical Thickener Sump to mechanical Thickeners: one FIR for each Mechanical Thickener
(e) Filtrate from Mechanical Thickener (combined filtrate line with a FIR)
(f) Thickened sludge pumps to digesters with flow measurement on each digester inlet
(g) Flow measurement to each sludge dewatering machine
(h) Flow measurement on filtrate/Centrate pumps
(i) Gas flow measurement from gas holders feeding gas to Gas Engines for utilization.
(j) Gas flow measurement on all gas flares
(k) Air flow to each section of bio reactors where control of DO is an important process requirement where air flow is a mixing requirement

### Weather Station

Install a complete weather station to and record

(i) Daily wet & dry bulb record

(ii) Relative humidity
(iii) Rain fall record
(iv) direction of wind with a wind rose

The weather station shall be located at a central place as directed by the engineer in charge and the data collected shall be fed into the PLC

**Level Switches/ Transmitters**

Level switches and transmitters shall be provided at all varying level sumps for operation of pumps.

For alarms, there shall be separate level switches. The level switch used for operation of pumps shall not be used for alarms.

**DO Meters**

DO meter shall be provided with interlock to the aeration blowers, there shall be separate DO meters for each Bio reactor tank.

Audio visual alarms which shall be activated on the following conditions

a) Low Level in all sumps / tank with interlock with pumps
b) XHL in all sumps / tanks with alarm
c) Water Quality of treated effluent not meeting the standards with respect to Turbidity
d) XHL in Sump and the drives which should be ON & OPERATING not started.
e) Air Blowers or Aerators Not Operating – & DO not up to level required

**Specific Operational Requirements for PLC & Control Cabinet**

**PLC Logic**

The treatment plant instrumentation shall be linked to a PLC. The conceptual PLC – operating plant philosophy technical Requirements is as follows

(a) The objective of the PLC is:
  (i) Provide Data Acquisition (DA) and operating status of the plant functions for plant operation and performance monitoring
  (ii) Control pumps as per automation philosophy interlocked to the level and pressure switches
  (iii) Record data of listed drives / parameters in plant - ie operating hours per day etc.
  (iv) Record and provide Trending of critical parameters as listed below
  (v) Provide Alarm of faults / breakdown

The data record and trending data, alarms from the PLC should go to a printer which should record the information as follows:

a) Alarms as and when it takes place with time and detail of fault
b) Data record of drives - to be automatically printed on a daily basis at a given time - say 1200 hrs. However a facility should be provided to take a status print out at any required moment using a manual signal - this signal can be given from a pressure

sensitive key board .The log report shall give service / preventive maintenance alarms for the drives - like lubrication, oil change, filter cleaning etc. after a set number of operating hours of each drive - these alarms are to be repeated until the service alarm accept button has been pressed by the operator.

c) Trending data of the listed parameters to be available as follows :
   (i) for the past 8-hour period
   (ii) for the past 24-hour period
   (iii) for the past 7 days' period

The trending data should be printed automatically for past 24 hr period at a given set time every day - say 1200 hrs and the record for the past 8 hrs , 24 hrs and 7 days be available by giving a signal from the pressure sensitive key board.

**Alarms**

**(i) Normal Alarms**

All alarms are software alarms - to be printed on the printer, accompanied with an audio - visual alarm for a definite time. however, whenever there has been an alarm of any time there shall be a facility to give an normal audio - visual alarm also to be enabled when the plant is under operation in an "attended " mode - i.e. there is an operator. This audio - visual alarm facility is to be disabled when the plant is under "non attended" mode.

**(ii) Emergency Alarms**

Emergency audio / visual / telephonic alarm is to be activated in case of an emergency fault in the "non attended mode ".

**(iii) Service Alarms**

Alarms along with the daily log report for service / preventive maintenance of the drives - like lubrication, oil change, filter cleaning etc. after a set number of operating hours of each drive - these alarms are to be repeated until the service alarm accept button has been pressed by the operator.

**Plant Operation Modes**

The plant shall be operated in two modes:

**(i.) Attended Mode -** i.e. when there is a operator present in the plant, and certain sections of the plant are to operate only in the attended mode such as sludge dewatering, screenings and grit removal.

(ii.)**Non Attended Mode** - i.e. no operator - normally this will take place at night and on weekends. The Emergency audio / visual / telephonic alarm is to be activated in case of an emergency fault.

**Plant Operational Data and Record**

The plant operational data from all the on line meters as well as manual laboratory data shall be stored online on "cloud based "Plant Management System (PMS).

The data should be available to authorized personnel on either PC, Laptop, Tablet or Smart Phones with internet capability.

The control system in addition to providing the facilities detailed in the preceding clauses shall provide the following specific requirements.

The automation system should automatically on the restoration of power (following a power failure) start the plant/Plant operation sequence after expiry of delay timers based on level of sump and follow a startup sequence to prevent the simultaneous startup of various drives. Automation system shall be designed in such a way that process control is automatic through various logics and process control parameter, flow, raw sewage characteristics etc.

The typical input/ output (I/O) requirements of various drives to be controlled and monitored through DDCs are shown in Table- 1

Plant should be controlled through central control room. Control system should provide complete information, including equipment/drive failure through alarm system, status of all drives, pressure on various lines, air/bio gas flow in various lines, sewage/sludge flow in various lines.

### 6.21 Intercom System

An intercom system with 3x12 EAPBX shall be provided at all suitable locations especially between the following points within existing treatment plant and the pump house area:

- Control room
- All rooms within the Administration Building
- The pump room with the adjacent main distribution panel room
- Duty Room
- Security Cabin at the entrance of the plant

**TABLE 1 : TYPICAL I/O SCHEDULE**

| Sl. No. | Items | I/O ,Controls and Alarm requirement | | | | | |
|---|---|---|---|---|---|---|---|
| | | DI | DO | AI | AO | Controls | Alarms |
| | | | | | | | |
| 1. | **Tanks and associated Pumps** | | | | | | |
| | Tank Level (Through Ultrasonic level transmitter) | | | * | | Level control | High and low |
| | Pump Start/Stop( 2A rated potential free relay contactoutput) | | * | | | Duty cycling on demand and runtime equalization. Standby to come online in case of dutyfailure | |
| | Pump Status( Through current relay) | * | | | | | Fail to start |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Pump trip status( Through potential free contact of overloadrelay) | * | | | | | Trip alarm |
| | Pump auto manual switch status(Through auxiliary potentialfree contact of auto manual switch) | * | | | | | Manual mode |
| | Pump current consumption(Through current transducer) | | | * | | | Over current |
| 2. | **All electrical drives** | | | | | | |
| | Start/Stop( 2A rated potential free relay contactoutput) | | * | | | Duty cycling on demand &runtime equalization. | |
| **Sl. No.** | **Items** | **I/O ,Controls and Alarm requirement** | | | | | |
| | | **DI** | **DO** | **AI** | **AO** | **Controls** | **Alarms** |
| | | | | | | Standby to come online in case of duty pumps failure | |
| | Status( Through current relay) | * | | | | | Fail to start |
| | Trip status( Through potentialfree contacts of overload relay) | * | | | | | Trip alarm |
| | Auto manual switch status(Through auxiliary potential free contact ofauto manual switch) | * | | | | | Manual mode |
| | Current consumption(Through current transducer) | * | | | | | Over current |
| | Control sensors for automatic operation of the drives ifrequired | * | | * | | | High/low value alarm |
| 3. | Power failure | * | | | | | Power failure alarm |
| 4. | DG Mode of operation | * | | | | Run reduced no of equipment as required | DG mode ON |
| 5 | Power failure restart | | | | | Restart pumps in sequence | Power failure restart mode ON |
| 6. | Pump house/plant energy consumption and electrical parametersmonitoring | | | * | | | |

**Notes :**

i. The I/O schedule detailed is indicative. The Contractor shall provide all the I/Os necessary in order to achieve the complete control and monitoring of the Pump house.
ii. 25% spare for each type of digital and analogue I/Os shall be provided in each DCS.

# Part 7 - Inspection, Testing, Erection & Commissioning

## 7.1 General

Inspection and tests schedule shall be as follows;

i) Manufacturer tests
ii) Acceptance Inspection / Quantity checking
iii) Install /Site Inspection
iv) Site Acceptance Test
v) Tests on Completion
vi) Process Wet Tests (by Raw Sewage)
vii) Operation Test (Tests After Installation)

All equipment under category 'A' & 'B' of the plants mentioned under clause 7.2 shall be liable for inspection and testing before dispatch at the Manufacturer's premises or workshop, as required by the Engineer, who reserve the right to be present in all testing to see that the equipment conform to the specifications. No materials of these categories shall be delivered to the site without inspection having been carried out or waived in writing by the Engineer.

All inspection and testing shall be carried out in accordance with the Specification and in absence of Specification, relevant Indian Standard or internationally approved equivalent standard.

All types (as applicable), routine and acceptance tests shall be conducted in the presence of Engineer / Third Party Inspection Agency on all the equipment as per latest applicable IS/IEC at no extra cost. Any modification / revision in the equipment as required by the Engineer shall be carried out by the Contractor without any extra cost. All such costs / fees for revisions / modifications shall be deemed to be included in the prices of supply of equipment as quoted by the Contractor. Typical type test reports for other equipment shall be submitted by the Contractor for approval by Engineer.

After award of contract, Contractor shall furnish a QA plan for approval by Engineer. QA plan shall include testing for incoming supply of raw materials and bought out items, stage inspections and tests on finished products at manufacturer's works / appropriate testing station. QA plan shall clearly indicate tests which are intended to be witnessed by the Contractor alone and those by both Contractor and Engineer.

The Engineer and/or duly authorised and designated representative/Third Party Inspection Agency, to be appointed by Engineer, shall be entitled to attend the aforesaid inspection and/or tests.

The Engineer and/or duly authorised and designated representative/ Third Party Inspection Agency shall have access to the Contractor's premises at all times to inspect and examine the material and workmanship of the mechanical and electrical plant and equipment during its manufacture there. If part of the plant and equipment is being manufactured on other premises, the Contractor shall obtain permission for the Engineer to inspect as if the plant and equipment was manufactured on the Contractors own premises. Testing (including testing for chemical analysis and physical properties) shall be carried out by the Contractor and certificates

submitted to the Engineer who will have the right to witness or inspect the above mentioned inspection /testing at any stage desired by him. Where inspection or testing is to be carried out at a subcontractor's works, a representative of the Contractor shall be present.

For bought out items, the Manufacturers shall have to show to the Engineer the test and guarantee certificates of the original materials supplier and furnish photocopies of the same for Engineer's records.

Contractor shall provide test procedure, pre-factory test results, and calculation sheet, photo in advance and provide all of test result with necessary document including its data and photo to show Engineer that test is carried out in proper condition and the its test results.

The procedure for the testing and inspection to be carried out during or following the manufacture of the materials to ensure the quality and workmanship of the materials and to further ensure that they conform to the Contract in whatever place they are specified shall be as described below:

(i) The Contractor shall give the Engineer at least 21 clear days' notice in writing of the date and the place at which any plant or equipment will be ready for inspection/testing as provided in the Contract. The Engineer or his duly authorised representative shall thereupon at his discretion notify the Contractor of his intention either to release such part of the plant and equipment upon receipt of works tests certificates or of his intention to inspect. The Engineer shall then give notice in writing to the Contractor, and attend at the place so named the said plant and equipment which will be ready for inspection and/or testing. As and when any plant shall have passed the tests referred to in this section, the Engineer shall issue to the Contractor a notification to that effect.

(ii) The Contractor shall forward to the Engineer duly certified 6 copies of the test certificates and characteristics performance curves for all equipment.

(iii) If the Engineer fails to attend the inspection and/or test, or if it is agreed between the parties that the Engineer shall not do so, then the Contractor may proceed with the inspection and/or test in the absence of the Engineer and provide the Engineer with a certified report of the results thereof as per (ii) above.

(iv) If any materials or any part of the works fails to pass any inspection / test, the Contractor shall rectify or replace such materials or part of the works and shall repeat the inspection and/or test upon giving a notice as per (i) above. Any fault or shortcoming found during any inspection or test shall be rectified to the satisfaction of the Engineer before proceeding with further inspection of that item. Any circuit previously tested, which may have been affected by the rectification work, shall be re-tested.

(v) Where the plant and equipment is a composite unit of several individual pieces manufactured in different places, it shall be assembled and tested as one complete working unit, at the maker's works.

(vi) Neither the execution of an inspection test of materials or any part of the works, nor the attendance by the Engineer, or the issue of any test certificate pursuant to (iii) above shall relieve the Contractor from his responsibilities under the Contract.

(vii) The test equipment, meters, instruments etc., used for testing shall be calibrated at recognised test laboratories having accreditation of NABL at regular intervals and valid certificates shall be made available to the Engineers at the time of testing. The calibrating instrument used as standards shall be traceable to National/International standards. Calibration certificates or test instruments shall be produced from a recognised/Laboratory for the Engineer's consent in advance of testing and if necessary instruments shall be recalibrated or substituted before the commencement of the test.

(viii) Items of plant or control systems not covered by standards shall be tested in accordance with the details and program agreed between the Engineer and Contractor's Representative. If such materials or works are found to be defective or not conforming to the Contract requirements, due to the fault of the Contractor or his sub-contractors, the Contractor shall defray all the expenses of such inspection and/or test and of satisfactory reconstruction.

(ix) Tests shall also be carried out such that due consideration is given to the Site conditions under which the equipment is required to function. The test certificates shall give all details of such tests.

(x) The Contractor shall establish and submit a detailed procedure for the inspection of materials or any part of the works to the Engineer for approval within the date indicated in the Programme Details. The detailed procedure shall indicate or specify, without limitation, the following:

- Applicable code, standard, and regulations.
- Fabrication sequence flow chart indicating tests and inspection points.
- Detailed tests and inspection method, indicating the measuring apparatus to be used, items to be measured, calculation formula, etc.
- Acceptance criteria.
- Test report forms and required code certificates and data records.
- Method of sampling, if any sampling test to be conducted.
- Contractor's or Engineer's witness points.

(xi) The Contractor shall not pack for shipment any part of the Plant until he has obtained from the Engineer written approval to the release of such part for shipment after any tests required by the Contract have been completed to the Engineer's satisfaction.

(xii) The Inspection and Testing procedures shall be carried out for the equipment as applicable.

(xiii) The detailed procedure shall indicate or specify, without limitation, the following:

- Material Certificates for all the specified materials
- Welding Qualification
- Stage Inspections (in process inspection)
- Visual Inspection.
- Dimension Checking

- Dynamic balancing for all rotating parts
- Hydrostatic / Leak testing for all pressure parts, Pneumatic Leak Test wherever applicable
- Operation check
- Liquid penetrate tests or magnetic particle tests for all machined surfaces of pressure parts.
- Ultrasonic test for forging materials viz.,
  - ✓ Plates of thickness 20mm and above for pressed / formed parts.
  - ✓ Plates, flanges and bars of thickness / dia. 40mm and above used for fabrication of pressure and load bearing members and rotating parts.
- Radiographic testing for all but welded parts, as per applicable codes.
- Hardness tests for all Hardened surfaces.
- Type, routine and acceptance test, as applicable

The Contractor shall maintain proper identification of all materials used, along with reports for all internal / stage inspection work carried out, based on the specific job requirement and based on the datasheets / drawings / specifications.

The travelling, boarding & loading arrangement shall be as per the provision.

However, cost of inspection when equipment/material or any part of the facilities is not ready at the time specified by the Contractor for inspection or when re-inspection is necessitated by prior rejection shall be borne by the Contractor and will not be reimbursed.

Witnessed testing will normally be waived off on standard types of equipment such as small motors made by approved manufacturers, individual standardised instruments, small mass produced components used in the manufacture of Plant items, small bore pipework and fittings, minor installation materials and low voltage cable. In order to remove doubt this shall not relieve the Contractor of his obligation under the Contract to ensure that all Plant is tested at the manufacturer's works prior to delivery to Site.

All destructively tested samples shall be replaced with new.

As a guide to the Contractor, the witness testing shall be of the following, but not limited to these items:

1. **Mechanical:**
   - All type of Pumps
   - Mechanical Medium and Fine Screens
   - Scraper System & Bridges of PST & SST
   - Complete Chemical Dosing Systems
   - Mixers
   - Air Blowers
   - Decanter equipment
   - All type of Valves Sluice Gates
   - Weir Gates
   - Valve And Penstock Actuators
   - Thickener System

- Sludge Dewatering Equipment and Associated Plant
- Fine Bubble Diffuser Systems
- Digester System
- Dewatering equipment
- EOT Cranes
- Storage and Process Vessels

2. **Electrical**:

- Power transformers if required.
- 11kV Outdoor Isolator Kiosk, HT & LT Breakers
- MCC s and switchboards
- Capacitor banks with APFCR
- Standby Generator systems.
- Motors (Rated higher than 25 Kw)
- HT & LT cables
- Battery and Battery charger with D.C Distribution board
- 11kV Disconnectors
- 11kV Lightning Arrestor
- 11kV Drop-Out Fuse
- Control and Instrumentation
- Plant control and MMI software systems;
- Control panels
- MMI s
- UPS s.
- Variable Frequency Drives
- APFCR Panel with Capacitor Banks

3. **Instrumentation and Control:**

- Level Measuring System
- Pressure Gauges
- Pressure Transmitter System
- Flow Measuring System
- DO analyzer
- ORP analyser
- Temperature Measuring System
- Instrumentation and Control Cables
- Instrument Control Panel
- Programmable Logic Controller
- SCADA / HMI System
- Uninterruptible Power Supply System

## 7.2 Materials, Plant and Equipment

The Contractor shall place orders for the material and the equipment only after approval of the Engineer.

The Contractor shall submit the detailed drawings from the approved manufacturer and the procedure of submission, review and revision shall be as specified herein:

The Contractor shall supply the manufacturer's test results and quality control certificates. The Engineer will decide whether he or his representative will inspect and test the material / equipment or whether he will approve it on the basis of the manufacture's certificate.

The following inspection and test categories shall be applied prior to delivery of the equipment, of various categories as indicated in the technical specifications for each type of the equipment:

**Category A:** -The drawing has to be approved by the Engineer before manufacture and testing. The equipment/material has to be inspected by the Engineer or a third party inspecting agency approved by the Engineer at the manufacturer's premise before packing and dispatching. The contractor shall provide the necessary equipment and facilities for tests and the cost thereof shall be borne by the Contractor.

**Category B**: - The drawings of the equipment have to be submitted and approved by the Engineer prior to manufacture. The equipment/material has to be tested by the manufacturer/contractor and the manufacturer's test certificates are to be submitted and approved by the Engineer before dispatching of the equipment. Notwithstanding the above, the Engineer, after examination of the test certificates, reserves the right to instruct the Contractor for retesting, if required, in the presence of the Contractor's representative

**Category C**: - Samples of the materials and/or equipment shall be submitted to the Engineer for pre- construction review and approval. Following approval by the Engineer, the material may be manufactured as per the approved standards and delivered to the Site.

For material/equipment under Category "A" and "B", the Engineer will provide an authorization for packing and shipping after inspection.

The testing and approval for dispatching shall not absolve the Contractor from his obligations for satisfactory performance of the plant.

### 7.2.1 Category of Inspection

The categorization of the various material, equipment and plant for purpose of inspections is as below. However, this list can be altered and additions or subtractions done or categories changed in due course during the implementation of the Contract by the Engineer.

#### 7.2.1.1 Mechanical Works

| Sr. No. | Items | Category of Inspection |
|---|---|---|
| (i) | All Types Pumps | Category A |
| (ii) | All types of Valves with / without Actuators (400 mm size & above) | Category A |

| | | |
|---|---|---|
| (iii) | Pipe work above 300mm | Category A |
| (iv) | Sluice gates | Category A |
| (v) | E.O.T Crane | Category A |
| (vi) | Mechanical Medium And Fine Screens | Category A |
| (vii) | Grit Removal System | Category A |
| (viii) | Mechanical Systems of PST and SST | Category A |
| (ix) | Air Blowers | Category A |
| (x) | Decanting | Category A |
| (xi) | Membrane | Category A |
| (xii) | MBBR Media | Category A |
| (xiii) | Thickener System | Category A |
| (xiv) | Digester Gas Mixing and Heating System | Category A |
| (xv) | Mechanical Sludge Dewatering System | Category A |
| (xvi) | Filtration system | Category A |
| (xvii) | UV Disinfection Systems | Category A |
| (xviii) | Metallic bellows, Expansion Joints and Dismantling joints of (400 | Category A |
| (xix) | Fine Bubble Diffuser System | Category A |
| (xx) | Gas Compressors/Blowers | Category A |
| (xxi) | Scrubbing System | Category A |
| (xxii) | Gas Engines & System | Category A |
| (xxiii) | Heat Exchanger System | Category B |
| (xxiv) | Actuators for Valves & Sluice Gates | Category B |
| (xxv) | Flame Arrester System | Category B |
| (xxvi) | Cooling water pumps | Category B |
| (xxvii) | Lubricating water pumps | Category B |
| (xxviii) | Air Ventilation System | Category B |
| (xxix) | Mixers | Category B |
| (xxx) | Drain and dewatering Pump sets | Category B |
| (xxxi) | Pipe Work 300mm and below | Category B |
| (xxxii) | Exhaust Fans | Category B |
| (xxxiii) | Portable Fire Extinguisher | Category B |
| (xxxiv) | Ventilation System/Air Conditioners | Category B |

### 7.2.1.2 Electrical Works

| Sr. No. | Items | Category of Inspection |
|---|---|---|
| (i) | Motor above 25 kW | Category A |
| (ii) | Motor below 25 kW | Category B |
| (iii) | HV Outdoor Current Transformer | Category A |
| (iv) | HV Outdoor Switch Disconnector/ Isolator | Category A |
| (v) | HV Outdoor Lightning Arrester | Category A |
| (vi) | Gantry/ Structure for Switchyard/ Transmission Line | Category A |
| (vii) | Transformer (including OLTC, RTCC panel) | Category A |
| (viii) | MV and LV Capacitors and APFC Panel | Category A |
| (ix) | HV, MV and LV switchboards | Category A |
| (x) | LV Variable Frequency Drive | Category A |
| (xi) | Starter for LV motors | Category A |
| (xii) | Battery and Battery Charger and DCDB | Category A |

| | | |
|---|---|---|
| (xiii) | EPABX System | Category A |
| (xiv) | Cathodic protection- Transformer/ Rectifier (T/ R) units | Category A |
| (xv) | Outdoor 11 kV accessories for substation (i.e. Fuse, ACSR Conductor, Clamps and connectors, hardwares, | Category B |
| (xvi) | Cathodic Protection equipment other than T/ R units | Category B |
| (xvii) | Neutral Grounding Resistor | Category B |
| (xviii) | Sub-Distribution Boards, Lighting Panels | Category B |
| (xix) | Lighting System | Category B |
| (xx) | VHF Communication System | Category B |
| (xxi) | UPS System | Category B |
| (xxii) | HV, MV and LV Power and Control Cables | Category A |
| (xxiii) | MV/LV Cable Termination | Category B |
| (xxiv) | Earthing System | Category B |
| (xxv) | Local Push Buttons | Category C |
| (xxvi) | Cable tray and accessories | Category B |

### 7.2.1.3 Instrumentation Works

| Sr. No. | Items | Category of Inspection |
|---|---|---|
| (i) | Instrument Control Panel for Primary Treatment system comprising of PLC/RI/Os System. | Category A |
| (ii) | Instrument Control Panel for Secondary Treatment system comprising of PLC/RI/Os System. | Category A |
| (iii) | Instrument Control Panel for Sludge Treatment system comprising of PLC/RI/Os System. | Category A |
| (iv) | Instrument Control Panel for Gas Handling system comprising of PLC/RI/Os System. | Category A |
| (v) | PLC control panel with SCADA system, digital indicator, alarm annunciator, pushbuttons etc. | Category A |
| (vi) | Temperature scanners | Category A |
| (vii) | Flow switches | Category A |
| (viii) | Digital panel meters | Category A |
| (ix) | Conductivity level switches | Category A |
| (x) | Control panel for surge protection system | Category A |
| (xi) | Full Bore Electromagnetic Flow meters | Category A |
| (xii) | Clarifier and dosing control panel | Category A |
| (xiii) | BOD/COD analyzer | Category A |
| (xiv) | TSS Analyzer | Category A |
| (xv) | Pressure Switches | Category B |
| (xvi) | Differential pressure switches | Category B |
| (xvii) | Ultrasonic type level measuring systems | Category A |
| (xviii) | Ultrasonic flow meter | Category A |
| (xix) | Float type Level Switches | Category B |
| (xx) | Instrumentation and Control cables | Category B |
| (xxi) | Surge Protection Devices | Category B |
| (xxii) | Radar type level meter | Category A |
| (xxiii) | Pressure transmitter | Category B |
| (xxiv) | Flow indicator and integrator | Category A |
| (xxv) | Alarm Annunciator | Category B |
| (xxvi) | Motorized Actuators for valves | Category B |

| Sr. No. | Items | Category of Inspection |
|---|---|---|
| (xxvii) | Open channel flow meter | Category A |
| (xxviii) | Turbidity meters | Category B |
| (xxix) | PH meter | Category B |
| (xxx) | Laboratory instruments and equipment | Category B |
| (xxxi) | Pressure Gauges | Category B |
| (xxxii) | Portable temperature monitor | Category B |
| (xxxiii) | Portable sound level meter | Category B |
| (xxxiv) | Portable vibration meter | Category B |
| (xxxv) | Laptop Computers | Category B |
| (xxxvi) | Printers | Category B |

### 7.3 Factory Acceptance Test (FAT) Document

At least Thirty-five (35) days prior to commencement of inspection of each Plant item / equipment the Contractor shall supply a Factory Acceptance Test (FAT) Document for approval. This shall comprise four copies of the following:

- Un-priced copy of the Contractors order for the Plant item / equipment concerned:
- Details of the inspection and test procedures to be carried out.
- Pre-factory test results and its photos.

The FAT Plan shall provide comprehensive details of the tests to be carried out, the purpose of each test, the equipment to be used in carrying out the test and the methods to be adopted in carrying out the tests. The FAT shall provide space within the documentation for results of the tests to be added and for each test and for the FAT as a whole to be signed off by the Contractor and the Engineer.

On completion of the tests, the Contractor shall provide four copies of all test certificates, curves etc. for the inspected Plant item. Test certificates shall be provided for the Plant item as a whole plus certificates for the relevant component parts.

The Contractor shall submit to the Engineer, not later than 35 days prior to the commencement of the first inspection and test during manufacture, a programme detailing the inspection dates for all Plant. Those items of Plant that the Engineer has specifically identified for witness testing test shall be highlighted in the programme.

The Contractor shall keep the Engineer informed of any changes to the programme.

The Engineer shall not be requested to inspect an item of Plant until the Contractor has satisfied himself that the equipment meets all requirements of the Engineer’s Requirements.

The Contractor shall inform the Engineer in writing at least 21 days in advance regarding readiness for carrying out inspection of equipment/material etc. at manufacturer's works or at places of inspection. The programme for inspection shall be finalised by the Engineer after the receipt of the above. In case inspection cannot be carried out due to non-readiness of equipment/material etc. a subsequent date shall be finalised for carrying out the inspection in

which event all expenses incurred by the CSCL for such visits shall be recovered from the Contractor. Contractor's Representatives shall essentially be present during all inspections. The following information shall be given in the inspection call letter mentioned above:

(i) Name of manufacturer/supplier;
(ii) Address of place where inspection is to be carried out;
(iii) Proposed date/s and equipment to be inspected;
(iv) Name/s of contact personnel at manufacturer's/ supplier/s works with their telephone and fax numbers.
(v) Name of Contractor's Representative who will be present during the inspection.
(vi) Confirmation that internal testing has been completed.

The Contractor shall provide all the necessary instruments, test facility, water / electric power, test piece, samples, engineers/ workers, and others to carry out the tests after assembly at his cost. All instruments used for such tests shall be calibrated and certified by and approved by an independent testing authority not more than one month prior to the tests in which they are used. Calibration certificates with expire date and name of authorization agency for instruments used for such tests shall be produced for the approval of the Engineer and if necessary, instruments shall be recalibrated before the commencement of the tests.

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 retested and re-inspected as required by the Engineer.

In case equipment/material etc. is found not to comply with the specification, dates for re-inspection shall be finalised and expenses incurred by the CSCL for such visits shall also be recovered from the Contractor.

## 7.4 Tests at Manufacturer's Premises

### 7.4.1 Mechanical Equipment

#### 7.4.1.1 Pumps

**1. General**

All pumps shall be assembled at the factory to ensure correct alignment and fitting of all parts, which shall be 'match marked' before shipment. All testing and inspections under this Sub-clause shall be performed satisfactorily prior to shipment of any pump.

The performance guarantee tests shall be conducted in two stages i.e., first at the manufacturer's works and finally at work site after complete installation and commissioning, including all preliminary test before final successful test in complying with the Engineer's approved test and inspection method and relevant standards.

All pumps shall undergo witness performance tests at the pump manufacturer's Works.

Each pump and all the mechanical equipment related to WWTP works shall be tested at its rated speed with one of the job motors, being supplied under the Contract, only after job motors have been successful tested as per specifications. Reduced speed tests shall not be acceptable.

All tests such as Q/H curve, efficiency of pumps, power consumption, vibration and noise level shall be conducted. Pump casings shall be subject to hydrostatic pressure testing as an assembly at 150% of the pump shut-off head or 200% of the pump rated head whichever is higher. The hydrostatic pressure shall be held for not less than 30 minutes after all leaks have been stopped between attachments. Impeller and pump rotating assembly shall be dynamically balanced as per ISO 1940 / Gr. 6.3 / VDI 2060.

The tests shall cover the entire range of total head from shut-off to the minimum total head at which the pump can operate without cavitation's, noise, or vibration with suction well water level indicated on the drawings as low water elevation. The minimum head shall be equal to or less than the run out head specified for each pump. Data shall be recorded for not less than seven points between shut-off and minimum total head for suction well low water elevation.

For final tests, pumps shall be run so as to obtain the range heads specified in the performance tables by means of throttling of opening valves on the pumping mains and test results will be compared with those guaranteed by averaging the KW consumption hour and overall efficiency/quantity curves shall be plotted to demonstrate that the plant will be capable of meeting the full range of operating conditions at Site.

After factory performance tests, the Contractor shall submit six (6) copies of test reports.

**2. Performance Tests**

For performance tests, pumps shall be run so as to obtain the designed head and range heads specified in the performance tables by means of throttling of opening valves on the pumping mains and test results will be compared with those guaranteed by averaging the KW consumption.

The pumps shall undergo witnessed performance (acceptance) tests as per BS EN ISO 9906:2000/ ISO 9906 applicable for Grade 1 at the rated speed at the pump manufacturer's factory. Other pumps shall be tested in accordance with IS 9137. All pumps shall be tested for performance without internal coating and with the same electric motor being supplied under this Contract but only after successful completion of type tests and routine tests of all the motors.

Performance test shall be conducted at the rated speed at manufacturer's works to measure the capacity, total head, efficiency and power. For acceptance, criteria specified by the said standard (BS EN ISO 9906:2000/ ISO 9906 applicable for Grade 1) for minus tolerance of pump discharge flow, pump head, pump efficiency etc. shall not be allowed. These tests shall form the basis for pump acceptance except for vibration and noise. The pump shall be tested over the entire range comprising shut off head to maximum flow at run out head specified at which the pump can operate without cavitation, noise, or vibration with suction pool water level indicated. Minimum seven readings approximately equidistant shall be taken for plotting the performance curve. The following formula shall be taken for computing the power input to the pump:

$$\text{Power input to the Pump in kW} = \frac{Q \times H}{367.2 \times p}$$

Where, Q = Discharge in cub-m/hr

H = Total head in mwc in case of Horizontal Pumps and Effective Head in

case of V T Pumps

p = Efficiency of pump.

NPSH tests of one pump of the same duty from each pumping station shall be undertaken to verify that the pumps meet the specified criteria. The pumps shall be run at constant flow capacity and speed with the suction condition varied to produce cavitation. Plots of pump head shall be made for various NPSH values. Site conditions shall be simulated as near as possible, particularly the minimum site NPSH condition.

If the vibration, noise level readings taken during performance test at manufacturer's works show higher values than that permitted, Contractor shall guarantee to show that the values shall be maintained at site after erection. Any cost of rectification needed on this count shall be borne by the Contractor. If the proposed modifications recommended by the contractor are not acceptable to the Engineer, the pump unit shall not be accepted.

The material certificates, physical properties, heat treatments and shop test certificates of pump casing, impeller, shaft, shaft sleeve, impeller and casing rings shall be duly approved and certified by the manufacturer and these shall be subject to review and approval by Engineer.

Notwithstanding the above requirement for inspection and quality control, the following inspection and quality control measures shall be carried out by the Manufacturer, but not limited to:

(i) Identification of all materials used in construction, check of their conformity to standards specified, sample coupon identification for cast, forged components, particularly of impeller, shafts, couplings, fasteners etc. and approval of materials for further processing.
(ii) Check of heat treatment of various components.
(iii) Check of machining accuracies, tolerances including horizontality, parallelism, concentricity, surface finish, run outs, rating tolerances, etc.
(iv) Mating clearances, tolerances, machining accuracies, run outs etc. of bearing housing, impeller and casing wear rings, etc.
(v) TIR of shafts.
(vi) Dyes penetrate Test on impeller and wear rings.
(vii) Ultrasonic test of all shafts.
(viii) Hardness test of mating components where differential hardness is specified like wear rings.
(ix) Surface preparation and painting of external surfaces.
(x) Any other tests, including NDT (as applicable), as specified in the data sheets / drawings /specifications.

### 7.4.1.2 Valve

All tests shall be carried out on all valves as per the latest edition of BIS or internationally approved standard.

During testing there shall be no visible evidence of structural damage to any of the valve component. Motorized valves shall be tested with their actuators, with a differential head equivalent to their maximum working pressure, to prove that the actuators are capable of opening and closing the valves under maximum unbalanced head condition within the specified opening or closing period.

Hydrostatically testing shall be as per relevant IS/BS standard for each type of valve. The following tests shall be carried out for sluice valves, Knife Gate valves etc.:

(i) Pressure test
(ii) Leakage test
(iii) Seat leakage test
(iv) Body hydrostatic test
(v) Valve operation

The following test shall be carried out for non-return valves:

(i) Pressure test
(ii) Leakage test
(iii) Seat leakage test
(iv) Body hydrostatic test
(v) Valve operation

#### 7.4.1.3 Air Blowers

The following tests shall be carried out:

(i) Visual inspection
(ii) Dimensional check for mounting and overall dimensions
(iii) Performance tests
(iv) Hydraulic leak tests

Tests shall be carried out in accordance with the relevant Indian/International Standard. All air blowers shall be tested with their ancillaries to confirm design performance particularly in respect of flow and pressure. The test shall demonstrate that vibration and noise are within the specified limits and that the pressure relief valve operates correctly.

Air receiver shall be tested in accordance with the relevant section of B.S. 5169 or IS: 7938.

Each and every rotating part/assembly/sub-assembly shall be dynamically balanced as per grade G16 of ISO 1940/1.

All pressure vessels shall be inspected and hydro water tightness tested.

#### 7.4.1.4 Process Plant Plants

All the process plant equipment/ items shall be tested to ensure they meet the Engineer's Requirements for quality of workmanship, construction, and performance.

Each and every rotating part/assembly/sub-assembly shall be dynamically balanced as per grade G16 of ISO 1940/1.

#### 7.4.1.5 Crane & Hoists

The cranes shall be completely assembled in the manufacturer's Works and shall be subjected to the tests as specified in IS 807 & IS 3177 or relevant internationally approved standard. The Contractor shall provide the test weights.

Hoists and lifting equipment shall also be assembled and tested at the place of manufacture in accordance with IS 3938.

Each and every rotating part/assembly/sub-assembly shall be dynamically balanced as per grade G16 of ISO 1940/1.

#### 7.4.1.6 Sluice Gates

All tests shall be carried out on all valves as per the latest edition of BIS or internationally approved standard.

(i) Seat Clearance Check

With the gate fully closed, the clearance between seating faces when checked with the thickness gauge, shall not exceed 0.1 mm.

(ii) Movement Tests

Each gate shall be shop operated three times from the fully open position to the fully closed position and return to fully open, under no flow conditions to demonstrate that the assemblyis workable.

(iii) Leakage Tests

With the gate in closed position design pressure shall be applied for a period not lesser than 5 minutes to the unseating side of the sluice gate and the leakage shall not exceed the maximum leakage permissible as per IS 13349.

(iv) Hydrostatic Tests

Finally, a differential of one and a half times the design pressure shall be applied to the unseating side of the gate. Under these tests no part shall show any deflection of deformation.

#### 7.4.1.7 Mechanically Raked Medium / Fine Screens

The screen shall be subjected to following tests at manufacturer's premises before dispatch:

(i) Dimensional Check:

All the important dimensions of the screen are to be verified with respect to approved G.A. drawing. Screens shall be checked for overall dimensions, clearance between the bars / aperture size and its material.

Conveyor shall be checked for dimensions and physical conditions, belt joint portion, travelling accuracy of belt, motors and its performance of safety device.

(ii) Operational Test:

The complete screen including its carriage, rake, drive system and brake motor shall be mechanically operated and tested in dry condition to verify interference free movement and satisfactory operation.

(iii) Material Identification Test:

To ensure that Screens are actually made of Stainless Steel of required material identification test shall be conducted for all important screen components like Bars, Frame, and Dead Plate etc. during inspection and reports shall be submitted along with joint inspection report.

(iv) Dye Penetration test:

Dye penetration test shall be conducted at random for checking the soundness of welding joints during the inspection. Both Procedure as well as person conducting the dye penetration test should be certified by the outside agency as per relevant standard.

(v) Review of WPS, PQR & Welder's qualification certificate:

All the certificates are to be offered for review during the inspection and copy of same to be submitted along with joint inspection report.

#### 7.4.1.8 Fine Bubble Diffusers

Clean water Standard Oxygen Transfer Efficiency (SOTE) tests shall be performed for each different diffuser grid geometry/arrangement proposed in the design. These tests shall be performed by the diffuser Manufacturer at the Manufacturer's testing facility or an equivalent facility appropriately equipped with an adequately sized testing tank and other required appurtenances. The testing shall be performed in full compliance with the latest version of the applicable standard testing protocol. These tests shall be witnessed by Engineer per procedures set forth for witnessing elsewhere in this document.

All diffusers including 5 % spares shall be thoroughly inspected by Contractor for physical damage to the membrane or any other part of the diffuser and results of the inspection shall be reported to Engineer.

All Fine bubble diffused aeration systems will be field tested.

Testing will verify the installation as well as the diffuser's ability to deliver the specified air flow rates at the manufacturer's stated pressure loss. Testing will also verify the uniformity of mixing provided.

(i) Levelling tests:

- □ Introduce clear water into each tank to the top of the diffuser elements.
- □ Check the level of the diffusers to verify that all element horizontal surfaces are within 10 mm of a common horizontal plane and at the specified elevation.

(ii) Leakage and distribution of flow tests:

- □ After successful completion of the levelling tests, raise the water level to 50mm above the manifold.

- □ Visually inspect the water surface to ensure that the airflow is uniformly distributed across the tank.
- □ Repair any leaks in the elements holders, elements, pipes or the like. Repeat the test until the installation is essentially void of air leaks.

#### 7.4.1.9 Pipe-work

Testing of pipes and fittings shall be carried out in accordance with relevant Indian Standards and internationally approved standards. Pipes, fittings and expansion bellows shall be hydrostatically tested for 1.5 times the rated pressure.

The following tests shall be carried out for pipelines:

- □ Pressure test
- □ Leakage test
- □ Colour check for welding pipeline
- □ Welding beat check

**1) Reinforced Cement Concrete Pipes**

(i) Testing

All pipes for testing purposes shall be selected at random from the stock of the manufacturer and shall be such as would not otherwise be rejected under the criteria of tolerances as mentioned in IS: 458.

Contractor shall provide laboratory test /analysis results of cement and aggregate component and cement vs. aggregate vs. water mixing ratio and concrete mixing time and mixing method.

During manufacture, tests on concrete shall be carried out as per IS:456. The manufacturer shall supply, when required to do so by the Engineer the results of compressive tests of concrete cubes and split tensile tests of concrete cylinders made from the concrete used for the pipes. The manufacturer shall supply cylinders or cubes for test purposes required by the Engineer and such cylinders or cubes shall withstand the tests prescribed as per IS:458. Every pressure pipe shall be tested by the manufacturer for the hydrostatic test pressure. For non-pressure pipes, 2 percent of the pipes shall be tested for hydrostatic test pressure.

The specimen of pipes for the following tests shall be selected in accordance with relevant clause of IS: 458 and tests in accordance with the methods described in IS: 3597.

- Hydrostatic test
- Three edge bearing test
- Absorption test
- Dimension and colour of surface
- Damage

(ii) Sampling and Inspection

In any consignment, all the pipes of same class and size and manufactured under similar conditions of production shall be grouped together to constitute a lot. The conformity of a lot to the requirements of this Engineer's Requirements shall be ascertained on the basis of tests on pipes selected from it.

The number of pipes to be selected from the lot for testing shall be in accordance with Table 15 of IS: 458.

Pipes shall be selected at random. In order to ensure randomness, all the pipes in the lot may be arranged in a serial order and starting from any pipe, every r-th pipe be selected till the requisite number is obtained, r being the integral part of N/n where N is the lot size and n is the sample size.

All pipes selected shall be inspected for dimensional requirements, finish and deviation from straight. A pipe failing to satisfy one or more of these requirements shall be considered as defective.

The number of pipes to be tested shall be in accordance with column 4 of Table 15 of IS: 458. These pipes shall be selected from pipes that have satisfied the requirements mentioned in the above clause.

A lot shall be considered as conforming to the requirements of IS:458 if the following conditions are satisfied.

The number of defective pipes shall not be more than the permissible number given in column 3 of Table 15 of IS:458.

All the pipes tested for various tests shall satisfy corresponding requirements of the tests.

In case the number of pipes not satisfying requirements of any one or more tests, one or two further samples of same size shall be selected and tested for the test or tests in which the failure has occurred. All these pipes shall satisfy the corresponding requirements of the test.

All destructively tested samples shall be replaced to new.

**2)** Steel Cylinders Pipes and Specials

(i) Testing

Welding beat check Remove all scale on the welding points and welding beat and its thickness shall be checked by the Engineer.

