

AHMEDABAD URBAN DEVELOPMENT AUTHORITY (AUDA)



CONSTRUCTION OF SEWERAGE NETWORK WITH PUMPING STATIONS AND STP UNDER TP SCHEMES NOS. 412A, 412B, 243, 109, 413 & 411 in AUDA Area

DRAFT TENDER PAPER

BID DOCUMENTS FOR “CONSTRUCTION OF SEWER NETWORK UNDER TP SCHEMES NOS. 412A, 412B, 243, 109, 413 & 411 AND CONSTRUCTION OF 3 NOS. PUMPING STATIONS (MPS 01- 11.98 MLD, MPS-2 12.24 MLD & MPS-3 20.55 MLD) AND SEWERAGE TREATMENT PLANT OF 30 MLD CAPACITY WITHIN AUDA TP SCHEME AREAS” (Job No. 40- 2025-26).

Milestone Dates	
Downloading of tender End Date	Date 27/03/2026 , Till 18:00 Hrs.
Online Submission of Bid	Up to date 27/03/2026 , Till 18:00 Hrs.
Submission of EMD, Tender fee & Document	Submission of all Tender Document along with tender fee and EMD Scan Copy in Online electronic format. Original Tender Fee, EMD and Original Copy of affidavit for Authenticity of documents must be sent in through R.P.A.D./ Speed Post so as to reach the office of Executive Engineer, Ahmedabad (AUDA), End Date 04/04/2026 Till 18:00 Hrs.
Date of Technical Bid Opening	Date 04/04/2026 & 18:10 Hrs. (if possible)
Date of Price Bid Document Opening	On Date 04/04/2026 & 18:15 Hrs. (if possible)

Estimated Cost (EC): ₹ 1,07,70,12,742.00 /-

(Rupees One Hundred Seven Crore Seventy Lakh Twelve Thousand Seven Hundred and Forty-Two Only)

(Construction Cost + O & M Cost)
Executive Engineer,
A.U.D.A

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**INVITATION FOR BID
(IFB)**

NATIONAL COMPETITIVE BIDDING

1. The AUDA invites bids for the construction of works detailed in the table.
The bidders may submit bids for any or all of the following works.

1 TABLE

Packag e No.	Name of work	Approximate value of works (Rs.)	Bid security (Rs.)	Cost of document	Period of completion	Class of Registration / Category of contractor if required
1	2	3	4	5	6	7
1	As Per NIT & Details Given Below	₹1,07,70,12,742.00	₹ 1,07,70,128.00 (In form of DD only)	Rs.18000/- (Non- Refundable)	24 Months (including 3 months trial run & Excluding Monsoon) (Monsoon period to be considered as 1st July to 30th September)	"AA"

- 1. NAME OF WORK: BID DOCUMENTS FOR " CONSTRUCTION OF SEWER NETWORK UNDER TP SCHEMES NOS. 412A, 412B, 243, 109, 413 & 411 AND CONSTRUCTION OF 3 NOS.PUMPING STATIONS (MPS 01- 11.98 MLD, MPS-2 12.24 MLD & MPS-3 20.55 MLD) AND SEWERAGE TREATMENT PLANT OF 30 MLD CAPACITY WITHIN AUDA TP SCHEME AREAS(JOB-40/2025-26)".**
2. Prospective / Interested bidder may download the Bid Documents from website <https://tender.nprocure.com> free of cost till the Time and Date as mentioned on online NIT at website <https://tender.nprocure.com>
3. However, Bidder who is submitting the Bid Online will have to pay the Bid Document Fee / Tender Fee through Demand Draft only of any Schedule Bank payable at Ahmedabad and in favour of "Ahmedabad Urban Development Authority". Once the Bid is received online, Bid Document / Tender Fee will not be refundable.
4. The Demand Draft for Bid Document / Tender fee and DD against Bid Security / EMD shall be submitted in electronic format through online (by scanning) while uploading the bid, this submission shall mean that bid document / tender fee and Bid Security / EMD has been received. Accordingly, the offer of only those shall be opened whose Bid Document / Tender Fee and Bid Security / EMD have been received electronically. However, for the purpose of realization of Demand Draft/ Bank Guarantee / DD bidder shall send the same in original through R.P.A.D. so as to reach to 'Executive Engineer, AUDA within mentioned in NIT (Days) from the last day of bid submission.
5. Penaltative action for not submitting Demand Draft / FDR / Bank Guarantee in original to Executive Engineer / Tender Inviting Authority by bidder shall be initiated.