(ii) Penetration Test

A suitable liquid penetrate (kerosene oil/Dye) is applied to the surface of the portion under examination and is permitted to remain there for sufficient time to allow the liquid to penetrate into any defects open at the surface. After the penetrate time, the excess penetrate which remains on the surface is removed. Then a light coloured powder absorbent called a developer is applied to the surface. This developer acts as a blotter and draws out a portion of the penetrate which had previously seeped into the surface openings. As the penetrate is drawn out it diffuses into the coating of the developer, forming indication of the surface discontinuities or flaws.

Each steel cylinder shall be subjected before lining/coating to a hydrostatic test under a water pressure equivalent to the test pressure in accordance with Clause 10 of IS:1916 and relevant provisions of IS:3597, provided that the whole of the area of the calculated reinforcement is used in the steel cylinder. In the case of pipes where a part of the principal reinforcement is

provided in the cage, the steel cylinder shall be subjected to proportionately less hydrostatic test pressure.

Manufacturer's standard specials shall be hydrostatically tested before lining/coating. Where feasible, other specials shall be hydrostatically tested (before lining/coating) at factory. However, when this is not practicable, at the discretion of the Engineer, the unlined specials shall be tested by penetration test as per IS:3658 or other approved means.

**3)** Cast Iron / Ductile Iron Pipes

(i) Mechanical Tests

Mechanical tests shall be carried out during manufacture of pipes and fittings as specified in relevant IS codes. The results so obtained shall be considered to represent all the pipes and fittings of different sizes manufactured during that period and the same shall be submitted to the Engineer. The method for tensile tests and the minimum tensile strength requirement for pipes and fittings shall be as per relevant IS codes.

(ii) Brinell Hardness Test

For checking the Brinell hardness, the test shall be carried out on the test ring or bars cut from the pipes used for the ring test and tensile test in accordance with IS 1500.

(iii) Retests

If any test 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 the specified requirements, the lot shall be accepted. Should either of these additional test pieces fail to pass the test, the lot shall be liable for rejection.

(iv) Hydrostatic test

For hydrostatic test at works, the pipes and fittings shall be kept under test pressure as specified in relevant IS codes for 15 seconds, they may be struck moderately with a 700 g hammer. They shall withstand the pressure test without showing any leakage, sweating or other defect of any kind. The hydrostatic test shall be conducted before coating the pipes and fittings.

#### 7.4.1.10 Ventilation system

The ventilation system shall be tested at manufacturer's works to verify the design flow and pressure.

#### 7.4.1.11 Generators

All tests shall be carried out as per the latest edition of BIS or internationally approved standard. The following tests shall be carried out:

(i) Visual inspection
(ii) Dimensional check for mounting and overall dimensions
(iii)Performance tests

The engine shall be tested at manufacturer works assembled with alternator. Test shall be carried on after at least 10 hrs in a continuous Engine running time under normal operation including idling adjustment.

Contractor shall provide the test procedure in advance.

The results shall be evaluated by calculated and measurement data to verify whether all data is cover the specification or not at manufacture.

Tests shall include but not necessary be limited to the following;

(i) Normal: 90%-100% load.
(ii) Load change test:115%
(iii)No load test: 0%

Inspection shall include but not necessarily be limited to the following;

(i) Quantity checking
(ii) Engine model /Type
(iii)Spare parts
(iv)Dimensions.

Performance test: It shall also include the followings:

(i) Starter (Auto/Manual)
(ii) Fuel consumption
(iii) Specific fuel consumption (Fuel Vs. output HP)
(iv) Efficiency of Engine out put
(v) Quick over load test.
(vi)Acceleration test
(vii) Fluctuation of engine temperature.( room air and engine)
(viii) Noise level (dB)
(ix) Vibration
(x) Motor speed (rpm)
(xi) Power factor
(xii) Voltage drop(Max, Total)
(xiii) Insulation resistance
(xiv) Over load test
(xv) Acceleration test

### 7.4.2 Electrical Equipment

The Contractor shall carry out further specified tests as follows in addition to any tests stated or implied by the foregoing sections of the bid specifications.

#### 7.4.2.1 Switchgear and Motor Control Gear Assemblies

Switchgear and control gear shall be witness tested as complete assemblies.

Factory built assemblies of HT/LV switchgear and control gear shall be tested in accordance with relevant Indian Standards. Additionally, switchgears and control gear assemblies shall be tested for the following:

**1. Interchange Ability**

All components of the same rating and construction, designated as draw out or plug-in shall be demonstrated as being interchangeable.

**2. Protection and Control Circuits**

For all forms of current transformer protection the following information, as applicable shall be made available to the Engineer before the time of inspection:

(i) Current transformer magnetising curve.
(ii) Recommended relay setting.
(iii) Calculated primary operating current at this setting
(iv) Calculated through-fault stability values where applicable.
(v) Values of any stabilising and setting resistors employed in the system.

As far as possible, based on the completeness of the circuits, in the final manufactured form within manufacturer's premises, the satisfactory operation of associated control and protection circuits shall be proved by the following tests as applicable:

(i) To ensure the correct operation of all relays and coils at the recommended setting by current injection.
(ii) To ensure the correct polarity between current and voltage elements of power relays, meters and instruments.
(iii) (iii) To ensure the correct operation of control circuits at normal operating voltage by operation of local control switches and simulation of operation from remote control positions.

Note: Checking the operation of protection relays and control circuits shall be carried out with all relevant circuits energized at their normal rated voltage.

The following tests shall be carried out:

(i) Dielectric tests at approved voltages.
(ii) Primary injection tests to ensure correct ratings and polarity of current and voltage transformers and of the current operated protection relays and direct acting coils, over their full range of settings.
(iii) Tests on auxiliary relays at normal operating voltages by operation of associated remote relays.
(iv) Correct operation of sequencing and control circuits at normal operating voltages by operation of local control switches, and simulation of operation from remote control positions.
(v) Correct functionality of the equipment in all modes of control.

#### 7.4.2.2 Motors

The manufacturer's type test certificate will be accepted for motors rated at less than 18.5 kW. A type test certificate and an individual motor test certificate shall be provided for all other motors. All type test certificates shall be not later than 3 years.

Electric motors shall be subjected to routine and acceptance tests in accordance with relevant Indian Standards.

It will be responsibility of the Contractor to select sizes, and types of motors to suit the starting and running characteristics of driven equipment with due consideration for specified margin over the requirement of the driven equipment at duty point. Motors not complying with the above shall be replaced by the Contractor at his own cost by appropriate motors. Replacement motors shall undergo testing and inspection as per the provisions in the contract. Cost of such testing and inspection shall be to Contractor's account.

**1. Routine Tests**

All routine tests shall be carried out on all motors as per the latest edition of IS 325 or internationally approved standard.

**2. Acceptance Tests**

Full load test to determine efficiency, power factor and slip shall be conducted on all the motors.

**3. Type Tests**

The following type tests shall be carried out on one motor of each rating above 18.5 kW.

(i) Isolation resistance test
(ii) Temperature rise test
(iii) Momentary overload test
(iv) Vibration measurement test
(v) Noise level test
(vi) Over speed /over load test
(vii) Starting current, starting torque, and pull out torque at reduced voltage

The motor rotor assembly shall be dynamically balanced as per grade 6.3 of ISO 1940/1.

#### 7.4.2.3 Transformers

Transformers shall be subject to routine and acceptance tests as defined in the relevant standard. Type test certificates not later 3 years shall be provided for the following:

(i) Impulse voltage withstand
(ii) Temperature rise.

#### 7.4.2.4 Capacitor bank with APFCR

The capacitor bank with APFCR will be subject to routine and acceptance tests as defined in the relevant standards.

#### 7.4.2.5 Battery and Battery Charger with D.C Distribution Board

The Battery and Battery Charger with D.C Distribution Board will be subject to works routine and acceptance tests as defined in the relevant standards

#### 7.4.2.6 Cables

All cables and armoured cables shall be subject to routine and acceptance tests in accordance with the relevant Indian Standards.

Test certificates shall be provided against each drum and/or cable length.

The tests carried out on every cable length and/or drum at manufacturer's premises shall include:

(i) High voltage DC insulation pressure test, between cores, each core to earth, metallic sheath or armour as applicable
(ii) Insulation resistance test
(iii) Core continuity and identification
(iv) Conductor resistance tes

#### 7.4.2.7 HV Disconnectors

Disconnectors shall be subject to routine and acceptance tests in accordance with the relevant Indian Standards.

#### 7.4.2.8 HV Lightning Arrestor Set

Lightning Arrestor shall be subject to routine and acceptance tests in accordance with the relevant Indian Standards.

#### 7.4.2.9 HV Drop-Out Fuse

Drop-Out Fuse shall be subject to routine and acceptance tests in accordance with the relevant Indian Standards.

#### 7.4.2.10 HV Outdoor Isolator Kiosk

HV Outdoor Isolator Kiosk shall be subject to routine and acceptance tests in accordance with the relevant Indian Standards.

#### 7.4.2.11 Standby Generator Sets

The Contractor shall carry out further specified tests as follows in addition to any tests stated or implied by the foregoing sections of bid documents.

(i) Functionality check
(ii) System operational test
(iii) Manufacturers standard tests
(iv) Run set for 2 hours at full load

(v) Step load acceptance and rejection tests using the maximum step loads plus 20 % to be applied in use at the Sewage treatment plant.

### 7.4.3 Instrumentation, PLC, SCADA and Associated Equipment

#### 7.4.3.1 General

Each item of plant shall be subjected to the manufacturer's own tests which shall be certified.

Each item of plant and its installation shall be subject to inspection and testing at the place of manufacture.

The Contractor shall be responsible for the provision of all necessary test equipment. The Contractor shall demonstrate to the Engineer, the correct operation of any item of plant and the Engineer may witness any test. Tests which, in the opinion of the Engineer, were failed or not performed correctly shall be repeated.

Calibration tests for field instruments and analytical instruments should be conducted on site after installation and the same should be witnessed by the Engineer.

Before any test is made, the Contractor shall submit to the Engineer a full list of test equipment & test procedures (method statements) to be used. Each item of test equipment shall have a standard of accuracy better than that stated by the manufacturer of the item to be tested. The Contractor shall provide evidence of the condition and performance of any item of test equipment, in the form of test certificates issued by an appropriate authority independent of the Contractor and manufacturer, or as otherwise directed by the Engineer. Test equipment shall be checked frequently during the period of the tests.

The Contractor's staff responsible for supervising and carrying out tests shall be fully conversant with the various items of equipment of other manufacturers and if necessary the Contractor shall arrange for his personnel to attend suitable training courses on his own expense.

Any fault or shortcoming found during any inspection or test shall be rectified to the satisfaction of the Engineer before proceeding with further inspection or testing of that item. Any circuit previously tested, which may have been affected by the rectification work, shall be re-tested.

#### 7.4.3.2 Preliminary Inspection and Testing

**1. Field-Mounted Instruments**

After the successful completion of the manufacturer's own inspection and testing of instruments supplied under the Contract, similar tests shall be carried out in the presence of the Engineer and the Contractor. Such tests shall include a demonstration that an increase or decrease of the measured value at several points over the full range of the instrument produces a corresponding increase or decrease in the instrument output signal. These tests shall include checks on the specified accuracy of the instrument at all points.

**2. Instrument Panels, Enclosures and Mounting Boards**

The manufacturer shall not present instrument panels, enclosures and mounting boards (assemblies) for inspection and testing until the manufacturer's own tests and inspection has been completed. A preliminary inspection and test of these assemblies may then be witnessed by the Engineer. The Contractor shall give not less than 7 days' notice in writing that he has completed his tests and inspection and is ready for the witnessed tests and inspection. Where this notice period is different in the Conditions of Contract this shall take precedent.

The witnessed inspection and testing shall include the following:

(i) A visual inspection of the panel assembly to show that the design, construction and finish are satisfactory and in accordance with the Specification;
(ii) A check that equipment is securely mounted, accessible for removal or calibration without damage to or undue disturbance of other components, wiring or piping;
(iii) That all engraving and labels are correctly positioned, fixed and designated in accordance with the Specification;
(iv) Panel power-distribution circuits have the correct breaker/fuse rating coordination and designation;
(v) Power-isolation facilities meet the Specification;
(vi) The main incoming supply voltage, frequency and/or pneumatic supply pressure is within the required limits, these being checked at the beginning and end of the test and the results recorded on test certificates;
(vii) The output of all power supply units again at the beginning and end of the testing with results being recorded;
(viii) The power supply voltage or air pressure of all component instruments of the assembly(s), these voltages/pressures being recorded on the test certificate;
(ix) The insulation resistance of all circuits except sensitive electronic equipment which is liable to damage by application of the test voltage, such circuits being disconnected before making the insulation resistance tests and these tests being carried out in accordance with IEE Wiring Regulations;
(x) That the clean earth bar is isolated from main frame of the panel.

Internal lighting and anti-condensation heaters and associated thermostats, isolators, limit switches and wiring shall be checked for compliance with the Specification.

Spare capacity within the panel(s) shall be checked to see that it complies with the Specification. This shall include future equipment space, spare terminals, space in wiring trunkings and provision for additional cable entry.

### 3. Functional Testing

Once the preliminary inspection and testing is complete to the satisfaction of the Engineer, functional testing shall commence. The purpose of the functional tests is to demonstrate that instrument panels enclosures and mounting boards (assemblies) conform to requirements of the Specification.

Not less than 30 days before the commencement of functional tests, the Contractor shall submit to the Engineer, for approval, two copies of comprehensive test procedural documents detailing each test to be carried out. The document shall include result forms on which the results of each

test will be entered. The forms shall include spaces for numerical values, where necessary, and witness signatures.

All applicable drawings and data shall be provided at the place of inspection by the Contractor.

The Contractor shall provide all test instruments and equipment necessary to test the assemblies in their entirety.

The following is a typical list of the equipment required:

(i) Switch boxes;
(ii) Indicator light boxes;
(iii) Analogue signal sources;
(iv) Dummy loads;
(v) Meters;
(vi) Simulators;
(vii) Desk-top computers;
(viii) Programmers for DCS or outstations;
(ix) Insulation test equipment

#### 7.4.3.3 Programmable Logic Controller (PLC) and SCADA

The Contractor shall carry out specified tests as follows in addition to any tests stated or implied by the foregoing sections of this clause.

The tests shall be carried out on the fully assembled control panel containing the PLC and associated equipment in order to demonstrate correct functional operation of the hardware and software systems.

### 7.5 Tests at Site

In addition to the progressive supervision and inspection by Engineer, the Contractor shall offer for inspection to Engineer, the completely erected plant/part of Plant on which tests are to be carried out. After such inspection, each equipment/sub-system shall be tested by the Contractor in accordance with the applicable standards in the presence of Engineer. Such tests shall include but not be limited to the tests specified in following clauses.

The Contractor shall possess during the entire working period the Electrical Contractor's licence of appropriate class from the concerned statutory authorities governing the area of work place. The Contractor shall fully comply with the relevant statutory rules and regulations. On completion of the installation or at intermediate stages, if required by the statutory authorities, the Contractor shall arrange for inspection and obtain the approval from the concerned statutory authorities. If any fees are to be paid to statutory authorities for testing, inspection and calibration these shall be paid by the Contractor and shall be included in his erection and commissioning charges.

## 7.6 Inspection at Site

During erection of the Plant the Engineer will inspect the installation from time to time in the presence of the Contractor's Supervisor to establish conformity with the requirements of the Specification. Any deviations found shall be corrected as instructed by the Engineer.

## 7.7 Plant Protection on Site

Factory finished plant shall be adequately protected both before and during installation against damage to finished surfaces, fitted components, and the ingress of dust. It may be necessary for structural finishing operations to be carried out in the vicinity of installed plant before it is taken over and the Contractor shall take this into consideration in complying with the requirement of this clause.

## 7.8 Civil Inspection (Water Leakage Test)

### 7.8.1 Tanks and Basins

Units with water retaining structures shall satisfy the following tests for water tightness, before external finishes are applied (if any):

The water for testing shall fill the first 1.25 meters and may be filled as quickly as supply permits. Between this and top water level, the rate of filling shall not exceed a steady rate of 300 mm per 24 hours unless otherwise directed. After filling to top water level no further water shall be introduced for 7 days. After expiry of seven days and after the filling, the level of the surface of the water shall be recorded. The level of water shall be recorded again at subsequent intervals of 24 hours over a period of seven days and the structure shall satisfy the test if at the end of this week no leakage is apparent and or the water level does not drop more than 40 mm over the period of 7 days.

The Engineer shall decide on the actual permissible nature of this drop in surface level, taking into account whether the tanks are open or closed and the corresponding effect it has on evaporation losses. Foregoing visible leakages and sweating will not be accepted.

If the structure does not satisfy the condition of test and the daily drop in water level is decreasing the period of test may be extended for a further seven days and the if specified limit is then reached the structure may be considered as satisfactory.

Following satisfactory completion of the tests the Contractor shall empty the structures and dispose of satisfactorily the contents. He shall clean and disinfect the structures and any equipment therein of all deposits left by the testing.

## 7.9 Erection

### 7.9.1 General

The Contractor’s staff shall include adequate and competent erection engineers with proven, suitable, previous experience on similar Contracts to supervise the erection of the Works and

sufficient skilled, semi-skilled and unskilled labour to ensure completion of Works in time. The Contractor shall not remove any representative, erector or skilled labour from the Site without prior approval of the Engineer.

The Contractor shall also provide sufficient erectors skilled in electrical, mechanical and instrument engineering.

In the case of a foreign firm based overseas the Contractor's Representative shall be thoroughly conversant with the manufacturer's Plant and equipment, and its erection and shall be an expatriate. Also the Contractor shall provide at least two approved senior English speaking working erectors to supervise the erection of all Plant.

The Contractor shall ensure that no installation or erection work shall commence until full and unconditionally approved working drawings, signed and stamped by the Engineer are available at Site.

The Contractor's erection staff shall arrive on the Site on dates to be agreed by the Engineer. Before they proceed to the Site, however, the Contractor shall first satisfy himself, as necessary, that sufficient plant of his (or his sub-contractors) supply has arrived on Site so that there will be no delay on this account.

The Contractor shall make all the necessary arrangements to ensure that sufficient plant has been or is about to be delivered to site, so that there shall be no delay to the start of erection. The Engineer will not entertain any claim by the Contractor in respect of delayed erection due to a delay in the delivery of any items of Plant to the site.

The Contractor's representative responsible for erection shall be an erection engineer who is conversant with the erection and commissioning of the complete Works. If there are more than one erector, one of them will be in charge and the Contractor shall inform the Engineer in writing which erector is designated as his representative and is in charge. Erection engineer is to report to Project Manager.

During erection of the Plant the Engineer will inspect the installation from time to time in the presence of the Contractor's Site representative to establish conformity with the requirements of the Specification. Any deviations and deficiencies found or evidence of unsatisfactory workmanship shall be corrected as instructed by the Engineer.

It shall be the responsibility of the contractor to obtain necessary License / Authorization / Permit for work from the Licensing Boards of the Locality/State where the work is to be carried out. The persons deputed by the Contractor's firm should also hold valid permits issued or recognized by the Licensing Board of the Locality/State where the work is to be carried out.

The installation work shall comply with the latest applicable Standards, Regulations, Electricity Rules and Safety Codes of the locality where the installation is to be carried out. Nothing in this specification shall be construed to relieve the Contractor of this responsibility.

It will be the Contractor's responsibility to obtain approval/clearance from local statutory authorities including Electrical Inspector, wherever applicable for conducting of any work or for installation carried out which comes under the purview of such authorities.

The Contractor shall carry out the complete erection of all plant, including the provision of all necessary skilled and unskilled labor, material, transportation, supplies, power and fuel, Contractor's Equipment and appurtenances necessary, for the complete and satisfactory erection of the Plant.

### 7.9.2 Workmanship

Erection of Plant shall be phased in such a manner so as not to obstruct the work being done by other contractors or operating staff who may be present at the time. Before commencing any erection work, the Contractor shall check the dimension of structures where the various items of Plants are to be installed and shall bring any deviations from the required position, lines or dimensions to the notice of the Engineer.

Plant shall be erected in a neat and workmanlike manner on the foundations and at the locations shown on the approved drawings. Unless otherwise directed by the Engineer, the Contractor shall adhere strictly to the aforesaid approved drawings. If any damage is caused by the Contractor during the course of erection to new or existing Plant or buildings or any part thereof, the Contractor shall, at no additional cost to the Engineer, make good, repair or replace the damage, promptly and effectively as directed by the Engineer and to the Engineer satisfaction.

The Contractor shall align all equipment and holding down bolts and shall inform the Engineer before proceeding with grouting-in the items concerned. The Contractor shall ensure that all equipment is securely held and remains in correct alignment before, during and after grouting-in.

The Contractor shall be responsible for setting up and erecting the plant to the line and levels of reference and of the positions, levels dimensions and alignment, appliances and labour in connection therewith. The checking of setting out of any line or level by Engineer shall not in any way relieve the Contractor of his responsibility for the correctness thereof.

The Contractor shall have a separate cleaning gang to clean all equipment under erection and as well as the work area and the project site at regular intervals to the satisfaction of the Engineer. In case the cleaning is not up to the Engineer’s satisfaction, he will have the right to carry out the cleaning operations and any expenditure incurred by the Engineer in this regard will be to the Contractor’s account.

The Contractor shall pin and plug in the holes prepared, all small clips, plugs, screws, nails, sleeves, inserts, etc., required for fixing electric wires and conduits, small pipe work and all other apparatus.

### 7.9.3 Precautions

The approval by the Engineer of the Contractor’s proposals for rigging and hoisting any items of the Plant into their final positions shall not relieve the Contractor from his responsibility for damage to completed structures, parts or members thereof or other installed equipment. He shall at his own cost make good, repair or replace any damaged or injured items, whether

structural, electrical, architectural, or of any other description, promptly and effectively to the satisfaction of the Engineer.

No Plant, equipment or other loads shall be moved across the floors of structures without first covering the floors with timber of sufficient size so that applied loads will be uniformly transferred to floor beams and girders. If it is required to reduce bending stresses and deflection, the beams and girders shall be provided with temporary supports. Any movement of Plant and other loads over the floor structures shall be subject to the prior approval of the Engineer.

### 7.9.4 Contractor's Equipment, Materials and Appurtenances

The Contractor shall have available on the Site sufficient suitable equipment and machinery, as well as all other materials and appurtenances required by him, of ample capacity to ensure the proper erection of Plant and to handle any emergencies such as may normally be expected in work of this character.

The Contractor shall be responsible if any installation materials are lost or damaged during installation. All damages and thefts of equipment/component parts, after takeover by the Contractor, till the installation is taken over by Engineer shall be made good by the Contractor to the satisfaction of Engineer.

### 7.9.5 Leveling and Grouting of Machinery

Contractor shall undertake, sufficiently in advance, chipping of any unevenness of concrete on foundations, anchor bolt pockets, cut-outs etc., to achieve uniform level of reference for erection. All concrete surfaces receiving grout shall be chipped as required to ensure better bonding with the grouting.

Contractor shall undertake the inspection of all components to be erected sufficiently in advance to check their soundness and conformity to drawings and the inspection records shall be signed by the Engineer as approval for undertaking the installation of the components. Any damage, shortfalls etc. shall be made good to the satisfaction of the Engineer.

All grout for equipment shall be carried out using non-shrinkable continuous grout materials with suitable framework of at least 12mm thickness. Surfaces to receive the grout shall be chipped and roughened and laitance shall be removed by wire brush or blast of air. Concrete surface shall be blown off by compressed air before commencing grouting. Grouting shall be done in one continuous operation from one side such that grout flows in a single wave until grout reaches all confined spaces with no air pockets and air from all confined spaces is expelled. A hydrostatic head of 150 mm shall be maintained during grouting operations. All grouting shall be carried out in the presence of the Engineer. All lines and levels shall be checked after grout is set. Blockouts shall be closed using cement concrete of the same grade as that of the parent structure.

### 7.9.6 Records, Procedures and Reports

The Contractor shall maintain records pertaining to the quality of installation / erection work and inspection, testing, compliance with all technical requirements in respect of all his works as described in the previous paragraphs. The reporting formats shall be in the approved formats.

The Contractor shall submit such records to the Engineer after the completion of any particular work before submitting the bill of supply / progress of work. Such report shall comprise shop inspection reports, shop testing reports, material test reports, based on which dispatch clearances are provided, and all the quality control reports of welding, erection and alignment records.

All the above mentioned records shall be submitted in the final form duly countersigned by the Engineer attesting conformity to specifications and his approval of installation, and duly incorporating all the additions, alternations, and information as required by the Engineer, on the basis of preliminary reports giving the progress of the work. Such records notwithstanding, any records submitted earlier with bill of supply / progress, etc., shall be duly bound and submitted to the Engineer in six copies by the Contractor on his notification of the mechanical completion of erection.

### 7.9.7 General Preparations Before Completion of the Plant

All documents are to be completed in accordance with the Contract schedule before completion of erection.

The Engineer and the Contractor shall preserve and control these documents in a safe and appropriate place on Site in order that both parties' personnel can make use of them at any time.

#### 7.9.7.1 Technical Documents

(i) Operation and Maintenance manual
(ii) Design documents including the Contractor's design data, drawings and Specifications.
(iii) Tools and test equipment list
(iv) Spare parts list
(v) Lubricant list

#### 7.9.7.2 Procedures

(i) Mechanical testing procedure
(ii) Electrical testing procedure
(iii) Instrumentation testing procedure
(iv) Detailed pre-commissioning and commissioning procedures
(v) Detailed Performance Test procedure

#### 7.9.7.3 General and Coordination Documents

(i) Detailed organization charts for pre-commissioning and commissioning showing lines of authorities and responsibility, and functions of all key personnel
(ii) Job description of the members of the team
(iii) Scheduled dates of assignment of each member to pre-commissioning and commissioning organization.
(iv) Detailed schedule showing the time sequence which the Contractor anticipates to follow for the various steps in completion of erection, pre-commissioning and commissioning of each unit and equipment.

(v) Regulations for safety, hygiene and discipline
(vi) Practical organization of the relationship (meetings, reports, etc.) between the Contractor and the Engineer at the phases of pre-commissioning and commissioning.
(vii) Emergency communication route.

#### 7.9.7.4 Manpower

Required manpower shall be provided as agreed between the Contractor and the Engineer in a Manpower Mobilization Plan, which shall include the number and qualifications of the operator and maintenance personnel to be furnished by the Engineer for the Plant.

### 7.9.8 Field Control Inspection

Contractor shall conduct periodic field control inspection to prevent any field accident. The Engineer shall field inspect jointly or conduct unannounced inspections.

### 7.9.9 Completion of Erection

The completion of Plant under erection by the Contractor shall be deemed to occur if all the units of the Plant are structurally and mechanically complete and will include, among other such responsibilities, the following:

(i) Plant in the Scope of the Contract has been erected, installed and grouted as per specifications.
(ii) Installation checks are completed and approved by the Engineer.
(iii) Erected Plants are totally ready for commissioning checks.

At the stage of completion of erection, the Contractor shall ensure that all the physical, aesthetic and workmanship aspects are totally complete and the Plant is fit and sound to undergo tests on completion and subsequent pre-commissioning checks.

Upon achieving the completion as described above, the Contractor shall, after having given 21 days' advance notice of the expected date for carrying out the inspection, notify the Engineer by a written notice intimating completion of erection and notify the Engineer for inspection. The Engineer shall proceed with the inspection of such units within 24 hours of such a notice.

The Engineer shall certify completion when there are no defects / defaults in the Works or provide the Contractor with a list of deficiencies for rectification, hereinafter referred as the "Punch List". The Contractor shall complete the rectification work within a jointly agreed period before pre-commissioning activities and obtain the Engineer's acceptance or approval before proceeding with the same.

The Engineer may inform the Contractor that the works are accepted with the Punch List (items which do not hamper operability, safety or maintainability) and allow the Contractors to proceed with the pre-commissioning checks when the Contractor under-takes to complete such outstanding works within an agreed time prior to or during the defects liability period. Taking over shall be based on rectification of all deficiencies which are to be completed before acceptance, as advised by the Punch List.

The erection period indicated by the Contractor would be deemed to cover all the activities up to Completion as stipulated in previous paragraphs, notice of completion by the Contractor, inspection by the Engineer for Completion, and Contractor's rectification of all deficiencies as noticed by the deficiency/Punch List, and acceptance by the Engineer of such rectification's, prior to Tests on Completion.

Minor defects, which in the opinion of Engineer do not hamper operability or maintainability, will not be taken into account for deciding Mechanical Completion Such defects shall be rectified concurrent to commissioning checks before Tests on Completion. However, the Engineer's decision in this regard is final.

The commissioning period as notified by the Contractor shall include all periods of pre-commissioning, trial runs and tests on completion.

It is in the Contractor's interest to offer the section/units/systems, progressively under Identified milestones within overall erection period, duly completed for rectification of any deficiencies pointed out by the Engineer and to achieve mechanical completion before undertaking the tests on Completion within the specified erection period. The Engineer also reserves the right to withhold the cost as estimated to be equivalent to the rectification of deficiencies pointed out to the Contractor until such a time as the deficiencies are rectified by the Contractor to the satisfaction of the Engineer.

### 7.9.10 Inspection after Erection

After the erection of any item of Plant and its associated equipment has been completed, it shall be offered to the Engineer for inspection in its static state prior to commissioning the item.

#### 7.9.10.1 Completion of erection and procedure prior to setting to work.

The mechanical completion of plant under erection shall be deemed to occur if all the units/systems of the Works are structurally and mechanically complete as noted below:

All rotary, static, structural equipment, piping, electrical/instrumentation and other equipment under the scope of the Contract have been erected, installed and grouted and are as per relevant specifications.

All systems have been washed/flushed/drained/boxed up where necessary.

All system testing including pressure, vacuum and non-destructive tests, no load tests and such other tests are completed with safety valves/relief valves set to operating conditions installed in position.

All panels, local control desks erected with power/control cable terminations with all continuity checks, insulation checks and other installation checks are carried out.

Prior to pre-commissioning checks, the Contractor shall erect the entire Plant and ensure readiness of civil works to the satisfaction of Engineer, so that the Works are physically ready to undergo pre- commissioning checks. Pre-commissioning checks will include checks like no-load running of machinery, checks on instruments and electrical including calibration and loop checks, functional checks, inter-lock checks etc.

At the stage of mechanical completion of erection, the Contractor shall ensure that all the physical, aesthetic and workmanship aspects are totally complete and the Plant is fit and sound to undergo pre- commissioning checks.

The following documentation shall be completed before the Contractor notifies Mechanical Completion of Erection to the Engineer

(i) All shop inspection records compiled and bound in 4 (four) copies. (ii) All erection and commissioning procedures duly approved.
(ii) All instruction manuals in draft form - with each sheet bearing a stamp to indicate "DRAFT FOR REVIEW ONLY" submitted in 4 (four) copies.

Upon achieving mechanical completion, the Contractor shall notify the Engineer of such completion of section/units/systems and readiness for inspection for acceptance ofmechanical completion of erection. The Engineer/ Engineer shall proceed with inspection of such sections/units/systems within 10 days of such notice.

Consequent to inspection, the Engineer will inform the Contractor a list of deficiencies for rectification and the Contractor shall complete the rectification work within a jointly agreed period prior to start of pre- commissioning tests. The erection period allowed by the Contractor shall include all activities of mechanical completion as noted above.

### 7.10 Pre-Commissioning

After the completion of erection, pre-commissioning activities listed below shall be carried out to make the Plant ready for commissioning. All instruments, materials and provisions necessary for conducting site tests shall be provided by the Contractor at his own cost.

Upon completion of erection of each piece of equipment, facility or discrete part of the plant, mechanical checks and tests shall be carried out according to the Contractor's checklist. The mechanical checks and tests shall be to establish that:

(i) The Plant is erected in accordance with the Contractor's construction drawings, pipe work drawings, instrument diagrams, etc., issued for the Plant;
(ii) Materials are installed and mechanically function in accordance with the Contract; and
(iii)Applicable codes as listed in the Contract are followed for materials and workmanship.

Items such as painting, thermal insulation and final clean-up which do not materially affect the operation or safety of the Plant will be excluded. All these items shall be listed and completed after pre-commissioning or commissioning at the discretion of the Contractor, but before acceptance.

The Contractor shall prepare and maintain at Site test forms and records, which shall include:

(i) Description of type of test or check;
(ii) Date and times of test or check;
(iii)Identification of equipment and facilities;
(iv) Test pressure, test data and results, including remarks, if any; and
(v) Signature of the Contractor's personnel attesting to data recorded; if any. The Contractor's construction forces thereof shall carry out checks, tests and records.

Wherever the Engineer's witnessing or attesting of the check or test is required, the Engineer or his Representative shall attend such check and test. For this purpose, the Contractor shall keep the Engineer informed of a day-to-day test plan schedule. The test plan schedule may be revised from time to time to reflect the actual progress of the work and test.

Any items found incomplete or requiring repair or adjustment shall be marked as such on the test records and reported by the Contractor to the Engineer and the Contractor's personnel in charge of the relevant construction area.

Checking procedures shall be repeated until all the items on the checklist are cleared. A complete set of test records shall be handed over to the Engineer on completion.

### 7.10.1 Pre-Commissioning Tests

The tests on the different mechanical, electrical and instrumentation equipment shall be conducted.

## 7.11 Commissioning

After the completion of pre-commissioning activities the final checks and preparations necessary for start-up of the plant shall be carried out. The Contractor shall submit to the Engineer a written Notice of Mechanical Completion, which shall include:

(i) Identity part of the Plant considered mechanically complete.
(ii) Copies of all relevant completed test reports.
(iii) Date on which the completion of the tests was achieved.
(iv) Check list.
(v) Request for issuance of a Mechanical Completion Certificate in respect of that part.
(vi) Within fourteen (14) days from the date of receipt of the Contractor's written Notice, the Engineer shall:

In the case of acceptance, issue a Mechanical Completion Certificate.

- In the case of objection, submit a rejection statement setting forth-remaining items to be completed or defects or deficiencies to be corrected before Mechanical Completion status can be accepted. When the Engineer rejects the Contractor's Notice the Contractor shall take any necessary action to complete or correct the items marked and give the Engineer a second Notice of Mechanical Completion.

After the issuance by the Engineer of a Mechanical Completion Certificate, commissioning activities listed below shall be carried out to enable the start-up and operation of the Plant. Procedures are described as below:

a) Commissioning procedure shall be carried out in a methodical sequence as follows:
   - ✓ Warming up
   - ✓ Start-up
   - ✓ Initial running
   - ✓ Operability adjustment
   - ✓ Stable operation
   - ✓ Final adjustment

b) At all stages of commissioning sequence, the Plant shall be operated at optimum Plant conditions. To ensure this, the Contractor may make minor adjustment to the conditions indicated in the Operation and Maintenance Manual as necessary.
c) The Contractor shall check the operating conditions of the Plant by constantly monitoring operating data.
d) The Contractor shall specify for each discrete part of the Plant the operational data to be recorded and the manner in which the data is to be taken.
e) The Engineer's Representative on the forms to be mutually agreed shall record all the operating data. The Engineer's Representative shall make a copy of the operating log and analytical data from initial operation through to the completion of Performance Test available to the Contractor for evaluation.
f) The Contractor shall carry out commissioning tests in the presence of the Engineer. The evaluation of test results and decision passed by the Engineer regarding the test results will be final and binding on the Contractor. Any additional tests or repetition of tests to establish satisfactory operation of any equipment shall be carried out by the Contractor, if so desired by the Engineer, at no extra cost.
g) All checks and tests shall be as per the Manufacturer's drawing manuals, relevant codes of installation and as per commissioning checklists.
h) Among other commissioning tests, the following shall be carried out at site after completion of installation. Contractor shall ensure to use calibrated test equipment having valid calibration test certificates from standard laboratories traceable to National Standards / International Standards. All tests to be carried out in the presence of Engineer.

### 7.12 Commissioning Tests

Following commissioning tests are to be carried out on all the equipment/systems, as applicable.

- ✓ Insulation resistance measurement of equipment, accessories, cabling/wiring etc.
- ✓ Dielectric tests on equipment, accessories, cabling/ wires etc.
- ✓ Phase sequence and polarity
- ✓ Voltage and current ratios
- ✓ Vector group
- ✓ Resistance measurement of winding, contacts etc.
- ✓ Continuity tests
- ✓ Calibration of indicators, meters, relays, etc.
- ✓ Control and interlock checks
- ✓ Settings of equipment and accessories
- ✓ Checking of accuracy/error
- ✓ Checking of operating characteristics, pick-up voltages and currents, etc.
- ✓ Operational and functional tests on equipment, accessories, control schemes, alarm /trip /indication circuits, etc.
- ✓ Measurement of guaranteed/approved design values including lighting levels, earth resistance measurement, etc.
- ✓ Complete commissioning checks of the system

### 7.13 Safety Procedure and Practice

Following safety procedure and practice should be provided by the Contractor in the switchboard room/ substation as per latest edition of I.S. 5216.

(i) Rubber matting in front of HV, MV and LV switchboard and other panels in switchboard room
(ii) Shock treatment chart in switchboard / electrical equipment room
(iii) Caution/Danger Board on -
- HV, MV and LV switchboard and other LV panels
- Lighting distribution board
- Transformer yard.

(iv) Sand bucket in switchboard / electrical equipment room/ transformer yard
(v) Fire extinguisher in switchboard/ electrical equipment room
(vi) One set of hand gloves in switchboard room
(vii) First aid box in switchboard / electrical equipment room

### 7.14 Fire Safety

The requirement of hand appliance in switchboard room, electrical equipment room shall be as per the latest edition of Fire Protection Manual of Govt. of India.

### 7.15 Site Acceptance Test Document

Fifty-six (56) days prior to commencement of Tests on Completion the Contractor shall supply a Site Acceptance Test (SAT) Document for approval. This shall comprise four copies of the details of the inspection and test procedures to be carried out in testing the Works.

The SAT Plan shall provide comprehensive details of the tests to be carried out, the purpose of each test, the equipment to be used in carrying out the test and the methods to be adopted in carrying out the tests. The SAT shall provide space within the documentation for results of the tests to be added and for each test and for the SAT as a whole to be signed off by the Contractor and the Engineer.

The SAT shall categorise tests as follows:

(i) Dry tests: Dry tests are those tests carried out without process fluid being present.
(ii) Wet tests: These can be further sub-divided into:

**Hydraulic tests**: Hydraulic wet tests are those tests carried out with potable water in order to prove the hydraulic capability of the Works.

**Process tests /System tests:** Process wet tests are those tests carried out with raw Sewage as the feed stock to prove the process capability of the Works.

The Contractor shall make his own arrangements for water supply, chemical, electric power, fuel, instrument and labour during hydraulic wet tests.

It shall be assumed that the co-operation of other contractors in the carrying out of Tests on Completion will not be unreasonably withheld.

## 7.16 Test on Completion

### 7.16.1 General

Prior to the commencement of Tests on Completion the Contractor shall submit for approval the following:

(i) Site Acceptance Test Documents
(ii) As-Built Drawings
(iii) Operation and Maintenance Manuals
(iv) Site test results / data sheet and photo

Tests on Completion shall not be commenced until the aforementioned documents are approved.

The initial charges of oil, grease, electrolyte, generator fuel / oil, chemical, disposal of cake, etc. necessary for Tests on Completion shall be provided by the Contractor. Raw Sewage and electricity required for Tests on Completion will be provided by the Engineer free of charge. If necessary, Contractor shall create design loading conditions for testing purposes by testing fewer than the total number of installed units of process tanks or equipment at a time. In such cases, multiple tests shall be conducted to ensure that all installed units are tested. In the event that raw sewage/influent wastewater is not available at the plant, the Contractor shall defer testing until such time as sewage becomes available for treatment as described elsewhere in these Bid Documents. The Contractor shall provide adequate notice (this notice period shall be determined by the normal lead time for locally purchased chemicals plus at least 28 days) of his chemical requirements prior to commencement of the Tests on Completion involving their use.

The cost of chemicals used for the Tests on Completion shall be met by the Contractor.

The inspection and tests procedure which will be carried out are provided under the general conditions of contract- Clause -- and shall also consist of the following:

### 7.16.2 Manual Commissioning Tests

Manual Commissioning Tests shall be such preliminary trials, tests and retests on individual items of Plant or complete systems as are required by the Engineer in order to demonstrate that the Plant as a whole is ready to undergo the Manual Operation Tests (Clause 3.11) and that these will take place with a minimum of interruption.

The Manual Commissioning Tests shall demonstrate not only the items of Plant under normal operation, but also their response to abnormal and emergency conditions.

The Engineer will notify to the Contractor which items of Plant will be tested and the extent to which they will be tested in order to fulfill the requirements of the Specification.

Leakage tests at 1.5 maximum working pressure shall be carried out on all erected pipe work prior to the Manual Commissioning Tests.

Pump curves shall be available for the Manual Commissioning Tests and all instruments essential for the tests shall have been calibrated.

### 7.16.3 Manual Operation Tests

When the Manual Commissioning Tests have been completed so that the items of Plant have been demonstrated to the satisfaction of the Engineer Representative, the Contractor shall commence the Manual Operation Tests.

These tests shall demonstrate the correct operation of the whole Plant whilst using the minimum quantity of automatic control and monitoring equipment. Such equipment shall be at least that required both for the maintenance of safety and for the normal mode of operation of the Plant.

The Plant will be required to demonstrate satisfactory operation at all design flow rates.

The tests shall be of seven consecutive days' duration; if the supply of water should fail or other matters interfere outside the Contractor's control, the tests may be of such number of broken days as the Engineer considers is the equivalent.

The exact date of commencement shall be subject to the approval of the Engineer and shall be dependent on the following conditions having been met:

(i) All relevant items of Plant in approved working order
(ii) All items of Plant correctly identified with labels

### 7.16.4 Automatic Commissioning Tests

The Automatic Commissioning Tests shall be such preliminary trials, tests and retests on individual items of Plant or complete system as are required by the Engineer in order to demonstrate that the Plant as a whole is ready to undergo the Tests of Completion (Clause 3.13) and that these will take place with a minimum of interruption.

At least one week before the commencement of these tests, the Engineer will notify the Contractor which items of Plant will be tested and the extent to which they will be tested in order to fulfill the requirements of the specification.

The Tests on Completion, as provided under the General Conditions of Contract – Clause 9 shall not be carried out until the completion of the above tests.

All pipe work shall be hydrostatically tested at site to a pressure equal to 1.5 times the maximum working pressure likely to be encountered in the system.

The Contractor shall carry out all tests on the Plant and shall supply four copies of all test results to the Engineer.

All tests shall be to the approval of the Engineer who may require them to be repeated, prolonged or modified as may be necessary to ensure that any or all items of Plant conform to the Contract.

The Engineer shall be permitted to inspect all Plant which is undergoing tests and may himself conduct tests.

Where it is necessary for the Engineer to make arrangements for the supply of water, chemicals, power, etc., for any testing, the Contractor shall not commence the tests until after these arrangements have been made on or after a date agreed by the Engineer and the Contractor shall make no claim for delay to such testing on this account except as provided for under General Conditions of contract.

If any item of plant fails during or after testing 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.

Vibration/noise level tests shall be carried out at site which will form basis for acceptance of the equipment. If the Contractor is not in a position to meet the requirements given below as per ISO 10816, the equipment may either be rejected or the Contractor shall carry out all necessary modifications to keep vibrations within the acceptable limits specified.

| Equipment | Noise Level (dB at 1.86 m from equipment) | Velocity of vibration (mm/sec) |
|---|---|---|
| All rotating equipment not having reciprocating parts with motor kW less than or equal to 15 kW | 85 | 1.12 |
| All rotating equipment not having reciprocating parts with motor kW more than 15 kW and less than or equal to 75 kW | 85 | 1.8 |
| All rotating equipment not having reciprocating parts with motor kW greater than 75 kW | 85 | 2.8 |
| All equipment having reciprocating parts viz. compressors, dosing pumps sampling pumps | 85 | - |

The Contractor shall have a minimum of two commissioning engineers, one for process and plant and the other for electrical/instrumentation works on site during all tests in order to both demonstrate the Plant and to correct any faults which may occur.

### 7.17 Dry Test Requirements

As a minimum requirement the following dry tests shall be carried out as a general requirement:

(i) A general inspection to check for correct assembly and quality of workmanship
(ii) A check on the presence of lubricant, cooling medium, electrolyte, etc.
(iii) A check on adequacy and security of Plant fixing arrangements.
(iv) A general check to ensure that all covers, access ladders, water proofing, guard railings etc are in place.

(v) A check on damp-proofing, rust-proofing and vermin-proofing and particularly the sealing of apertures between building structures, chambers etc and the outside.

### 7.17.1 Civil and Building Works

As a minimum requirement the following dry tests shall be carried out on the civil engineering and building works:

(i) Check for the presence of foreign bodies in pipe work and structures.

### 7.17.2 Mechanical Works

As a minimum requirement the following dry tests shall be carried out on the mechanical systems:

(i) Carry out preliminary running checks as far is permitted by circumstances in order to ensure smooth operation of Plant.

### 7.17.3 Electrical Works

As a minimum requirement the following dry tests shall be carried out on the electrical systems:

(i) Check phasing and polarity.
(ii) Carry out point to point check on all cables.
(iii) Check on security of cable terminations.
(iv) Check on completeness and adequacy of earthing systems.
(v) Check setting on protection relays, sizes of fuses and motor overload settings.
(vi) Carry out checks on cabling systems in accordance with the requirements of the relevant standards.
(vii) Check operation of main circuit breakers by secondary injection methods.
(viii) Check rotational direction of Plant.
(ix) Check instrument loop integrity, functionality and calibration.
(x) Check operation of standby generator installation and mains / generator changeover procedures;
(xi) 4-hour load test (using the normal load of the Works) shall be carried out on the generator when the load is available.
(xii) Check plant functionality.
(xiii) Check functionality of the central MMI and its power supply.

## 7.18 Process Plant Item / Equipment

All process plant items / equipment shall be tested to ensure they meet the Engineer's Requirements for quality of workmanship, construction and performance.

### 7.18.1 Hydraulic Wet Test Requirements

Hydraulic wet tests shall be carried out on completion of dry tests.

Clear Water shall be used for hydraulic wet tests. The purpose of the tests is to prove the hydraulic performance of the Works. In order to demonstrate this, the Contractor shall ensure

that each part of the Works is hydraulically loaded to its rated throughput for a period of at least four hours.

In order to ensure a sufficient supply of water to carry out these tests the Contractor shall provide all required facilities, including but not limited to any temporary facilities that may be required for storage and recycle of Clear Water or facilities for the disposal of the water off Site in an approved manner.

The following tests inter alia shall be carried out:

i. Pressure testing of all piped systems laid direct in ground in accordance with the relevant standards.
ii. Fill all structures and check for leaks.
iii. Filling of all storage vessels to check for leaks and distortion.
iv. Running of all pumped systems in order to check for.
v. Correct functionality.
vi. Absence of leaks.
vii. Correct running temperatures.
viii. Smoothness of running and the absence of undue vibration or stress.
ix. Check drive running currents.
x. Carry out calibration of instruments where appropriate.
xi. Carry out valve operation, diversions etc. to fully hydraulically load each process element (or where there is a requirement to withstand an over load), overload each process element.
xii. Demonstrate correct functionality of electrical, control and instrumentation systems.

The Contractor shall simulate the conditions that will prevail when operating as a process in order to demonstrate the correct functionality of process control loops etc.

During these tests a check on the performance of Plant shall be made to compare its site performance with the factory test data and to identify any constraints on performance due to site conditions.

### 7.18.2 Safety Audit

After satisfactory completion of hydraulic wet tests and prior to introduction of process fluid to the plant a safety audit shall be carried out to ensure compliance with the necessary requirement for safety and for operation of Plant. The safety audit shall be documented. The safety audit document shall be approved by the Engineer prior to commencement of Plant commissioning.

### 7.18.3 Process Wet Tests (with Raw Sewage)

On approval by the Engineer the Contractor shall carry out process wet tests.

Raw Sewage shall be used as the primary feed stock for process wet tests. These tests shall be carried out to demonstrate the process performance of the Works. In order to demonstrate this, the Contractor shall ensure that each part of the Works is loaded to its rated throughput (including a period of overload if required in order to demonstrate compliance with the Engineer's Requirements) for a continuous stable operating period of not less than 48 hours. If

necessary, Contractor shall create design loading conditions for testing purposes by testing fewer than the total number of installed units of process tanks or equipment at a time. In such cases, multiple tests shall be conducted to ensure that all installed units are tested. In the event that raw sewage/influent wastewater is not available at the plant, the Contractor shall defer testing until such time as sewage becomes available for treatment as described elsewhere in these Bid Documents.

The Contractor shall provide all required facilities for the disposal off Site in an approved manner. The following tests inter alia shall be carried out:

(i) Check for leaks on vessels, structures, pumps and pipe work.
(ii) Running of all pumped systems in order to check for.
- Correct functionality.
- Absence of leaks.
- Correct running temperatures.
- Smoothness of running and the absence of undue vibration or stress.
- Check drive running currents where the solution pumped is different from that pumped during hydraulic wet tests.

(i) Carry out calibration of instruments.
(ii) Carry out valve operation, diversions etc. to fully hydraulically load each process element (or where there is a requirement to withstand an over load), overload each process element.
(iii) Demonstrate correct functionality of electrical, control and instrumentation systems not checked during dry or hydraulic wet tests or which may have changed as a result of the different operating conditions now prevailing.

On completion of the tests on the various parts of the works the Contractor shall run the plant as a whole in order to demonstrate the full functionality and performance of the Works at various throughput rates for a continuous period of not less than 15 days.

During the various process tests the Contractor shall take samples and carry out Sewage quality analysis at not greater than one-hour intervals in order to demonstrate to the Engineer that the Works is functioning in accordance with the Engineer's Requirements. Each sample shall comprise two 1 litre (minimum) quantities and shall be labelled to identify the contents, where taken and time and date. The flow recorded at the time of sampling shall also be indicated in the log book or record. One sample shall be used by the Contractor for his analysis; the other shall be handed over to the Engineer.

The Engineer reserves the right to take additional samples and to carry out his own tests or to check the samples taken by the Contractor.

The Engineer shall be given reasonable access to the premises where analysis is taking place in order to check on working practices and the procedures being adopted.

### 7.18.4 Co-operation with other Contractors in the Execution of their Tests

The Contractor shall, where required, assist other contractors in carrying out their tests on completion and or tests after completion.

Where this assistance does not constitute part of the Contractors own work associated with Tests on Completion or Tests after Completion the Contractor shall be reimbursed at the rates approved by the Engineer.

## 7.19 PERFORMANCE TEST

After the final operation of the Plant, a Performance Test shall be carried out to demonstrate the compliance with the technical particulars furnished in Technical Schedules, Section IV; Part 1.

Prior to conducting Performance Test, the Contractor and the Engineer shall agree upon detailed Performance Test Procedure.

Performance Test including the tripping of the pump sets to verify the adequacy of surge Protection device schedule shall be determined with due regard to the actual progress of the Works and condition of the Plant.

Performance Test shall be carried out by the Contractor's personnel according to the instructions set forth in the Contractor's Operation and Maintenance Manual and under the supervision of Engineer's operating personnel.

Performance tests shall be conducted for continuous 72 hour

### 7.19.1 Evaluation of Performance Test Data

Evaluation of Performance Test data accumulated during, or as a part of Performance Test shall be done by the Contractor within seven days (7) after the completion of Performance Test and to be submitted to the Engineer for his approval.

Any abnormal test data which is not compatible with other significant data shall be ignored or the test data in question may be taken again if practical from the Plant operating conditions.

#### 7.19.1.1 Tolerances

(i) The performances of the materials or the Plant shall be evaluated on the basis of the average performance over the entire period of Performance
(ii) The guarantees given in respect of output and power Input shall be verified according to the standard BS EN ISO-9906:2000 criteria at the manufacturer's work,

#### 7.19.1.2 Report of Test Results

- The Contractor shall submit to the Engineer a report on Performance Test in writing, indicating whether the Performance Guarantee has been met.
- The report shall include:
  - Test results,
  - Analysis,

- The Contractor's evaluation, and
- Reference information supporting the evaluation.

#### 7.19.1.3 Reasons for Failure

If Performance Test results show that Test was unsuccessful, the Contractor shall state probable reasons for such failure.

#### 7.19.1.4 The Engineer's Response to the Report

Within fourteen (14) days after receipt of the performance Test Report, the Engineer shall signify in writing agreement or comments.

#### 7.19.1.5 Contractor's Action in the Case of Performance Test Failure

If the evaluation of Performance Test results shows that the failure of Performance Test is Contractor's fault then the Contractor shall advise the Engineer of his intention as to whether he wishes to pay the Liquidated Damages or takes corrective measures and repeat Performance Test.

### 7.19.2 Additional Performance Test

If, due to the Contractors default, any parts of the Performance Guarantee are not met and the Contractor takes corrective actions to enable the Plant to satisfy the Guarantees, an additional Performance Test shall be conducted pursuant to sub-clause 7.4 and Clause 9 of the General conditions of Contract in Part 1 of bid document.

#### 7.19.2.1 Modifications of the Plant

Before repetition of any Performance Tests, the Contractor shall take the following actions:

Investigate the cause for non-fulfilment of the Performance guarantees,

Make such changes, modifications or additions to the Engineering or equipment of the Plant as considered necessary to meet the Guarantees.

#### 7.19.2.2 Engineer's Permission

The Engineer shall allow the Contractor necessary time to carry out any actions deemed necessary by the Contractor and the Engineer shall make the Plant available for that purpose and operate the Plant in such conditions as required by the Contractor.

## 7.20 ACCEPTANCE

### 7.20.1 Acceptance Conditions

Acceptance will occur in any of the three following possible ways:

(i) Fulfillment of Guarantees

When Performance Test has been successfully completed and the Performance Guarantees are met.

(ii) Deemed Acceptance

When Performance Test has not been completed or has not been carried out for reasons not attributable to the Contractor within the specified date or other mutually agreed period.

(iii) Payment of liquidated Damages

When the Contractor has paid the liquidated damages specified in this Specification.

### 7.20.2 Procedures for Acceptance

Procedures for acceptance are stated as below: -

For each of the above three cases, the Contractor shall submit a written request to the Engineer for a Taking over Certificate to be issued with the following statements:

(i) Fulfilment of Guarantees
- Identification of the Plant (or any individual unit),
- Date of Completion of Performance Test,
- Date and Reference No. of Performance Test Report. and
- Statement that all the performance Guarantees have been met.

(ii) Deemed Acceptance
- Identification of the Plant (or any individual unit),
- Specified or mutually agreed date of Completion Date, and
- Statement that Performance Test has not been carried out or completed due to the reasons not attributable to the Contractor and specifying the reasons thereof.

(iii) Payment of Liquidated Damages
- Identification of the Plant (or any individual unit)
- Date of Completion of Performance Test,
- Date and Reference No. of Performance Test Report, and
- Document showing that the Contractor has paid to the Engineer a due amount of
- Liquidated Damages corresponding to the performance deficiencies.

# Part - 8 Operation & Maintenance

## 8.1 Scope of Works

Operation & Maintenance of plant shall start after completion of Defect Liability period. It shall be of 15 years and 1 year DLP period.

The contractor shall operate and maintain sewage treatment Facilities and all associated works and systems under this contract, for a period of 15 years and 1 year DLP. The Facilities consists of:

i) Waste Water Treatment Plants (WWTPs) of 30 MGD Diggian, 5 MGD Raipur Kalan, 2 MGD Raipur Khurd, 11 MGD 3 BRD, 1.65 MGD Dhanas and 2 MLD Sukhna Lake capacity including all civil units, electromechanical equipment and instrumentation as per the contractor's proposal, to ensure that all the output guarantees are met including Power Generation by using biogas from the sludge treatment process of the plant,

ii) General facilities and utility services including all other components of work done under this contract,

iii) PLC based SCADA system,

iv) All other equipment and systems stipulated in technical specification for Civil Works, Process, and Electrical and Mechanical equipment,

v) All buildings and staff quarters.

vi) Job training for Engineers & engineering staff.

vii) Any other services required for smooth operation of the Facility.

The Contractor shall also dispose of sludge, screenings, grit and any other material, as per specifications and to the satisfaction of the Engineer. It is noted that all costs during the Operation and Maintenance (O&M) period, excluding the cost of power is to be borne by the Contractor. Within the Contractor's quoted cost, the Contractor is to ensure that the following guarantees are maintained during the operation and maintenance period. Each is explained in further detail in this specification section:

i) Quality of treated effluent.

ii) Quality of Dewatered Sludge.

iii) Consumption ofchemicals.

iv) Consumption of Electricity.

## 8.2 General

The scope of work under this contract for operations and maintenance broadly comprises but is not limited to the following:

a) All the cost for operation and maintenance of the WWTP such as manpower, chemicals, fuel, spares, tools, transportation, disposal of treated effluent, disposal of sludge, disposal of screening waste and grit, maintenance of civil structures, electrical and mechanical equipment and automation is in the scope of the Contractor. The Contractor scope of work shall include preventive maintenance, repairs and replacements as required by the equipment manufacturer's written instructions at no extra payment other than whatever has been quoted.

b) Under this Contract, the Contractor is required to operate and maintain the entire WWTP facilities consisting of treatment plants, the pumping main, the communication system, 11kV/0.433 kV switchyards, electrical, instrumentation and control systems, all ancillary buildings, campus area, roads and ancillary civil structures along road for 15 years and 1 year DLP as specified in the Contract (as at the commencement date of O&M period and all the additions, alterations done under this Contract thereafter).

c) During operation and maintenance the Contractor shall ensure the required output parameters as specified in the bid document.

Without limiting the Contractor's obligations during the Operations and Maintenance Period, the Contractor shall:

(i) Assist the Engineer in identifying any additional clearances that are to be required to be obtained by the Engineer for the fulfillment of the obligations of the Contractor under the Conditions of Contract.

(ii) Provide all required consumables, including chemicals and spares required for functioning of equipment, except power.

(iii) The chemical consumables, including chlorine used under the Contract shall be provided by the Contractor at his cost and included in his O &M price.

(iv) Arrange all the necessary manpower for the operation and maintenance of the facility

(v) Make all necessary arrangements for the tools and plant, spares, machinery and transportation vehicles necessary for operation and maintenance

(vi) Procure and store all required materials/consumables, equipment, lubricants, inventory for repair and maintenance required for operation and maintenance, and maintain proper stock register for the same.

(vii) Be responsible for providing all Operation and Maintenance Services

(viii) Be responsible for the security of the facility and comply with applicable laws and/or statutory requirements as may be applicable in the land from time to time

(ix) Plan, manage, co-ordinate and carry out the treatment and pumping of raw sewage and treated sewage as per the instructions given by the Engineer from time to time

(x) Maintain adequate stores and inventory, as per the operation and maintenance manual, for timely repairs.

(xi) Maintain and operate all civil structures, mechanical, electrical and instrumentation control equipment in pumping stations, treatment plant, roads and communication systems.

(xii) Co-ordination with other Contractors/agencies

(xiii) Be responsible to minimize wastage by attending to leakages within the specified period.

(xiv) Be responsible for most efficient use of chemicals

(xv) Be responsible for most efficient use of power in running of plant and machinery

(xvi) Be responsible for the implementation of the environmental and social mitigation measures as specified

(xvii) Be responsible for the Residue Management Disposal of sludge and Hazardous Substances or Hazardous Waste, and providing necessary Residue Disposal Facility Information to the appropriate agency

(xviii) Maintain operating and maintenance/repair records of all civil structures,

mechanical, electrical and instrumentation control equipment in pumping station, treatment plant, and communication systems

(xix) Maintain inspection book at all units of the WWTP

(xx) Maintain drinking water supply facilities at administrative building, WWTP Campus and all its units and staff quarters.

(xxi) Make the necessary arrangements to dispose of the sludge produced by the WWTP

(xxii) Be responsible for submission of monthly report

### 8.2.1 Output and Operational Guarantees

(1) The contractor is fully responsible for treating all the sewage reaching at the inlet chamber. The performance of the contractor shall be treated as non-compliance if the treated effluent does not meet with the guarantees listed under this clause unless in force majeure condition.

**(2) Treated Effluent Quality**

The contractor shall operate the Waste Water Treatment Plants i.e. 30 MGD Diggian, 5 MGD Raipur Kalan, 2 MGD Raipur Khurd, 11 MGD 3 BRD, 1.65 MGD Dhanas that at all times the treated effluent quality attains the following parameters:-

| S No | Particulars | To be Guaranteed by Bidder |
|---|---|---|
| 1 | pH | 7.5 |
| 2 | TSS | ≤ 5 mg/lt |
| 3 | Total Nitrogen | ≤ 5 mg/l |
| 4 | Ammonical Nitrogen (NH4-N) | ≤ 5 mg/lt |
| 5 | $BOD_5$ | ≤ 5 mg/lt |
| 6 | COD | ≤ 50 mg/lt |
| 7 | $PO_4$-P (TP) | ≤ 1 mg/lt |
| 8 | Fecal Coliform | <230 MPN/100ml |

For 2 MLD STP at Sukhna Lake

Treated effluent Characteristics

| SNO. | CONSTITUENTS | UNITS | VALUE |
|---|---|---|---|
| 1 | PH | - | 7.0-8.0 |
| 2 | $BOD_5$ | mg/l | <1 |
| 3 | COD | mg/l | <10 |
| 4 | TSS | mg/l | <1 |
| 5 | TN | mg/l | <2 |
| 6 | TP | mg/l | 0.1 (Target) Guarantee 0.5 |
| 7 | Coliform | MPN/100ml | 100 |

**(3) Sludge Quality Standard**

Sludge processing unit shall produce class A Bio-solids for land application or incineration as per USEPA 40 CFR part 503 regulations, so that it can be effectively reused for various application as deemed fit by the bidder. The bidder shall not be allowed to dump the sludge or dispose it off in a low land area for filling in environmentally unsafe manner

**i) Plant Residuals Guarantee**

The plant residuals shall achieve the following:

**Screenings:** The screenings shall comprise of all particles of an effective size in excess of 5 mm and be "free of dripping water" i.e. the screenings on collection does not contain any dripping water when disposed from the plant.

**Grit:** The grit removed shall contain the maximum putrescible organic matter less than 10 % on dry basis of an average particle size between of more than 150 microns but less than 1000 microns.

All dewatered sludge shall be appropriately treated and made reusable in an environmentally safe manner.

**(4) Chemical Requirements**

The chemical consumed to operate the Waste Water Treatment Plant and other facilities under this contract shall not exceed the guaranteed chemical consumption as guaranteed by the contractor in the Bid Document. All cost related to the extra chemical consumption and rectification of the works to the guaranteed chemical consumption will be borne by the contractor.

**(5) Deleted**

**(6) Electric Power Consumption Guarantees**

The contractor shall ensure that the net power consumption in the plant should not be more than the figure so guaranteed by the bidder. Damages payable by Contractor to Employer on excess consumption of net electrical energy shall be equal to the actual cost of the excess energy used for Operation and Maintenance of the Works for WWTP under the Contract, based on the guaranteed consumption provided by the Contractor and the current rates charged to the Employer for electricity consumed. Tests and Sampling during O&M Period

### 8.2.2 Tests and Sampling during O&M Period

The sampling and testing shall be carried out as detailed in the following table. The Contractor's schedule for tests and sampling shall also be maintained during the O&M period:

| SAMPLING PROTOCOL FOR WWTP PROCESS | | | |
|---|---|---|---|
| **Sr. No.** | **Parameter** | **Frequency of Sampling** | **Type of Sample** |
| 1. | Influent & Effluent Temperature | Daily | Grab |
| 2. | Influent & Effluent pH | Daily | Grab |
| 3. | Influent, Primary and Final Effluent BOD5 | Daily | Composite |

| | | | |
|---|---|---|---|
| 4. | Influent, Primary and Final Effluent COD | Daily | Composite |
| 5. | Influent, Primary and Final Effluent TSS | Daily | Composite |
| 6. | Effluent Ammonical Nitrogen | Daily | Composite |
| 7. | Effluent Fecal Coliforms | 3x / week | Grab |
| 8. | Effluent Phosphorous | Daily | Composite |
| 9. | Effluent Sulphates | 3x / week | Composite |
| 10. | Effluent Total Kjedahl Nitrogen | Daily | Composite |

| SAMPLING PROTOCOL FOR WWTP PROCESS | | | |
|---|---|---|---|
| **Sr. No.** | **Parameter** | **Frequency of Sampling** | **Type of Sample** |
| 11. | Biological Reactor D.O. | Continuous | Online |
| 12. | Biological Reactor MLSS, and SVI | Daily | Grab |
| 13. | All Sludge VSS, TSS and Specific Gravity | 3x / week | Grab |
| 14. | Dewatered Stabilized Sludge after Centrifuge % Solids | Daily | Grab |

### 8.2.3 The Operation

**1 General**

The Contractor shall from the date for commencement of the Operation and Maintenance until expiry of the Operation Period carry out the Operation in strict accordance with the Registered Design, the Contractor's Plan and the programme consented to by the Employer and the provisions of the Contract. The Contractor shall provide all necessary Plant, and equipment to ensure the safe and secure Operation of the Facility. The scope of work for the Operation shall include the following:

- Liaise with the Employer and other stakeholders;
- Implement quality system and environmental management system in accordance with ISO 9001 and ISO 14001;
- Operation of all systems associated with the Facilities and disposal of residue from the operation.
- Prepare records and reports;
- Keep the Facility in clean, hygienic, tidy and safe conditions;
- Sustain and maintain condition of landscape establishment;
- Implement security control of the Facility;
- Carry out tests and laboratory analysis;
- Carry out preventive and corrective maintenance;
- Carry out audits, Performance Tests, Condition Surveys and Residual Life Assessments;
- Carry out overhaul, renewal and replacement of Plant;
- Carry out refurbishment of buildings, structures and civil works;
- Review and update the Contractor's Plan;
- Prepare submissions to the Employer and/ or the Employer's Representative, utility companies, government departments and authorities;
- Obtain and renew licences, permits and certificates necessary to operate the Facility;
- Conduct trainings for Contractor's staff and Employer's staff;
- Handback the Facility to the Employer and the follow-on contractor at the end of the Operation Period;
- All other activities set out in the Specification;
- All other liabilities, obligations set forth and reasonably implied in the Contract; and
- Handle and resolve complaints of public in relation to the operation of the Facility;
- Provide ambient air monitoring

**2** The Contractor shall operate the Facility in full compliance with the Environmental Performance Requirements and Operational Performance Requirements as specified in the Specification. In the event that the Employer certifies non-compliances with these requirements

under the Conditions of Contract, the payment of the Operation Fees shall be reduced or penalty will be applied, without prejudice to other provisions in the Contract, in accordance with the Conditions of Contract. Non-compliance points are allocated as specified.

**3** The Contractor shall apply for and maintain all licences, permits and certificates necessary for the Operation of the Facility. Whenever there is alteration or modification of requirements of the said licenses, permits or certificates, the Contractor shall propose the necessary changes to the Registered Design, the programme and/or relevant parts of the Contractor's Plan for the Employer's consent.

**4** The Contractor shall supervise and control the actions of all Plant, and personnel on the Site to ensure the safe and secure Operation of the Facility. The Contractor shall maintain all areas in a clean and orderly condition at all times and shall ensure the correct and proper operation and handling of all equipment and materials. In particular, the Contractor shall comply with the approved operation and maintenance procedures for all plants and equipment and shall ensure that the safety systems are fully operative at all times.

### 8.2.4 Site Usage

1 Without the prior written consent of the Employer, the Contractor shall not erect nor bring on to the Site any additional structures, plants, equipment, materials or accommodation, other than those in the Registered Design or Contractor's Plans consented to by the Employer.

2 Without the instruction of the Employer, the Contractor shall not use the Facility, including but not limited to all Plant for any activities other than for the Operation under provisions of the Contract.

### 8.2.5 Condition of the Facility

(1) During the Operation Period, the Contractor shall carry out maintenance, repair, rehabilitation and replacement work to ensure safe and effective operation of the Facility. The specific requirements are provided in the Specification.

(2) On the expiry of the Operation Period, the Facility shall be handed back to the Employer in a good and fully serviceable condition suitable for the immediate and continual use by the Employer, his agents or the follow-on contractor in accordance with the Conditions of Contract and the Specification.

(3) The colour of any paintwork and external finishes of buildings and structures, including any architectural finishes or the Registered Design shall not be changed without the prior consent in writing of the Employer's Representative. The Contractor shall inspect all paintwork and external finishes of buildings and structures at least once every year and shall carry out repainting or remedial works as necessary to the consent of the Employer's Representative.

### 8.2.6 The Contractor's Plan

(1) The requirements for the Contractor's Plan are specified in the Specification. The following plans in the Contractor's Plan are relevant to the Operation:-

a) Project Management Plan;

b) Human Resources Plan;

c) Operation Plan;

d) Asset Management Plan;

e) Handing Over Plan;

f) Environmental Management and Quality Plan; and

g) Safety and Health Plan

(2) The Contractor shall review, update and submit if necessary, plans (a) to (e) above annually during the Operation Period. In case there is no change to the previous plan(s), the Contractor shall declare such status in writing to the Employer instead of submitting the same plan(s).

(3) The Contractor shall review, update and submit if necessary, the plans (f) to (g) above at monthly intervals during the Operation Period. In case there is no change to the previous plan(s), the Contractor shall declare such status in writing to the Employer instead of submitting the same plan(s).

(4) If the Employer is of the opinion that any of the plans does not meet the requirements of the Contract, the Contractor shall revise or update the relevant plans and submit to the Employer for consent within 7 days of the date of notice served by the Employer.

### 8.2.7 Health and Safety

(1) The Contractor shall be responsible for the adequate stability and safety of all work and operations connected with the execution of the Operation and the safety and health of all persons on the Site.

(2) The Contractor shall take all reasonable measures necessary to ensure that all facilities within the Site are safely secured during typhoons and all other inclement weather conditions. The measures taken shall prevent facilities from causing damage to the Plant, and all persons on the Site.

(3) The Contractor shall ensure that the Facility is adequately lit at all times, the level of illumination of each part of the Facility being consistent with the safe and effective functioning of that part of the Facility and for security purposes. The Contractor shall provide emergency lighting in accordance with the Specification.

(4) The Contractor shall maintain the fire services installations at the Facility for fire detection and fire fighting. Fire services installations shall be approved by the Chandigarh Fire Services Department as appropriate.

(5) The Contractor shall display guidelines on personnel health precautions to be taken by all employees and users of the Facility, including those guidelines concerned with the risk of Leptospirosis (Weils Disease) at locations agreed by the Employer's Representative.

(6) The Contractor shall develop and implement a Safety and Health Plan. The Contractor shall review and update the Safety and Health Plan in accordance with the Specification. For the avoidance of doubt, the Safety and Health Plan shall take into account of construction work associated with maintenance of the Facility.

(7) The Contractor shall develop site specific safety training for all personnel as specified in the Specification.

(8) The Contractor shall keep records on all safety and health matters. Such records shall be updated daily and be available at all time for inspection by the Employer's Representative. The safety and health records shall include as a minimum the following information:-

a) A record of all employees on the Site;

b) Dates and times of employees and staff having completed site orientation/safety training courses/drill exercises;

c) List of safety and health equipment issued and maintenance records;

d) Safety and health inspections carried out under the supervision of the Safety Manager;

e) Safety and health instructions issued to employees and staff;

f) Safety and health incidents/accidents and actions taken; and

g) Safety and health prosecutions, non-compliances or observations notified by the Employer's Representative, Ministry of Labour and Employment or other authorities, and actions taken.

(9) The Contractor shall formulate and implement strategies to promote good air quality and prevent indoor air pollution problems for buildings or any part of the building which is totally enclosed and served with mechanical ventilation and air conditioning system for human comfort, such as the offices, control rooms, and all indoor locations accessed by operation personnel.

(10) The Contractor shall conduct fire and emergency drills at least 4 times each year during the Operation Period in enabling his staff and all personnel working in the Facility to familiarize with the proper response to fire incidents and emergency situations. The drill plans shall be included in the Operation Plan for consent and the drill records shall be submitted to the Employer's Representative.

(11) First aid kits shall be provided and maintained by the Contractor throughout the Operation Period.

### 8.2.8 Environmental Management and Quality Assurance

(1) The Contractor shall be responsible for taking mitigation measures to reduce environmental impacts and nuisances arising from the Operation of the Facility.

(2) The Contractor shall implement an Environmental Management System in accordance with the requirements of ISO 14001 and develop a comprehensive Environmental Management Plan. The Contractor shall review and update the Environmental Management Plan when appropriate.

(3) The Contractor shall maintain proper function of the ventilation for the whole operation to prevent any leakage of objectionable odour.

(4) The Contractor shall implement a Quality Assurance System in accordance with the requirements of ISO 9000 and develop a comprehensive Quality Plan. The Contractor shall review and update the Quality Plan in from time to time and when appropriate.

(5) Ensure Noise Pollution within the WWTP as per MoEF norms .

(6) Ensure Air Quality within the plant is devoid of corrosive gasses and the environment is within the health norms specified by the Ministry of Environment

### 8.2.9 Cleanliness

(1) The Contractor shall all the times keep the Site and the Facility in a clean, tidy and hygienic condition to ensure that efficient operation of the Facility is maintained and appropriate environmental standards are complied with during the Operation Period.

(2) The Contractor shall clean litter and debris from surface water drainage channels on a regular and frequent basis. If features are found that are preventing the adequate performance of the surface water management system or which may develop to an extent so that the performance requirements of the system are no longer adhered to, appropriate remedial work shall be carried out.

(3) In addition to regular cleaning, the Contractor shall carry out thorough cleaning at least once per month of all indoor carpets to ensure free of deep seated dirt, stains and soils, with wet / steam carpet cleaning method.

(4) The Contractor shall clean and wash the streets of the Facility at least three times a day. The area to be washed and cleansed is hereinafter referred to as "the streets". "The streets" means the highway and all adjacent footways and verges within the Facility. The Contractor shall take necessary measures to avoid spillage/leakage of sludge, water, wastewater, chemicals, fuels or other waste within the Site. Any spillage/leakage occurred shall be confined and cleaned immediately. The Contractor shall conduct a thorough check and clean-up at the end of the opening hours on each working day.

### 8.2.10 Landscape Establishment

(1) The Contractor shall sustain and maintain in healthy, attractive and safe condition for all trees, shrubs, groundcovers, annuals, perennials and turf within the Site established in accordance with the Registered Design. The Contractor shall also clean-up and dispose of all clippings, pruning, etc., generated in the process.

(2) The following items of work are general descriptions for guidance only and shall not be construed as a complete detailed list of all operations to be performed:-

- Maintain all landscape plant materials;
- Control and eliminate weeds in mulched areas, turf areas, planting beds, and inert materials;
- Control and eliminate pests; and
- Mow and edge turf.

(3) The Contractor shall be responsible for the maintenance of landscape of the WWTP that is not limited to irrigation and watering of the grass land inside the boundary of the WWTP.

### 8.2.11 Good Relations

(1) The Contractor shall take all necessary and reasonable actions to preserve good relations with stakeholders, neighbours, statutory authorities and bodies and to avoid impairing any amenities by the behaviour and actions of his employees, by the use of Plant, or by air or water pollution, or otherwise.

(2) The Contractor shall immediately correct any nuisance such as dust, odour, waste or the like caused by receiving and treatment of Sludge and by transfer of ash and residue.

### 8.2.12 Safety & Security

1) The Contractor shall take all safety precautions under various acts and rules under the Central and State Governments. The Contractor shall be responsible for safety of staff and the consequences thereof. The Contractor shall deploy round the clock security personnel at the plant entrance and in the compound for the safety of the plant and premises during the O&M

period. The Contractor shall be completely responsible for the safety of the plant, equipment and personnel.

2) The care of the whole of the permanent works shall remain with the Contractor who shall be responsible for all accidents or damages from whatever cause arising and chargeable for anything that may be stolen, removed, destroyed or damaged to whomsoever belonging and also for making good all defects and damages to the said works or to any property adjoining to any cause whatever, whether such damage or defects were occasioned by the negligence of the Contractor or not or completion whereof or whether payment may wholly or partially have been made or the works approved as supposed to have been properly done and no certificate of approval of any works by any officers or members of the Engineer shall affect or prejudice the right of the Engineer against the Contractor or be considered or held as at all conclusive as to the sufficiency of any work materials.

3) Adequate safety precautions against fire, flooding, lightening, electrical shocks, accident due to moving /non- moving heavy /light equipment shall be strictly observed by the Contractor at the Contractor's own cost. Suitable safety measures like gumboots, gloves, safety belts, ladders, safety la, gas masks, Oxygen apparatus, insulated tools, alarm etc. shall be provided by the Contractor. Necessary medical first aid kit shall be made available all time. In presence of observance of above safety precautions, the Contractor shall be responsible for any unforeseen loss of the equipment or persons dealing with it. Special care shall be taken by the Contractor while carrying out the work in sewage gas zone. Any incidence of loss of human life or accident will be totally Contractor's responsibility.
4) The Contractor shall ensure that the staff employed takes all necessary precautions while carrying out the work either in shift duties or any general shift as per Indian Electricity Rules /Factory Act/CPHEEO Manual or, manufacturer's special instruction for safety /gas handling. The staff shall use: gas masks, oxygen breathing apparatus, gum boots, safety belts, safety la and hand gloves during execution of the work as required per the task.

5) During night hours, the main gate shall be locked. However, shift duty staff shall be alerted and open the gate during surprise checking by Engineer's staff or any other Government authorities or the Contractor's nominee without any wait after checking their proof of identification. Only bona-fide persons shall be allowed on the WWTP premises. Smoking, consumption of alcohol and other illegal substances are strictly prohibited within the WWTP site.

6) The Contractor shall provide security services to meet the following objectives:
   - To prevent damage, vandalism and the like to the Facility;
   - To prevent unauthorized removal of any part of the Facility;
   - To prevent unauthorized entry to the Facility;
   - To prevent unauthorized parking within the Facility;
   - To prevent unauthorized use of the Facility; and
   - To provide first aid in an emergency in the Facility.
7) The Contractor shall provide security services on a 24-hour basis throughout the Operation Period.
8) Before and after opening hours of the Facility, the Contractor shall provide security personnel to patrol the Facility, and provide a gate control service at the main entrance to the Facility.
9) Outside the opening hours of Facility, the security personnel shall observe the CCTV monitors in the guard house at the main entrance to the Facility with the CCTV cameras trained on, but not limited to:
   - peripheral areas along the Site boundary;
   - Open tanks including aeration tanks, primary sedimentation tanks and secondary clarifiers,

- entrances to buildings and office area;

10) Any malfunctioning of security and safety installations (including CCTV cameras) and procedures shall be logged and remedied promptly and the Contractor shall ensure that security and safety are not materially compromised at any time. Where necessary, interim provisions shall be implemented

11) Security and safety installations and procedures shall be reviewed and updated at regular intervals during the Operation Period to take advantage of technological improvements and comply with prevailing good practice.

12) Regular tests, inspections and maintenance of the fire alarm system, and the fire services installations in line with industry standards and statutory requirements shall be carried out. Any malfunctioning shall be logged and remedied promptly.

13) The Contractor shall arrange the issue of passes to his employees for the Operation of the Facility, and persons authorised by the Employer for the admission to the Site and the Facility, and in such event any person who fails to show his pass on demand to any duly authorised person shall be refused admission. Incidents of unauthorised entry shall be reported to the Employer's Representative promptly.

14) The Contractor shall not allow and shall prevent any persons, other than his employees, agents for the Operation of Facility, and persons authorised by the Employer, from entering the Site and the Facility. For the avoidance of doubt, no visitor shall be allowed without prior permission of the Employer's Representative.

15) The Contractor shall maintain a record showing the names identity document numbers of all his employees or persons authorised by the Employer to whom passes have been issued. An updated record shall be available at all times for the Employer's inspection. The Contractor shall ensure that any pass issued must be returned and invalidated on the cessation of the bearer's employment, or as directed by the Employer's Representative, and in any case on the issue of the Handover Certificate.

## 8.3 Facility Operation

### 8.3.1 Operation Plan

The Contractor shall submit a draft Operation Plan to the Employer's Representative for certification. The draft Operation Plan shall be developed based on and shall not differ in any material respect from the Outline Operation Plan submitted by the Contractor. The Operation Plan shall include, but shall not be restricted to, the following sections:

**(1) <u>General Matters</u>**

- Overall plan for operation and maintenance of the Facility with due consideration on the reliability of performance, flexibility to cope with variability, diligence to maintain tidiness and cleanliness, capability to respond to emergency situations and effectiveness to handle complaints and to meet the Environmental Performance Requirements and Operational Performance Requirements;
- Provision of spare parts and special tools with quantity and particulars throughout the Operation Period for effective and uninterrupted operation of the Facility;
- Plan for maintaining good communication and relationship with neighbours and stakeholders; and
- Measures to enhance and sustain the good image of the Facility and the public acceptance.

**(2) Operation and Maintenance**

- Sampling and testing methodologies in determining physical, chemical and biological characteristics of influent and effluent of the Facility;
- Identification, elimination and mitigation of safety and health risks associated with the Operation of the Facility;
- Means and flow of communication among field staff, staff at control rooms and truck drivers for sludge disposal;
- Procedures and plans to maximize energy recovery and power generation from biogas produced in the sewage treatment;
- Inventory control of consumables such as fuel, sand and various types of chemicals, dangerous goods and hazardous materials;
- Safe and proper storage and transfer of various types of materials and chemicals, dangerous goods and hazardous materials to assure the continuous operation of the Facility, the compliance with statutory requirements and avoidance of environmental nuisance;
- Upkeep of the CMMS(Computerized Maintenance Management System) to ensure availability of reliable on-line and archived data to satisfy operational needs as well as for assessment of the Contractor's compliance with contract requirements;
- Maintenance management plans for every system, building and infrastructure of the Facility;
- Preventative maintenance programmes;
- Procedures to handle corrective maintenance;
- Precautionary measures and arrangements for inclement weathers;
- Procedures to record and handle complaints;
- Arrangements for Employer's Audits;
- Operational arrangements related to Performance Tests;
- Operational arrangements related to Condition Surveys and Residual Life Assessments; and
- Procedures to prepare and submit routine records and reports to the Employer and the Employer's Representative.

**(3) Operational Performance and Environmental Performance Monitoring**

- Procedures, plans and actions to achieve compliance with the contract requirements in respect of Operational Performance and Environmental Performance;
- Setting of appropriate triggering levels for early action against potential non-compliance with the contract requirements in respect of Operational Performance and Environmental Performance;
- Procedures, plans and actions to avoid non-compliance with the contract requirements in respect of Operational Performance and Environmental Performance; and
- Procedures and actions to rectify non-compliance with the contract requirements in respect of Operational Performance and Environmental Performance.

**(4) Operational Contingency Plan**

- Identification of potential problems that may cause disruptions to operation and assessment of potential impacts;
- Measures to handle identified potential problems and prevent disruptions to operation;
- Measures to handle emergency situations that may cause disruptions to operation and even shutdown of the Facility;
- Estimation of the duration of shutdown due to various disruption incidents;
- Procedures to handle unauthorized entry to the Facility;

- Precautions and procedures to resume operation after removal of the emergency situations; and
- Fire and emergency drill plans.

**(5) Information Technology System**

- Arrangements for ensuring data security and integrity, and prevention of unauthorized alteration;
- Arrangements for data recovery in dealing with accidental lost of essential operational data;
- Arrangements for allowing flexibility of the computer database to store and process data upon introduction of new technologies and data management system; and
- Provision of access to the Employer and the Employer's Representative in the specific parameter of operation.

**(6) Environmental Considerations**

- Assessment of air impacts including emission from power generation, arising from the Operation of the Facility;
- Assessment of water impacts arising from the Operation of the Facility,
- Assessment of noise impacts arising from the Operation of the Facility;
- Assessment of ecological impacts arising from the Operation of the Facility;
- Assessment of waste management arising from the Operation of the Facility;
- Assessment of rodent and insect control arising from the Operation of the Facility; and
- Assessment of other potential nuisances and environmental impacts arising from the Operation of the Facility.

**(7)** The Contractor shall obtain the Employer's consent on the certified draft Operation Plan, which will then be construed as the Operation Plan. The Contractor shall review and update the Operation Plan from time to time or when required.

**(8)** The Contractor shall update or amend the Operation Plan whenever the need to do so becomes apparent, which may include but not limited to the following:-

- a Change ordered by the Employer, in accordance with the Conditions of Contract;
- any new or emerging technologies, techniques, practices and methods related to the Operation of the Facility that is more efficient or effective;
- any change in the procedures and arrangement of the treatment process as a result of liaison with the Drainage Services Department;
- any change required due to additions, amendments to current enactment, regulations, bye-laws or rules, or new enactments, regulations, bye-laws or rules made during the continuance of the Operation.

**(9)** The Contractor shall submit the updated Operation Plan for the Employer's consent in a timely manner so as not to interfere the Operation. Submission of revision or update shall not relieve the Contractor from any of his liability or obligation under the Contract.

**(10)** Throughout the Operation Period, the Contractor shall operate the Facility wholly in accordance with the currently consented Operation Plan.