6. Bids received online, will be opened on the time, date and place as specified in the online NIT at website <https://tender.nprocure.com> in the presence of the bidders or their authorized representatives, who wish to remain present.
7. If the office happens to be closed on the day of opening of the bids as specified, the bids will be opened on the next working day at the same time and venue.
8. A pre bid meeting will be held on 12/03/2026 at 15:30 hrs. at the office of **Executive Engineer, Engineering Branch, AUDA** to clarify the issues and to answer questions on any matter that may be raised at that stage as stated in clause 9.2 of 'instructions to Bidders' of the bidding documents.
9. Bid Security (EMD) is equal to 1% of Estimated Amount put to bid / tender and should be rounded off to the next thousand rupees.
10. Other Information is as under:
 - A. Agencies can prepare and edit their offers a number of times before the end of the tender submission date and time. After the tender submission date and time, the bidder cannot modify / edit / withdraw their submitted offer in any case. No written or online request in this regard shall be granted.
 - B. Offers in physical form will not be accepted in any case.
 - C. Demand Draft purchased by the other than bidder and issued after the last date of submission of Bids, will not be considered or accepted.
 - D. The cost incurred by the contractor for this offer for clarification or attending discussion, conferences or site visits will not be reimbursed by the Employer or Engineer-in-Charge.
 - E. Conditional tender shall not be accepted.
 - F. Any changes, addition, alternation made in the prescribed form attached with tender are liable to be rejected.
 - G. ~~Any change in format or conditional Bank Guarantee will not be accepted and the bidder will be considered non-responsive.~~
 - H. All the bidders are instructed to fill in information strictly in accordance with the format given in the checklist /qualification document / tender document.
 - I. It is mandatory for the bidders to supply each and every information as asked strictly in electronic format at appropriate places only.
 - J. Blank / insufficient information shall be treated as nil information and shall result in disqualification.
 - K. Even if the bidder has been qualified in a similar or larger size of project in the past, it shall not be deemed to be a ground / reason for not giving required information for this work / bid.

- L. Information supplied for earlier projects shall not be considered while evaluation of this bid. The Government will not ask for any other information, unless it is found absolutely necessary by the competent authority.
- M. If found necessary, the contractor will be intimated for negotiation,

Executive Engineer
AUDA

SECTION – 1
INSTRUCTIONS TO BIDDERS (ITB)

Section 1: Instructions to Bidders

Table of Clauses

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9.	Clarification of Bidding Documents	27.	Correction of Errors
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A. GENERAL

1. Scope of Bid

- 1.1 The Employer (Named in Appendix to ITB) invites bids for the Construction of works (as defined in these documents and referred to as 'the works') detailed in the table given in IFB. The bidders may submit bids for any or all of the works detailed in the table given in IFB.
- 1.2 The successful bidder will be expected to complete the works by the intended completion date specified in the Contract data.
- 1.3 Throughout these bidding documents, the terms 'bid' and 'tender' and their derivatives (bidder/ tenderer, bid / tender, bidding/ tendering, etc.) are synonymous.

2. Source of Funds

- 2.1 The expenditure on this project will be met from the budget of **Govt. of Gujarat** / Govt. of India for centrally sponsored projects.

3. Eligible Bidders

- 3.1 This Invitation for Bids is open to all eligible bidders.
- 3.2 All bidders shall provide in Section 2, Forms of Bid and Qualification Information, a statement that the Bidder is neither associated, nor has been associated, directly or indirectly, with the consultant or any other entity that has prepared the design, specifications, and other documents for the Project or being proposed as Project Manager for the Contract. A firm that has been engaged by the Employer to provide consulting services for the preparation or supervision of the works, and any of its affiliates, shall not be eligible to bid.

4. Qualification of the Bidder

- 4.1 All bidders shall provide in Section 2, Forms of Bid and Qualification Information, a preliminary description of the proposed work method and schedule, including drawings and charts, as necessary. The proposed methodology should include a program of construction backed with equipment planning and deployment duly supported with broad calculations and quality assurance procedures proposed to be adopted justifying their capability of execution and completion of work as per technical specifications, within stipulated period of completion.

~~4.2 In the event that Pre-qualification of potential bidders has been undertaken, only bids from prequalified bidders will be considered for award of Contract. These qualified bidders should submit with their bids any information updating their original prequalification applications or, alternatively, confirm in their bids that the originally submitted prequalification information remains essentially correct as of date of bid submission. The update or confirmation should be provided in Section 2. A copy of the original prequalification application and the letter of prequalification should also be furnished. With the updated information, the bidder must continue to be qualified in accordance with the criteria laid down in the prequalification document. All bidders shall also furnish the following information in Section 2:-~~

- ~~(i) Evidence of access to or availability of credit facilities (minimum 10% of estimated cost) certified by the bankers.~~
- ~~(ii) Undertaking that bidder would be able to invest a minimum of cost up to 25% of the contract value of work, during implementation of contract.~~
- ~~(iii) Proposal, if any, for sub-contracting of elements of work, costing more than 10% of the bid amount.~~
- ~~(iv) Power of attorney.~~
- ~~(v) Latest income tax clearance certificate from concerned department.~~