### 8.3.2 Opening Hours of the Facility for Sludge Reception

(1) The Facility shall run 24 hours every day and 365 days each year continuously under normal operation. It is the obligation of the Contractor to maintain the system operation safely with redundant backup despite failure occurs on non-critical systems.

(2) All activities on the Site likely to produce any noise shall be subject to the requirements of the latest Noise Pollution (Control and Regulation) Rules with respect to the Operation.

### 8.3.3 Contractor's Resources

#### (1) Organization Structure

The Contractor shall develop and implement a Human Resources Plan to manage the Facility. The information shall include:

a) Description of human resources plan, strategy and monitoring mechanism;

b) Organization structure, bureaucracy and line of reporting;

c) Position description, qualification and, responsibility and authority; and

d) Succession planning of key positions.

#### (2) Staffing

For all operation and maintenance works, the Contractor shall provide skilled staff which has adequate qualifications and sufficient experience of similar works.

The Contractor shall appoint a Plant Manager to be responsible for managing the Operation of the Facility. This manager shall be suitably qualified and experienced and shall have experience of managing similar facilities elsewhere. A detailed curriculum vita (CV) of the Operation Manager shall be provided to the Employer for approval prior to the commencement of the Operation of the Facility. Also CV of Shift-in-charge, Plant Supervisors shall be approved by the Engineer.

The following Table describes the minimum staffing, and their minimum qualifications and experience in similar works that the Contractor will be required to deploy for carrying out the O&M functions.

The requirements below are minimum only. The Contractor shall arrange for extra work force, as and when required, so as to smoothly run the operation and maintenance including preventive maintenance, repairs etc. and general cleanliness of the installations.

The Contractor shall make appropriate arrangements for maintenance of items like road work, buildings, horticulture, patrolling and maintenance of civil structures, vehicle operations and other activities defined to fulfill its obligations under O&M Contract.

In the event of absence of staff during DLP and O&M period, the deduction of payment shall be done on a per day basis for the number of days absent. A day salary will be deducted at the recovery rates considering 30 calendar days in a month as mentioned below:

| Sr. No. | Personnel | No. | Qualification | Minimum experience | Main Task of the Personnel | Man-day Recovery Rate for each Personnel* in Rs. |
|---|---|---|---|---|---|---|
| 1. | Plant Manager/Engineer In charge | 2 | BE (Civil/ Chemical/Env. ) | 15 years | Manage and co-ordinate the operation activities to achieve satisfactory operation of the Facility | 5000 |
| 2. | Engineer (Mechanical/ Electrical) | 2 | BE (Mech/ Electrical) | 8 years | Responsible for daily O&M, process units, electrical / mechanical equipment of the WWTP and data collection. | 4000 |
| 3. | Jr. Engineer (Civil) | 2 | Diploma (civil) | 5 years | Responsible for daily maintenance of civil works | 3000 |
| 4. | Chemist | 2 | (M.Sc. Chemistry/ Env.) | 5 years | Daily analysis of samples of WWTP and fixing of chlorine doses and sludge withdrawal | 2000 |
| 5. | Lab technician (one no. in each shift) | 6 | BSc/Diploma | 5 years | To assist the chemist in daily analysis of samples. | 1500 |
| 6. | Lab attendant (one no. in each shift) | 6 | Graduate | 2 years | To assist the chemist in daily analysis of samples and to work in shift. | 1000 |
| 7. | Health and safety officer | 2 | Diploma in H&S | 5 years | Responsible for H&S of plant and staff. | 3000 |
| 8. | Operators/Shift In charge | As per requirement.** | ITI | 5 years | Execution of specific tasks as indicated by the Engineer (Mech) and (E&I) for operating the different installation of WWTP. | 2000 |
| 9. | SCADA Operators (one no in each shift) | 6 | ITI | 5 years | Responsible for Operation & maintenance of SCADA system. | 2500 |
| 10. | Electrician (one no in each shift) | 6 | ITI | 5 years | Responsible for maintenance of electrical equipment. | 1500 |
| 11. | Fitter(Mech.) (one no in each shift) | 6 | ITI | 5 years | Responsible for maintenance of mechanical equipment. | 1500 |

| Sr. No. | Personnel | No. | Qualification | Minimum experience | Main Task of the Personnel | Man-day Recovery Rate for each Personnel* in Rs. |
|---|---|---|---|---|---|---|
| 12. | Helper/Non-Skilled labour | As per requirement.** | NA | NA | Assistance to operators & fitters for maintenance of plant | 1000 |
| 13. | Cleaner/Sweeper | As per requirement.** | NA | NA | Plant cleaning, assistance in removal of screenings/grit/sludge etc. | 500 |
| 14. | Security Guards | 4 per shift per plan | NA | NA | Plant safety | 600 |
| 15. | Gardener | 1 No per plant | NA | NA | To maintain the garden/Landscaping of the plant | 500 |

**Recovery rate shall be increased @8% per year on the rates specified above.*
*** Bidder to propose minimum number of persons to be deployed.*

### 8.3.4 Manning Level

(1) The Facility shall be manned 24 hours every day with adequate number of the Contractor's staff as may be necessary to ensure the safe and effective Operation of the Facility in compliance with the Contract. The Contractor shall determine the required manning level of each shift of operation and arrangement during emergencies and inclement weather conditions for the Employer's consent. The manning level shall be maintained at all times as that set out in the Human Resources Plan.

(2) The Contractor shall at all times provide sufficient personnel to enable the fulfillment of all Operational Performance Requirements and Environmental Performance Requirements in accordance with the Specification, including the provision of sufficient staffing and equipment to handle any emergencies such that Operational Performance Requirements and Environmental Performance Requirements are maintained.

(3) The Contractor shall appoint an Operation Manager to be responsible for managing the Operation of the Facility. This manager shall be suitably qualified and experienced and shall have experience of managing similar facilities elsewhere. The Contractor shall refer to the Specification for detailed qualification requirements of the Operation Manager. A detailed curriculum vita of the Operation Manager shall be provided to the Employer for approval prior to the commencement of the Operation of the Facility.

(4) Staff credentials and experience shall be provided to the Engineer for approval in advance of placement or replacement for the duration of the Contract.

(5) Not more than one of the Contractor's key staff (noted in table above) shall be absent from the project site at any given time. In case, it is necessary for more than one of the key personal to be absent at a given time, the Contactor shall provide replacements of equivalent or better qualifications for prior approval by Engineer.

(6) The Engineer is authorized to direct removal of any or all staff employed during the O&M period of the WWTP if in the sole opinion of the Engineer it becomes necessary. The Contractor shall comply with such directions and post a suitable substitute(s).

### 8.3.5 Operation and Maintenance Manual

(1) The Contractor shall prepare standard operation and maintenance procedures for the Facility.

(2) The Contractor shall update the standard operation and maintenance procedures on an ongoing basis to reflect any changes to the Facility of newly introduced regulations and standards.

(3) The Contractor shall prepare the Operation and Maintenance Manuals for the Facility, in a format to be agreed by the Employer. The scope of the manual for all the major equipment and systems of the treatment works should include the following:

a) Introduction
b) Permits and Standards,
c) Description, Operation and Control of Wastewater Treatment Facilities
d) Description, operation and Control of Sludge Handling Facilities
e) Personnel
f) Sampling and Laboratory Analysis
g) Records and Reporting
h) Maintenance
i) Emergency Operation and Response Program
j) Safety
k) Utilities

(4) The Contractor shall ensure that the Operation and Maintenance Manuals are comprehensive and cover all Plants of the Facility. The Operation and Maintenance Manuals shall have detailed descriptions of operation and maintenance procedures supplemented by updated drawings, figures, graphs, photographs and manufacturers' literatures.

(5) A draft set of the Operation and Maintenance Manuals shall be submitted to the Employer's Representative for certification and subsequently to the Employer for consent at least 60 days before the Plant Commissioning.

(6) Upon receiving certification and consent of the draft Operation and Maintenance Manuals, the Contractor shall update the Operation and Maintenance Manuals on an ongoing basis to reflect changes of the facilities, changes of work safety or other related regulations and standards.

### 8.3.6 Traffic Control

(1) The Contractor shall be responsible for the control of all traffic within the Site.

(2) The Contractor shall be responsible for the implementation of the traffic management within the Site. The Contractor shall provide assistance to and coordinate all the works required by other departments and authorities to implement the traffic arrangement.

(3) The Contractor shall erect and maintain in good conditions traffic control and warning signs inside the Facility. Traffic signs and road markings shall be in accordance with the Specification and local safety regulation related.

### 8.3.7 Handling, Disposal/ Reuse of Waste Water Treatment By-products

The Contractor shall operate and maintain a system for the handling and disposal/ reuse of by-products from the treatment, including solid waste, screenings, grit and sludge and other residue. Contractor shall transport the screening, grit material and reusable dewatered sludge for various purposes as per Contractors choice but will not be allowed for filling or dumping purpose.

(1) All costs related to handling of the by-products, including but not limited to license application, transportation, tests and treatment shall be borne by the Contractor and deemed to be included in the Operation Fees.

### 8.3.8 Release of Bio-Gas

The Contractor shall conduct his activities in the WWTP site in such manner that bio-gas will not be released or leak at the site or elsewhere. The Contractor shall bear the cost of correcting any adverse consequences resulting from any such release, leakage or spillage and shall make / file reports with respect to enquire under the conditions of contract for operation and maintenance and applicable law. In case release /flaring of bio-gas is required, necessary arrangement shall be provided for flaring the gas as per the norms as prescribed by CPCB/ CPCC.

### 8.3.9 Release of Hazardous Substances or Hazardous Wastes

The Contractor, after first notifying the Engineer, shall be responsible for fulfilling all requirements associated with any release of any substance or waste into the environment (from the facility to the site ) as required by the Applicable law or by any Legal Entitlement including but not limit to the notification or reporting of release / Hazardous Waste. The Contractor shall prepare memorandum evidence such notification or reporting and provide copies thereof to the Engineer along with any documents provided to the relevant regulatory agency regarding such release.

### 8.3.10 On-site Communications

(1) The Contractor shall manage and maintain computer facilities and telemetry connections between the Facility and the Employer's on-site and off-site offices as specified in the Specification.

(2) The Contractor shall manage and maintain telephone and facsimile services to the Facility and for the use of the Employer’s Representative.

(3) The Contractor shall establish communication links and provide proper equipment for communication between field staff, staff at control rooms, and truck drivers for operation and by-product disposal.

(4) Prior to using any radio-communications on the Site, the Contractor shall have to obtain necessary licenses granted by the Wireless Planning and Coordination Wing and all relevant bodies and authorities.

### 8.3.11 Inventory Control

Throughout the Operation Period, the Contractor shall provide and maintain special tools and spare parts in accordance with the Registered Design and sufficient for 2 years operation. The Contractor shall also maintain stock level of all consumables as required in the Specification or otherwise consented to by the Employer, to ensure continuous operation of the Facility. The required stock levels shall take into consideration reliability of sources and supply interruptions, for example, due to inclement weather.

(1) The target stock levels to meet the requirements the Specification shall be set out in the Operation Plan. The quantity or amount of each item required to meet the target stock level shall be entered in the Computerised Maintenance Management System (CMMS) for monitoring.

(2) The current stock levels shall either be updated on-line by monitoring signals of the SCADA system (e.g. level of chemical tanks) or by manual input to the CMMS at a reasonable frequency with reference to the respective consumption rates, but in any case not fewer than once per week. All delivery of spare parts and consumables shall be recorded as appropriate.

(3) The Contractor shall develop and implement an appropriate inventory control system and work procedures such that stock levels of spare parts and consumables shall be updated in the CMMS and appropriate record files immediately at the time the spare parts and consumables are retrieved from the store. In general, the method and frequency of updating shall be stated in the Operation Plan for the Employer's consent.

(4) The Contractor shall carry out inventory checks in every six months. The inventory checks shall be scheduled to avoid disturbance to the Operation and a one-week advance notice shall be served to the Employer's Representative. The Employer may, at his discretion, attend any of these inventory checks.

### 8.3.12 Chemicals, Dangerous Goods and Hazardous Materials

(1) The Contractor shall provide and maintain storage of chemicals, Dangerous Goods and hazardous materials required for the Operation. Dangerous Goods means any of the goods or substances to which the Dangerous Goods Ordinance applies.

(2) The Contractor shall include in his Operation Plan a detailed list all chemicals, Dangerous Goods and hazardous materials to be used in the Operation with inventory control programme, safety plan and procedures for handling and storage.

(3) The Contractor shall maintain appropriate stock levels to allow continuous and efficient Operation of the Facility but the quantity stored in the Facility shall not exceed the regulatory limits.

(4) All chemicals, Dangerous Goods and hazardous materials shall be packed in containers of suitable design and construction so as to prevent leakage, spillage or escape of the contents under normal conditions of handling, storage and transportation, and shall comply with relevant statutory and the requirements of Chandigarh Fire Services Department.

(5) Storage areas of chemicals, Dangerous Goods and hazardous materials, including any room, cupboard, cabinet or bin, should display a hazard warning panel, notice or marking at or near the entrances or opening of the storage area and such panel, notice or marking should:

a) be indicated in English and Hindi;

b) be securely attached to or worked in vertical plane of the storage structure;
c) be weather resistant and rigid;
d) be kept clean and free from obstruction; and
e) meet statutory and Chandigarh1 Fire Services Departments requirements where appropriate.

### 8.3.13 Breakdown and Emergencies

#### 8.3.13.1 General

a) The Contractor shall notify the Employer's Representative in advance in writing of all shutdowns and interruptions to any part of the Operation. Provided that in the event of an emergency shutdown or any emergency action at the Site, the Contractor shall forthwith give notice by telephone and as soon as practicable thereafter give notice in writing to the Employer's Representative and specify the probable cause, effect and extent of such emergency.

b) Without limiting the Contractor's obligations and responsibilities under the other provisions of the Contract, the Contractor shall provide from time to time all temporary arrangements and contingency provisions necessary or as may be provided in the Contract to maintain the Operation during the maintenance, overhaul, renewal, breakdown, Performance Tests, Condition Surveys and subsequent repair of any part of the Facility, without limitation to the generality of the foregoing:-

c) The Contractor shall not be permitted to suspend the Operation by reason of any such event;

d) The Contractor shall make available at all times such workers, Plant as provided in the Contract for the execution of emergency works to the Facility;

e) If by any reason of any accident or failure of other event occurring which, in the opinion of the Employer's Representative requires the emergency works to be executed or services to be performed, the Employer's Representative may give to the Contractor an order verbally in the first instance, to be followed by an instruction within 1 days of the issue by the Employer's Representative of the verbal order. The Contractor shall upon receipt of the verbal order immediately execute the works or perform the services with due diligence as instructed in the verbal order.

### 8.3.14 Emergency Procedures

**8.3.14.1** The Contractor shall prepare an Operational Contingency Plan as part of the Operation Plan. This shall state the non-routine operational procedures to be adopted during emergencies, and shall include at least the following:-

- Fire;
- Vehicle breakdown and accidents;
- Facility closure;
- Procedure to handle excessive incoming sewage due to rain storm or infiltration;
- Floods;
- Inclement weather conditions;
- Power outage;
- Spillage of chemicals;
- Labour disputes; and
- Others.

**8.3.14.2** The Operational Contingency Plan shall be submitted to all relevant authorities including but not limited to the Employer's Representative for comment and submitted to the

Employer for approval. The Contractor shall review and update the Operational Contingency Plan regularly or when considered necessary by the Employer.

### 8.3.15 Employer's Audit

**8.3.15.1** Unless otherwise specified, an Employer's Audit of the Facility operations shall be carried out, on a monthly basis, jointly by the Contractor and the Employer's Representative and shall include, without limitation, inspection and audit of the following:-

a) Influent/Effluent quantities and characteristic;
b) General plant and equipment conditions;
c) Spare parts conditions;
d) Storage of chemicals, dangerous goods and hazardous materials;
e) Storage of consumables;
f) Conditions of security and safety installations;
g) Site Cleanliness and Housekeeping;
h) Odour;
i) Noise;
j) Lighting;
k) Surface water;
l) Dust;
m) Vermin/insect;
n) Site Diary and Safety and Health Records;
o) Operational records and data including SCADA and CMMS database;
p) Manning levels;

**8.3.15.2** The observations and findings of the Employer's Audit, among the observations and findings identified from the routine inspection carried out by the Employer's Representative, shall be used to determine non-compliance with the Environmental Performance Requirements and the Operational Performance Requirements as specified in the Specification. In such case, the Employer will notify the Contractor as soon as is practicable specifying his observation of non-compliance in accordance with the Conditions of Contract.

**8.3.15.3** On the basis of the Employer's Audit the Contractor shall be required to remedy any part of the Operation that is not in accordance with the requirements of the Contract.

**8.3.15.4** Nothing in relation to the Employer's Audit shall relieve the Contractor of his obligations, liabilities and responsibilities and shall not constitute any admission on the part of the Employer that any such obligations, liabilities and responsibilities have been complied with.

**8.3.15.5** The Employer's Representative will advise the Contractor of the date and time of the Employer's Audit. The Contractor's Operation Manager and Safety Manager shall be present during the Employer's Audits.

### 8.3.16 Unscheduled Audit

**8.3.16.1** From time to time the Employer will send an audit team comprising the Employer's employees and/or the Employer's agents to carry out on-site detailed monitoring of every aspect of the operation and maintenance of the Facility. The Employer will give the Contractor 7 days' notice (the notice should be kept to the minimum) of commencement of the said audit. The Contractor shall make provisions to assist the Employer's audit team to monitor the operation and maintenance.

**8.3.16.2** These shall include without limitation the following:

a) To provide detailed operational and maintenance procedures and records within 3 days of being requested by the Employer in writing;

b) To provide on the spot verbal explanation of operational and maintenance matters when asked;

c) To provide responses to questions raised by the said team on the operation and maintenance of the Facility; and

d) To provide comments within 14 days of receipt of report(s) produced by the said team regarding the operation and maintenance of the Facility.

## 8.4 Facility Maintenance

### 8.4.1 General

8.4.1.1 The Contractor shall carry out corrective and preventive maintenance for the Facility in accordance with the maintenance management plans in the consented Operation Plan to ensure the facilities and equipment perform to the specific standards.

8.4.1.2 The Contractor shall ensure on a continuing basis that at all times his maintenance procedures are sufficient so that:

a) The Facility operates on a continuous basis in compliance with all stipulated performance requirements;

b) The Facility is maintained to achieve its full working life; and

c) The condition of the Facility at the expiry of the Operation Period enables it to meet its residual design life requirements as set out in the Specification.

8.4.1.3 All elements of the Facility shall be maintained at regular and frequent intervals so that their performance requirements are met.

8.4.1.4 The system of planned maintenance shall include the maintenance of adequate records.

8.4.1.5 Maintenance shall be carried out in a safe manner following the procedures for ensuring the safety of operatives including but not limited to a "permit-to-work" system, the correct use of lifting equipment and the isolation of Plant.

8.4.1.6 All elements of the Facility shall be regularly and frequently cleaned, checked for damage, and repairs made as appropriate. The frequency of cleaning and checking shall be proposed by the Contractor for agreement with the Employer's Representative.

8.4.1.7 The cost of maintenance, including remedial works identified in the Performance Tests and Condition Surveys, shall be deemed to be included in the Operation Fees.

8.4.1.8 The Contractor shall complete remedial works identified in the Performance Tests and Condition Surveys in the manner and within the time allowed in accordance with the Conditions of Contract. If the Contractor fails to complete the remedial works to the satisfaction of the Employer's Representative within the specified time, the Employer is empowered to instruct the remedial works to be carried out by other contractors and deduct the costs for such instruction from any payments due to the Contractor.

8.4.1.9 The Contractor shall make and maintain detailed records of all Facility maintenance work, which shall remain available for inspection by the Employer's Representative within 24 hours' notice.

8.4.1.10 In accordance with the Specification, the records of Facility maintenance work shall be submitted by the Contractor to the Employer's Representative on a monthly basis, and will be made available for inspection by Contractor bidding for any follow-on contract.

8.4.1.11 The Contractor shall maintain the Facility wholly in accordance with the requirements of the Contract and the approved maintenance management plans in the Operation Plan. If the Contractor identifies any possible alternative method of maintenance that may be more efficient he shall notify the Employer accordingly. If any such change to the method is acceptable to the Employer it will be implemented in accordance with the relevant provisions of the Contract.

### 8.4.2 Preventive and Corrective Maintenance

8.4.2.1 The Contractor shall be responsible throughout the Operation Period for the maintenance of the Facility and parts thereof including all preventive maintenance, overhaul, repairs, rehabilitation, renewal and replacement of Plant which at all times shall be maintained in good functional conditions and to perform in accordance with the Specification.

8.4.2.2 The Contractor shall develop and implement specific preventive maintenance programmes for every system, equipment, building and infrastructure of the Facility with the objective of maximizing their availabilities as well as minimizing any unscheduled maintenance or emergency shutdown.

8.4.2.3 The scope and frequency of preventive maintenance shall meet the manufacturer's recommendations, as a minimum, and shall be adjusted with reference to conditions identified in the previous preventive maintenance and any repair carried out recently.

8.4.2.4 The preventive maintenance programmes shall be incorporated into the Operation Plan and updated whenever necessary in accordance with the Specification. The same shall be entered into the CMMS in accordance with the Specification for generation of work orders and for monitoring.

8.4.2.5 For the avoidance of doubt, the replaced items or parts upon maintenance or repair shall be regarded as the property of the Contractor and at his disposal and/or removal off-site away of these items shall be made known to the Employer's Representative.

8.4.2.6 Scheduling of preventive maintenance which requires system or equipment shutdown shall ensure that the ability of remaining system or equipment can meet the Operational Performance Requirements and Environmental Performance Requirements.

8.4.2.7 The Contractor shall effect all necessary or appropriate maintenance with due diligence and expedition. Conditions of the Facility shall be proactively managed with defects rectified within a time frame agreed to by the Employer's Representative. The Contractor shall rectify any defects identified by the Employer's Representative in accordance with the Conditions of Contract.

8.4.2.8 Preventive maintenance, corrective maintenance and the subsequent repairs, renewal or replacement work shall be carried out in a safe manner, including the adoption of the appropriate safe work procedures stated in the Safety and Health Plan.

8.4.2.9 The Contractor shall pay particular attention to the setup and use of temporary equipment / works such as mobile lifting equipment, mobile access platforms, scaffolding, platforms and ladders, etc. All relevant guidelines, Code of Practices and statutory requirements shall be strictly followed.

### 8.4.3 Maintenance Management

8.4.3.1 The CMMS shall include functions for the creation and upkeep of work orders and maintenance records. The database shall include the following information:

- Preventive maintenance programmes of systems, equipment, building and infrastructure of the Facility, which are used to generate work orders for preventive maintenance automatically;
- Logs off system or equipment fault / breakdown and automatic generation of work orders for corrective maintenance;
- Date of inspection / maintenance (preventive or corrective) carried out;
- Names and positions of Contractor's staff carried out the inspection / maintenance;
- Logs off manual alterations of any operations records, etc;
- Details of inspection / maintenance carried out including:-
  - Causes of maintenance
  - Maintenance procedures
  - Special gears / equipment used
  - Spare parts used
  - Equipment / parts replaced
  - Any follow-up actions / recommendations (e.g. change of operational procedures, etc.)

8.4.3.2 The CMMS shall have functions to organize, sort and filter the maintenance records in the database as required and perform statistical analysis and generate reports for performance monitoring.

8.4.3.3 The CMMS database shall be archived on a monthly basis. One electronic copy of the entire database shall be stored on the Site for retrieval as necessary. Another backup copy shall be passed to the Employer's Representative.

### 8.4.4 Calibration of Instruments and Measuring Equipment

8.4.4.1 The Contractor shall maintain accuracy and reliability of all measurement facilities throughout the Operation Period to enable correct and effective monitoring and control of the Facility.

8.4.4.2 The Contractor shall be responsible for the calibration and re-calibration as necessary of all measurement facilities. All calibration work shall be carried out so as not to delay or disrupt the Operation. Calibration frequency shall not be less than that recommended by the manufacturers of the instruments or measuring equipment and in any case no longer than 12-month intervals. For the avoidance of doubt, all costs associated with any agreed calibration shall be deemed to be borne by the Contractor and included in the Operation Fees.

8.4.4.3 The calibration shall be carried out by an accredited testing and calibration organization consented to by the Employer's Representative. The results of calibration shall be made available to the Employer's Representative.

### 8.4.5 Special Tools and Spare Parts

8.4.5.1 During the Operation Period, the Contractor shall provide and maintain special tools and spare parts in accordance with the Registered Design.

8.4.5.2 The storage of special tools and inventory of spare parts shall be recorded and monitored in accordance with the Specification.

8.4.5.3 At the expiry of the Operation Period, the Contractor shall handover to the Employer all special tools and spare parts in accordance with the Registered Design. The stock level of spare parts shall be sufficient for 2 years operation from the date of Handover Certificate.

## 8.5 Records and Reporting

### 8.5.1 Archiving of SCADA and CMMS Data

8.5.1.1 The Contractor shall maintain all operation and maintenance records, including the SCADA and CMMS data, throughout the Operation Period in a safe and secure manner. No record shall be discarded without prior consent of the Employer. Any amendment to the records shall only be made in accordance with proper checking and authorization procedures, which shall be included as part of the Operation Plan submitted to the Employer for consent.

8.5.1.2 The Employer's Representative shall be allowed to check the abovementioned data and records described at any time.

8.5.1.3 As far as possible, all records shall be kept electronically utilizing the Contractor's Site computer facilities with backup security. If the computer facilities fail, then appropriate paper records shall be produced and filed.

8.5.1.4 The records shall be filed electronically and the electronic files shall be submitted to the Employer and/ or the Employer's Representative upon request. Copies of any paper record shall also be submitted at the same time. The Contractor shall submit formats of electronic and paper records to the Employer for consent.

8.5.1.5 For the purpose of retrieving SCADA and CMMS data under this Clause, the Contractor shall provide and maintain workstations at the Employer's offices, including an on-site office and an off-site office, the location of which shall be determined by the Employer. The requirements of these workstations shall be in accordance with the Specification. The workstations shall be complete with all necessary hardware and software. All cost, including for the avoidance of doubt application and subscription fees for licences and communication services, are deemed to be included in the fixed Operation Fees.

### 8.5.2 Site Diary

8.5.2.1 The Contractor shall maintain a Site Diary which shall include, as a minimum, the following information on a daily basis:

- Date and weather;
- Operation hours;

- Labour on the Site;
- Flow and quality records of influent and effluent;
- Disposal records of treatment by-products;
- Accidents and incidents;
- Instructions to the Contractor;
- Comments by the Contractor;
- Complaints received and action taken;
- Authorized visitors to the Site; and

8.5.2.2 The exact scope, form and layout of the Site Diary shall be agreed with the Employer from time to time.

8.5.2.3 The Site Diary shall be in a printed proforma completed with one original and three copies:

a) Employer (Original);
b) Employer's Representative;
c) Contractor; and
d) File copy.

8.5.2.4 The Site Diary shall be checked and signed by authorized personnel of the Contractor in accordance with the consented Operation Plan. The completed Site Diary shall be made available to Employer's Representative for inspection not later than noon time on the following day.

8.5.2.5 The Contractor shall keep appropriate records of all personnel employed at the Site. These records shall be available for inspection by the Employer's Representative at any reasonable time. These records shall be kept available for inspection throughout the Operation Period.

8.5.2.6 The Contractor shall retain at the Facility a Construction Site Safety Manual or approved equivalent. All accidents occurring to personnel during the Operation Period shall be recorded and reported to the Employer's Representative within two hours of the occurrences of the accidents.

### 8.5.3 Safety and Health Records

8.5.3.1 The Contractor shall keep records on all safety and health matters as specified in the Specification and update such records daily for inspection by the Employer's Representative.

### 8.5.4 Monthly Report

8.5.4.1 The Contractor shall provide and present details, in the form of Monthly Reports, of operational data and information in relation to the Operation of the Facility to the Employer in a systematic and concise manner. Monthly Reports shall be submitted in duplicate to the Employer and the Employer's Representative by the 14th day of the month following the month to which the report relates. Typical required information and data shall include, but not be limited to the following:-

8.5.4.1.1 Project Management

- An updated organization chart which includes details such as number of employees in the Facility by trades;
- Change of staffing;
- Summary of visits to the Facility;
- Performance Tests or Condition Surveys carried out and scheduled in the following month;
- Meetings held with the Employer, and other related authorities, etc;
- Scheduled meeting in the following month; and
- Quantity and quality of influent and effluent, and a summary of problems encountered during the month.

8.5.4.1.2 Energy Consumption, Energy Recovery and Power Generation Data

- Summary of energy consumption (fuel and electricity) of the Facility,;
- Quantity of biogas produced and power generated;

8.5.4.1.3 Inventory and Consumables Data

- Quantities of chemicals, reagents, fuel and spare parts consumed;
- Stock level of chemicals, reagents, fuel and spare parts;
- A list of current suppliers for chemicals, reagents and additives and their contact details;
- Delivery records of all consumables.

8.5.4.1.4 Environmental Monitoring Data

- Records and document concerning the disposal of treatment by-products.

8.5.4.1.5 Maintenance Records

- Summary of all preventive and corrective maintenance, plant alteration, renewal and replacement activities with descriptions, photos and drawings as appropriate;
- Summary of the CMMS database for ongoing maintenance / repair work carried forward to the next month;
- Summary generated from CMMS database for backlog of outstanding preventive maintenance work orders for 30 days and more (counting from the CMMS preset work order completion date), with reasons of delay and measures taken / plan to rectify;
- Summary generated from CMMS database for backlog of outstanding corrective maintenance work orders for 3 days and more, with reasons of delay and measures taken / plan to rectify; and
- Programme showing the scheduled maintenance (including planned and ongoing) work in the following month.

8.5.4.1.6 Incident Report

- Covering injury of any staff or members of the public / fire / property damage, etc. and their corresponding statistical analysis;
- Covering any fatal incidents of any staff or members of the public;
- Details of incidents and recommendation on prevention of re-occurrence;
- Comparison with relevant statistics in the past; and
- Safety and security issues.

8.5.4.1.7 Complaint Record

- Detailed account of each complaint including complainant, time, nature, issue of complaint and action taken; and
- Statistical analysis of all complaint records.

8.5.4.2 The Contractor shall supplement and present any additional operational data and information, in form of Monthly Reports or in ad-hoc manner, as requested by the Employer's Representative from time to time.

8.5.4.3 Details of report formats shall be approved by the Employer.

### 8.5.5 Annual Report

8.5.5.1 The Contractor shall submit Annual Reports to the Employer and the Employer's Representative before the last day of the anniversary month following the year to which the report relates.

8.5.5.1.1 summaries of quantities and characteristics of sewage received and treated at the Facility during the reporting year;

8.5.5.1.2 overall performance of the Facility with highlights on non-compliance with Operational Performance and Environmental Performance Requirements;

8.5.5.1.3 summary of expiry dates for licences, permits and certificates for the Operation;

8.5.5.1.4 summary of major equipment breakdown, repair, overhaul, renewal, replacement, modification, Performance Tests, Condition Surveys carried out, with CMMS reports;

8.5.5.1.5 summary of incidents related to safety and health, environmental issues, security and complaints;

8.5.5.1.6 scheduled maintenance, overhaul, renewal, replacement, modification of major plant and equipment, Performance Tests and Condition Surveys in the forthcoming 12 months;

8.5.5.1.7 list of Changes ordered by the Employer, with details and status;

8.5.5.1.8 summary of payments of Operation Fees; and

8.5.5.1.9 records of the Contractor's financial performance including audited accounts with balance sheets and profit/loss statements.

8.5.5.2 Details of report formats shall be approved by the Employer.

### 8.5.6 Monthly Environmental Monitoring Report

8.5.6.1 The Contractor shall submit Monthly Environmental Monitoring Reports to the Employer and the Employer's Representative by the 14th day of the month following the month to which the report relates. Typical required information and data shall include, but not be limited to the following:-

- results of environmental monitoring undertaken during the reporting period;
- actions and mitigation measures adopted or to be adopted to redress unacceptable, consequential or unanticipated environmental impacts, together with an assessment of their likely effectiveness;
- comparison with both statutory and contractual compliance limits; and

- details of response in the event of any omissions or failures.

8.5.6.2 Details of report formats shall be approved by the Employer.

### 8.5.7 Annual Environmental Audit Report

8.5.7.1 The Contractor shall submit Annual Environmental Audit Reports to the Employer and the Employer's Representative before the last day of the anniversary month following the year to which the report relates.

8.5.7.2 The Annual Environmental Audit Report shall include review on environmental monitoring data and operational data obtained in the reporting year, with particular reference to the effectiveness of mitigation measures identified in the previous Environmental Monitoring/Audit Reports and measures that the Contractor proposes to adopt in overcoming any shortcoming.

## 8.6 Asset Management

### 8.6.1 General

8.6.1.1 The Contractor shall submit a draft Asset Management Plan to the Independent s Representative for certification. The draft Asset Management Plan shall be developed based on and shall not differ in any material respect from the Outline Asset Management Plan submitted by the Contractor. The Asset Management Plan shall include, but shall not be restricted to, the following sections:-

8.6.1.1.1 Asset Overview

- classification and registry of assets of the Facility;
- significance of assets to the performance of the Facility;
- dependencies between the assets;
- asset management strategy;

8.6.1.1.2 Performance and Standards

- design lives of Plant, buildings and structures;
- benchmarks, standards and guidelines adopted for Performance Tests, Condition Surveys and Residual Life Assessments;

8.6.1.1.3 Asset Performance Monitoring

- plans, scopes, arrangements and reporting for Condition Surveys and Residual Life Assessments in accordance with the Specification;
- plans, scopes, arrangements and reporting for Performance Tests in accordance with of the Specification;

8.6.1.1.4 Asset Remediation Plans

- refer to the appropriate section in the following,

8.6.1.2 The Contractor shall obtain the Employer's consent on the certified draft Asset Management Plan, which will then be construed as the Asset Management Plan. The Contractor shall review and update the Asset Management Plan annually.

8.6.1.3 The Contractor shall carry out all corrective and preventive maintenance programmes for the Facility in accordance with the consented Operation Plan and Asset Management Plan.

8.6.1.4 The Contractor shall carry out or cause to be carried out repair, replacement and rehabilitation of the Facility and the Site as required for the ongoing operation of the Facility in accordance with the design performance and standards.

8.6.1.5 The Contractor shall note that all reports prepared by the Contractor under this Specification will be made available for inspection by the Contractor for any follow-on contracts.

8.6.1.6 All costs associated with works and services pursuant to this Specification shall be borne by the Contractor and deemed to be included in the Operation Fees.

### 8.6.2 Asset Remediation Plans

8.6.2.1 The Contractor shall develop and implement asset remediation plans which shall include, as a minimum, the following:-

- schedules for overhaul and replacement of Plant;
- schedules for refurbishment and renewal of buildings and structures;
- planned actions to bring or keep the assets above their minimum conditions required under the Contract;
- criteria for acquisition and disposal of assets; and
- means and arrangements to demonstrate to the Employer that the Plant, , buildings and structures have the respective residual lives specified in the Specification at the expiry of the Operation Period;

8.6.2.2 If the design life of any Plant, buildings or structures stated in the Asset Management Plan or otherwise established during Residual Life Assessments in accordance with the Specification expires during the Operation Period, the Contractor shall before such expiry renew, rehabilitate or replace such Plant, buildings or structures. The cost of such renewal, rehabilitation or replacement shall be deemed to be included in the Operation Fees provided that with respect to the design life of any Plant, buildings or structures which is due to expire but which Plant, buildings or structures still performs safely and efficiently and in accordance with the Contract requirements, the Contractor may at the option of the Employer's Representative defer such renewal, rehabilitation or replacement so long as the said performance continues but the Contractor shall in any event complete the said renewal, rehabilitation or replacement before expiry of the Operation Period.

### 8.6.3 Condition Surveys

8.6.3.1 The Contractor shall engage with the Employer's Representative to carry out Condition Surveys of the Facility in the presence of the Contractor or the Employer's Representative. The surveys shall be carried out in the seventh month of the 3rd, 6th and 8th year of the Operation Period, unless otherwise consented to by the Employer.

8.6.3.2 The scope of the Condition Survey shall include:

8.6.3.2.1 Inspection and auditing of manuals, schedules, reports, SCADA and CMMS records for compliance;

8.6.3.2.2 Visual inspection of all components, including Plant, buildings and structures for state of maintenance and repairs;

8.6.3.2.3 Inspection of performance records and performance evaluation of the plant and equipment in operating condition;

8.6.3.2.4 Witness testing of the plant and equipment in operating condition, including the Performance Tests specified in the Specification;

8.6.3.2.5 Based on the above information, forming a view as to the general operation and maintenance condition of the Plant, buildings and structures, with due regard to their service hours and/or age; and

8.6.3.2.6 Making recommendation on enhancement of the operation and maintenance of the Facility, where applicable.

8.6.3.3 The Contractor shall compile and submit a condition survey plan to the Employer for approval at least 45 days prior to commencement of the Condition Survey. The condition survey plan shall be prepared in consultation with the Contractor to ensure uninterrupted Operation of the Facility. The condition survey plan shall include the following information, as a minimum:

8.6.3.3.1 a programme showing the systems, equipment, structures, etc. which are included in the Condition Survey;

8.6.3.3.2 detailed descriptions of precautionary measures, methodologies, procedures, timing for the inspections, audits, measurements or tests to be carried out on each survey item;

8.6.3.3.3 effect on normal operation of the Facility including any reduction in redundancy or standby capacity, with mitigation measures or temporary arrangements clearly stated;

8.6.3.3.4 any safety, health and environmental related issues;

8.6.3.3.5 details of any temporary work for the Condition Survey; and

8.6.3.3.6 contingency plan for emergency situations that may arise during the Condition Survey.

8.6.3.4 The Condition Survey shall not commence until the condition survey plan have been approved to by the Employer. The entire condition survey shall be completed within 1 calendar month.

8.6.3.5 The Contractor shall prepare and submit to the Employer and the Employer's Representative, a detailed condition survey report within 28 days of the completion of the Condition Survey. The report shall include:-

8.6.3.5.1 methodologies and findings of the survey;

8.6.3.5.2 identification of any damage or defects;

8.6.3.5.3 recommendation of rectification work required to satisfy requirements of the Contract; and

8.6.3.5.4 recommendation of enhancement to the operation and maintenance of the Facility.

8.6.3.6 In the event that the Employer considers, as a result of the Condition Survey and the Residual Life Assessment specified in the Specification, if appropriate, that any part or parts of the Facility require repair, maintenance, rectification or replacement to satisfy the requirements of the Contract, the Employer will serve notice under the Conditions of Contract on the Contractor of the work necessary to be carried out. The Contractor shall ensure that all such repair, maintenance, rectification or replacement are completed within reasonable time and in any case not more than 90 days after receipt of the Employer's notice, unless otherwise consented to by the Employer.

8.6.3.7 Prior to the handing over of the Facility, the Contractor shall conduct an End-of-Contract Condition Survey as specified in the Specification.

8.6.3.8 The Condition Surveys in the $10^{th}$, $13^{th}$&$15^{th}$ years of the Operation Period shall include the Residual Life Assessment as specified in the Bid Document.

8.6.3.9 For the avoidance of doubt, all costs associated with the carrying out and reporting of the Condition Surveys shall be borne by the Contractor deemed to be included in the Operation Fees.

**8.6.4 Residual Life Assessments**

8.6.4.1 The Condition Surveys in the $10^{th}$, $13^{th}$&$15^{th}$ years of the Operation Period and the End-of Contract Condition Survey shall include a Residual Life Assessment. The Residual Life Assessment shall be carried out as part of the Condition Surveys by the Independent Surveyor.

8.6.4.2 The Residual Life Assessment shall benchmark the Facility against relevant international standards / guidelines, and performance of similar facilities on a worldwide basis.

8.6.4.3 The Contractor shall include a separate section in the survey report specified in the Specification for the Residual Life Assessment, to record the following:-

8.6.4.3.1 Residual life assessment methodology;

8.6.4.3.2 Standards, guidelines and references adopted;

8.6.4.3.3 Detailed descriptions of assessment carried out;

8.6.4.3.4 Findings of assessment; and

8.6.4.3.5 Recommendation of work required for the upkeep of the Facility in satisfactory conditions.

**8.6.5 End-of-Contract Condition Survey**

8.6.5.1 All requirements for Condition Surveys specified in the Specification and those for Residual Life Assessments specified in the Specification shall apply to the End-of-Contract Condition Survey unless otherwise specified.

8.6.5.2 The End-of-Contract Condition Survey shall be carried out at least 9 months but not more than 12 months prior to the expiry of the Operation Period to verify conditions of the Facility and ascertain the residual life of the Facility.

8.6.5.3 For the avoidance of doubt, the End-of-Contract Condition Survey shall include a Residual Life Assessment as specified in the Specification.

8.6.5.4 As part of the End-of-Contract Condition Survey, the Contractor shall carry out tests and provide all necessary assistance to the Employers' Representative to determine whether the

Facility to be handed over to the Employer is in good and serviceable condition suitable for continual use and meets the residual life requirements as specified in the Specification.

8.6.5.5 The Contractor shall compile and submit an End-of-Contract Condition Survey Plan to the Employer for consent at least 60 days prior to commencement of the End-of-Contract Condition Survey. The plan shall include tests and inspections requested by the Employer.

8.6.5.6 The Contractor shall prepare and submit to the Employer, and the Employer's Representative, a detailed End-of-Contract Condition Survey report within 28 days of the completion of the End-of-Contract Condition Survey. The report shall include recommendation of work required to meet the residual life requirements specified in the Specification.

8.6.5.7 In the event that the Employer considers, as a result of the End-of-Contract Condition Survey, that any part or parts of the Facility require repair, maintenance, rectification or replacement to satisfy the requirements of the Contract, the Employer will serve notice under the Conditions of Contract on the Contractor for the work necessary and the work that becomes necessary during the remainder of the Contract to be carried out and completed to the satisfaction of the Employer no later than 60 days prior to the expiry of the Operation Period. In the interpretation of the End-of-Contract Condition Survey, the Employer will have due regard for the obligation under this Contract on the Contractor to fully maintain the Facility that is to be handed over to the Employer in good and serviceable condition suitable for continual use to the performance requirements of the Facility.

8.6.5.8 If in the opinion of the Employer, the Contractor has failed to carry out any work to hand over the Facility in good and serviceable condition to the Employer for continual use at the expiry of the Operation Period, the Employer may order such defects to be made good and deduct the Costs from any payments due to the Contractor from this or any other contract the Contractor may have with the Employer.