- 4.3 If the Employer has not undertaken prequalification of potential bidders, all bidders shall include the following information and documents with their bids in Section 2:

~~(a) copies of original documents defining the constitution or legal status, place of registration, and principal place of business; written power of attorney of the signatory of the Bid to commit the Bidder;-~~

~~(b) total monetary value of construction work performed for each of the last five years;-~~

~~(c) experience in works of a similar nature and size for each of the last five years, and details of works underway or contractually committed; and clients who may be contacted for further information on those contracts;-~~

~~(d) major items of construction equipment proposed to carry out the Contract;-~~

~~(e) qualifications and experience of key site management and technical personnel proposed for Contract;-~~

~~(f) reports on the financial standing of the Bidder, such as profit and loss statements and auditor's reports for the past five years;-~~

~~(g) evidence of access to line(s) of credit and availability of other financial resources facilities (10% of contract value), certified by the Bankers (Not more than 3 months old)-~~

~~(h) undertaking that the bidder will be able to invest a minimum cash up to 25% of contract value of work, during implementation of work.-~~

~~(i) authority to seek references from the Bidder's bankers;-~~

~~(j) information regarding any litigation, current or during the last five years, in which the Bidder is involved, the parties concerned, and disputed amount;-~~

~~(k) proposals for subcontracting components of the Works amounting to more than 10 per cent of the Bid Price (for each, the qualifications and experience of the identified sub-contractor in the relevant field should be annexed); and-~~

~~(l) the proposed methodology and programmed of construction, backed with equipment planning and deployment, duly supported with broad calculations and quality control procedures proposed to be adopted, justifying their capability of execution and completion of the work as per technical specifications within the stipulated period of completion as per milestones (for all contracts over Rs.5 Crore)-.~~

~~4.4 Bids from Joint ventures are not acceptable. or Bids from prequalified firms or prequalified joint ventures only will be acceptable.~~

4.5 QUALIFICATION CRITERIA:

(Applicable for the works which require Post Qualification)

4.5.1 Qualification will be based on Applicant's meeting all the following minimum pass/ fail criteria regarding the Applicant's general and particular experience, personnel and equipment capabilities and financial positions, as demonstrated by the applicant's responses in the forms attached to the letter of application (specified requirement for joint ventures are given under para 4.6 below) Subcontractors experience and resources shall not be taken in to account in determining the applicants compliance with the qualifying criteria to qualify for more than one contract, the applicant must demonstrate having experience and resources sufficient to meet the aggregate of the qualification criteria for each contract given in paragraphs 4.5.4, 4.5.5 and 4.5.9 below

4.5.2 Base year and Escalation

The base year shall be taken as **Current financial year (2025-26)**

Following enhancement factors will be used for the costs of works executed and the financial figure to a common base value for works completed in India.

<u>Year</u>	<u>Financial Year</u>	<u>Multiplying factor</u>
Base year of inviting tender	2025-2026	1.00
-1	2024-2025	1.10
-2	2023-2024	1.21
-3	2022-2023	1.33
-4	2021-2022	1.46

5	2020--2021	1.61
6	2019-2020	1.77
7	2018-2019	1.95

Applicant should indicate actual figures of costs and amount for the works executed by them without accounting for the above-mentioned factors.

In case the financial figures and value of completed works are in foreign currency the above enhanced multiplying factors will not be applied. Instead, the current market exchange rate (State Bank of India BC Selling rate as on the last date of submission of the bid) will be applied for the purpose of conversion of the amount in foreign currency into India rupees.

4.5.3. General Experience.

To qualify, each bidder in the same name and style should have achieved the following performances:

• List of Mandatory documents to be submitted

- a. Registration
- b. EMD/Bid Security /Tender Fee
- c. Solvency Certificate
- d. Turn Over
- e. Bid Capacity
- f. Document supporting similar nature of work & physical criteria
- g. Declaration of Non-Blacklisted / Debarred from Anywhere in Gujarat & also in India. The Declaration will be on the Rs.300/- non-judicial paper should be submitted (Mandatory)
- h. ITR, PAN card, GST Certificate
- i. MOU of RCC/DI Pipe if Required
- j. MOU with a road contractor registered in Class 'AA' and above
- k. MOU with a STP technology provider on the Rs.300/- non-judicial paper should be submitted (Mandatory)

l. All Forms and Other Certificate Mention in the Tender.

If bidder fails to submit above documents or mandatory criteria are not fulfilled, bidder shall be considered as not qualified and their financial bid shall not be open. To qualify, each bidder in the same name and style should have achieved the following performances:

- a. **Registration:** A certificate of registration as approved contractor of concerned state government/Railway /CPWD/ Government Bodies. The Applicant(s) who are registered with other government (State/Central), Board, Corporation, & Government undertaking/ Organizations of state & central government in including all public sector units shall submit proof of application for registration for "AA" Class in Gujrat State (Scanned Copy).

b. EMD and Tender Fees

As per tender notice.

- **FINANCIAL**

4.5.3.1 TURNOVER:

The bidder must have Achieved a minimum annual financial turnover **. ₹ 1,07,70,12,742.00 /-** (defined as billing for works in progress and completed in all classes of civil engineering **construction works only**) **in any one year**, within the last five financial years, i.e., **from 2020-21 to 2024-2025**.

Note: The details pertaining to turnover **from 2020-21 to 2024-2025** shall be certified by Chartered Accountant on his own letter head and duly attested. **Turnover of financial year 2025-26 shall be considered subject to submission of provisional**/audited certificate from chartered accountant by the Bidder

4.5.3.2 SIMILAR NATURE OF WORK:

The bidder must have completed similar nature of work **i.e., Drainage /Sewerage Projects** within last five financial years i.e., **from 2020-21 to 2024-2025** and up to one month prior to last date of submission of the bid of value not less than:

One similar completed works costing not less than the amount equal to Rs. 43,08,05,097.00/- (40% of Estimated project cost)

4.5.3.3 AVAILABLE BID CAPACITY

The Bidder who fulfils the qualifying criteria mentioned above shall be qualified only if he fulfils the requirement of bidder's capacity. The bidding capacity of any tender/ Bidder is required to be more than or equal to the estimated cost of the work i.e., **Rs. ₹ 1,07,70,12,742.00** The bidder's capacity shall be computed as shown below.

$$\text{Available Bid Capacity} = [(A \times N \times 2.0) - B]$$

Where:

A	=	Maximum value of construction works executed in any one year during the last Five years updated at the financial year updated at 2025-26 Price level .
B	=	Value of the existing commitments as on date of bid submission for works (complete or partial) to be completed in the next (24 Months) . The details shall be countersigned by the Executive Engineer or the equivalent officer of the employer on whose behalf the firm is carrying out the works. Also, declaration of financial liabilities, work on hand/completed projects on Rs.300/- non-Judicial stamp paper. In the case of a Joint Venture (Not Applicable) , parameters A and B shall be determined based on details pertaining to such partners who propose to undertake physical execution of work and in proportion to their participation/stake as specified in respective clause in the tender documents.
N	=	Years prescribed for completion of the work for which bids are invited. - 2.0 year (24 Months)

If the Tender has been invited as a Package/Slice Minimum aggregate required Bid Capacity shall be considered and accordingly the Bidder may qualify for less number of Packages/Slices. In case of individual Tenders (not invited in a single Basket) the Bidder may qualify for a particular work (based on his Technical Bid), but at the time of evaluation of Price Bid, if a greater number of such individual Bids are evaluated simultaneously, aggregate Bid Capacity shall be considered. In such a case, if the Bidder does not have adequate capacity for all the Bids in which his Bid is the lowest responsive Bid, he may be considered for a smaller number of Bids. Decision of the Employer based on the least cost combination as may be the most advantageous to Competent authority shall be final and binding to all the Bidders.

Note:

- (a) The statement showing the value and details of completed works, existing commitments and ongoing works as well as the stipulated period of completion remaining for each of the work listed should be countersigned by the officer not below the rank of an Engineer-In-Charge.
- (b) The certificate for past performance should be as per prescribed Performa in Form11.
- (c) The Bidders are required to upload latest client's certificates in Form-11 (or in any format with yearly breakup) obtained from the concerned authorities/ employers towards proof of their having executed contracts satisfactorily along with their bids. The quantities involved should be certified by the top executive of the firm in the prescribed Performa in Form 11 (or in any format with yearly breakup) of Volume-I.
- (d) Physical and Financial Performance of Any Work Not Supported By Client Certificate in Form-11 or In Any Form Will Not Be Considered For Qualification.
- (e) The applicant Bidder must provide by uploading evidence of having adequate experience. The bid should include supporting certificate or report relating to physical, financial, technical and other capability of Bidder in their original language along with certified translation of relevant portion of the certificate/ report in English. The Bidder should furnish the information about financial capability in Rupees only.
- (f) Depending upon the actual bid capacity assessed and other qualifying requirements, the applicant will be qualified for the work.
- (g) The bidder is required to submit the declaration of his financial liabilities, work on hand/completed projects on Rs.300/- non-Judicial stamp paper. In case of false statement/ declaration the bidder shall be liable for penal action. Further, the details furnished in the relevant form as per tender should be in line to the declaration by the bidder.
- (h) The criteria mentioned above at shall be evaluated based on the details submitted with the documents. Such bidder shall have to submit the details in the prescribed Performa which are applicable to them. Bidders should read the note under each Form/Annexure carefully and submit the details accordingly.
- (i) Turnover of previous year and cost of completed / executed similar nature of work/ O&M shall be given additional weightage of ten percent per year to bring them to **2025-2026** Price level to account for price escalation as illustrated below:
- (j)