8.6.5.9 After the remedial works carried out according to the notice served by the Employer after the End-of-Contract Condition Survey, the Contractor shall carry out joint inspections with the Employer's Representative on the plant and equipment that has been maintained or replaced, including all necessary tests to demonstrate that the requirements of the Contract have been met.

## 8.7 Handing Over of the Facility

### 8.7.1 Handback Plan

8.7.1.1 The Contractor shall submit a draft Handback Plan to the Employer's Representative for certification. The draft Handback Plan shall be developed based on and shall not differ in any material respect from the Outline Handback Plan submitted by the Contractor. The Handback Plan shall include, as a minimum, the following:

(a) Plans to transfer the Facility to the Employer or the follow-on contractor;

(b) Transition plans with respect to the Contractor's Personnel including a plan for transition of the operators to the Employer or the follow-on contractor;

(c) A proposed process for the transfer of all Contract Records to the Employer;

(d) Plans to transfer operations and maintenance functions to the Employer or the follow-on contractor, and

(e) A 3-month programme to train staff of the Employer and/or Employer's agents in all aspect of the Operation and Maintenance of the Facility

8.7.1.2 The Contractor shall obtain the Employer's consent on the certified draft Handback Plan, which will then be construed as the Handback Plan. The Contractor shall review and update the Hand back Plan every year.

8.7.1.3 No later than 6 months prior to the expiry of the Operation Period the Contractor shall carry out training in the Handback Plan. All costs and expenses associated with the training of Employee's staff shall be borne by the Contractor and included in the Operation Fee.

### 8.7.2 Pre-handover Procedures

8.7.2.1 The Contractor shall take all reasonable steps and co-operate fully with the Employer and any follow-on contractor so that any continuation of the operation is achieved with minimum disruption and so as to prevent or mitigate any inconvenience or risk to health and safety of the employees of the Employer and members of public.

8.7.2.2 The Contractor shall use reasonable endeavours to assist the Employer in the preparation for, and conduct of, a fair and competitive bidding process for any follow-on contract. In particular, the Contractor, shall make available to the Employer any information, and assist in the verification of any information as the Employer reasonably requires in connection with the bidding process

8.7.2.3 All the information provided by the Contractor to the Employer shall be true and correct in all material respects and will not be misleading, by omission or otherwise.

8.7.2.4 The Contactor shall make available at least 18 months prior to the expiry of the Operation Period, full details of the operation and maintenance documentation and records of the Facility for the entire Operation Period to date so that these can be made available for inspection by Contractor for any follow-on contact.

8.7.2.5 The report of the End-of-Contract Condition Survey and records of the subsequent maintenance and replacement works (if any) will be made available for inspection by Contractor for any follow-on contract.

### 8.7.3 Handing over on Completion

To ensure smooth transition of the Operation from the Contractor to the follow-on contractor, the Contractor shall co-operate fully with the follow-on contractor from the date of his appointment to allow the follow-on contractor's staff to train and work alongside the Contractor's own operatives before the expiry of the Operation Period to gain familiarity in the provision of the Operation.

## 8.8 Training Requirements

### 8.8.1 General

The Contractor shall provide comprehensive training for the different categories of the Employers operation and maintenance staff. Training shall fall into two main types which are 'off the job' and 'on the job'. Off the job training shall take place in the class room and on the job training shall be carried out on the running plant(s).

### 8.8.2 Off The Job Training

8.8.2.1 The Contractor shall prepare formal training documentation for distribution to the trainees. Visual aids shall be used to illustrate the points being made and to make the training programme interesting and enjoyable for the participants.

The off the job training shall comprise the following:

*Off the Job Training Programme for all Trainees*

To provide training:

- on the simple physical-chemical and biological process principles involved in the operation of the Works;
- regarding basic features of the electro-mechanical and instrumentation equipment to be installed
- health and safety;
- plant safety procedures;
- on the use of the local and central HMIs.

*Off the Job Process Training Programme for Operators*

To provide training:

- on the operation of individual items of plant and sections of the Works including automatic operation and manual operation;
- on the day to day operation of the Works and procedures;
- on a comprehensive list of 'what if' scenarios dealing with the actions to be taken in the event of potential process problems, alarms, plant failures, overflows, power failures etc.;
- on first line mechanical maintenance;
- safe work practices;
- on safety procedures to be followed in operating, maintaining, and cleaning the plant;
- special procedures to be followed in the event of chlorine leak.

*Off the Job Training Programme for Electrical Maintenance Staff]*

To provide training:

- on the configuration, construction and operation of the electrical Plant;
- on the electrical maintenance requirements of the Works;
- on the switching and safety procedures to be followed;
- safe methods of working;
- on fault finding and repair procedures.

*Off the Job Training Programme for Control and Instrumentation (ICA) Maintenance Staff (Refer to the following section)*

*Off the Job Training Programme for Mechanical Maintenance Staff*

To provide training:

- on the routine mechanical maintenance requirements of the Works;
- on lubrication requirements of the Works;
- on fault finding, repair and overhaul procedures;
- safe methods of working.

*Off the Job Training Programme for Waste Water Treatment Management Staff*

To provide training:

- sewage treatment process management techniques;
- Waste Water Treatment Plant cost management;
- Waste Water Treatment Plant laboratory management;
- safe methods of work general;
- on safety procedures to be followed in operating, maintaining and cleaning the plant.

### 8.8.3 On The Job Training

8.8.3.1 The Contractor shall utilise the Operation and Maintenance Manuals as the primary training aid in carrying out the on the job training. Shortcomings, omissions and errors identified in the O & M Manuals during the training shall be rectified prior to final acceptance of the O & M Manuals.

*On the Job Training Programme for all Trainees*

To provide training:

- plant familiarisation tour;
- on the use of the local and central HMIs;
- health and safety;
- identify areas where special safety precautions are necessary.

*On the Job Process Training Programme for Operators*

To provide training:

- under operational conditions on the operation of individual items of plant and sections of the Works including automatic operation and manual operation;
- illustrate by example the day to day operation of the Works and procedures;
- illustrate by example the actions to be taken in the event of potential process problems, alarms, plant failures overflows, power failures etc. (as identified in the 'what if' scenario off the job training);
- illustrate by example the first line mechanical maintenance;
- illustrate by example safety procedures to be followed in operation, maintenance and cleaning of the Works.

*On the Job Training Programme for Electrical Maintenance Staff*

To provide training:

- carry out detail tour of the electrical plant;
- illustrate by example the operation of the electrical Plant;
- illustrate by example the electrical isolation and maintenance procedures;
- illustrate by example fault finding and repair procedures;
- illustrate by example switching and safety procedures to be followed;
- illustrate by example safe systems of work.

*On the Job Training Programme for Mechanical Maintenance Staff*

To provide training:

- illustrate by example the routine mechanical maintenance requirements of the Works;
- illustrate by example lubrication procedures;
- illustrate by example fault finding, repair and overhaul procedures.
- illustrate by example safe systems of work.

### 8.8.4 Training Programme

8.8.4.1 Off the job training shall be carried out prior to Handing Back of the Works or any section of the Works.

8.8.4.2 Off the Job training shall be carried out prior to On the Job training. On the Job training shall be completed as a condition for acceptance of the Works following completion of the Tests after Completion.

8.8.4.3 The Contractor shall provide a training plan for each category of staff. The training plan shall detail the content and duration of each course. The training plan shall be submitted for the approval of the Engineer at least 120 days prior to the commencement of the Tests on Completion. The duration of training offered for each category of staff shall not be less than that detailed in the following table.

| Category of Staff | Off the Job (minimum days duration for each course) | On the Job (minimum days duration for each course) |
|---|---|---|
| All staff | 1 | 1 |
| Operator | 3 | 5 |
| Electrical technician/electrician | 2 | 2 |
| Control/instrument technician | 10 | 5 |
| Mechanical technician/fitter | 2 | 2 |
| WWTP management | 3 | (see note) |

**Note:** It is assumed that WWTP managers on the job training will be continuous throughout 12 months in a calendar year when the plant(s) is operated by the Contractor.

8.8.4.4 The training day shall be assumed to be not less than 8 (eight) hours split into two sessions. The Contractor shall provide facilities for training which shall include inter alia the training rooms/locations, tables and chairs, projectors, white/black boards, training aids etc.

8.8.4.5 Where trainees of a given category can all be released from their Works operational duties simultaneously they may be trained together. Where this is not possible the Contractor shall repeat the complete course for those who could not attend.

### 8.8.5 Training Personnel

8.8.5.1 The Contractor shall provide suitably qualified trainers to carry out the off the job and on the job training.

8.8.5.2 The trainers are to be experienced in Waste Water Treatment Plant management, operation and maintenance in their relevant discipline and in the training of skilled and unskilled staff.

8.8.5.3 The Contractor shall submit the curriculum vitae of the trainer nominee's to the Engineer for approval 120 days prior to the commencement of the Tests on Completion. The training expert shall be fluent in English and Hindi Languages or the Contractor shall provide the services of an interpreter during the training periods.

### 8.8.6 Instrumentation, Control & Automation Training requirements

8.8.6.1 The Contractor/ system supplier shall conduct training courses for personnel selected by the Employer. Training shall be conducted by personnel employed by the Contractor/ system supplier familiar with the system supplied and who have experience and training in developing and implementing instructional courses.

8.8.6.2 The contractor shall arrange training for personnel of the Employer for 5 days before the conduction of the completion test of the Facility.

8.8.6.3 The entire cost of the complete training programme, including reasonable per diem expenses to cover meals, lodging, transport and similar expenses for all the Employer’s personnel and the consultants attending the training program, shall be the borne by the Contractor/ system supplier and shall be included in the contract price.

8.8.6.4 The Contractor shall submit information on the training programme for approval, prior to shipment of the equipment. This submittal shall include a course outline; time required, course schedule, sample workbook and instructor qualification information for each level.

8.8.6.5 The Contractor/ system supplier shall make a workbook on each course available to every person taking the courses listed herein. The workbook shall be of sufficient detail so that, at a later date, a trainee could review in detail the major topics of the course.

8.8.6.6 The training times shall be scheduled by the Employer in advance with the Contractor/ system supplier so as not to disrupt the Employer’s ability to operate the plant.

### 8.8.7 Operations and Maintenance Training

8.8.7.1 Training shall be provided for ten (10) of the Employer’s personnel at the Contractor/ system supplier facility on operations and maintenance of all system components separately for the WWTP. The training program shall be divided into two segments and shall consist of at least 5 (five) working days, each of 8 (eight) hours duration.

8.8.7.2 The maintenance training program shall be developed for personnel that have electronics maintenance and repair experience and a general knowledge of computer systems, but shall not assume any familiarity with the specific hardware furnished.

As a minimum, the following subjects shall be covered:

- System Architecture and Layout
- Hardware Components
- Module Switch Settings (Configuration Switches)
- I/O Modules
- Power Supplies
- Data Highway:
- Programmer connection
- IOP programming and diagnostic techniques
- Battery replacement and recharging
- PC and workstation familiarization and maintenance:
- Troubleshooting
- Disassembly
- Cleaning
- Component Replacement
- Re-assembly
- The operation training programme shall include the following topics:
- Power-up, bootstrapping and shutdown of all hardware devices
- Interpretation of all standard displays
- Appropriate actions for software and hardware error occurrences
- Use of operator interface displays and keyboards
- Use of printer including replenishment of supplies
- Manual data entries
- Creation and editing of graphic operator display screens.
- Loading of any required software into the system
- Data base creation and editing.

# List of Makes

At the time of Detailed Design Engineering, the lowest Bidder will provide/submit to CSCL minimum three number of quotations of proposed makes w.r.t. equipments listed herewith. Moreover, CSCL reserves the right to finalize/approve the make as proposed by the said bidder. However, following is the list of preferable makes.

## 1. Mechanical Equipments

| Mechanical Equipment's | | |
|---|---|---|
| **Sr. No.** | **Equipment's** | **Preferable Makes** |
| 1. | Anerobic Digesters, Gas Mixing System | Utile Engg. Co. |
| | | Gardner Denver |
| | | Siemens |
| | | Degremont |
| | | HDO |
| | | VA Tech |
| | | Triveni |
| | | Voltas |
| 2. | Agitator Cum Mixer | REMI |
| | | Mixrite |
| | | Rathi Lightnin |
| | | Philgear |
| | | Fibre & Fibre |
| | | Voltas |
| | | Johnson |
| | | Microtrans |
| 3. | Air Valve | Kirloskar Brothers Limited (KBL) |
| | | Indian Valve Company (IVC) |
| | | VAG |
| | | DVD |
| | | AVK |
| 4. | Bar Screen | Jash Engg. Ltd. |
| | | Johnson Screen Ind. Ltd. |
| | | EVA |
| | | EIMCO |
| | | Hindustan Dorr liver |
| | | Huber Technology |
| | | Headworks |
| 5. | Screening Conveyance Compaction and Dewatering | Jash Engg. Ltd. |
| | | Johnson Screen Ind. Ltd. |
| | | EVA |
| | | EIMCO |
| | | Hindustan Dorr liver |
| | | Huber Technology |
| | | Headworks |
| 6. | Cast Iron / Ductile Iron Pipes & Fittings and Dismantling Joints | The Indian Iron & Steel Company Ltd. |
| | | Jindal Saw Ltd. |
| | | Electro Steel Castings |
| | | Tata Iron & Steel Co. |
| 7. | Centrifugal Turbo Air Blower | Siemens India Ltd. |
| | | Howden |
| | | Siemen's, |
| | | Ciegelski |

| Mechanical Equipment's | | |
|---|---|---|
| **Sr. No.** | **Equipment's** | **Preferable Makes** |
| | | ABS |
| | | Arzener |
| | | C-Tech. |
| 8. | Centrifuge | Humbolt |
| | | Alfa Laval |
| | | Hiller |
| | | Pennwalt |
| 9. | Chain Pulley Block | Indef Engg. |
| | | Hercules Hoists Ltd. |
| | | Reva Engineering |
| | | W.H.Brady & Co. Ltd. |
| 10. | Chlorinator | Toshcon Jescon |
| | | Pennwalt |
| | | Aldos |
| | | Metito |
| | | Chloro-Control |
| | | Gesco Germany |
| 11. | Diffuser | SSI |
| | | EDI |
| | | OTT |
| | | REHAU |
| | | Eurotech |
| | | Flyght |
| | | Xylem |
| | | ABS |
| | | Grundfos |
| | | Ovivo |
| 12. | Dosing System / Dosing Pump / Metering Pump | Asia LMI |
| | | Prominent |
| | | Toshcon |
| | | Milton Roy |
| | | AQUA Aerobic |
| | | Westech |
| | | Ovivo |
| | | Kruger/ Hydro Tech |
| | | Positive Metering |
| 13. | Fire Extinguisher | Steelage Industries (MINIMAX) |
| | | Kooverji Devshi & Co. Ltd. (FIREX) |
| | | Vijay Fire Protection System Pvt. Ltd. (VIJAY) |
| | | Amco |
| | | Ahluwalia |
| 14. | Flame Arrestor Moisture Trap PVRV / Flare System | Combustion Research Associates |
| | | PROTEGO India Pvt. Ltd. |
| | | Innovative Environmental Technology |
| | | Protego India Pvt. Ltd, Innovative Environmental Technology |
| 15. | FST | HDO |
| | | EMCO |
| | | HGE |

| Mechanical Equipment's | | |
|---|---|---|
| **Sr. No.** | **Equipment's** | **Preferable Makes** |
| | | Geo Miller & Co. Pvt. Ltd. |
| | | Triveni |
| | | Voltas |
| 16. | Gas Compressor | SWAM Pneumatics Pvt. Ltd. |
| | | Kirloskar Pneumatic Co. |
| | | Ingersoll Rand |
| | | Chicago Pneumatic (I) Ltd. |
| | | KAY / SWAM |
| | | Elgi |
| | | USHA |
| | | Mapro |
| 17. | Gas Valves | Audco |
| | | Combustion Research Associates (CRA) |
| 18. | Gate Valves/Sluice Valves | Kirloskar Brothers Limited |
| | | Indian Valves Company |
| | | VAG |
| | | Dorot |
| | | DVD |
| | | AVK |
| 19. | Gear Reducers | Essen Pro |
| | | Radicon |
| | | Elecon |
| | | Greaves |
| | | Allen Beri |
| 20. | Geared Motors | Bonfigli |
| | | SEW |
| | | REMI |
| | | Radicon |
| 21. | Gravity Thickener | Triveni |
| | | Geo Miller & Co. Pvt. Ltd. |
| | | Degremont |
| | | EMCO |
| | | Dorr-Oliver |
| | | Micro Trans |
| 22. | Horizontal Centrifugal Pumps | Mather & Platt |
| | | Kirloskar Brothers Limited |
| | | Jyoti |
| | | KSB |
| | | LUBI |
| | | WPIL |
| 23. | HOT and EOT | Hercules Hoists Ltd. (Indef) |
| | | W.H.Brady & Co. Ltd. |
| | | AVON Cranes |
| | | Reva Engineering |
| | | Batliboi |
| | | West Works Sales Corporation |
| 24. | Knife Gate Valves | VAG |
| | | Fouress |
| | | Jash |

| Mechanical Equipment's | | |
|---|---|---|
| **Sr. No.** | **Equipment's** | **Preferable Makes** |
| | | Degremont Technologies |
| | | Veolia |
| | | AQUA Aerobic |
| | | DVD |
| 25. | Membrane Filtration (vacuum/ pressure) | Kubota |
| | | Norit |
| | | Mitsubishi |
| | | Siemens |
| | | GE/Suez |
| | | HyFlux |
| | | Hitachi |
| | | Toray |
| 26. | Disc/ Cloth Filters | Siemens/Evoqua |
| | | AQUA Aerobic/ Meta Water |
| | | Westech |
| | | Ovivo |
| | | Kruger/ Hydro Tech |
| | | EuroTech |
| 27. | Nuts & Bolts | TATA |
| | | GKW |
| 28. | PST | HDO |
| | | EMCO |
| | | HGE |
| | | Geo Miller & Co. Pvt. Ltd. |
| | | Triveni |
| 29. | Safety Equipment | Perfect Chloro System |
| | | SS Engineers & Safety Consultant |
| | | Medical Engineers |
| | | Super Safety Services |
| 30. | Screw Pumps | Roto |
| | | Netzsch |
| | | ABS |
| | | UT Pumps Pvt. Ltd. |
| 31. | Gas Engine | Excellent Engine |
| | | Pilani |
| | | Eurotech |
| | | Innovative Environmental Technology |
| | | Green Power |
| | | Mann |
| | | Deutz |
| | | Caterpillar |
| | | Jenbacher (Austria) |
| | | Guascor (Spain) |
| | | Waukesha – USA |
| 32. | Sluice Gates | Kirloskar Brothers Ltd. |
| | | Indian Valve Company |
| | | Jash Engineering |

| Mechanical Equipment's | | |
|---|---|---|
| **Sr. No.** | **Equipment's** | **Preferable Makes** |
| | | DVD |
| 33. | Submersible Mixer | Grundfos |
| | | ABS |
| | | Flyght |
| | | Sulzer |
| 34. | Submersible Pumps | Flyght |
| | | KSB Pumps |
| | | ABS |
| | | Grundfos |
| | | Kirloskar Brothers Ltd. |
| | | Aqua Machineries Pvt Ltd. (Aqua) |
| 35. | Submersible Pumps for Tube well | BS |
| | | Mody |
| | | Great India |
| | | ABS |
| | | KSB |
| | | GGL |
| | | LUBI |
| 36. | Sump Pumps / Dewatering Pumps and Pit Pumps | SU Motors P. Ltd. |
| | | Mody Ind. FC Pvt. Ltd. |
| | | Grundfos - Pumps |
| | | Darling |
| | | Harison |
| | | Kishore Pumps |
| | | KSB |
| | | ABS |
| | | WEDA |
| | | Aqua Machineries Pvt Ltd. (Aqua) |
| 37. | Valves (Non Return Valve, Pressure Release Valve, Sluice Valve) | Kirloskar Brothers Ltd. |
| | | Indian Valve Company |
| | | VAG |
| | | Dorot |
| | | DVD |
| 38. | Vortex Type Grit Separator | Smith & Loveless |
| | | Huber Technology |
| | | Geo Miller |
| | | Triveni |
| | | Dorr-Oliver |
| | | Fluiteco |
| | | Ovivo |
| | | Voltas |
| 39. | DAF Thickener | CROFTA |
| | | World Water Works |
| | | OVIVO |
| 40. | UV System | Trozen |
| | | Wedco |
| | | Calgon |
| | | OVIVO |
| | | Evoqua |

# 2. Electrical Equipments

| LIST OF EQUIPMENT (ELECTRICAL) | | |
|---|---|---|
| **Sr. No.** | **Equipments** | **Preferable Makes** |
| 1 | 11 KV Switch Gear | Asian Brown Boveri |
| | | Kirloskar Systems |
| | | Bharat Heavy Electricals Ltd. |
| | | Jyoti Ltd. |
| | | Siemens India Ltd. |
| | | Crompton Greaves |
| | | Kirloskar Electric Ltd. |
| | | Alstom / Ariva |
| | | Schneider |
| | | NGEF |
| 2 | 415V Switch Gear/ Bus Duct | Larsen & Toubro Ltd. |
| | | Siemens India Ltd. |
| | | ABB |
| | | Control and Switchgrear |
| | | Schneider |
| | | GE |
| | | English Electric Ltd. |
| | | Voltas Ltd. |
| | | Jyoti ltd. |
| | | Bhartia Cutler Hammer |
| | | Electric Control Gear Ltd. |
| 3 | Actuator | Rotork |
| | | AUMA India |
| | | Limitorque |
| | | Marsh |
| | | L & T |
| 4 | Alternator | Jyoti |
| | | KEC |
| | | Stamford |
| 5 | Battery Charger | Uptron Powertronics (Shreetron) |
| | | Statcom |
| | | Automatic Electric ltd. |
| | | Chabi |
| | | Kerla State Electricity Crop. |
| | | APCO |
| | | AEP |
| | | Baroda Power Electronics |
| | | Reltronix |
| | | Tata Emerson |
| 6 | Battery (Maintenance Free) | Standard Batteries Ltd. |

| LIST OF EQUIPMENT (ELECTRICAL) | | |
|---|---|---|
| **Sr. No.** | **Equipments** | **Preferable Makes** |
| | | Chloride India Ltd. |
| | | Amco Batteries Ltd. |
| | | Exide |
| | | Tatagreen |
| 7 | Cables (Power & Control) | Fort Gloster |
| | | ICL |
| | | CCI |
| | | ICC |
| | | Universal |
| | | Grandlay |
| | | Asian Cables Corporation Ltd. |
| | | Gemscab |
| | | Finolrex Cables Ltd. |
| | | Rajdhani |
| | | Nicco |
| | | DELTON |
| | | Batra Henley |
| 8 | Cable Glands | Comet |
| | | Braco |
| | | Siemens |
| 9 | Cable Lugs | Dowell |
| | | 3D |
| | | Braco |
| 10 | Ceiling Fans | Bajaj |
| | | Orient |
| | | Usha |
| | | Crompton |
| | | Khaital |
| | | Havells |
| 11 | Electric Poles | Jindal |
| | | Tata |
| | | Utkarsh |
| | | Surya |

| LIST OF EQUIPMENT (ELECTRICAL) | | |
|---|---|---|
| **Sr. No.** | **Equipments** | **Preferable Makes** |
| 12 | Exhaust Fan | Bajaj Electricals Ltd. |
| | | Crompton Greaves Ltd. |
| | | Jay Engg. Works |
| | | Alstom |
| | | General Eelctric Co. Ltd. |
| | | Khaitan |
| 13 | Flame Proof Push Button Station & Lighting Fittings | Siemens |
| | | Schneider |
| | | BCH |
| | | Havells |
| | | Bajaj Electrical Ltd. |
| | | Crompton Greaves Ltd. |
| | | Philips |
| | | Wipro Ltd. |
| 14 | Flame Proof Equipment | FCG |
| | | Flexpro |
| | | Sudhir Switchgear |
| | | Baliga |
| | | Exprotecta |
| 15 | Lightening Arrester | National Radio & Electronics Co. Ltd. |
| | | Lighting Protection International Ltd. |
| 16 | Lighting Accessories (Switch/socket etc) | GE Power |
| | | Larsen & Toubro Ltd. |
| | | Siemens |
| | | HPL |
| | | C&H |
| | | Havells |
| | | Control & Switchgear |
| | | Schneider |
| | | EEI |
| 17 | Lighting Switch Gear/ Ballast | Philips |
| | | Bajaj |
| | | Crompton |
| | | Havells |
| | | Opal |
| | | Wash low |

| LIST OF EQUIPMENT (ELECTRICAL) | | |
|---|---|---|
| **Sr. No.** | **Equipments** | **Preferable Makes** |
| 18 | LED Lamps | Syska |
| | | Surya |
| | | Philips |
| | | Osram |
| | | GE |
| | | Fiem |
| | | Havells |
| | | Bajaj |
| 19 | MCB/ MCCB | L&T |
| | | Siemens |
| | | Havells |
| | | lndocorp |
| | | MDS |
| | | Cutler Hammer |
| | | C&S |
| | | Alstom |
| | | ABB |
| | | MDS |
| | | Ind Kopp |
| | | Datar |
| | | S & S |
| 20 | Motors | Jyoti |
| | | KEC |
| | | Crompton |
| | | ABB |
| | | Siemens |
| | | BHEL |
| | | NGEF |
| 21 | Numerical Relays | ALSTOM |
| | | JYOTI |
| | | Universal Electric |
| | | ER |
| 22 | Power capacitors & APFC relays | Siemens, L&T, BHEL |
| | | Crompton, Khatau |
| | | ABB, Meher ,Manohar Brothers |
| | | Madhav Domain Javiac |
| | | Schneider ,EPCOS, Kapsales ,Genelec |
| | | ASIAN and Voltas Ltd |
| 23 | Power Transformer | KEC, Crompton |

| LIST OF EQUIPMENT (ELECTRICAL) | | |
|---|---|---|
| **Sr. No.** | **Equipments** | **Preferable Makes** |
| | | BBL, BHEL |
| | | ABB, Siemens |
| | | Voltamp, EMCO. (Nasik) |
| | | Alstom, Bharat Bijlee |
| | | NGEF ,Voltas |
| 24 | Soft Starters | Innovative |
| | | Jaishree |
| | | Siemens |
| | | ABB |
| | | L&T |
| | | Schneider |
| | | Danfoss |
| | | Alstom |
| 25 | UPS | Tata emerson |
| | | Merlin Grein |
| | | Mitsubishi |
| | | AROS (Italy) |
| | | Tata Liebert |
| | | Reliance |
| | | APC |
| 26 | VFD | L&T |
| | | Schneider |
| | | Siemens |
| | | ABB |
| | | Danfoss |
| | | Allen Bradley |
| | | Reliance |
| 27 | HT Termination Kit | Birla 3M |
| | | Raychem |
| | | Siechem |

# 3. Instrumentation

| LIST OF EQUIPMENT (ONLINE INSTRUMENTATION) | | |
|---|---|---|
| **Sr. No.** | **Equipment's** | **Preferable Makes** |
| 1 | Electromagnetic Flow meter / Ultrasonic Flow Meter | ABB |
| | | Forbes Marshall |
| | | Siemens |
| | | Endress Hauser (E&H) |
| | | KENT |
| | | Krohne Marshall |
| | | Schlumburger |
| | | YBL Yokogawa |
| | | Mangnetrol |
| | | Combustion Research Associates |
| | | Rosemount |
| 2 | Instrumentation / Continuous Online Water Quality Monitoring Instruments | Emerson |
| | | ABB |
| | | E&H |
| | | Siemens |
| | | Forbes Marshall Polymetron |
| | | Orion |
| | | Analytical Instruments |
| | | Chemtrols |
| | | DR. Lange. |
| | | Royce |
| | | Endress Hauser |
| | | Hach |
| | | S::Can |
| | | Xylem |
| | | M/s. Panam Engineers Ltd. |
| | | ORBIT |
| | | Polymetron |
| 3 | LEVEL SWITCH | Endress Hauser |
| | | EIP |
| | | Nivo Control |
| | | ABB |
| | | Level Cone |
| | | Mangntrol |
| | | Forbes Marshall |
| | | Hach |
| | | Orbit |
| | | Softbit |
| | | Toshiniwal |
| | | BB |
| | | Bells |
| 4 | PRESSURE GAUGES | Fiebig |

| LIST OF EQUIPMENT (ONLINE INSTRUMENTATION) | | |
|---|---|---|
| **Sr. No.** | **Equipment's** | **Preferable Makes** |
| | | Verna Trifag |
| | | H. Guru |
| | | GIL |
| | | ANI |
| | | AGI |
| 5 | PRESSURE TRANSMITTERS | Danfoss |
| | | Switzer |
| | | High Tech (Orion) |
| | | Forbes Marshall |
| | | Hach |
| | | Orbit |
| | | Softbit |
| | | Seimens |
| | | Emerson |
| | | ABB |
| | | Endress & Hausser |
| 5 | ULTRASONIC LEVEL TRANSMITTER | Toshniwal |
| | | Hach |
| | | Level Tech |
| | | OTT |
| | | GLI |
| | | Seimens |
| | | ABB |
| | | Endress & Hausser |
| | | Emerson |
| 6 | Area Velocity Flowmeter | Teledyne |
| | | Greyline |
| | | Hach |
| **LIST OF EQUIPMENT (AUTOMATION)** | | |
| 1 | Control System/ Instrumentation, DCS/ PLS & SCADA System | Siemens |
| | | Rockwell Automation |
| | | ABB |
| | | Schneider |
| | | E&H |
| | | Tata Honeywell |
| | | KLG |
| | | Yokogava |
| | | Johnson Controls (I) Pvt. Ltd. |
| | | Landis & Staefa (I) Pvt. Ltd. |
| | | GEFANUC |
| | | Alstom |
| | | Forbes Marshall |
| | | Tushcon |
| | | HACH |
| | | Softbit |
| **LIST OF SUB-COMPONENTS FOR SCADA SYSTEM** | | |
| 1 | Optical Fiber Cables | Delink |

| LIST OF EQUIPMENT (ONLINE INSTRUMENTATION) | | |
|---|---|---|
| **Sr. No.** | **Equipment's** | **Preferable Makes** |
| | | Cords |
| | | RR Cable |
| | | Icon |
| | | Aksh |
| **LIST OF LABORATORY INSTRUMENT** | | |
| 1 | Laboratory Instruments | Merc |
| | | Hach |
| | | Xylem |
| | | ORBIT |
| | | Thermo |
| | | WTW |

Blank

REHABILITATION/UPGRADATION OF 5 NOS. EXISTING SEWAGE TREATMENT PLANTS (STPS) AND CONSTRUCTION OF 1 NO. NEW STP ON DESIGN, BUILD AND OPERATE (ONE YEAR DLP PLUS 15 YEARS O&M) BASIS AT CHANDIGARH UNDER SMART CITY MISSION

# DRAFT REQUEST FOR PROPOSAL
# 31-12-2018

## VOLUME– 3

*Chandigarh Smart City Limited*
**New Bridge Building - 2, 2nd Floor, Near TDI Mall, Sector 17 – A, Chandigarh – 160017**

## VOLUME 3 - SECTION XI

### Table of Contents

**Page No.**

## Letter of Price Bid

Following Volume 3 : Section XI is part of the Price Bid, thus shall be filled/submitted online on http:/etenders.chd.nic.in by the Bidder(s).

## Section – XI: Schedules of Payment and Prices

### Schedule of Payment

a) If payment is based on completion by stages.

| **Payment Schedule (Reference to Sub-Clause 14.4 of the Particular Conditions of Contract)** | | | | |
|---|---|---|---|---|
| **Major Work Category** | **Type of Payment** | **Payment (in % of Total Price)** | **Amount (INR)** | **Cumulative %** |
| **Design and Documentation** | **LS** | **100 %** | | |
| **Civil Works** | | | | |
| **Water Retaining Structures** (e.g. Pre Treatment, Biological Reactor, Clarifiers, Digesters, Thickeners etc.) | P | 90 % | | |
| **Water Retaining Structures** after Hydraulic Testing | P | 5% | | |
| **Water Retaining Structures** after successful completion of testing, trial run, and performance guarantee test | LS | 5% | | |
| **Non Water Retaining Structures,** (Like Pump House Electrical Panel Room Blower Room, Laboratory roads, drains pathways, stairs etc.). | P | 95% | | |
| **Non Water Retaining Structures,** On completion of work & putting the plant/unit in to full service. | LS | 5% | | |
| **Mechanical & Electrical. Instrumentation Plant and Equipment for Incorporation in the Permanent Works ( including trial run )** | | | | |
| Mechanical and Electrical Equipment, Instrumentation, Automation etc. supply on site. | P | 70 % | | |
| Payment on completion of installation. | P | 20 % | | |

| **Payment Schedule (Reference to Sub-Clause 14.4 of the Particular Conditions of Contract)** | | | | |
|---|---|---|---|---|
| **Major Work Category** | **Type of Payment** | **Payment (in % of Total Price)** | **Amount (INR)** | **Cumulative %** |
| Payment on successful completion of testing, trial run, commissioning and performance guarantee test | LS | 10 % | | |
| **Operation and Maintenance during DLP Period** | | | | |
| Monthly O&M Services (On completion of each month's operations and maintenance) inclusive of man power and consumables. | P | 100 % | | |
| **Operation and Maintenance during fifteen (15) Years Period** | | | | |
| Monthly O&M Services (On completion of each month's operations and maintenance) inclusive of man power, consumables & preventive maintenance/replacement. | P | 100 % | | |

**Price Schedules: Quoted Price**

| **PRICE BID: SUMMARY SHEET** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **REHABILITATION/UPGRADATION OF 5 NOS. EXISTING SEWAGE TREATMENT PLANTS (STPs) AND CONSTRUCTION OF 1 NO. NEW STP ON DESIGN, BUILD AND OPERATE (ONE YEAR DLP PLUS 15 YEARS O&M) BASIS AT CHANDIGARH UNDER SMART CITY PROJECT** | | | | | | | | |
| **This BOQ Template must not be modified/replaced by the bidder and the same should be uploaded after filling the relevant columns, else the bidder is liable to be rejected for this tender. Bidders are allowed to enter the values in highlighted cells only.** | | | | | | | | |
| **Inviting Authority:** | **CHANDIGARH SMART CITY LIMITED (CSCL)** | | | | | | | |
| **Contract No.:** | | | | | | | | |
| **Details of the Bidder:** | | | | | | | | |
| **Name:** | | | | | | | | |
| **Address:** | | | | | | | | |
| **S.No.** | **Description** | **Amount, INR** | | | | | | |
| | | **30 MGD, DIGGIAN** | **5 MGD, RAIPUR KALAN** | **2MGD, RAIPUR KHURD** | **0.44 MGD, SUKHNA** | **11 MGD, 3 BRD** | **1.65 MGD, DHANAS** | **TOTAL PRICE** |
| **I** | **WORKS CONTRACT** | | | | | | | |
| A-1 | (Price Schedule A-1) **DESIGN COST** | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- |
| A-2 | (Price Schedule A-2) **WORKS COST** | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- |
| A-3 | (Price Schedule A-3) **DEMOLITION COST** | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- |
| **TOTAL COST (I) , INR** | | **Rs. -** | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- |

| S.No. | Description | Amount, INR | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | **30 MGD, DIGGIAN** | **5 MGD, RAIPUR KALAN** | **2MGD, RAIPUR KHURD** | **0.44 MGD, SUKHNA** | **11 MGD, 3 BRD** | **1.65 MGD, DHANAS** | **TOTAL PRICE** |
| **II** | **O&M CONTRACT** | | | | | | | |
| A-4 | (Price Schedule A-4) **OPERATION & MAINTENANCE COST FOR 15 YEARS AND DEFECTS LIABILITY PERIOD FOR 1 YEAR** | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- |
| **TOTAL COST (II) , INR** | | **Rs. -** | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- |
| **GRAND TOTAL COST (I+II), INR** | | **Rs. -** | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- |
| **UNCONDITIONAL DISCOUNT (if any), %** | | **0%** | **0%** | **0%** | **0%** | **0%** | **0%** | |
| **NET TOTAL COST (in figures), INR** | | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- |
| **NET TOTAL COST (in words), INR** | | **Zero Rupees Only** | | | | | | |

**NOTE:**

| | |
|---|---|
| (i) | I accept all Terms & Conditions given in the DNIT. |
| (ii) | Bidders are required to quote the Price (INR) w.r.t. all the items given in the respective Tabs. |

**PRICE BID: SCHEDULE A-1**

**REHABILITATION/UPGRADATION OF 5 NOS. EXISTING SEWAGE TREATMENT PLANTS (STPs)
AND CONSTRUCTION OF 1 NO. NEW STP ON DESIGN, BUILD AND OPERATE
(ONE YEAR DLP PLUS 15 YEARS O&M) BASIS AT CHANDIGARH UNDER SMART CITY PROJECT**

**This BOQ Template must not be modified/replaced by the bidder and the same should be uploaded after filling the relevant columns,
else the bidder is liable to be rejected for this tender. Bidders are allowed to enter the values in highlighted cells only.**

| S.No. | Description | Amount, INR | | | | | | |
|---|---|---|---|---|---|---|---|---|
| A-1 | DESIGN COST | 30 MGD, DIGGIAN | 5 MGD, RAIPUR KALAN | 2MGD, RAIPUR KHURD | 0.44 MGD, SUKHNA | 11 MGD, 3 BRD | 1.65 MGD, DHANAS | TOTAL PRICE |
| (i) | Survey(s), Soil-Investigation(s), Flow Measurement(s), Sampling & Analysis, etc. | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- |
| (ii) | Detailed Design Engineering | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- |
| (iii) | Documents comprising Technical, Drawings, Manuals, etc. | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- |
| (iv) | if any, for successful running & commissioning of Plant(s) | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- |
| **TOTAL COST (in figures), INR** | | **Rs. -** | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- |
| **TOTAL COST (in words), INR** | | **Zero Rupees Only** | | | | | | |

**NOTE:**

| | |
|---|---|
| (i) | I accept all Terms & Conditions given in the DNIT. |
| (ii) | Bidders are required to quote the Price (INR) w.r.t. all the items given above in the Table. |

**PRICE BID: SCHEDULE A-2**

**REHABILITATION/UPGRADATION OF 5 NOS. EXISTING SEWAGE TREATMENT PLANTS (STPs) AND CONSTRUCTION OF 1 NO. NEW STP ON DESIGN, BUILD AND OPERATE (ONE YEAR DLP PLUS 15 YEARS O&M) BASIS AT CHANDIGARH UNDER SMART CITY PROJECT**

**This BOQ Template must not be modified/replaced by the bidder and the same should be uploaded after filling the relevant columns, else the bidder is liable to be rejected for this tender. Bidders are allowed to enter the values in highlighted cells only.**

| S.No. | Description | Amount, INR | | | | | | |
|---|---|---|---|---|---|---|---|---|
| A-2 | WORKS COST | 30 MGD, DIGGIAN | 5 MGD, RAIPUR KALAN | 2MGD, RAIPUR KHURD | 0.44 MGD, SUKHNA | 11 MGD, 3 BRD | 1.65 MGD, DHANAS | TOTAL PRICE |
| (i) | Civil | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| (ii) | Electrical | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| (iii) | Mechanical | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| (iv) | Instrumentation & SCADA | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| **TOTAL COST (in figures), INR** | | **Rs. -** | **Rs. -** | **Rs. -** | **Rs. -** | **Rs. -** | **Rs. -** | **Rs. -** |
| **TOTAL COST (in words), INR** | | **Zero Rupees Only** | | | | | | |

**NOTE:**

| | |
|---|---|
| (i) | I accept all Terms & Conditions given in the DNIT. |
| (ii) | Bidders are required to quote the Price (INR) w.r.t. all the items given above in the Table. |
| (iii) | Bidders are required to provide the detailed break up **(refer to Table given below)** of each items w.r.t. Civil, Electrical, Mechanical, Instrumentation & SCADA, etc. as summarized above in the Schedule A-2. Also, said Schedule A-2 without necessary break up of each items or remarks such as "included in above" or "to be furnished later" etc. shall be considered as non-responsive and may lead to rejection of the bid. Moreover, items against which No Price is entered by the Bidder will not be paid for by the Employer when executed and shall be deemed to be covered by the prices for other items, and Items not proposed above by the Bidder, but are deemed necessary for the successful running and commissioning of the plant will not be paid for by the Employer when executed and shall be deemed to be covered by the prices for other items |

| DETAILED BREAK UP OF ITEMS w.r.t. CIVIL, ELECTRICAL, MECHANICAL, INSTRUMENTATION & SCADA | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| S.No. | Description | Amount, INR | | | | | | |
| | | 30 MGD, DIGGIAN | 5 MGD, RAIPUR KALAN | 2MGD, RAIPUR KHURD | 0.44 MGD, SUKHNA | 11 MGD, 3 BRD | 1.65 MGD, DHANAS | TOTAL PRICE |
| (i) | Civil | | | | | | | |
| i | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| ii | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| iii | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| iv | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| v | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| vi | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| vii | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| viii | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| ix | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| x | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| xi | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| xii | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| xiii | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| xiv | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| xv | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| xvi | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| xvii | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| xviii | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| xix | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| xx | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| xxi | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| xxii | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| xxiii | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| xiv | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| xv | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| **TOTAL COST (in figures), INR** | | **Rs. -** | **Rs. -** | **Rs. -** | **Rs. -** | **Rs. -** | **Rs. -** | **Rs. -** |

| DETAILED BREAK UP OF ITEMS w.r.t. CIVIL, ELECTRICAL, MECHANICAL, INSTRUMENTATION & SCADA | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| S.No. | Description | Amount, INR | | | | | | |
| | | 30 MGD, DIGGIAN | 5 MGD, RAIPUR KALAN | 2MGD, RAIPUR KHURD | 0.44 MGD, SUKHNA | 11 MGD, 3 BRD | 1.65 MGD, DHANAS | TOTAL PRICE |
| (ii) | Electrical | | | | | | | |
| i | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| ii | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| iii | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| iv | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| v | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| vi | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| vii | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| viii | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| ix | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| x | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| xi | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| xii | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| xiii | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| xiv | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| xv | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| xvi | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| xvii | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| xviii | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| xix | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| xx | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| xxi | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| xxii | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| xxiii | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| xiv | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| xv | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| **TOTAL COST (in figures), INR** | | **Rs. -** | **Rs. -** | **Rs. -** | **Rs. -** | **Rs. -** | **Rs. -** | **Rs. -** |

| DETAILED BREAK UP OF ITEMS w.r.t. CIVIL, ELECTRICAL, MECHANICAL, INSTRUMENTATION & SCADA | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| S.No. | Description | Amount, INR | | | | | | |
| | | 30 MGD, DIGGIAN | 5 MGD, RAIPUR KALAN | 2MGD, RAIPUR KHURD | 0.44 MGD, SUKHNA | 11 MGD, 3 BRD | 1.65 MGD, DHANAS | TOTAL PRICE |
| (iii) | Mechanical | | | | | | | |
| i | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| ii | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| iii | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| iv | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| v | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| vi | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| vii | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| viii | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| ix | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| x | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| xi | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| xii | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| xiii | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| xiv | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| xv | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| xvi | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| xvii | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| xviii | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| xix | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| xx | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| xxi | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| xxii | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| xxiii | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| xiv | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| xv | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| **TOTAL COST (in figures), INR** | | **Rs. -** | **Rs. -** | **Rs. -** | **Rs. -** | **Rs. -** | **Rs. -** | **Rs. -** |

| DETAILED BREAK UP OF ITEMS w.r.t. CIVIL, ELECTRICAL, MECHANICAL, INSTRUMENTATION & SCADA | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| S.No. | Description | Amount, INR | | | | | | |
| | | 30 MGD, DIGGIAN | 5 MGD, RAIPUR KALAN | 2MGD, RAIPUR KHURD | 0.44 MGD, SUKHNA | 11 MGD, 3 BRD | 1.65 MGD, DHANAS | TOTAL PRICE |
| (iv) | Instrumentation & SCADA | | | | | | | |
| i | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| ii | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| iii | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| iv | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| v | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| vi | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| vii | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| viii | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| ix | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| x | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| xi | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| xii | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| xiii | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| xiv | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| xv | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| xvi | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| xvii | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| xviii | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| xix | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| xx | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| xxi | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| xxii | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| xxiii | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| xiv | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| xv | | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| **TOTAL COST (in figures), INR** | | **Rs. -** | **Rs. -** | **Rs. -** | **Rs. -** | **Rs. -** | **Rs. -** | **Rs. -** |