Financial Year	Turnover/ Cost of Executed work/O&M	Effective cost of executed work at previous completed financial year's price level
2020-2021	F	1.61X F
2021-2022	E	1.46 x E
2022-2023	D	1.33 x D
2023-2024	C	1.21 x C
2024-2025	B	1.10 x B
2025-2026	A	1.00 x A

Note:

- (i) Financial year means period beginning from the 1st April to 31st March of the next year.
- (ii) The details pertaining to Turnover for the year 2020-21 to 2024-25 and the details pertaining to Net Cash Accrual, Net Worth and Net Working Capital for the year 2020-21 to 2024-25 shall be certified by Chartered Accountant on his own letter head and duly attested. The cost of material supplied by the Government/ Client shall not be taken into account for experience against Turnover & Similar nature of work.

• **PHYSICAL CRITERIA:**

The bidder must have successfully carried out minimum quantities of the following work in any one project during last Five (5) i.e., 2020-21 to 2024-25 and up to one month prior to last date of submission of the bid.

4.5.3.4 Pipeline Work

A. Metallic Pipeline

Procure, Lowering, Laying, Jointing, Testing and Commissioning of minimum length (as under) of metallic pipeline in any single project during last Five (5) financial years i.e., 2020-21 to 2024-25 and upto one month prior to last date of submission of the bid. If the pipeline work has been completed along with successful testing, such works shall also be considered for the evaluation based on the facts and circumstances as certified by the client.

The material supplied by the client will not be considered for procurement purpose.

Type of Pipeline	Min. Diameter (In mm)	Min. Length (In Km)
Metallic	200 mm	≥ 2.024 Km

B. Non Metallic Pipeline

Procure, Lowering, Laying, Jointing, Testing and Commissioning of minimum length (as under) of non metallic pipeline in any single project during last Five (5) financial years i.e., 2020-21 to 2024-25 and upto one month prior to last date of submission of the bid. If the pipeline work has been completed along with successful testing, such works shall also be considered for the evaluation based on the facts and circumstances as certified by the client's

The material supplied by the client will not be considered for procurement purpose.

Type of Pipeline	Min. Diameter (In mm)	Min. Length (In Km)
Non metallic	350 mm	≥ 23.336 Km

4.5.3.5 Pumping Machinery:

The bidder must have experience of supply, installation, testing and commissioning of electro mechanical works not less than **206.25 KW** in single contract during last Five (5) financial years i.e., 2020-21 to 2024-25 and up to one month prior to last date of submission of the bid.

4.5.3.6 Experience in Design, Construction, Installation, Testing and Commissioning:

The bidders must have experience of design and execution of STP/ETP/CETP/WTP of any technology (Except Oxidation Pond / ditch / Aerated Lagoon / DEWATS / SBT/ Green Technology) to the tune of at least **9.00 MLD** (Single capacity), in any single completed project. The Bidder shall provide the information about their general experience in this regard in Application Form 3-(A). Bidders are required to substantiate the information by submission of appropriate client certificates. All STP/ETP/CETP/WTP as referred should have been completed during last Five (5) financial years i.e., 2020-21 to 2024-25 and up to one month prior to last date of submission of the bid and shall have been in successful operation for at least one year immediately preceding one month prior to last date of bid submission. The Bidder shall provide the information about the particular experience in this regard by submission of appropriate client certificates. The STPs proposed should have been implemented in anywhere in India.

Bidders Experience	Qualifying Requirement
For experience in STP/ ETP/ CETP / WTP	9.00 MLD (Single capacity) in any single completed project.

4.5.3.7 Experience of Designing and Execution of Proposed Technology Provider (As applicable):

In case of the open technology, plant will become technology driven. If the sole bidder/ lead partner is not a technology provider then the lead partner/ sole bidder must form memorandum of understanding (MoU) with the technology provider (As applicable depending on type of Technology Proposed) for design/ performance guarantee along with the performance credentials of the offered process, its philosophy, process/design with calculations, drawing, layout, hydraulic flow diagram, process flow diagram, P&I diagram, O&M manuals, control philosophy etc. The technology provider must have a registered office in India fully equipped with trained manpower to extend services as and when required. Documentary evidence on above shall be submitted along with the offer.