**PRICE BID: SCHEDULE A-3**

**REHABILITATION/UPGRADATION OF 5 NOS. EXISTING SEWAGE TREATMENT PLANTS (STPs) AND CONSTRUCTION OF 1 NO. NEW STP ON DESIGN, BUILD AND OPERATE (ONE YEAR DLP PLUS 15 YEARS O&M) BASIS AT CHANDIGARH UNDER SMART CITY PROJECT**

**This BOQ Template must not be modified/replaced by the bidder and the same should be uploaded after filling the relevant columns, else the bidder is liable to be rejected for this tender. Bidders are allowed to enter the values in highlighted cells only.**

| S.No. | Description | Amount, INR | | | | | | |
|---|---|---|---|---|---|---|---|---|
| A-3 | DEMOLITION COST | 30 MGD, DIGGIAN | 5 MGD, RAIPUR KALAN | 2MGD, RAIPUR KHURD | 0.44 MGD, SUKHNA | 11 MGD, 3 BRD | 1.65 MGD, DHANAS | TOTAL PRICE |
| (i) | Demolishing of all existing civil structures including electrical & mechanical equipment's, complete de-sludging, backfilling, levelling, debris removal, etc. as per Volume 2: Section X: Employer Requirements and as specified in the Bid Document. | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| (ii) | Other minor works (if any), for successful running & commissioning of Plant(s) | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| **TOTAL COST (in figures), INR** | | **Rs. -** | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - | Rs. - |
| **TOTAL COST (in words), INR** | | **Zero Rupees Only** | | | | | | |

**NOTE:**

| | |
|---|---|
| (i) | I accept all Terms & Conditions given in the DNIT. |
| (ii) | Bidders are required to quote the Price (INR) w.r.t. all the items given above in the Table. |

**PRICE BID: SCHEDULE A-4**

**REHABILITATION/UPGRADATION OF 5 NOS. EXISTING SEWAGE TREATMENT PLANTS (STPs) AND CONSTRUCTION OF 1 NO. NEW STP ON DESIGN, BUILD AND OPERATE (ONE YEAR DLP PLUS 15 YEARS O&M) BASIS AT CHANDIGARH UNDER SMART CITY PROJECT**

**This BOQ Template must not be modified/replaced by the bidder and the same should be uploaded after filling the relevant columns, else the bidder is liable to be rejected for this tender. Bidders are allowed to enter the values in highlighted cells only.**

| S.No. | Description | Amount, INR | | | | | | |
|---|---|---|---|---|---|---|---|---|
| A-4 | OPERATION & MAINTENANCE COST FOR 15 YEARS AND DEFECTS LIABILITY PERIOD FOR 1 YEAR | 30 MGD, DIGGIAN | 5 MGD, RAIPUR KALAN | 2MGD, RAIPUR KHURD | 0.44 MGD, SUKHNA | 11 MGD, 3 BRD | 1.65 MGD, DHANAS | TOTAL PRICE |
| (i) | for Defects Liability Period (DLP) | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- |
| (ii) | for O&M during Year - 1 | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- |
| (iii) | for O&M during Year - 2 | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- |
| (iv) | for O&M during Year - 3 | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- |
| (v) | for O&M during Year - 4 | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- |
| (vi) | for O&M during Year - 5 | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- |
| (vii) | for O&M during Year - 6 | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- |
| (viii) | for O&M during Year - 7 | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- |
| (ix) | for O&M during Year - 8 | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- |
| (x) | for O&M during Year - 9 | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- |
| (xi) | for O&M during Year - 10 | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- |
| (xii) | for O&M during Year - 11 | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- |
| (xiii) | for O&M during Year - 12 | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- |
| (xiv) | for O&M during Year - 13 | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- |
| (xv) | for O&M during Year - 14 | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- |
| (xvi) | for O&M during Year - 15 | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- |
| **TOTAL COST (in figures), INR** | | **Rs.-** | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- | Rs.- |
| **TOTAL COST (in words), INR** | | **Zero Rupees Only** | | | | | | |

| **NOTE:** | |
|---|---|
| (i) | I accept all Terms & Conditions given in the DNIT. |
| (ii) | Bidders are required to quote the Price (INR) w.r.t. all the items given above in the Table. |
| (iii) | Contractor to quote O&M Cost for each year along with DLP in such a way that the Annual O&M Cost for each year shall not be less than 3% of the Works Contract. |

**Price Schedule - B1: Operation and Maintenance**

Operation and maintenance includes the supply of all spares parts as required including the supply of all labour, materials, consumables, equipment's, tools and tackles and comprehensive operation and maintenance of all 06 STPS (30 MGD Diggian/5 MGD Raipurkalan/2 MGD/Raipur Khurd/ 2 MLD Sukhna Lake/11 MGD at 3BRD/1.65 MGD, Dhanas) and other related associated/allied appurtenant works as necessary during the operation and maintenance period of 15 years after successful completion of defect liability period shall fill separately.

**The Fixed Charges shall not exceed 60% of the monthly Operation Charges**

| S. No | Description | | Lump Sum Price for O & M (INR) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | DLP | 1st year | 2nd year | 3rd year | 4th year | 5th year | 6th year | 7th year | 8th year | 9th year | 10th year | 11th year | 12th year | 13th year | 14th year | 15th year |
| **A.** | | | **Fixed Part**<br>Fixed Part shall include followings:<br>a) Manpower for O&M, Administration & Management including Security of plant sites, running office, laboratory<br>b) Maintenance of all utility building & facility, maintenance of green belt plantation including training etc.<br>c) Civil works repair & maintenance including preventive maintenance.<br>d) Electro-mechanical works repair & maintenance including normal & routine maintenance, refurbishment of spare parts, general utilities etc.<br>e) Reserve fund for major maintenance & repairs.<br>f) Laboratory and other testing expenses.<br>g) Spare parts, Tools & tackles | | | | | | | | | | | | | | |
| | **Total for (A) (INR)** | | | | | | | | | | | | | | | | |
| **B.** | | | **Variable Part: For all 06 STPs separately*** (This part shall include the Cost of chemicals and fuel for Power backup). | | | | | | | | | | | | | | |
| | **Total for (B) INR.** | | | | | | | | | | | | | | | | |
| **C.** | **Total Price for O&M (A + B) (INR)** | | | | | | | | | | | | | | | | |

* Payment of variable Part shall be made based on actual sewerage treated i.e.

Actual Sewerage Treated x Total Variable Cost
Total Sewerage to be treated

**Price Schedule: B2** for all 06 STPS (30 MGD Diggian/5 MGD Raipurkalan/2 MGD/Raipur Khurd/ 2 MLD Sukhna Lake/11 MGD at 3BRD/1.65 MGD, Dhanas) separately in line with format given below:

**Staff Deployment**

Schedule for Recovery Rates for Operating Manpower (1 year Defect Liability Period + 15 years O & M).

| Sr. No. | Personnel | Recommended No. | Recovery Rate / per day Rs |
|---|---|---|---|
| 1. | Plant Manager/Engineer In charge | 2 | 5000 |
| 2. | Engineer (Mechanical/ Electrical) | 2 | 4000 |
| 3. | Jr. Engineer (Civil) | 2 | 3000 |
| 4. | Chemist | 2 | 2000 |
| 5. | Lab technician (one no. in each shift) | 6 | 1500 |
| 6. | Lab attendant (one no. in each shift) | 6 | 1000 |
| 7. | Health and safety officer | 2 | 3000 |
| 8. | Operators/Shift in charge | as per requirement | 2000 |
| 9. | SCADA Operators (one no. in each shift) | 6 | 2500 |
| 10. | Electrician (one no. in each shift) | 6 | 1500 |
| 11. | Fitter(Mech.) (one no. in each shift) | 6 | 1500 |
| 12. | Helper/Non Skilled labour | as per requirement | 1000 |
| 13. | Cleaner/Sweeper | as per requirement | 500 |
| 14. | Security Guards | 4 per shift per plant | 600 |
| 15. | Gardener | 1 No per plant | 500 |
| 16. | Any other staff (Specify) | | |

Note:

1. If staff is not engaged as above by the bidder, recovery shall be made at the rates specified above.
2. Recovery rate shall be increased @8% per year on the rates specified above

# Section – XII
# Service Level Agreement during 15 Years of Operation and one year of DLP.

# Section – XII: Service Level Agreement during 15 Years of Operation and one year of DLP.

Variations allowed in treated effluent quality during 15 Years of Operation & Maintenance and one year of DLP and penalty for not maintaining the standards:

The treated effluent quality and other key deliverable standards shall be demonstrated by the Contract at :

- The nominal design flow
- 25% of nominal design flow*
- 10% above the nominal design flow*
- The pollutant concentration of all incoming pollutants as freight (i.e. kg/day in terms of flow received) in a range of 75% to 110% of the pollutant freight calculated at the design pollutant concentration and nominal design flow.

**On some occasions during the year like festivals, excessive rain, extreme weather conditions etc.*
The treated effluent quality for proposed STPs as per effluent criteria defined in section X part 1

Non-compliance to demonstrate the plant performance during the completion tests with respect to treated effluent quality and sludge quality for a continuous period of 72 hours, is not acceptable and the Contractor shall rectify the facility to demonstrate the performance. Not being able to demonstrate the plant performance shall render the plant as "Non-Acceptable" leading to a liquidity damage of 10% and shall forfeit the performance securities.

Contractor to maintain guarantee parameters for treated effluent quality during O & M period and during Defect Liability Period. These quality parameters are subject to presumptions that actual pollutant (Pollutants like BOD, SS, Nitrogen etc. in kg/day) load will not exceed design pollutant load (kg/day) per day for every parameter. However, on some occasions during the year (i.e. festivals, excessive rain, extreme weather conditions), individual pollutant concentration (mg/l) can exceed up to 10% of design parameters, and total sewage flow can exceed up to 10% design flow.

The treated effluent parameters shall be demonstrated with 24-hour composite samples with95% compliance on monthly basis i.e. not more than 5% cumulative samples during the month can be off specifications.

The Maximum Allowed Concentration (MAC) on individual grab samples shall not be more than2 times of the above specified 95 percentile value.

If any parameter of any grab sample exceeds the MAC values, the sample shall be considered as "Non-Complaint".

Guarantee for Fecal Coliform shall be based on 15-day geometric mean value.

However, if pollutants load (kg/day) exceeds the design pollutant load per day basis, or total flow exceeds to the given flow for all 06 STPs (as per section X part 1) (24 hr. basis), no penalty shall be applicable.

During trial run and commissioning, no penalties will be applied and Contractor will rectify the plant to ensure successful commissioning.

However, during 15 Years of Operation & Maintenance and one year of DLP, CSCL will impose following penalties/liquidated damages for not maintaining the guaranteed parameters, as described below:

**Condition A:-**

**Liquidated Damages for non-compliance of treated effluent standards**

| Event Triggering the recovery of Liquidity Damages | Liquidated Damages per plant | Frequency |
|---|---|---|
| Non-conformance with MAC for BOD Standard | Rs.2000/- | For every event of non-conformance* |
| Non-conformance with MAC for TSS Standard | Rs.2000/- | For every event of non-conformance* |
| Non-conformance with MAC for Total Nitrogen | Rs.2000/ | For every event of non-conformance* |
| Non-conformance with MAC for Ammonia Nitrogen | Rs.2000/ | For every event of non-conformance* |
| Non-conformance with MAC for Fecal Coliform Standard | Rs.2000/ | For every event of non-conformance** |

* *An event is defined as online reporting duration not exceeding 3minutes i.e. a maximum of total 30 minutes a day i.e. 98% system reliability.*

** *An event is defined as daily composite sample, not exceeding one non-conforming sample in 30 samples in a month i.e. 97% system reliability.*

The cumulative of above liquidated damages shall not exceed the monthly O&M cost (Maximum Liquidated Damages).

**Condition-B: Breakdown of Equipment:**

In case of breakdown of equipment for more than the stipulated time period as below, on discretion of Engineer-in-Charge, the Contractor shall be penalized as mentioned below:

| Equipment | Breakdown Time Period | Penalty Imposed |
|---|---|---|
| **Critical Equipment/ Instrumentation** (Critical equipment shall mean those equipment's / systems which are essential to ensure the plants performance and it shall include all flow and treated effluent quality measuring instruments and systems including submersible mixers, blowers, MLE pump, sludge and MLSS recirculation pumps, Tertiary filters, disinfection, Biogas Power generation system, electrical systems such as critical electrical system such transformers, electrical panels etc. | beyond 72 hours | 3% of Monthly O&M Cost per day of default beyond permitted breakdown time period. |
| **Semi-Critical Equipment** | beyond 7 | 2% of Monthly O&M |

| Equipment | Breakdown Time Period | Penalty Imposed |
|---|---|---|
| Semi Critical equipment shall mean that equipment's / systems which are normally necessary to ensure the plants performance and they shall include but not limited to all screens, grit removal systems, clarifiers, sludge thickening, sludge hydrolysis and digestion systems etc. | days | Cost per day of default beyond permitted breakdown time period |
| **Non Critical Equipment**<br>Non Critical equipment shall mean that equipment's/ systems which have been provided at the plant are but are not critical in for delivering the plants performance, such as area lighting, air conditioners, Instruments not critical towards operation of the plant. | beyond 10 days | 1% of Monthly O&M Cost per day of default beyond permitted breakdown time period |

The cumulative of above liquidated damages shall not exceed the monthly O&M cost (Maximum Liquidated Damages).

**NOTE:** In case the non-conformance, on a continuous basis, due to Condition A and Condition B becomes equal to or more than 50% of the monthly O&M value for a period more than 3 months in a year i.e. 90 days in a year, then the Employer reserves the right to terminate the Contractor after in-cashing all the Security Deposits, retention Money and Performance Guarantees.

**Condition- C:** In any case if the grid power failure is more than 8 hrs. in a single occasion in a day or cumulative grid power failure is more than 8 hrs. in a day

a) No treatment standards will be compulsory. However, contractors are encouraged to maintain standards as far as possible. No penalties will be imposed on contractor. Above relaxation shall be applicable only for a period of 24 hours after resuming regular grid power.

**Condition-D: Liquidated Damages for not meeting the Power Consumption Guarantee**

Contractor shall give complete details of total power consumption, guaranteed power generation and net power consumption from grid by the contractor.

During Operation and Maintenance, damages payable by Contractor to Employer on excess consumption of net electrical energy shall be equal to the actual cost of the excess energy used for Operation and Maintenance of the Works for WWTP under the Contract, based on the guaranteed consumption provided by the Contractor and the current rates charged to the Employer for electricity consumed. Such payable will be assessed for each month during O&M period in which the actual power consumption exceeds the guaranteed power consumption calculated on a "kilowatt-hour consumed per litre of sewage" basis.

During Operation and Maintenance, damages payable by Contractor to Employer on reduction in Power Generation from WWTP shall be equal to the value of the power generation deficiency, based on the guaranteed Power Generation provided by the Contractor for WWTP and the current rates charged to the Employer for electricity consumed. Such payable by Contractor will be assessed for each month during the O&M Period in which the actual power generation is less than the guaranteed power

generation calculated on a "kilowatt-hour generated per litre of sewage treated" basis.

After the Completion Test, the guarantees would come into effect for net power consumption.

**Condition-E: Residual Handling & Disposal/ Reuse**

The Plant Residuals shall conform to the following specifications:

**Screenings**

The screenings shall comprise of all particles of an effective size in excess of 5 mm and be "free of dripping water "i.e. the screenings on collection does not contain any dripping water when disposed from the plant.

**Grit**

The grit removed shall contain less than 3% organic matter on dry basis of an average particle size between of more than 100 microns but less than 1000 microns and be free of dripping water

Screenings & Grit: Disposal to the Sanitary Land fill (the tipping charges shall be borne by the Contractor)

**Re-use of Sludge**

Dewatered Sludge shall be of suitable quality so that it can be re-used by the contractor without any restrictions for soil amendment, fertilizer, raw material in making bricks and pavement blocks or raw material for cement manufacturing or as a base material in construction of roads or any other option(s) that provides effective reuse of bio-solids (sludge) for beneficial purposes.

# REHABILITATION/UPGRADATION OF 5 NOS. EXISTING SEWAGE TREATMENT PLANTS (STPS) AND CONSTRUCTION OF 1 NO. NEW STP ON DESIGN, BUILD AND OPERATE (ONE YEAR DLP PLUS 15 YEARS O&M) BASIS AT CHANDIGARH UNDER SMART CITY MISSION

## REQUEST FOR PROPOSAL

**31-12-2018**

## VOLUME 4

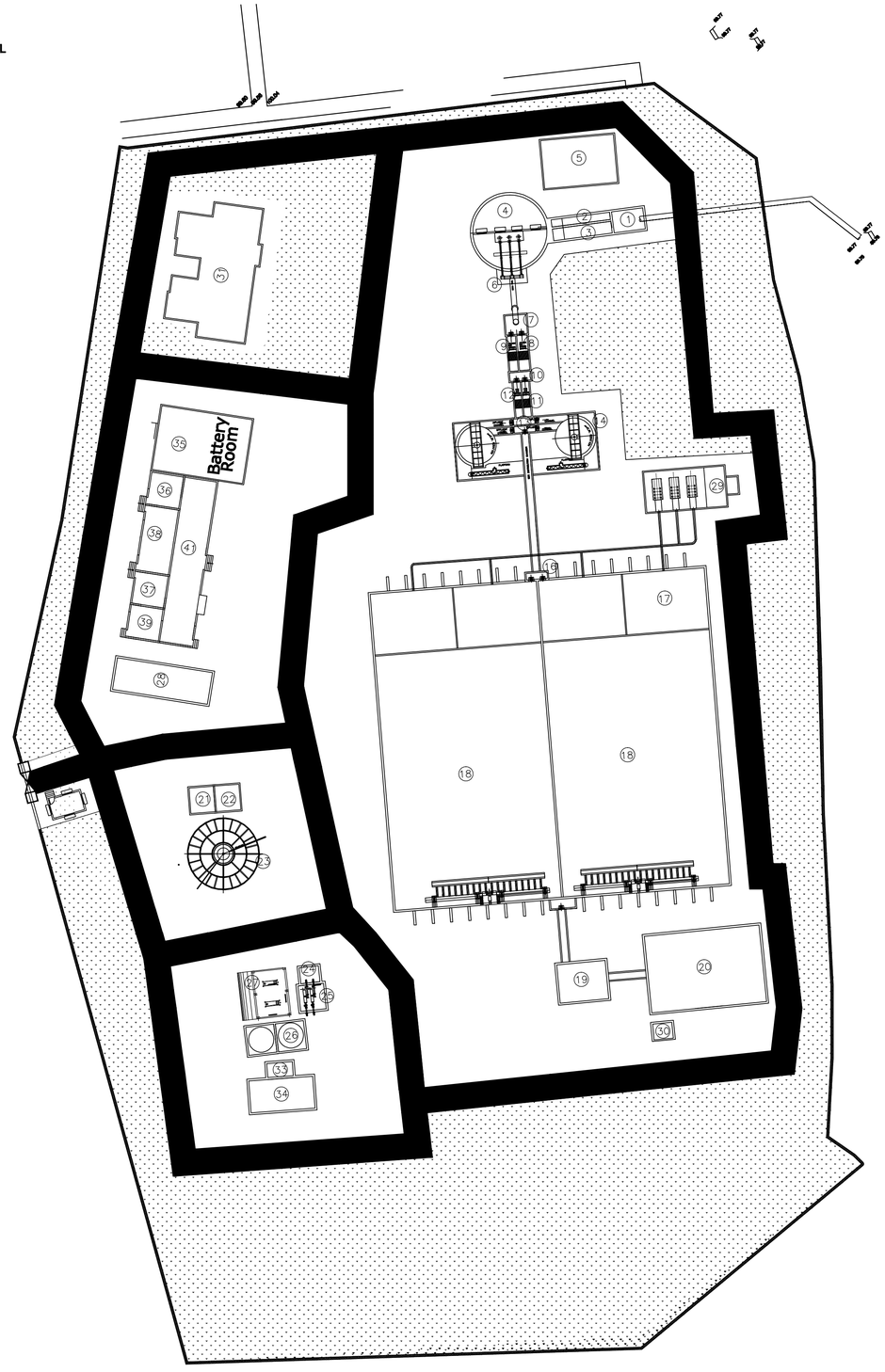
*Chandigarh Smart City Lmited*
**New Bridge Building - 2, 2nd Floor, Near TDI Mall, Sector 17 – A, Chandigarh – 160017**

# VOLUME 4 - SECTION XIII

## List of Conceptual Drawings

1. **LAYOUT PLAN OF 5.0 MGD STP AT RAIPUR KALAN**
2. **HYDRAULIC FLOW DIAGRAM (HFD) OF 5.0 MGD STP AT RAIPUR KALAN**
3. **PIPING AND INSTRUEMENTATION DIAGRAM (P&ID) OF 5.0 MGD STP AT RAIPUR KALAN**
4. **LAYOUT PLAN OF 2.0 MGD STP AT RAIPUR KHURD**
5. **HYDRAULIC FLOW DIAGRAM (HFD) OF 2.0 MGD STP AT RAIPUR KHURD**
6. **PIPING AND INSTRUEMENTATION DIAGRAM (P&ID) OF 2.0 MGD STP AT RAIPUR KHURD**
7. **LAYOUT PLAN OF 30.0 MGD STP AT DIGGIAN**
8. **HYDRAULIC FLOW DIAGRAM (HFD) OF 30.0 MGD STP AT DIGGIAN**
9. **PIPING AND INSTRUEMENTATION DIAGRAM (P&ID) OF 30.0 MGD STP AT DIGGIAN**
10. **LAYOUT PLAN ADDITIONAL UNITS OF 11 MGD STP AT 3 BRD**
11. **LAYOUT PLAN ADDITIONAL UNITS OF 1.65 MGD STP AT DHANAS**
12. **LAYOUT PLAN OF 2.0 MLD STP AT SUKHNA LAKE**
13. **HYDRAULIC FLOW DIAGRAM (HFD) OF 2.0 MLD STP AT SUKHNA LAKE**
14. **PIPING AND INSTRUEMENTATION DIAGRAM (P&ID) OF 2.0 MLD STP AT SUKHNA LAKE**

PLANT ROAD
BOUNDARY WALL
GREENERY
TREE

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## LIST OF CIVIL UNITS, STP, RAIPUR KALAN

### 1. UNIT OF MPS - RAIPUR KALAN

| Sl. No. | Units | Quantity | Length/ Dia, m | Width m | SWD/ HT,m | FB m |
|---|---|---|---|---|---|---|
| 1 | Receiving Chamber | 1 | 3.00 | 3.00 | 2.00 | 4.83 |
| 2 | Coarse Screen Channel - Mechanical | 1 | 5.50 | 1.30 | 0.90 | 6.00 |
| 3 | Coarse Screen Channel - Manual | 1 | 5.50 | 1.30 | 0.90 | 6.00 |
| 4 | Raw Sewage Sump | 1 | 9.00 | Dia | 3.00 | 6.47 |
| 5 | Raw Sewage Pump House | 1 | 20.00 | 20.00 | 5.50 | - |
| 6 | Valve Chamber Platform | 1 | 7.00 | 7.00 | 2.00 | - |

### 2. LIST OF CIVIL UNITS OF 5 MGD STP AT RAIPUR KALAN

| Sl. No. | Units | Quantity | Length m | Width m | SWD/ HT, m | FB m |
|---|---|---|---|---|---|---|
| 7 | Inlet Chamber | 1 | 3.00 | 3.30 | 2.00 | 0.50 |
| 8 | Medium Screen Channel - Mechanical | 1 | 5.50 | 1.60 | 0.90 | 0.50 |
| 9 | Medium Screen Channel - Manual | 1 | 5.50 | 1.30 | 0.90 | 0.50 |
| 10 | Fine Screen Distribution Chmber | 1 | 1.35 | 3.30 | 2.00 | 0.50 |
| 11 | Fine Screen Channel - Mechanical | 1 | 5.50 | 1.10 | 0.90 | 0.50 |
| 12 | Fine Screen Channel - Manual | 1 | 5.50 | 1.10 | 0.90 | 0.50 |
| 13 | Grit Distribution Chamber | 1 | 2.70 | 3.30 | 1.00 | 0.50 |
| 14 | Grit Chamber - Vortex | 2 | 8.00 | 8.00 | 1.15 | 0.50 |
| 15 | Parshall Flume Channel | 2 | 12.50 | 0.60 | 0.80 | 0.50 |
| 16 | SBR Inlet Chamber | 1 | 4.50 | 1.50 | 1.10 | 0.50 |
| 17 | SBR Basins | 2 | 49.50 | 26.00 | 5.0 | 0.5 |
| 18 | Anoxic Zone | 2 | 3.00 | 26.00 | 5.0 | 0.5 |
| 19 | Filter Bed Platform | - | 7.60 | 6.00 | - | - |
| 20 | Chlorination Tank | 1 | 18.00 | 12.00 | 5.00 | 0.50 |
| 21 | Sludge Sump | 1 | 4.00 | 4.00 | 2.00 | 0.50 |
| 22 | Thickener Feed Pumping Station | 1 | 4.00 | 4.00 | - | - |
| 23 | Gravity Sludge Thickener | 2 | 11.00 | Dia. | 3.00 | 0.50 |
| 24 | Centrifuge feed sump | 1 | 3.00 | 2.50 | 2.00 | 0.50 |
| 25 | Centrifuge Pumping Station | 1 | 4.00 | 4.00 | 3.50 | - |
| 26 | Dewatering Polyelectrolyte Dosing Tanks | 2 | 2.00 | Dia. | 2.00 | 0.50 |
| 27 | Centrifuge Building | 1 | 10.00 | 8.00 | 9.00 | G+1 |
| 28 | MCC & Electrical Panel Room | 1 | 15.00 | 5.00 | 4.50 | - |
| 29 | SBR Air Blower | 1 | 20.00 | 11.00 | 6.00 | - |
| 30 | Chlorination cum Chlorine | 1 | 4.00 | 4.00 | 4.50 | - |
| 31 | Admin Building | 1 | 21.00 | 12.50 | 3.60 | G+1 |
| 32 | Guard Room | 1 | 3.00 | 3.00 | 3.00 | - |
| 33 | Filtrate Sump | 1 | 4.00 | 2.50 | 1.50 | 0.50 |
| 34 | Filterate Pump House | 1 | 10.00 | 5.00 | - | - |
| 35 | HT Panel Room | 1 | 5.00 | 5.00 | 5.00 | - |
| 36 | Transformer Room | 1 | 5.00 | 5.00 | 5.00 | - |
| 37 | Metering Room | 1 | 5.00 | 5.00 | 5.00 | - |
| 38 | DG Set Room | 1 | 12.00 | 10.00 | 4.50 | - |
| 39 | Electrical Authority Room | 1 | 5.00 | 5.00 | 4.50 | - |
| 40 | Battery Room Control Panel Room | 1 | 5.00 | 5.00 | 3.50 | - |
| 41 | Control Panel Room | 1 | 25.00 | 5.00 | 4.50 | - |
| 42 | Boundary Wall | 1 | 470.00 | - | - | - |

| REV.NO. | DATE | DESCRIPTION | DRAWN | CKD. BY | APPD. BY |
|---|---|---|---|---|---|
| 2 | | | | | |
| 1 | | | | | |
| 0 | 16/08/2018 | | | | |

**CLIENT :** CHANDIGARH SMART CITY LIMITED (CSCL)

**DOCUMENT:** DRAFT DETAILED PROJECT REPORT TREATMENT FACILITY (AUGMENTATION OF EXISTING STPs)

**CONSULTANT**
egis INTERNATIONAL S.A.
ROOM NO. 21/22/23, GROUND FLOOR, NEW DELUXE BUILDING, JAN MARG, SECTOR-17-E, CHANDIGSRH - 160017

**PROJECT :** TO DESIGN, DEVELOP, MANAGE AND IMPLEMENT SMART CITY PROJECTS UNDER SMART CITY MISSION IN CHANDIGARH (UT)

**DRAWING TITLE**
LAYOUT PLAN OF 5.0 MGD STP AT RAIPUR KALAN

DRAWING NUMBER: CHD/P/LA/STP/001
REVISION NUMBER: R-0
DATE : 16/08/2018
SHEET N0: 01 OF 01 | SHEET SIZE: A1 | SCALE SIZE: 1:275


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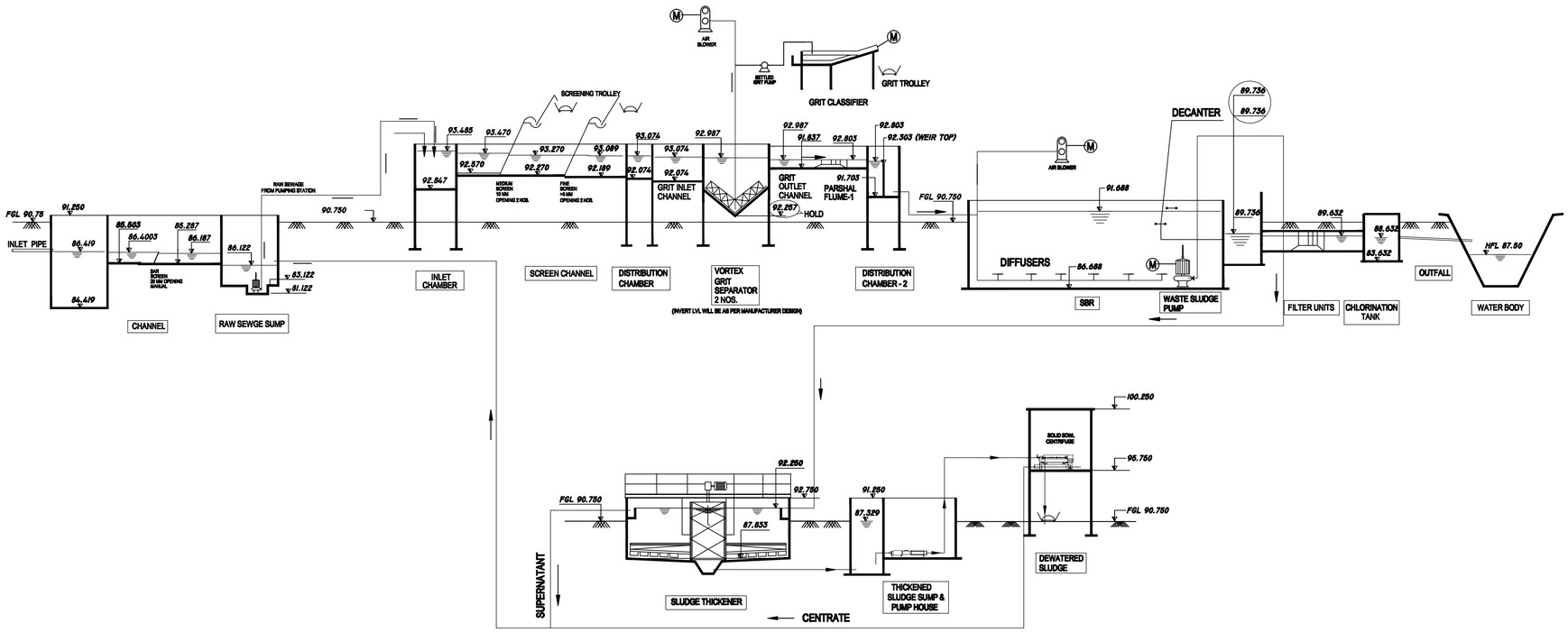


## HYDRAULIC FLOW DIAGRAM
SCALE - NTS

NOTES:-
1) ALL DIMENSIONS ARE IN mm & LEVELS ARE IN MTER, UNLESS OTHERWISE STATED.
2) PLANT FINISH GROUND LEVEL IS (FGL) = 90.750 M
3) PLEASE REFER P&ID DRG. NO.:CH/D/P/P&ID/STP/03/REV.0 FOR SIZING OF ALL PIPES AND CHANNELS.

| LEGENDS:- | | |
|---|---|---|
| 1. | TL | - TOP LEVEL |
| 2. | IL | - INVERT LEVEL |
| 3. | WL | - WATER LEVEL |
| 4. | BWL | - BOTTOM WATER LEVEL |
| 5. | TWL | - TOP WATER LEVEL |
| 6. | FGL | - FINISH GROUND LEVEL |
| 7. | FFL | - FINISH FLOOR LEVEL |

| REV.NO. | DATE | DESCRIPTION | DRAWN | CKD. BY | APPD. BY |
|---|---|---|---|---|---|
| 2 | | | | | |
| 1 | | | | | |
| 0 | 16/08/2018 | | | | |

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CONSULTANT
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**PROJECT :** TO DESIGN, DEVELOP, MANAGE AND IMPLEMENT SMART CITY PROJECTS UNDER SMART CITY MISSION IN CHANDIGARH (UT)

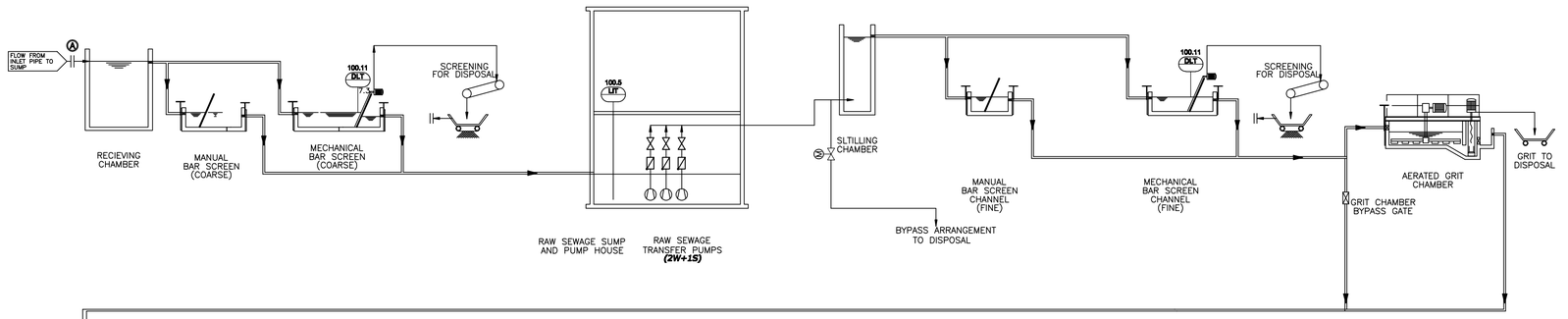
DRAWING TITLE
HYDRAULIC FLOW DIAGRAM OF 5.0 MGD STP AT RAIPUR KALAN

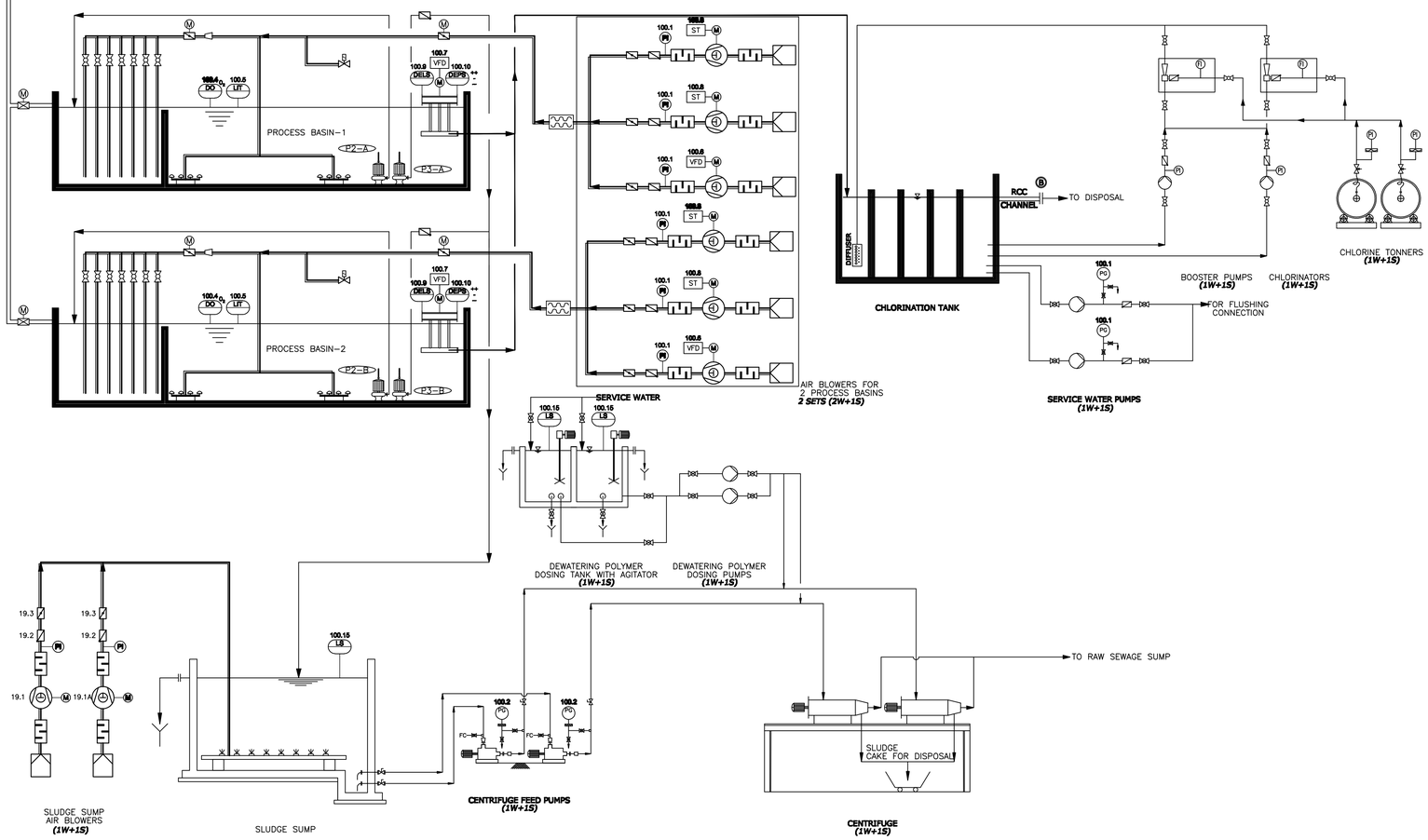
DRAWING NUMBER: CHD/P/LA/STP/002

REVISION NUMBER: R-0

DATE : 16/08/2018

| SHEET NO: 01 OF 01 | SHEET SIZE: A1 | SCALE SIZE: 1:275 |
|---|---|---|




## INSTRUMENT LIST

| MK.NO. | DESCRIPTION | QTY. | REMARK |
|---|---|---|---|
| PI 100.1 | PRESSURE GAUGES | 14 | BOURDON TYPE |
| PI 100.2 | PRESSURE GAUGES | 03 | DIAPHRAGM TYPE |
| DO 100.4 | DISSOLVED OXYGEN METER | 02 | IMMERSION TYPE |
| LIT 100.5 | LEVEL INDIACATING TRANSMITTER | 03 | |
| VFD 100.6 | VARIABLE FREQUENCY DRIVE | 01 | FOR BLOWERS |
| VFD 100.7 | VARIABLE FREQUENCY DRIVE | 02 | FOR DECANTERS |
| ST 100.8 | SOFT STARTER | 02 | FOR BLOWER |
| DELS 100.9 | DECANTER LEVEL SENSOR | 02 | FOR DECANTER |
| DEPS 100.10 | DECANTER POSITION SENSOR | 2 SETS | FOR DECANTER |
| DLT 100.11 | DIFFERENTIAL LEVEL TRANSMITTER | 02 | ULTRASONIC |
| LS 100.15 | LEVEL SWITCH | 03 | |
| | | | |

## TERMINATION POINT (ALL FLG. DRILLED TO ASA 150 #)

| MK.NO. | DESCRIPTION | PRESSURE | REMARK |
|---|---|---|---|
| A | RAW SEWAGE INLET | ATMOSPHERIC | |
| B | CHLORINATION TANK OUTLET | ATMOSPHERIC | |
| | | | |

## LINE LEGEND

| | |
|---|---|
| | PROCESS LINE |
| | AUXILARY LINE |
| | AIR LINE |
| | INSTRUMENT SIGNAL |
| | DRAIN LINE |
| | RCC CHANNEL |

## LEGEND

| | |
|---|---|
| | NON–RETURN VALVE |
| | BUTTERFLY VALVE |
| | PNEUMATIC BUTTERFLY VALVE |
| M | MOTORIZED GATE |
| | GATE VALVE |
| | BALL VALVE |
| | NEEDLE VALVE |
| VFD | VARIABLE FREQUENCY DRIVE |
| ST | SOFT STARTER |
| FC | FLUSHING CONNECTION |
| | AIR COOLER |

| REV.NO. | DATE | DESCRIPTION | DRAWN | CKD. BY | APPD. BY |
|---|---|---|---|---|---|
| 2 | | | | | |
| 1 | | | | | |
| 0 | 16/08/2018 | | | | |

**CLIENT :** CHANDIGARH SMART CITY LIMITED (CSCL)

**DOCUMENT:** DRAFT DETAILED PROJECT REPORT TREATMENT FACILITY (AUGMENTATION OF EXISTING STPs)

**CONSULTANT**

egis INTERNATIONAL S.A.
ROOM NO. 21/22/23, GROUND FLOOR, NEW DELUXE BUILDING, JAN MARG, SECTOR-17-E, CHANDIGSRH - 160017

**PROJECT :** TO DESIGN, DEVELOP, MANAGE AND IMPLEMENT SMART CITY PROJECTS UNDER SMART CITY MISSION IN CHANDIGARH (UT)

**DRAWING TITLE**
PIPING AND INSTRUEMENTATION DIAGRAM (P&ID) OF 5.0 MGD STP AT RAIPUR KALAN

**DRAWING NUMBER:** CHD/P/P&ID/STP/03

**REVISION NUMBER:** R-0

**DATE :** 16/08/2018

| SHEET N0: 01 OF 01 | SHEET SIZE: A1 | SCALE SIZE: 1:275 |
|---|---|---|

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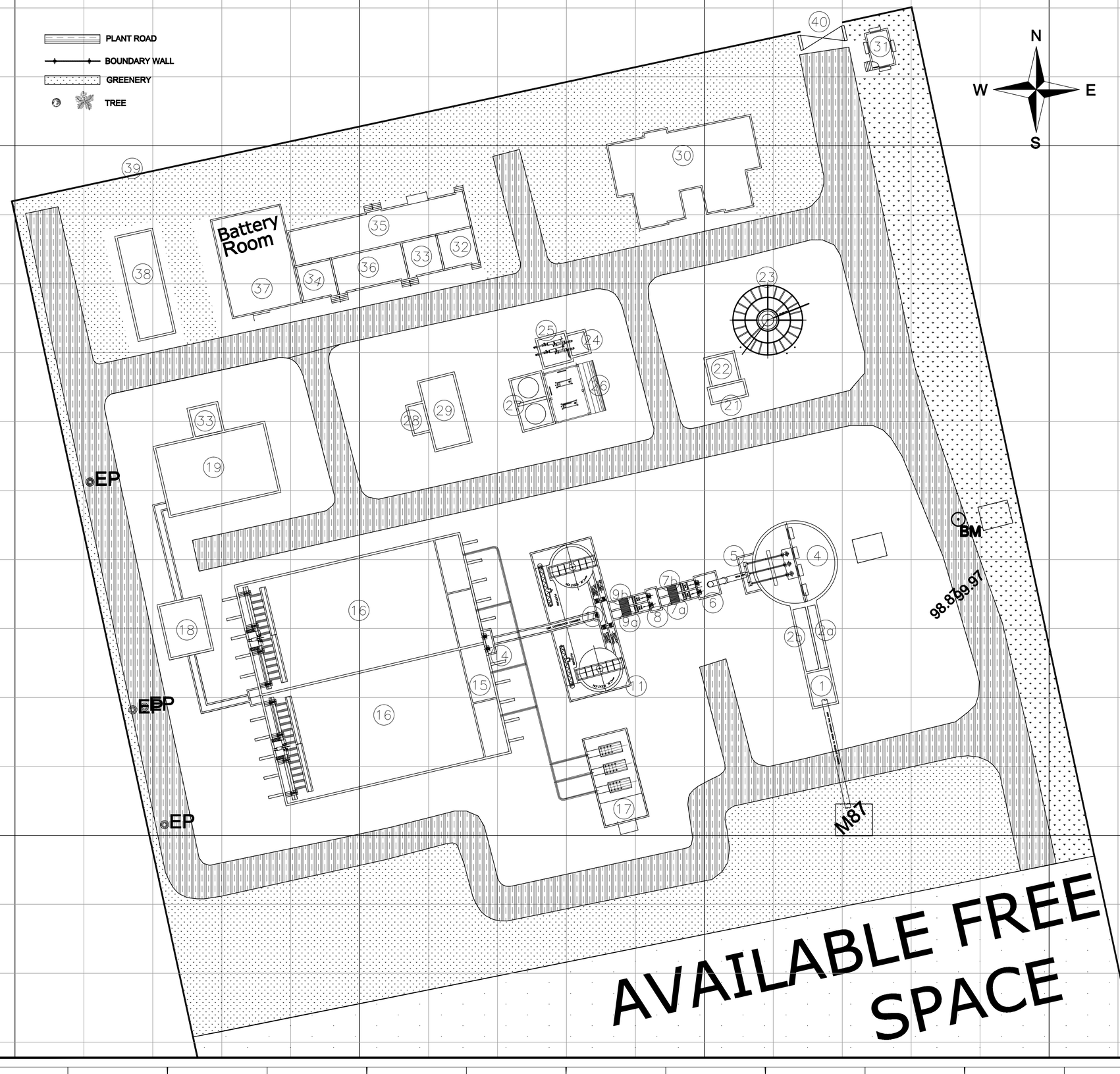


## LIST OF CIVIL UNITS, STP, RAIPUR KHURD

| Sl. No. | Units | Quantity | Length / Dia, m | Width m | SWD/ HT m | FB m |
|---|---|---|---|---|---|---|
| 1 | Receiving Chamber | 1 | 2.50 | 3.20 | 0.50 | 6.33 |
| 2 | Coarse Screen Channel - (Mechanical + Manual) | 2 | 5.00 | 1.10 | 0.50 | 0.50 |
| 3 | Common Outlet Chamber | 1 | 2.50 | 3.20 | 0.50 | 0.50 |
| 4 | Raw Sewage Sump | 1 | 6.00 | **Dia** | 3.00 | 0.50 |
| 5 | Valve Chamber Platform | 1 | 6.00 | 4.00 | 2.00 | - |
| **2. LIST OF SEWAGE TREATMENT PLANT AT RAIPUR KHURD** | | | | | | |
| 6 | Inlet Chamber | 1 | 3.00 | 3.10 | 0.90 | 0.50 |
| 7 | Medium Screen Channel - | 2 | 5.50 | 1.10 | 0.50 | 0.50 |
| 8 | Fine Distribution Chamber | 1 | 3.00 | 3.10 | 0.90 | 0.50 |
| 9 | Fine Screen Channel - (Mechanical+Manual) | 2 | 5.50 | 1.10 | 0.50 | 0.50 |
| 10 | Grit Distribution Chamber | 1 | 2.00 | 2.00 | 0.75 | 0.50 |
| 11 | Grit Chamber - Vortex | 2 | 3.50 | Dia. | 1.25 | 0.50 |
| 12 | Parshall Flume | 1 | 9.60 | 0.30 | 0.50 | 0.50 |
| 13 | Distribution Chamber | 1 | 3.00 | 2.00 | 0.50 | 0.50 |
| 14 | SBR Inlet Chamber | 1 | 2.00 | 0.75 | 1.20 | 0.50 |
| 15 | Anoxic Zone | 2 | **3.50** | **16.00** | **5.00** | **0.50** |
| 16 | SBR Basins | 2 | **33.00** | **16.00** | **5.00** | **0.50** |
| 17 | SBR Air Blower | 1 | 20.00 | 11.00 | 6.00 | - |
| 18 | Filter Platform | 1 | 7.60 | 6.00 | - | - |
| 19 | Chlorination Tank | 1 | 16.00 | 10.00 | 3.00 | 0.50 |
| 20 | Chlorination cum Chlorine | 1 | 4.00 | 4.00 | 4.50 | - |
| 21 | Sludge Sump | 1 | 2.00 | 5.00 | 1.50 | 0.50 |
| 22 | Thickener Feed Pumping Station | 1 | 4.00 | 4.00 | - | - |
| 23 | Gravity Sludge Thickener | 1 | 10.00 | Dia. | 2.50 | 0.50 |
| 24 | Centrifuge Feed Sump | 1 | 2.25 | 2.00 | 1.50 | 0.50 |
| 25 | Centrifuge Feed Pumping Station | 1 | 4.00 | 4.00 | 3.50 | - |
| 26 | Centrifuge Building | 1 | 10.00 | 8.00 | 9.00 | - |
| 27 | Dewatering Polyelectrolyte Dosing Tanks | 2 | 1.50 | **Dia.** | 1.50 | 0.50 |
| 28 | Filtrate Sump | 1 | 2.00 | 2.00 | 0.90 | 0.50 |
| 29 | Filterate Pump House | 1 | 10.00 | 5.00 | - | - |
| 30 | Admin Building | 1 | 21.00 | 12.50 | 3.60 | G+1 |
| 31 | Guard Room | 1 | 3.00 | 3.00 | 3.00 | - |
| 32 | HT Panel Room | 1 | 5.00 | 5.00 | 5.00 | - |
| 33 | Transformer Room | 1 | 5.00 | 5.00 | 5.00 | - |
| 34 | Metering Room | 1 | 5.00 | 5.00 | 5.00 | - |
| 35 | DG Set Room | 1 | 12.00 | 5.00 | 4.50 | - |
| 36 | Electrical Authority Room | 1 | 5.00 | 10.00 | 4.50 | - |
| 37 | Battery Room Control Panel Room | 1 | 5.00 | 5.00 | 3.50 | - |
| 38 | Control Panel Room | 1 | 25.00 | 5.00 | 4.50 | - |
| 39 | Boundary Wall | 1 | 880.00 | - | - | - |
| 40 | Gate | 1 | - | - | - | - |

| REV.NO. | DATE | DESCRIPTION | DRAWN | CKD. BY | APPD. BY |
|---|---|---|---|---|---|
| 2 | | | | | |
| 1 | | | | | |
| 0 | 07/11/2016 | SUBMITTED | | | |

**CLIENT :** CHANDIGARH SMART CITY LIMITED (CSCL)

**DOCUMENT:** DRAFT DETAILED PROJECT REPORT TREATMENT FACILITY (AUGMENTATION OF EXISTING STPs)

**CONSULTANT**

egis INTERNATIONAL S.A.
ROOM NO. 21/22/23, GROUND FLOOR, NEW DELUXE BUILDING, JAN MARG, SECTOR-17-E, CHANDIGSRH - 160017

**PROJECT :** TO DESIGN, DEVELOP, MANAGE AND IMPLEMENT SMART CITY PROJECTS UNDER SMART CITY MISSION IN CHANDIGARH (UT)

**DRAWING TITLE**

LAYOUT PLAN OF 2.0 MGD STP AT RAIPUR KHURD

**DRAWING NUMBER:** CHD/P/LA/STP/004

**REVISION NUMBER:** R-0

**DATE :** 16/08/2018

| SHEET N0: 01 OF 01 | SHEET SIZE: A1 | SCALE SIZE: 1:275 |
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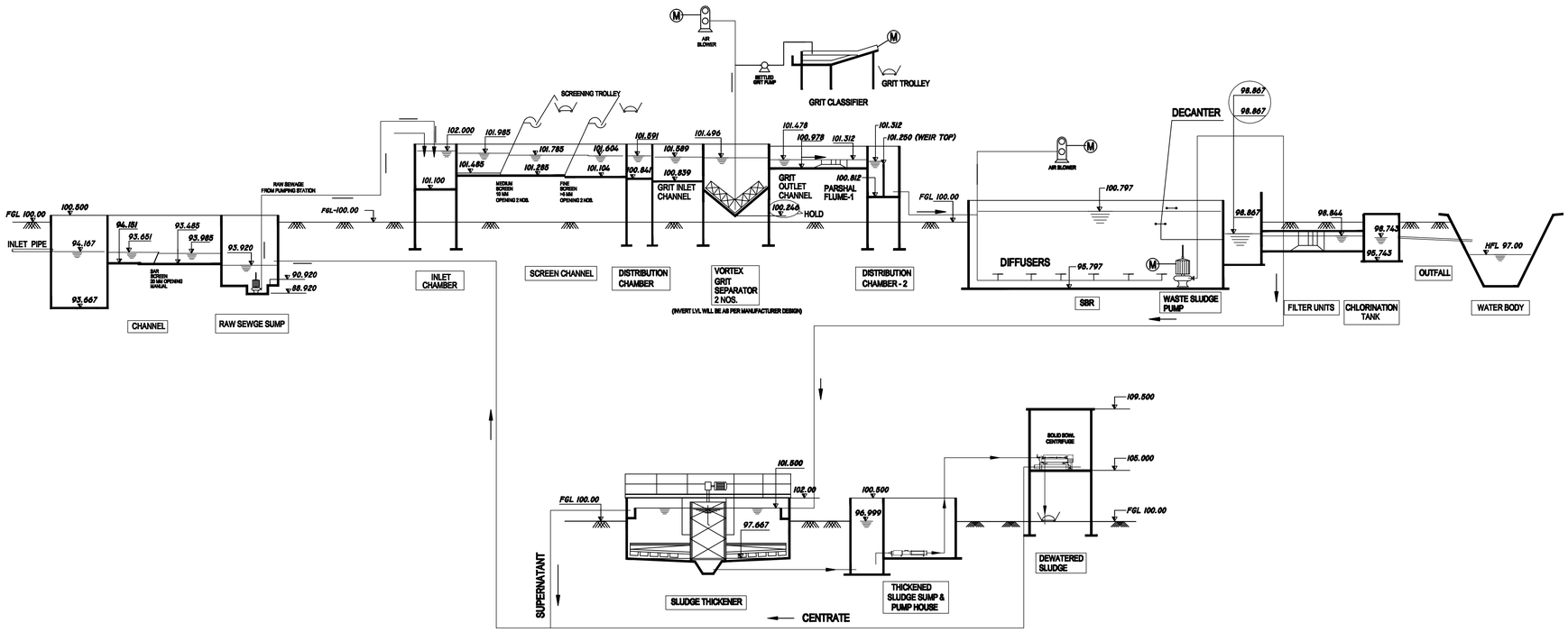


## HYDRAULIC FLOW DIAGRAM
SCALE - NTS

NOTES:-
1) ALL DIMENSIONS ARE IN mm & LEVELS ARE IN MTER, UNLESS OTHERWISE STATED.
2) PLANT FINISH GROUND LEVEL IS (FGL) = 100.00 M
3) PLEASE REFER P&ID DRG. NO.CHD/P/P&ID/STP/05/REV.0 FOR SIZING OF ALL PIPES AND CHANNELS.

| LEGENDS:- | | |
|---|---|---|
| 1. | TL | - TOP LEVEL |
| 2. | IL | - INVERT LEVEL |
| 3. | WL | - WATER LEVEL |
| 4. | BWL | - BOTTOM WATER LEVEL |
| 5. | TWL | - TOP WATER LEVEL |
| 6. | FGL | - FINISH GROUND LEVEL |
| 7. | FFL | - FINISH FLOOR LEVEL |

| REV.NO. | DATE | DESCRIPTION | DRAWN | CKD. BY | APPD. BY |
|---|---|---|---|---|---|
| 2 | | | | | |
| 1 | | | | | |
| 0 | 16/08/2018 | | | | |

**CLIENT :** CHANDIGARH SMART CITY LIMITED (CSCL)

**DOCUMENT:** DRAFT DETAILED PROJECT REPORT TREATMENT FACILITY (AUGMENTATION OF EXISTING STPs)

CONSULTANT
egis INTERNATIONAL S.A.
ROOM NO. 21/22/23, GROUND FLOOR, NEW DELUXE BUILDING, JAN MARG, SECTOR-17-E, CHANDIGSRH - 160017

**PROJECT :** TO DESIGN, DEVELOP, MANAGE AND IMPLEMENT SMART CITY PROJECTS UNDER SMART CITY MISSION IN CHANDIGARH (UT)

DRAWING TITLE
HYDRAULIC FLOW DIAGRAM OF 2.0 MGD STP AT RAIPUR KHURD

DRAWING NUMBER: CHD/P/LA/STP/005

REVISION NUMBER: R-0

DATE : 16/08/2018

| SHEET NO: 01 OF 01 | SHEET SIZE: A1 | SCALE SIZE: 1:275 |
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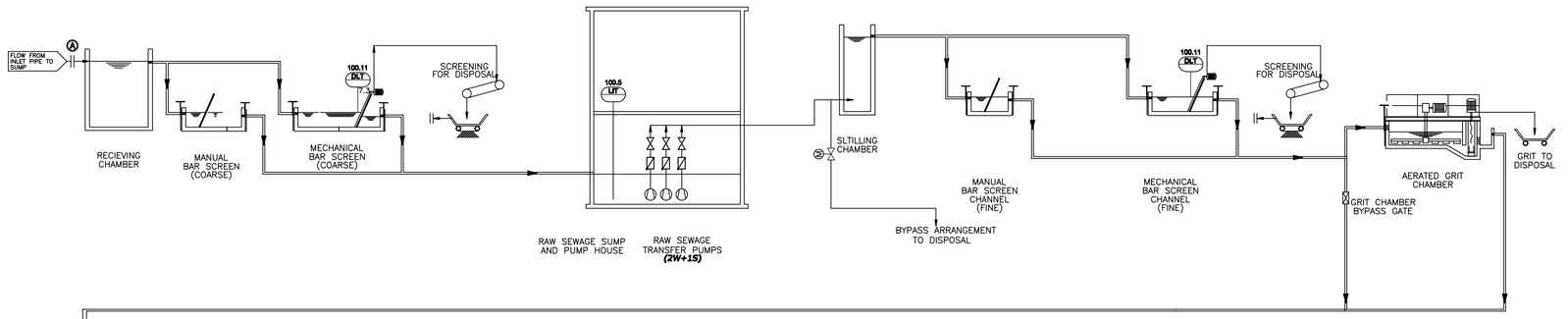


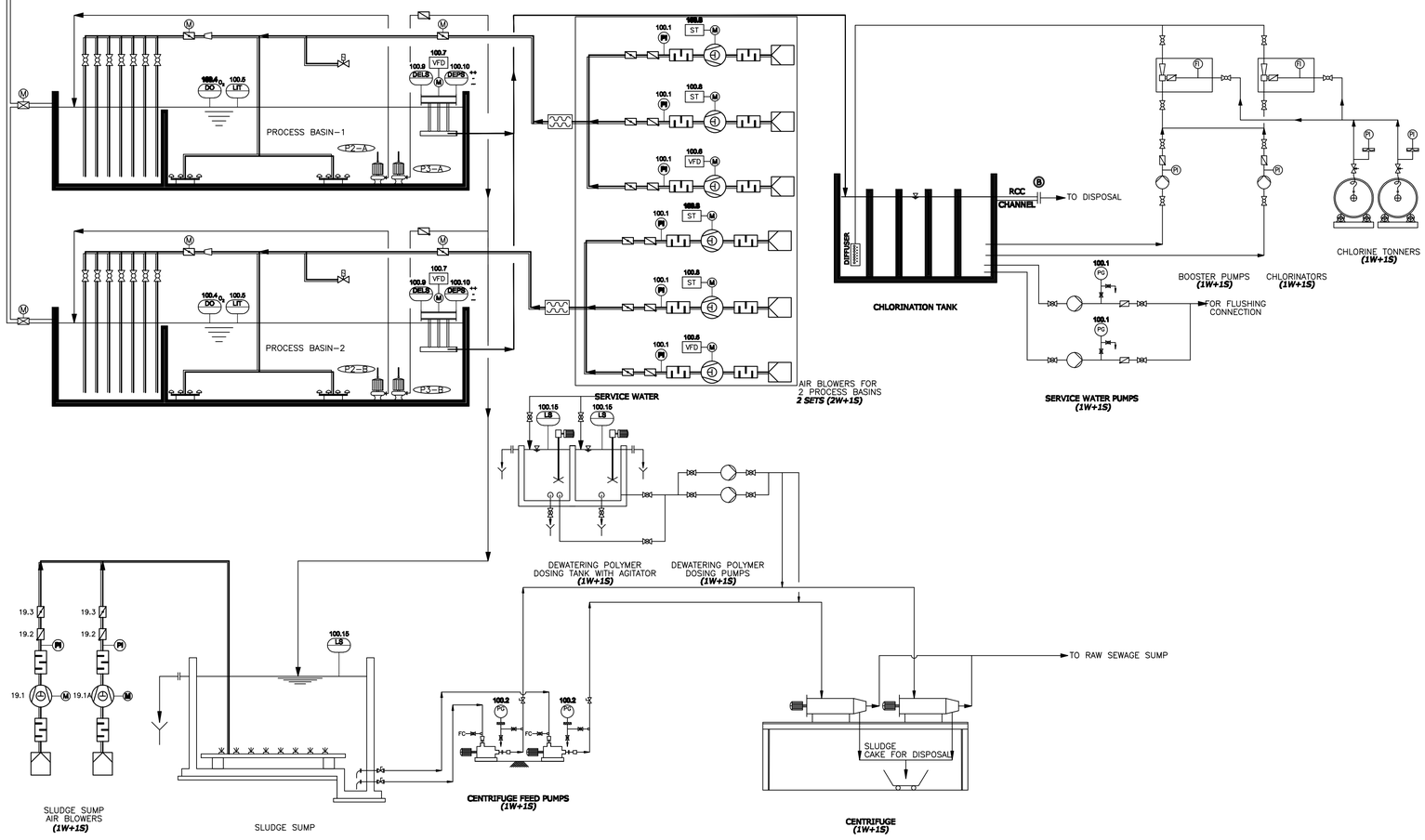


## INSTRUMENT LIST

| MK.NO. | DESCRIPTION | QTY. | REMARK |
|---|---|---|---|
| PI 100.1 | PRESSURE GAUGES | 14 | BOURDON TYPE |
| PI 100.2 | PRESSURE GAUGES | 03 | DIAPHRAGM TYPE |
| DO 100.4 | DISSOLVED OXYGEN METER | 02 | IMMERSION TYPE |
| LIT 100.5 | LEVEL INDIACATING TRANSMITTER | 03 | |
| VFD 100.6 | VARIABLE FREQUENCY DRIVE | 01 | FOR BLOWERS |
| VFD 100.7 | VARIABLE FREQUENCY DRIVE | 02 | FOR DECANTERS |
| ST 100.8 | SOFT STARTER | 02 | FOR BLOWER |
| DELS 100.9 | DECANTER LEVEL SENSOR | 02 | FOR DECANTER |
| DEPS 100.10 | DECANTER POSITION SENSOR | 2 SETS | FOR DECANTER |
| DLT 100.11 | DIFFERENTIAL LEVEL TRANSMITTER | 02 | ULTRASONIC |
| LS 100.15 | LEVEL SWITCH | 03 | |
| | | | |

## TERMINATION POINT (ALL FLG. DRILLED TO ASA 150 #)

| MK.NO. | DESCRIPTION | PRESSURE | REMARK |
|---|---|---|---|
| A | RAW SEWAGE INLET | ATMOSPHERIC | |
| B | CHLORINATION TANK OUTLET | ATMOSPHERIC | |
| | | | |

## LINE LEGEND

| | |
|---|---|
| | PROCESS LINE |
| | AUXILARY LINE |
| | AIR LINE |
| | INSTRUMENT SIGNAL |
| | DRAIN LINE |
| | RCC CHANNEL |

## LEGEND

| | |
|---|---|
| | NON-RETURN VALVE |
| | BUTTERFLY VALVE |
| | PNEUMATIC BUTTERFLY VALVE |
| M | MOTORIZED GATE |
| | GATE VALVE |
| | BALL VALVE |
| | NEEDLE VALVE |
| VFD | VARIABLE FREQUENCY DRIVE |
| ST | SOFT STARTER |
| FC | FLUSHING CONNECTION |
| | AIR COOLER |

| REV.NO. | DATE | DESCRIPTION | DRAWN | CKD. BY | APPD. BY |
|---|---|---|---|---|---|
| 2 | | | | | |
| 1 | | | | | |
| 0 | 16/08/2018 | | | | |

**CLIENT :** CHANDIGARH SMART CITY LIMITED (CSCL)

**DOCUMENT:** DRAFT DETAILED PROJECT REPORT TREATMENT FACILITY (AUGMENTATION OF EXISTING STPs)

**CONSULTANT**

egis INTERNATIONAL S.A.
ROOM NO. 21/22/23, GROUND FLOOR, NEW DELUXE BUILDING, JAN MARG, SECTOR-17-E, CHANDIGSRH - 160017

**PROJECT :** TO DESIGN, DEVELOP, MANAGE AND IMPLEMENT SMART CITY PROJECTS UNDER SMART CITY MISSION IN CHANDIGARH (UT)

**DRAWING TITLE**
PIPING AND INSTRUEMENTATION DIAGRAM (P&ID) OF 2.0 MGD STP AT RAIPUR KHURD

**DRAWING NUMBER:** CHD/P/P&ID/STP/06

**REVISION NUMBER:** R-0

**DATE :** 16/08/2018

| SHEET N0: 01 OF 01 | SHEET SIZE: A1 | SCALE SIZE: 1:275 |
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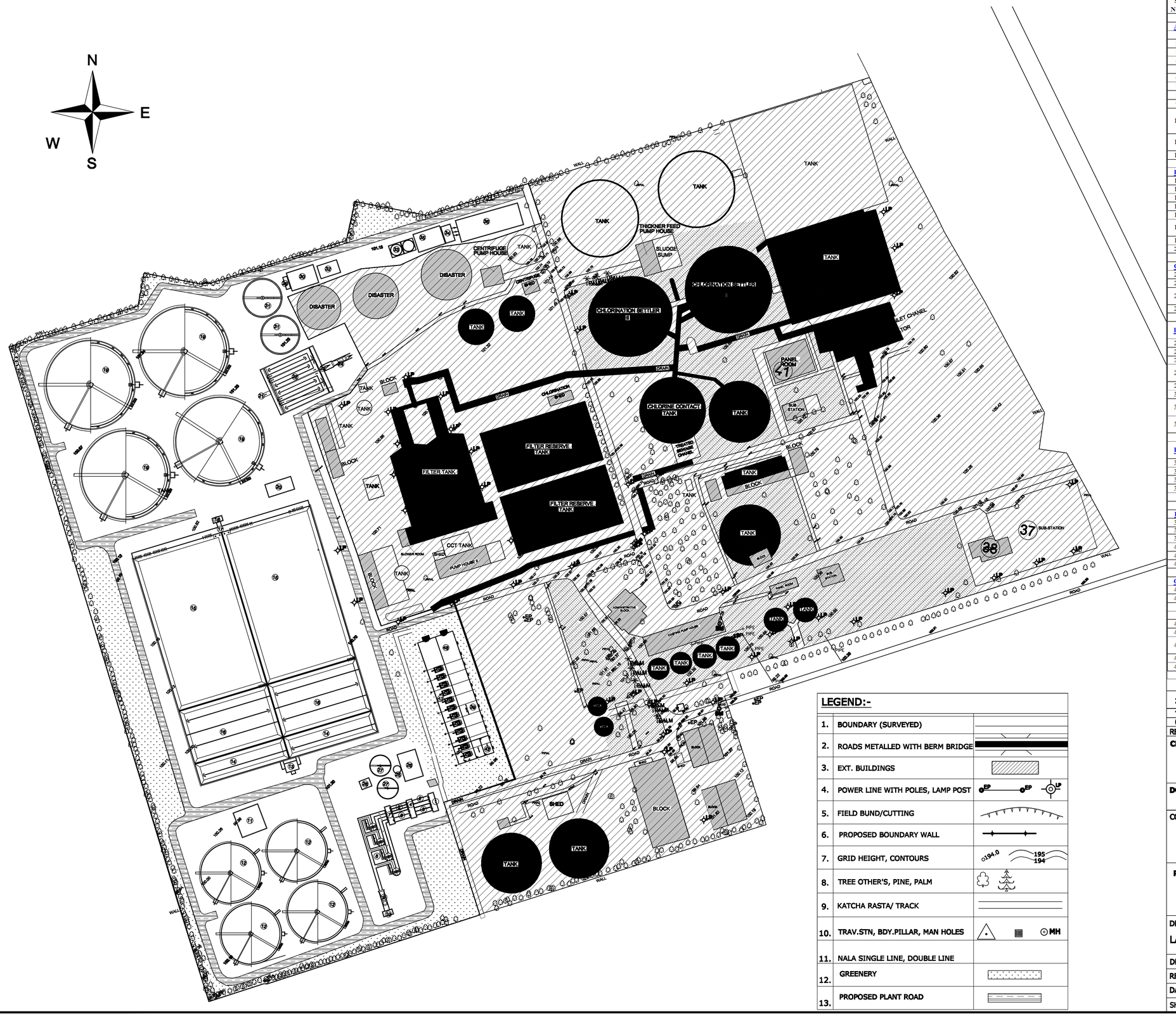


## LEGEND:-

| | | |
|---|---|---|
| 1. | BOUNDARY (SURVEYED) | |
| 2. | ROADS METALLED WITH BERM BRIDGE | |
| 3. | EXT. BUILDINGS | |
| 4. | POWER LINE WITH POLES, LAMP POST | EP EP LP |
| 5. | FIELD BUND/CUTTING | |
| 6. | PROPOSED BOUNDARY WALL | |
| 7. | GRID HEIGHT, CONTOURS | 194.0 195 194 |
| 8. | TREE OTHER'S, PINE, PALM | |
| 9. | KATCHA RASTA/ TRACK | |
| 10. | TRAV.STN, BDY.PILLAR, MAN HOLES | MH |
| 11. | NALA SINGLE LINE, DOUBLE LINE | |
| 12. | GREENERY | |
| 13. | PROPOSED PLANT ROAD | |

## LIST OF CIVIL UNITS, STP, DIGGIAN

| S. Nos. | Component | No. of T | No. of W | Size in metres L | W | Dia | D/H | FB |
|---|---|---|---|---|---|---|---|---|
| A. | **PRIMARY TREATMENT** | | | | | | | |
| 1 | Inlet Chamber | 1 | 1 | 2.8 | 10.00 | - | 1.80 | 0.50 |
| 2 | Mechanical Medium Screen Channel | 3 | 3 | 8.5 | 1.80 | - | 0.90 | 0.50 |
| 3 | Mannual Medium Screen Channel | 2 | 2 | 8.5 | 1.80 | - | 0.90 | 0.50 |
| 4 | Fine Screen Distribution Chamber | 1 | 1 | 6.5 | 8.30 | - | 0.94 | 0.50 |
| 5 | Fine Screen Channels - Mechanical | 3 | 3 | 8.5 | 1.10 | - | 0.90 | 0.50 |
| 6 | Fine Screen Channels - Mannual | 2 | 2 | 8.5 | 2.00 | - | 0.90 | 0.50 |
| 7 | Aerated Grit Distribution Chamber | 1 | 1 | 2.4 | 8.00 | - | 1.00 | 0.50 |
| 8 | Aerated Grit Chamber | 4 | 4 | 26.2 | 3.02 | - | 3.00 | 0.50 |
| 9 | Parshall Flume | 2 | 2 | 24.3 | 1.20 | - | 0.90 | 0.50 |
| 10 | RCC Channel from GRIT CHAMBER to Primary Distribution Chamber | 1 | 1 | 30.0 | 3.00 | - | 1.20 | 0.50 |
| 11 | Primary Clarifier Distribution Structure | 1 | 1 | 5.15 | 2.50 | - | 2.50 | 0.50 |
| 12 | Primary Clarifiers | 4 | 4 | - | - | 33.0 | 3.5 | 0.50 |
| B. | **BIOREACTOR** | | | | | | | |
| 13 | Bioreactor Intheint Channel | 2 | 2 | 20.00 | 2.0 | - | 0.9 | 0.50 |
| 14 | Anaerobic Zones | 2 | 2 | 12.00 | 50.0 | - | 6.0 | 0.50 |
| 15 | Aeration Basins | 2 | 2 | 87.10 | 50.0 | - | 5.7 | 0.50 |
| 16 | Anoxic Zones | 2 | 2 | 30.10 | 50.0 | - | 5.8 | 0.50 |
| 17 | Bioreactor Effluent Channel | 1 | 1 | 30.00 | 2.4 | - | 1.2 | 0.50 |
| 18 | Secondary Clarifier Distribution Structure | 1 | 1 | 5.20 | 2.5 | - | 2.5 | 0.50 |
| 19 | Secondary Clarifier Tank | 4 | 4 | - | - | 47.2 | 3.5 | 0.50 |
| 20 | Cloth Disc Filter | 1 | 1 | 14.55 | 7.0 | - | 2.3 | 0.50 |
| C. | **CHLORINE CONTACT TANK** | | | | | | | |
| 21 | Chlorine Contact Tank Inlet Channel | 1 | 1 | 30.0 | 2.5 | - | 1.2 | 0.50 |
| 22 | Chlorine Contact Tanks | 1 | 1 | 25.0 | 29.5 | - | 4.0 | 0.50 |
| 23 | Chlorine Contact Tank Effluent Channel | 1 | 1 | 30.0 | 3.0 | - | 1.2 | 1.50 |
| 24 | Effluent Parshall Flume | 2 | 2 | 24.30 | 1.20 | - | 1.20 | 0.50 |
| D. | **SLUDGE THICKENING SYSTEM** | | | | | | | |
| 25 | Primary Sludge Sump | 1 | 1 | - | - | 4.0 | 2.0 | 0.50 |
| 26 | Primary Sludge Pumping Station | 1 | 1 | 15.0 | 10.0 | | 5.0 | - |
| 27 | Gravity Sludge Thickener - Primary | 2 | 2 | - | - | 11.0 | 3.0 | 0.50 |
| 28 | Primary Sludge Thickener Dilution water Sump | 1 | 1 | 5.50 | 4.50 | - | 3.0 | 0.50 |
| 29 | Secondary Sludge Sump | 1 | 1 | 15.0 | 22.0 | - | 6.0 | 0.50 |
| 30 | Secondary Sludge Pumping Station | 1 | 1 | 15.0 | 13.5 | - | 5.0 | - |
| 31 | Gravity Sludge Thickener - Secondary | 2 | 2 | - | - | 20.0 | 3.0 | 0.50 |
| 32 | Secondary Sludge Thickener Dilution water Sump | 1 | 1 | 11.00 | 7.00 | - | 3.0 | 0.50 |
| E. | **SLUDGE DEWATERING SYSTEM** | | | | | | | |
| 33 | Polydosing Tank | 2 | 1 | - | - | 6.0 | 2.5 | 0.50 |
| 34 | Centrifuge feed Sump | 1 | 1 | 9.0 | 5.0 | - | 2.5 | 0.50 |
| 35 | Centrifuge Feed Pumping Station | 1 | 1 | 15.0 | 10.0 | - | 5.0 | - |
| 36 | Centrifuge Building (Lower Level) | 1 | 1 | 35.0 | 25.0 | - | 6.0 | - |
| | Centrifuge Building (Upper Level) | 1 | 1 | 35.0 | 25.0 | - | 5.0 | - |
| F. | **SUB-STATION** | | | | | | | |
| 37 | 66/11 kV switchyard | 1 | 1 | 50.0 | 40.0 | - | - | - |
| 38 | Switchgear Building | 1 | 1 | 30.0 | 20.0 | - | 5.0 | - |
| 39 | MCC Building | 1 | 1 | 20.0 | 10.0 | - | 5.0 | - |
| 40 | D G Room | 1 | 1 | 30.0 | 20.0 | - | 6.0 | - |
| 41 | Electric Panel Room | 1 | 1 | 20.0 | 5.0 | - | 5.0 | - |
| 42 | 11 kV Emergency Panel Building | 1 | 1 | 15.0 | 10.0 | - | 5.0 | - |
| G. | **UTILITY BUILDING** | | | | | | | |
| 43 | Process Air Blower Building | 1 | 1 | 75.5 | 20.0 | - | 6.0 | |
| 44 | Chemical Building | | | | | | | |
| | Chemical Building (Lower Level) | 1 | 1 | 16 | 13.4 | - | 5.5 | - |
| | Chemical Building (Upper Level) | 1 | 1 | 16 | 13.4 | - | 5.5 | - |
| 45 | Chlorine Building | 1 | 1 | 35.0 | 15.0 | - | 4.5 | - |
| 46 | Chlorine Scrubber Foundation | 1 | 1 | 3.5 | 3.5 | - | | |
| 47 | Administration, Laboratory, and SCADA Building | 1 | 1 | 20.0 | 12.5 | - | 3.6 | - |
| 48 | Maintenance Workshop | 1 | 1 | 15.0 | 10.0 | - | 4.5 | - |
| 49 | Guard Room (Security Room) | 1 | 1 | 3.5 | 3.5 | - | 3.0 | - |

| REV.NO. | DATE | DESCRIPTION | DRAWN | CKD. BY | APPD. BY |
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| 0 | 16/08/2018 | | | | |

**CLIENT :** CHANDIGARH SMART CITY LIMITED (CSCL)

**DOCUMENT:** DRAFT DETAILED PROJECT REPORT TREATMENT FACILITY (AUGMENTATION OF EXISTING STPs)

**CONSULTANT**

egis INTERNATIONAL S.A.
ROOM NO. 21/22/23, GROUND FLOOR, NEW DELUXE BUILDING, JAN MARG, SECTOR-17-E, CHANDIGSRH - 160017

**PROJECT :** TO DESIGN, DEVELOP, MANAGE AND IMPLEMENT SMART CITY PROJECTS UNDER SMART CITY MISSION IN CHANDIGARH (UT)

**DRAWING TITLE**

LAYOUT PLAN OF 30 MGD STP AT DIGGIAN

**DRAWING NUMBER:** CHD/P/LA/STP/007

**REVISION NUMBER:** R-0

**DATE :** 16/08/2018

| SHEET N0: 01 OF 01 | SHEET SIZE: A1 | SCALE SIZE: 1:275 |
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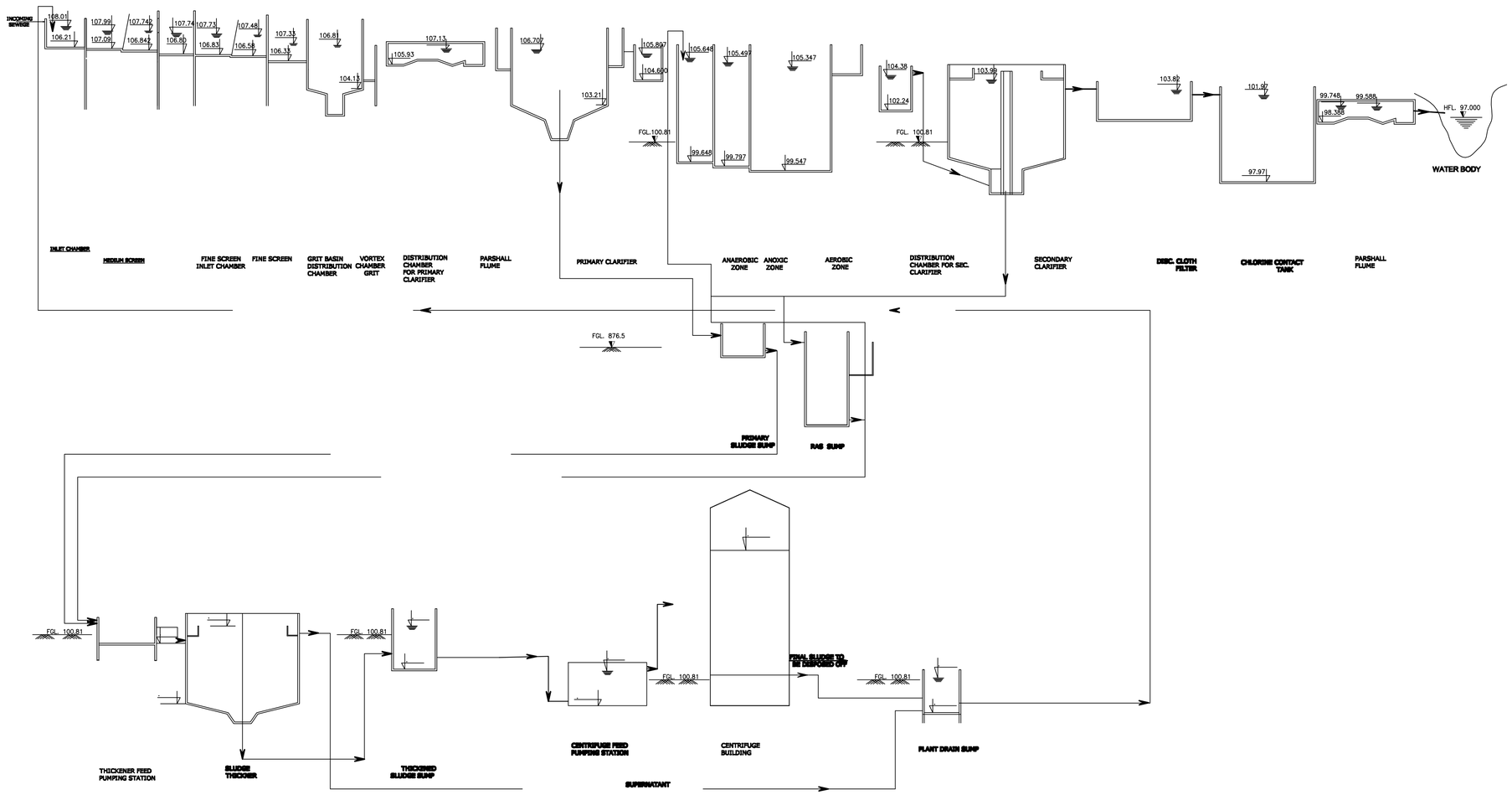


NOTES:-

1) ALL DIMENSIONS ARE IN mm & LEVELS ARE IN METER, UNLESS OTHERWISE STATED.
2) PLANT FINISH GROUND LEVEL IS (FGL) = 90.790 M
3) PLEASE REFER P&ID DRG. NO. CHD/P/P&ID/STP/008/REV.0 FOR SIZING OF ALL PIPES AND CHANNELS.

| LEGENDS: | |
|---|---|
| 1. | TL - TOP LEVEL |
| 2. | IL - INVERT LEVEL |
| 3. | WL - WATER LEVEL |
| 4. | BWL - BOTTOM WATER LEVEL |
| 5. | TWL - TOP WATER LEVEL |
| 6. | FGL - FINISH GROUND LEVEL |
| 7. | FFL - FINISH FLOOR LEVEL |

| REV.NO. | DATE | DESCRIPTION | DRAWN | CKD. BY | APPD. BY |
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| 0 | 16/08/2018 | | | | |

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CONSULTANT
egis INTERNATIONAL S.A.
ROOM NO. 21/22/23, GROUND FLOOR, NEW DELUXE BUILDING, JAN MARG, SECTOR-17-e, CHANDIGSRH - 160017