AUDA may cross verify the documents in case required. Bid will be disqualified in case of any ambiguity found. Technology provider if he wants to be a bidder, either as a 'sole bidder' or 'Joint venture partner' shall not participate in more than one bid for this tender. However, without being a bidder he can be technology Provider for more than one bidding entities. The proposed technology (Except Oxidation Pond/ ditch/ Aerated Lagoon/ DEWATS/ SBT/ Green Technology) Provider (MoU Partner) must have experience

of designing Proposed Technology to the tune of **9.00 MLD (Single capacity)** in any single completed project. The STP as referred should have been completed in during last Five (5) financial years i.e., 2020-21 to 2024-25 and up to one month prior to last date of submission of the bid and shall have been in successful operation, for at least one year immediately preceding one month prior to the last date of bid submission. The technical bid shall be evaluated based on the facts and circumstances certified by the client not below the rank of executive engineer or equivalent, fulfilling the above required experience by the technology provider as evidence. Memorandum of Understanding (MoU) with qualified technology provider shall be submitted on Rs.300/- non-judicial stamp paper duly notarized and signed by the respective authorized representatives clearly stating the terms & conditions of the MoU as per Form-24. Such MOU should be valid up to Operation and Maintenance period and it shall not be amended or modified without prior consent from AUDA during the period of performance of contract; AUDA shall not allow such change except for special reasons. Also, MoU between the technology provider/contractor shall be made part of the bid/contract.

Technology provider shall be responsible for providing necessary supervision, support, spare/replacement inventory on need basis for the performance of the plant. The process design & drawings shall be vetted and signed by the technology provider also. Technology provider shall enter into MOU as per Form-24.

In case of STP works where Technology Provider is not required for the proposed Technology, Contractors shall submit CV/Credentials of Employees who is/are on payroll of company and has 5 years' experience of Design and Engineering of STP based on proposed Technology. The bidder should substantiate such experience in Form-14 along with relevant degree Certificate of such employee.

4.5.3.8 Operation & Maintenance:-

The bidder must have experience of **Operation & Maintenance for minimum 1-year of STP/ETP/CETP/WTP of any technology** (Except Oxidation Pond/ ditch/ Aerated Lagoon/ DEWATS/ SBT/ Green Technology) to the tune of at least **9.00 MLD, (Single capacity)** in any single completed project. The Bidder shall provide the information about the particular experience in this regard in Application Form 3-(A). Bidders are required to substantiate the information by submission of appropriate client certificates. All STP/ ETP/ CETP/ WTP as referred should have been completed during last Five (5) financial years i.e., 2020-21 to 2024-25 and up to one month prior to last date of submission of the bid and shall have been in successful operation for at least one year immediately preceding one month prior to last date of bid submission. The Bidder shall provide the information about the particular experience in this regard by submission of appropriate client certificates. The STPs proposed should have been implemented in anywhere in India

Bidders Experience	Qualifying Requirement
For experience in STP/ ETP/ CETP / WTP	9.00 MLD (Single capacity) in any single completed project.

4.5.3.9 Road Work:

For road work: MOU with road contractor having AA class with special category-1 and having own batch mix plant with capacity 120 TPH & completed 40% of the value of road work (i.e. Rs 6,10,02,882) within the last five years. (3A certificate & MOU, Registration certificate, plant location and fitness certificate has to attached with bid)

Note to 4.5.3 Physical Criteria:

- I) The works for which bidder have not entered in to contract agreement will not be considered
- II) The above experience shall be within last Five (5) financial years i.e., 2020-21 to 2024-25 and up to one month prior to last date of submission of the bid for which Form -3A/11 must be submitted.
- III) Experience as sub-contractor shall not be considered.
- IV) The experience of works executed in Government (State/Central), Board, Corporation, and Government Undertaking /Organizations of state & Central Government shall only be considered for evaluation. The experience certificate IN Form 3A format from the client equivalent to not below the rank of Executive Engineer / Authority shall be considered. The experience of sublet works shall not be considered.
- V) All MOUs shall be on a Nonjudicial stamp paper of appropriate value duly notarized and signed by respective authorized representatives.
- VI) The Bidder/JV MEMBER/MOU partners contract should not have been terminated/blacklisted/debarred in any State Govt/ Municipal Corporations/ Central Govt./ Any state Govt Organization, Urban Local body and/or its undertaking company or its SPV, Asian Development Bank/ World Bank or similar international funding agencies organizations due to delay in projects during last five years.
- VII) The works for which bidder have not entered in to contract agreement will not be considered.
- VIII) If the bidder claiming Technical/ Physical Eligibility Criteria for the works has completed any of the works in joint venture with any other company then, along with the experience certificates, the firm shall submit the joint venture agreement for that particular work. Experience certificates not accompanied by joint venture agreement shall not be considered for evaluation. The credit for the bidder which has completed a work in joint venture is allocated as follows:
 - (1) If the bidder has completed the work as a member in the project, then the bidder can claim credit for the entire scope of the work in proportion to the stake (e.g., if the capacity of the ESR executed is 30 ML and if the firm has executed the project as member with a 40% stake then the firm can claim credit for (40% x 30 ML) 12 ML works. A statutory auditor certificate specifying the payments received for the project should be submitted. In the event of percentage participation in the project calculated through the statutory auditor certificate differs from the percentage in the Joint Venture Agreement (If applicable), the percentage participation calculated through payments received shall be considered for evaluation purposes.