**PROJECT :** TO DESIGN, DEVELOP, MANAGE AND IMPLEMENT SMART CITY PROJECTS UNDER SMART CITY MISSION IN CHANDIGARH (UT)

DRAWING TITLE
HYDRAULIC FLOW DIAGRAM OF 30.0 MGD STP AT DIGGIAN

DRAWING NUMBER: CHD/P/LA/STP/008

REVISION NUMBER: R-0

DATE : 16/08/2018

| SHEET NO: 01 OF 01 | SHEET SIZE: A1 | SCALE SIZE: 1:275 |
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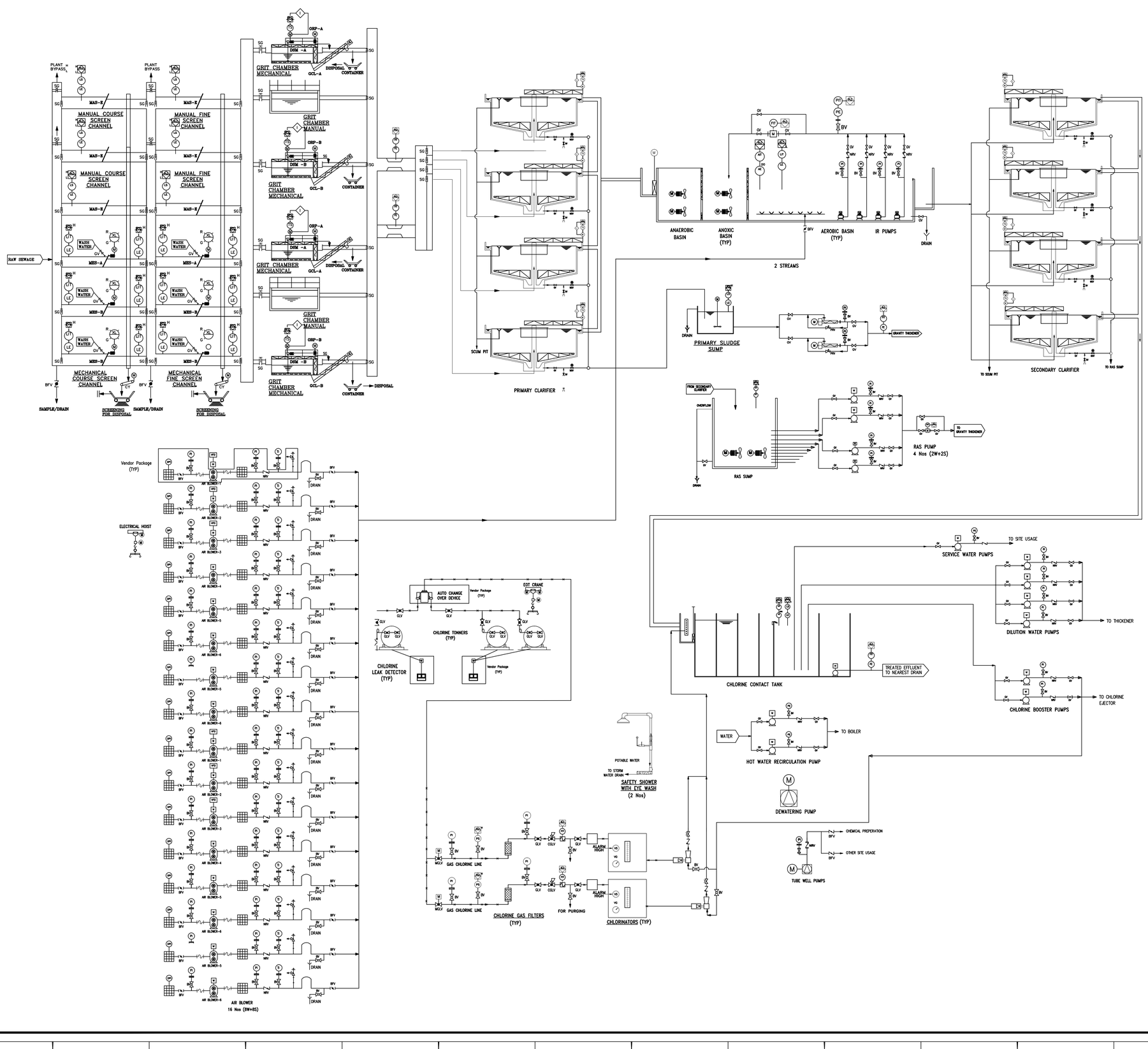


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| 2 | | | | | |
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**CLIENT :** CHANDIGARH SMART CITY LIMITED (CSCL)

**DOCUMENT:** DRAFT DETAILED PROJECT REPORT TREATMENT FACILITY (AUGMENTATION OF EXISTING STPs)

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DRAWING TITLE
PIPING & INSTRUEMENTATION DIAGRAM (P&ID) OF 30.0 MGD STP AT DIGGIAN

DRAWING NUMBER: CHD/P/LA/STP/009

REVISION NUMBER: R-0

DATE : 16/08/2018

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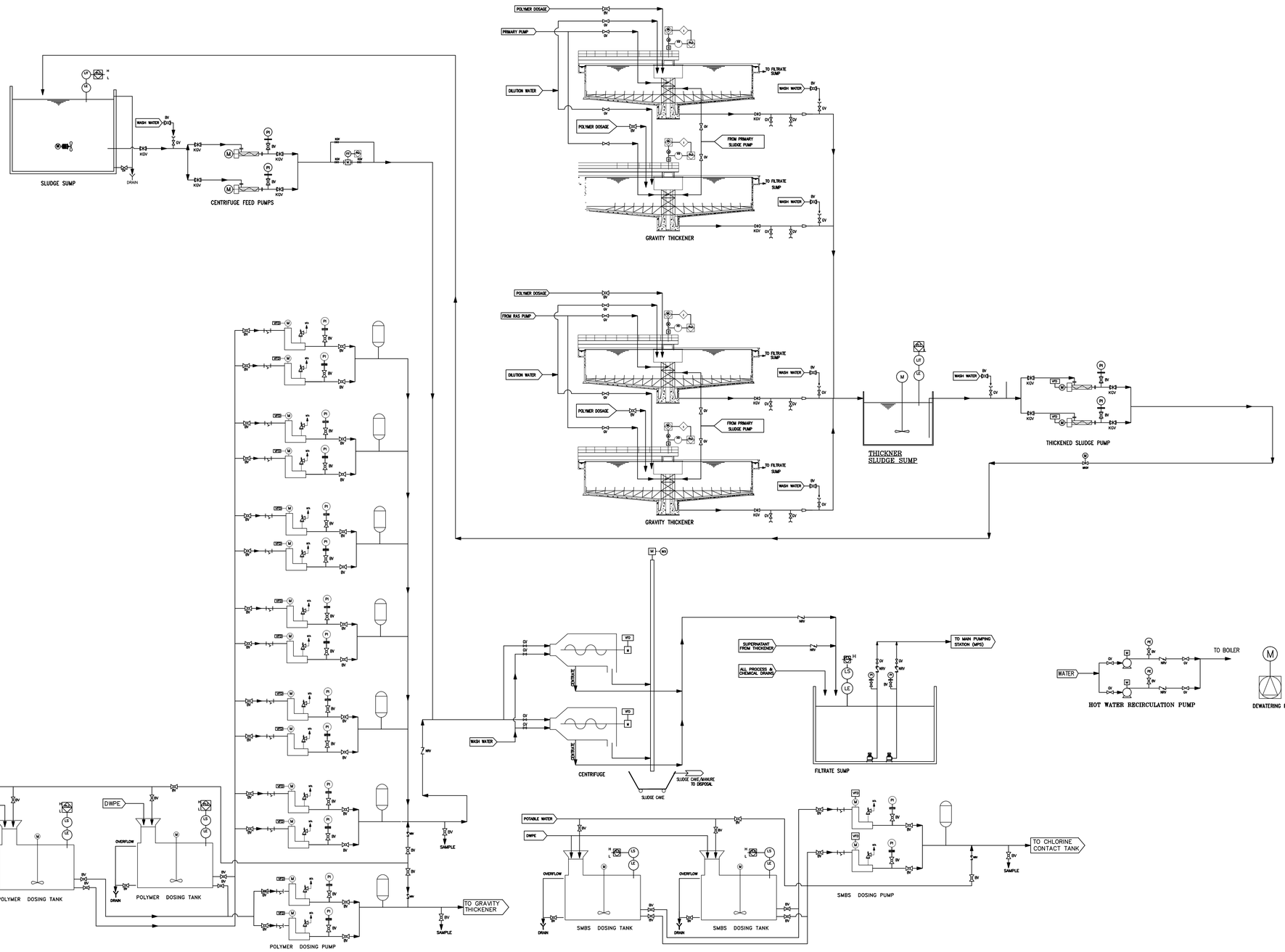


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DRAWING TITLE
PIPING & INSTRUEMENTATION DIAGRAM (P&ID) OF 30.0 MGD STP AT DIGGIAN

DRAWING NUMBER: CHD/P/LA/STP/009

REVISION NUMBER: R-0

DATE : 16/08/2018

| SHEET N0: 02 OF 03 | SHEET SIZE: A1 | SCALE SIZE: 1:275 |
|---|---|---|

## VALVES

| | |
|---|---|
| | GATE VALVE/SLUICE VALVE (MANUAL) |
| | GATE VALVE/SLUICE VALVE/SLUICE GATE (MOTORISED) |
| | KNIFE GATE VALVE |
| | MOTORISED KNIFE GATE VALVE |
| | CONTROL KNIFE GATE VALVE |
| | NON-RETURN VALVE |
| | BUTTERFLY VALVE (MANUAL) |
| | MOTORISED BUTTERFLY VALVE |
| | BALL VALVE |
| | SLUICE GATE (MANUAL) |
| | PRESSURE SAFETY VALVE |
| | SOLENOID VALVE |
| | PRESSURE REDUCING VALVE |
| | DIAPHRAGM VALVE |

## ABBREVIATIONS

| | |
|---|---|
| BV | – BALL VALVE |
| CV | – CONTROL VALVE |
| GV | – GATE VALVE |
| GLV | – GLOBE VALVE |
| MGV | – MOTORISED GATE VALVE |
| KGV | – KNIFE GATE VALVE |
| CKGV | – CONTROL KNIFE GATE VALVE |
| MKGV | – MOTORISED KNIFE GATE VALVE |
| NRV | – NON RETURN VALVE |
| ST | – STRAINER |
| BFV | – BUTTERFLY VALVE (MANUAL) |
| MBFV | – MOTORISED BUTTERFLY VALVE |
| SV | – SOLENOID VALVE |
| PSV | – PRESSURE SAFETY VALVE |
| DV | – DIAPHRAGM VALVE |

## INSTRUMENTATION

| | |
|---|---|
| FI | FLOW INDICATOR |
| FIT | FLOW INDICATING TRANSMITTER |
| LS | LEVEL INDICATING SWITCH |
| LIT | LEVEL INDICATING TRANSMITTER |
| AIT | ANALYSER INDICATOR |
| AE | ANALYSER ELEMENT |
| LL | LOW LOW |
| LA | LEVEL ALARM |
| HA | HIGH ALARM |
| VFD | VARIABLE FREQUIENTIAL DRIVE |
| FRC | FLOW RECORDER |
| FIT | FLOW INDICATING TRANSMITTER |
| FE | FLOW ELEMENT |
| FIA | FLOW ALARM |
| FQ | FLOW TOTALISER |
| LIT | LEVEL INDICATING TRANSMITTER |
| FIRQ | FLOW INDICATING CONTROLLER RECORDER |
| ZS | POSITION SWITCH |
| RLS | REST LIMIT SWITCH |
| L | LOW |
| H | HIGH |
| M | MOTOR |
| LSA | LEVEL SWITCH ALARM |
| LICA | LEVEL INDICATING CONTROL ANALYSER |
| PI | PRESSURE INDICATOR |
| LG | LEVEL GAUGE |
| PS | PRESSURE SWITCH |
| DO | DISSOLVED OXYGEN ANALYSER |
| LIT | LEVEL INDICATING TRANSMITTER |

## GENERAL

| | |
|---|---|
| | POSITIVE DISPLACEMENT OR METERING PUMP |
| | SUBMERSIBLE VERTICAL PUMP |
| | BLOWER |
| | CENTRIFUGAL PUMP |
| | SCREW PUMP |
| | Y TYPE STRAINER |
| | DIFFUSER |
| | MOTORISED AGITATOR |
| | AIR FILTER |
| | VERTICAL PROPELLER PUMP |
| | SUBMERSIBLE MIXER |
| | FILTER / SILENCER |
| | STATIC MIXER |
| | DRAIN |
| | HOSE CONNECTION |
| | TUBE WELL PUMPS |
| | CONVEYOR |
| | AUTO CHNAGE OVER DEVICE |
| | CHLORINE LEAK DETECTOR |
| | HEAT EXCHANGER |
| | EJECTOR |
| | PULSATION DAMPNER |
| | EYE SHOWER |
| | CHLORINE TONNERS |

| REV.NO. | DATE | DESCRIPTION | DRAWN | CKD. BY | APPD. BY |
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| 0 | 16/08/2018 | | | | |

**CLIENT :** CHANDIGARH SMART CITY LIMITED (CSCL)

**DOCUMENT:** DRAFT DETAILED PROJECT REPORT TREATMENT FACILITY (AUGMENTATION OF EXISTING STPs)

**CONSULTANT**

egis INTERNATIONAL S.A.
ROOM NO. 21/22/23, GROUND FLOOR, NEW DELUXE BUILDING, JAN MARG, SECTOR-17-e, CHANDIGSRH - 160017

**PROJECT :** TO DESIGN, DEVELOP, MANAGE AND IMPLEMENT SMART CITY PROJECTS UNDER SMART CITY MISSION IN CHANDIGARH (UT)

**DRAWING TITLE**
PIPING & INSTRUEMENTATION DIAGRAM (P&ID) OF 30.0 MGD STP AT DIGGIAN

**DRAWING NUMBER:** CHD/P/LA/STP/009

**REVISION NUMBER:** R-0

**DATE :** 16/08/2018

| SHEET NO: 03 OF 03 | SHEET SIZE: A1 | SCALE SIZE: 1:275 |
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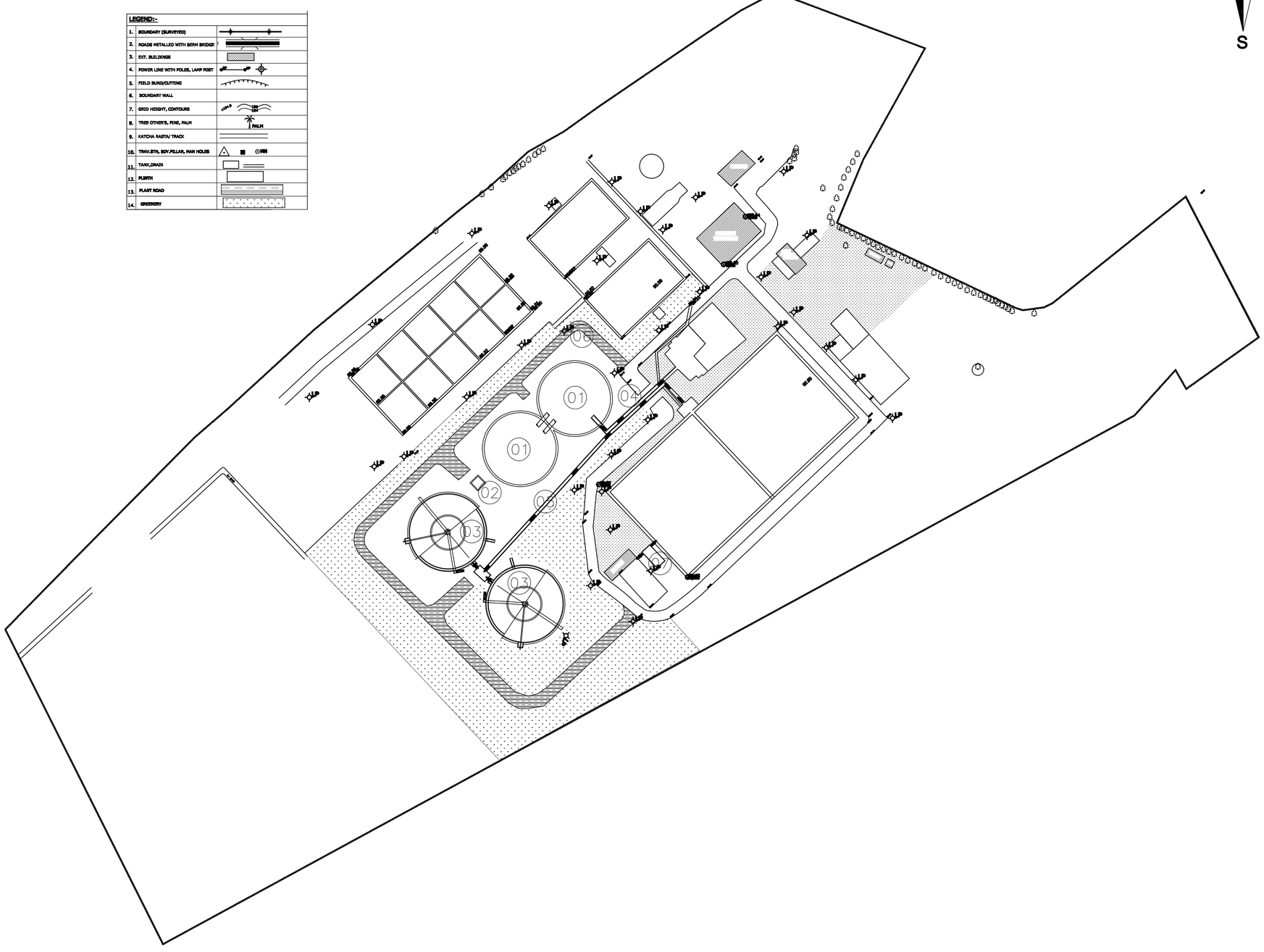


**LIST OF CIVIL UNITS, STP, 3 BRD**

| S. Nos. | Component | No. of Units | | | Size in metres | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Total | W | SB | L | W | Dia | D/H | FB |
| A. | PRIMARY TREATMENT | | | | | | | | |
| 1 | Equalization Tank | 2 | 2 | 0.0 | - | - | 34.0 | 7.00 | 0.50 |
| 2 | Flash Mixer Tank | 1 | 1 | 0.0 | 4.5 | 4.50 | - | 3.00 | 0.5 |
| 3 | Clariflocculator | 2 | 2 | 0.0 | - | - | 34.0 | 3.50 | 0.5 |
| 4 | Inlet Channel to Equalization tank | | | | | | | | |
| 5 | Outlet channel from clariflocculator to SBR | | | | | | | | |
| 6 | Proposed road | | | | | | | | |
| 7 | Filter unit plarform | 1 | 1 | | 5 | 3 | - | - | - |

| REV.NO. | DATE | DESCRIPTION | DRAWN | CKD. BY | APPD. BY |
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| 2 | | | | | |
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| 0 | 07/11/2016 | SUBMITTED | | | |

**CLIENT :** CHANDIGARH SMART CITY LIMITED (CSCL)

**DOCUMENT:** DRAFT DETAILED PROJECT REPORT TREATMENT FACILITY (AUGMENTATION OF EXISTING STPs)

CONSULTANT
egis INTERNATIONAL S.A.
ROOM NO. 21/22/23, GROUND FLOOR, NEW DELUXE BUILDING, JAN MARG, SECTOR-17-E, CHANDIGSRH - 160017

**PROJECT :** TO DESIGN, DEVELOP, MANAGE AND IMPLEMENT SMART CITY PROJECTS UNDER SMART CITY MISSION IN CHANDIGARH (UT)

DRAWING TITLE
LAYOUT PLAN FOR ADDITIONAL UNITS OF 11 MGD STP AT 3 BRD

DRAWING NUMBER: CHD/P/LA/STP/010

REVISION NUMBER: R-0

DATE : 16/08/2018

SHEET N0: 01 OF 01 | SHEET SIZE: A1 | SCALE SIZE: 1:275


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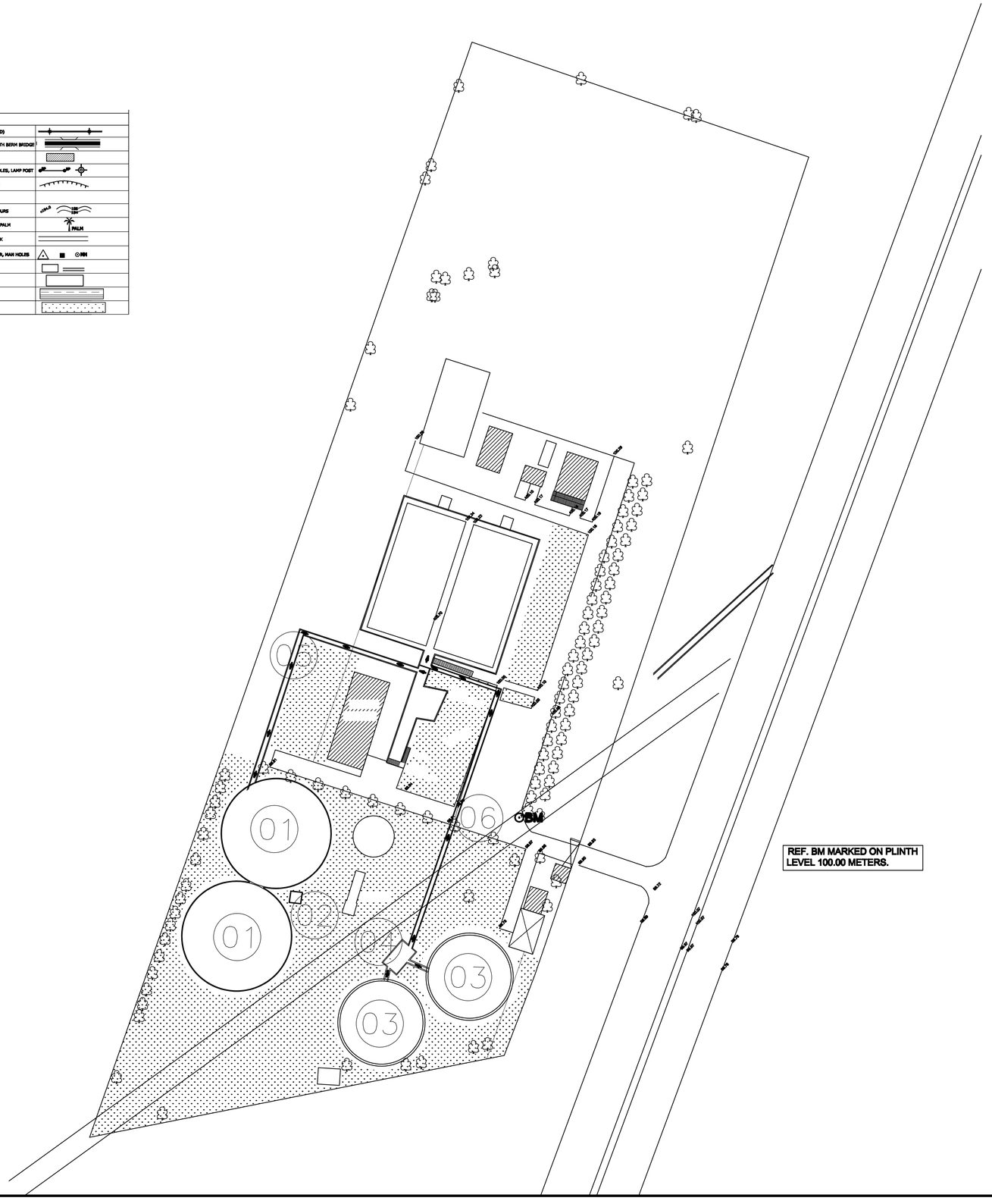
| LEGEND:- | |
|---|---|
| 1. | BOUNDARY (SURVEYED) |
| 2. | ROADS METALLED WITH BERM BRIDGE |
| 3. | EXT. BUILDINGS |
| 4. | POWER LINE WITH POLES, LAMP POST |
| 5. | FIELD BUND/CUTTING |
| 6. | BOUNDARY WALL |
| 7. | GRID HEIGHT, CONTOURS |
| 8. | TREE OTHER'S, PINE, PALM |
| 9. | KATCHA RASTA/ TRACK |
| 10. | TRAV.STN, BOY.PILLAR, MAN HOLES |
| 11. | TANK,DRAIN |
| 12. | PLINTH |
| 13. | PLANT ROAD |
| 14. | GREENERY |




REF. BM MARKED ON PLINTH LEVEL 100.00 METERS.

## LIST OF CIVIL UNITS, STP, DHANAS

| S. Nos. | Component | No. of Units | | | Size in metres | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Total | W | SB | L | W | Dia | D/H | FB |
| A. | PRIMARY TREATMENT | | | | | | | | |
| 1 | Equalization Tank | 1.00 | 1.00 | 0.00 | - | - | 25.00 | 4.00 | 0.50 |
| 2 | Flash Mixer Tank | 1.00 | 1.00 | 0.00 | 2.00 | 2.00 | - | 2.50 | 0.50 |
| 3 | Clarifloculator | 1.00 | 1.00 | 0.00 | - | - | 20.00 | 3.00 | 0.50 |
| 4 | Collection Chamber for Calrifloculato | 1.00 | 1.00 | | 5.00 | 3.00 | | 0.90 | 0.50 |
| 5 | Inlet channel for Equalization Tank | | | | | | | | |
| 6 | Outlet channel for Clarifloculator | | | | | | | | |

| REV.NO. | DATE | DESCRIPTION | DRAWN | CKD. BY | APPD. BY |
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| 1 | | | | | |
| 0 | 07/11/2016 | SUBMITTED | | | |

**CLIENT :** CHANDIGARH SMART CITY LIMITED (CSCL)

**DOCUMENT:** DRAFT DETAILED PROJECT REPORT TREATMENT FACILITY (AUGMENTATION OF EXISTING STPs)

CONSULTANT

egis INTERNATIONAL S.A.
ROOM NO. 21/22/23, GROUND FLOOR, NEW DELUXE BUILDING, JAN MARG, SECTOR-17-E, CHANDIGSRH - 160017

**PROJECT :** TO DESIGN, DEVELOP, MANAGE AND IMPLEMENT SMART CITY PROJECTS UNDER SMART CITY MISSION IN CHANDIGARH (UT)

DRAWING TITLE
LAYOUT PLAN FOR ADDITIONAL UNITS OF 1.65 MGD STP AT DHANAS

DRAWING NUMBER: CHD/P/LA/STP/011

REVISION NUMBER: R-0

DATE : 16/08/2018

| SHEET NO: 01 OF 01 | SHEET SIZE: A1 | SCALE SIZE: 1:275 |
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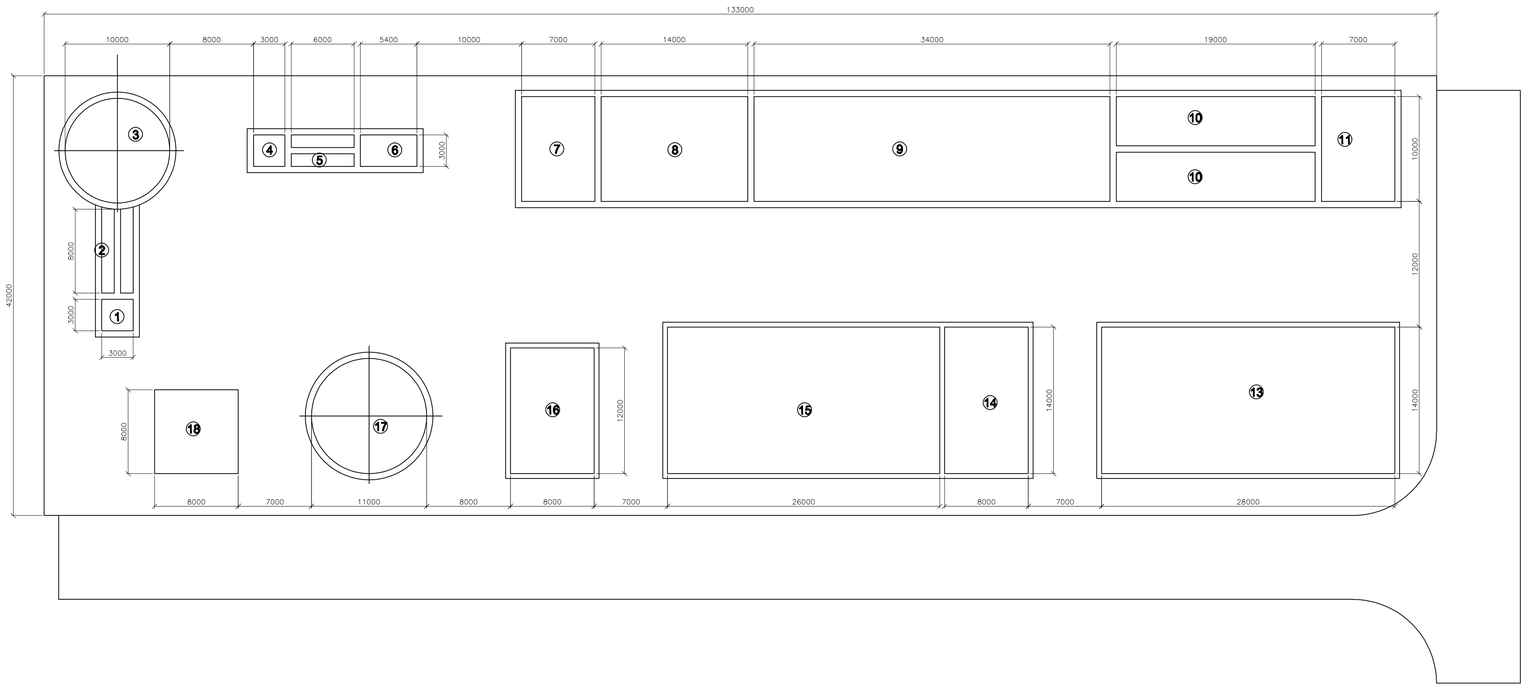


## LIST OF CIVIL UNITS, STP, SUKHNA LAKE

**1. UNIT OF MPS - SUKHNA LAKE**

| Sl. No. | Units | Quantity | Length/ Dia, m | Width m | SWD/ HT,m | FB m |
|---|---|---|---|---|---|---|
| 1 | Receiving Chamber | 1 | 1.50 | 0.75 | 0.50 | 0.30 |
| 2 | Coarse Screen Channel - Mechanical | 1 | 8.00 | 0.50 | 0.50 | 0.30 |
| 2 | Coarse Screen Channel - Manual | 1 | 8.00 | 0.50 | 0.50 | 0.30 |
| 3 | Raw Sewage Sump | 1 | 3.00 | Dia | 1.75 | 0.60 |

**2. LIST OF CIVIL UNITS OF 2 MLD STP AT SUKHNA LAKE**

| Sl. No. | Units | Quantity | Length m | Width m | SWD/ HT, m | FB m |
|---|---|---|---|---|---|---|
| 4 | Inlet Chamber | 1 | 1.50 | 0.75 | 0.50 | 0.30 |
| 5 | Fine Screen Channel - Mechanical | 1 | 5.00 | 0.70 | 0.60 | 0.30 |
| 5 | Fine Screen Channel - Manual | 1 | 5.00 | 0.70 | 0.60 | 0.30 |
| 6 | Grit Distribution Chamber | 1 | 1.50 | 0.75 | 0.50 | 0.30 |
| 6 | Grit Chamber - Aerated | 2 | 2.75 | 0.80 | 3.00 | 0.50 |
| 7 | Anaerobic | 1 | 3.50 | 5.00 | 5.00 | 0.50 |
| 8 | Anoxic | 1 | 7.00 | 5.00 | 4.75 | 0.50 |
| 9 | Pre - Aeration Tank | 2 | 17.00 | 5.00 | 4.3 | 0.50 |
| 10 | MBR | 2 | 6.40 | 4.30 | 4.3 | 0.50 |
| 11 | Permeate Water Tank | 1 | 4.20 | 5.00 | 4.0 | 0.50 |
| 12 | Gravity Sludge Thickener | 1 | 5.50 | - | 3.0 | 0.5 |
| 13 | Ozone/ Admn building | 1 | 14 | 7 | - | G+1 |
| 14 | Chemical Building | 1 | 4 | 7 | - | G+1 |
| 15 | Blower/ MCC Building | 1 | 13 | 7 | - | G+1 |
| 16 | Sludge Dewatering Building | 1 | 6 | 4 | - | G+1 |
| 17 | Sludge Holding Tank | 1 | 5.5 | - | 3 | 0.5 |
| 18 | Transformer Area | 1 | 4 | 4 | | |

| REV.NO. | DATE | DESCRIPTION | DRAWN | CKD. BY | APPD. BY |
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| 0 | 16/08/2018 | | | | |

**CLIENT :** CHANDIGARH SMART CITY LIMITED (CSCL)

**DOCUMENT:** DRAFT DETAILED PROJECT REPORT TREATMENT FACILITY (AUGMENTATION OF EXISTING STPs)

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**PROJECT :** TO DESIGN, DEVELOP, MANAGE AND IMPLEMENT SMART CITY PROJECTS UNDER SMART CITY MISSION IN CHANDIGARH (UT)

DRAWING TITLE

LAYOUT PLAN OF 2 MLD STP AT SUKHNA LAKE

DRAWING NUMBER: CHD/P/LA/STP/007

REVISION NUMBER: R-0

DATE : 16/08/2018

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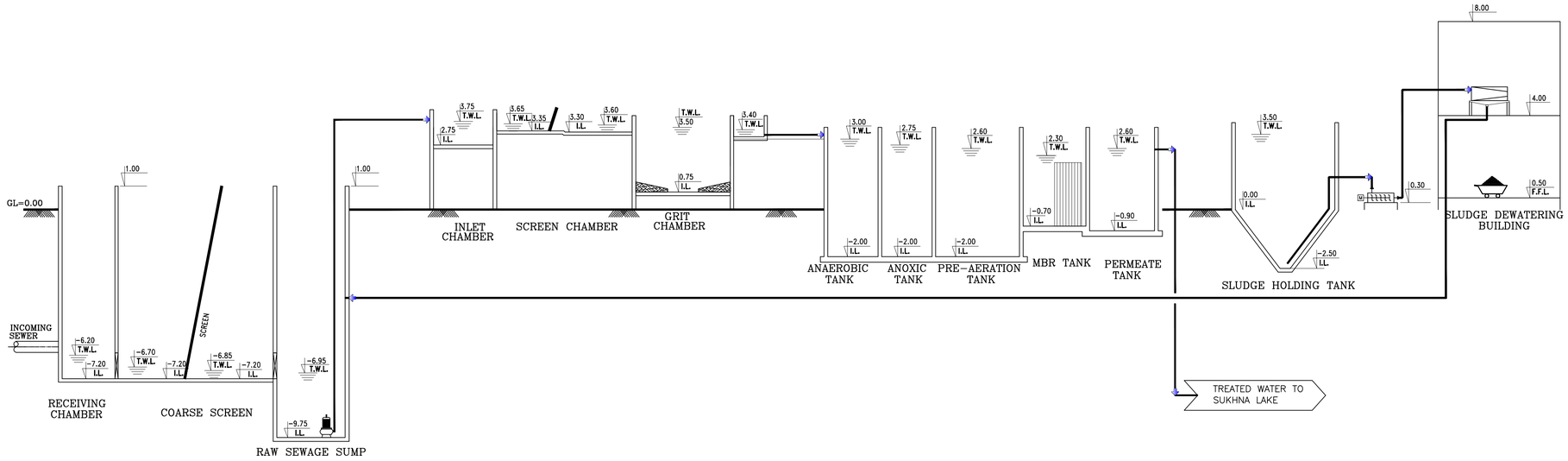


NOTES:-

1) ALL DIMENSIONS ARE IN mm & LEVELS ARE IN METER, UNLESS OTHERWISE STATED.
2) PLANT FINISH GROUND LEVEL IS (FGL) = 0.0 M ( CONSIDERED)
3) PLEASE REFER P&ID DRG. NO.CHD/P/P&ID/STP/014/REV.0 FOR SIZING OF ALL PIPES AND CHANNELS.

| REV.NO. | DATE | DESCRIPTION | DRAWN | CKD. BY | APPD. BY |
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| 1 | | | | | |
| 0 | 16/08/2018 | | | | |

**CLIENT :** CHANDIGARH SMART CITY LIMITED (CSCL)

**DOCUMENT:** DRAFT DETAILED PROJECT REPORT TREATMENT FACILITY (AUGMENTATION OF EXISTING STPs)

CONSULTANT

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ROOM NO. 21/22/23, GROUND FLOOR, NEW DELUXE BUILDING, JAN MARG, SECTOR-17-e, CHANDIGSRH - 160017

**PROJECT :** TO DESIGN, DEVELOP, MANAGE AND IMPLEMENT SMART CITY PROJECTS UNDER SMART CITY MISSION IN CHANDIGARH (UT)

DRAWING TITLE
HYDRAULIC FLOW DIAGRAM OF 2.0 MLD STP AT SUKHNA LAKE

DRAWING NUMBER: CHD/P/LA/STP/013

REVISION NUMBER: R-0

DATE : 16/08/2018

| SHEET NO: 01 OF 01 | SHEET SIZE: A1 | SCALE SIZE: 1:275 |
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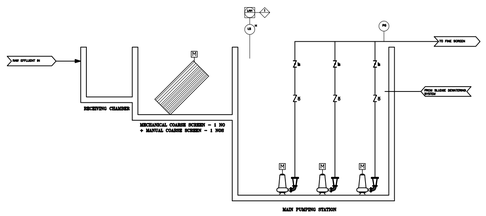


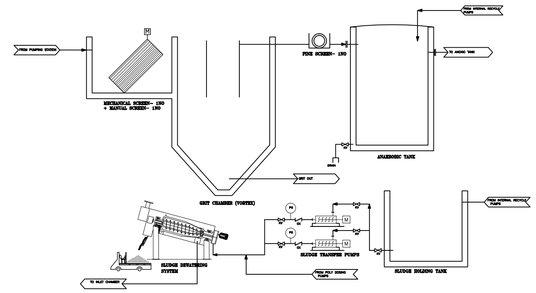


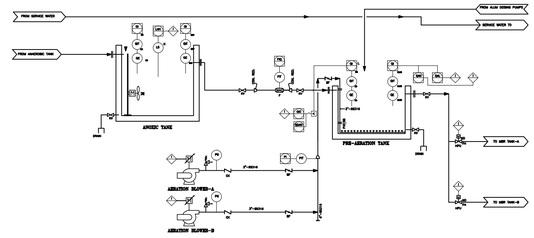


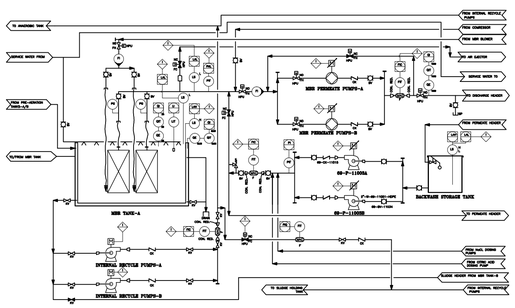


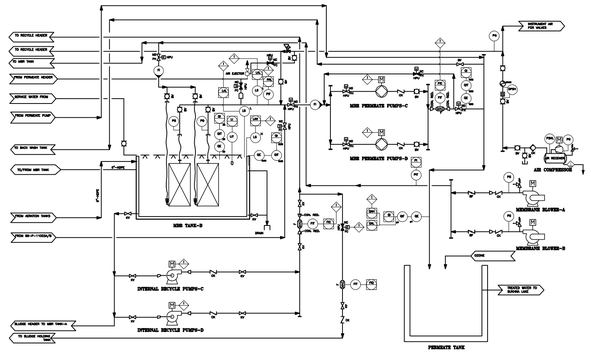


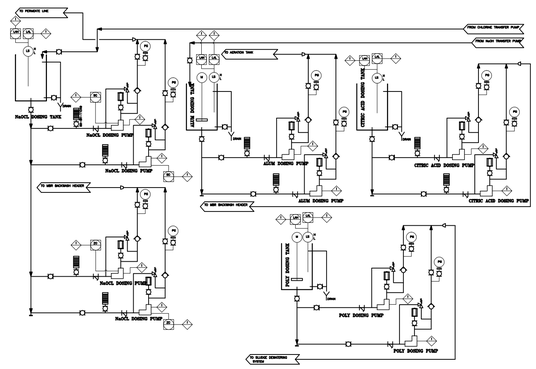


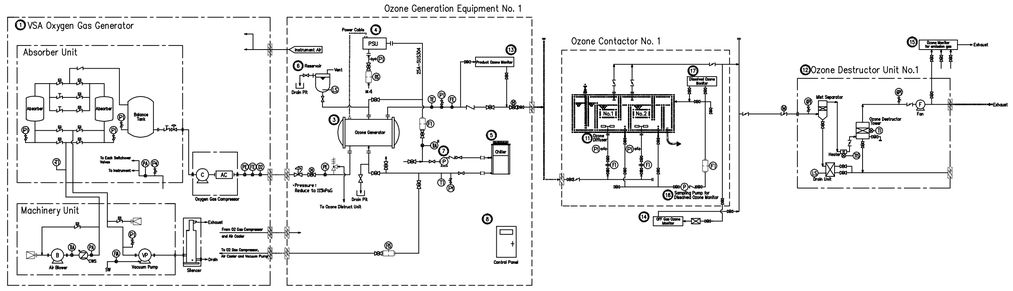


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**DOCUMENT:** DRAFT DETAILED PROJECT REPORT TREATMENT FACILITY (AUGMENTATION OF EXISTING STPs)

CONSULTANT

egis INTERNATIONAL S.A.
ROOM NO. 21/22/23, GROUND FLOOR, NEW DELUXE BUILDING, JAN MARG, SECTOR-17-e, CHANDIGSRH - 160017

**PROJECT :** TO DESIGN, DEVELOP, MANAGE AND IMPLEMENT SMART CITY PROJECTS UNDER SMART CITY MISSION IN CHANDIGARH (UT)

DRAWING TITLE
PIPING & INSTRUEMENTATION DIAGRAM (P&ID) OF 2.0 MLD STP AT SUKHNA LAKE

DRAWING NUMBER: CHD/P/LA/STP/014

REVISION NUMBER: R-0

DATE : 16/08/2018

| SHEET N0: 01 OF 01 | SHEET SIZE: A1 | SCALE SIZE: 1:275 |
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