Note: The above condition shall also apply to Clause No. 4.2.2 'Similar Nature of work' under financial

criteria.

5.0 Bidder should fulfil the following criteria mentioned under Clause 4.0, Minimum Qualifying Criteria. If not fulfilled, he will be out rightly rejected.

4.5.4. Personnel Capabilities.

Availability for his work of personnel with adequate experience as required; as per

- **Appendix.**

4.5.5. Equipment Capabilities

Based on the studies carried out by the Engineer, the minimum suggested major equipment to attain the completion of works in accordance with the prescribed construction schedule are shown in the Appendix.

The bidders should, however, undertake their own studies and furnish with their bid, a detailed construction planning and methodology supported with layout and necessary drawings and calculations to allow the employer to review their proposals. The numbers, types and capacities of each plant/equipment shall be shown in the proposals along with the cycle time for each operation for the given production capacity to match the requirements.

4.5.6. Financial Position

The Applicant should give undertaking that he has access to, or has available, liquid assets (aggregate of working capital, cash in hand and uncommitted bank guarantees) and / or credit facilities up to 25 percent of the value of the contract / contracts applied issued by Nationalized Bank or Bank listed as per latest GR of. Finance Department GR. No.: FD/MSM/e-file/4/2025/2859/D.M.O. dated 01/05/2025.

4.5.7. The audited balance sheets for the last five years should be submitted, which must demonstrate the soundness of the applicant's financial position, showing long – term profitability including an estimated financial projection for the next two years If necessary, the employer will make inquiries with the applicant's bankers.

4.5.8. Litigation History

The Applicant should provide accurate information on any litigation or arbitration resulting from contracts completed or under execution by him over the last five years. A consistent history of awards against the Applicant or any partner of a joint venture may result in failure of the applicant.

4.5.9. Disqualification

Even though the applicants meet the above criteria, they are subject to be disqualified if they have:

Made misleading or false representation in the forms, statements submitted, and / or Record of poor performance such as abandoning the work, rescinding of contract for which the reasons are attributable to the non – performance of the contractor; consistent history of litigation awarded against the applicant or financial failure due to bankruptcy. The rescinding of contract of a joint venture on account of reasons other than non – performance, such as Most Experienced partner of joint venture pulling out, court directions leading to breaking up of a joint venture before the start of work, which are not attributable to the poor performance of the contractor will, however, not affect the qualification of the individual partners.

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~~• **4.6 JOINT VENTURE: (Maximum 3 Members i.e. 1 Lead & 2 Others) (Applicable only for estimated project cost of 50 Crore and above) – JV NOT APPLICABLE**~~

~~**4.6.1. Joint ventures must comply with the following requirement:**~~

~~(a) Following are the minimum qualification requirements:~~

~~(i) The lead partner shall meet not less than 50 percent of all criteria given in para 4.5.3 & 4.5.6 above. The joint venture must collectively satisfy the criteria of para 4.5.3 & 4.5.6 above. The experience of the other joint venture partners shall be considered if it is not less than 30 percent of the qualifying criteria in para 4.5.3 & 4.5.6 above.~~

~~(ii) Individually each member must satisfy the requirements of para 4.5.7 & 4.5.8 above.~~

~~(b) Bid shall be signed so as to legally bind all partners, jointly and severally, and shall be submitted with a copy of the joint venture agreement providing the joint and several liabilities with respect to the contract.~~

~~4.6.2. Qualification of a joint venture does not necessarily qualify any of its partners individually or as a partner in any other joint venture. In case dissolution of a joint venture, each one of the constituent firms may qualify if they meet all the qualification requirements, subject to the written approval of the Employer.~~

- **4.7.Bid Capacity.**
- **As per 4.5.3.3**

4.8 Even though the bidders meet the above qualifying criteria, they are subject to be disqualified if they have:

- Made misleading or false representation in the forms, statements and Attachments the submitted in proof the qualification requirements; and / or Record of poor performance such as abandoning the works, not properly completing the contract, inordinate delay in completion, litigation history, or financial failures etc.; and/ or participated in the previous bidding for the same work and had quoted unreasonably high bid prices and could not furnish rational justification to the employer.

5. One bid per bidder

- 5.1. Each bidder shall submit only one bid for one package. A bidder who submits or participates in more than one bid (other than as a subcontractor or in cases of alternatives that have been permitted or requested) will cause all the proposals with the bidder's participation to be disqualified.

6. Cost of Bidding

- 6.1. The bidder shall bear all costs associated with the preparation and submission of his Bid, and the Employer will in no case be responsible and liable for those costs.

7. Site Visit

- 7.1. The Bidder, at the Bidder's own responsibility and risk is encouraged to visit and examine the Site of work and its surrounding and obtain 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.

**Executive Engineer
AUDA**

B. BIDDING DOCUMENTS

8. Content of Bidding Documents

- 8.1 The set of bidding documents comprises the documents listed below and addenda issued in accordance with Clause 10:

Section	Particulars	Volume No.
-	Invitation for Bids	I
1	Instructions to Bidders	
2	Qualification Information, and other forms	
3	Conditions of Contract	
4	Contract Data	
5	Technical Specifications	II
6	Form of Bid	III
7	Bill of Quantities	
8	Securities and other forms	
9	Drawings	IV
10	Documents to be furnished by bidder	V
11	Extent of Work	VI
12	Data Sheets	

- 8.2. Volumes I, II, III and IV are available online and documents to be furnished by the bidder in compliance to section 2 will be prepared by him and furnished as Volume- V in two parts (refer clause 12).
- 8.3. The bidder is expected to examine carefully all instructions, conditions of contract, contract data, forms, terms, technical specifications, bill of quantities, forms, Annexes and drawings in the Bid Document. Failure to comply with the requirements of Bid Documents shall be at the bidder's own risk. **Pursuant to clause 26 hereof**, bids which are not substantially responsive to the requirements of the Bid Documents shall be rejected.

9. Clarification Bidding Documents

- 9.1 A prospective bidder requiring any clarification of the bidding documents may notify the Employer in writing or through E-mail at the Employer's address indicated in the invitation to bid. The Employer will respond to any request for clarification which he received earlier than 15 days prior to the deadline for submission of bids. Employer's response will be published on website including a description of the enquiry but without identifying its source.

9.2. Pre-bid meeting

- 9.2.1. The bidder or his official representative is invited to attend a pre-bid meeting which will take place at the address, venue, time and date as indicated in the appendix.
- 9.2.2. The purpose of the meeting will be to clarify issues and to answer questions on any matter that may be raised at that stage.
- 9.2.3. The bidder shall be required to submit any questions in writing or e-mail to reach the

Employer not later than 03 days before the meeting.

9.2.4 Minutes of the meeting, including the question raised (Without identifying the source of enquiry) and the responses given will be published without delay on the tender website i.e. <https://tender.nprocure.com> Any modification of the bidding documents listed in sub-Clause 8.1 which 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 Clause 10 and not through the minutes of the pre-bid meeting.

9.2.5. Non-attendance at the pre-bid meeting will not be a cause for disqualification of a bidder.

10. Amendment of Bidding Documents

10.1 Before the deadline for submission of bids, the Employer may modify the bidding documents by issuing addenda.

10.2. Any addendum thus issued shall be part of the bidding documents. The Employer will assume no responsibility for the same.

10.3. To give prospective bidders reasonable time in which to take an addendum into account in preparing their bids, the Employer may, at his discretion, extend as necessary the deadline for submission of bids, in accordance with Sub-Clause 20.2 below.

C. PREPARATION OF BIDS

11. Language of the Bid

11.1 All documents relating to the bid shall be in the English language.

12. Documents Comprising the Bid

12.1. The bid be submitted by the bidder as Volume V of the bid document (refer Clause 8.1) shall be in two separate parts:

Part I shall be named "Technical Bid" and shall comprise

- (i) Bid Security in the form specified in Section 8
- (ii) Qualification Information and supporting documents as specified in Section 2
- (iii) Certificates, undertakings, affidavits as specified in Section 2
- (iv) Any other information pursuant to Clause 4.5 of these instructions
- (v) Undertaking that the bid shall remain valid for the period specified in Clause 15.1

Part II shall be named "Financial Bid" and shall comprise

- (i) Form of Bid as specified in Section 6
- (ii) Priced Bill of Quantities for items specified in Section 7

12.2. The Bidder shall submit the details / information pertaining to each part i.e. technical as well as financial and must be submitted online only.

12.3. Following documents will be deemed to be part of the bid.

Section	Particulars	Volume No.
-	Invitation for Bids	I
1	Instructions to Bidders	
2	Qualification Information, and other forms	
3	Conditions of Contract	
4	Contract Data	
5	Technical Specifications	II
6	Form of Bid	III
7	Bill of Quantities	
8	Securities and other forms	
9	Drawings	IV
10	Documents to be furnished by bidder	V
11	Extent of Work	VI
12	Data Sheets	

13. Bid Prices

13.1 The Contract shall be for the whole works as described in Sub-Clause 1.1, based on the priced Bill of Quantities submitted by the Bidder.

13.2 The bidder shall fill in rates and prices and line item total (both in figures and words) for all items of the Works described in the Bill of Quantities along with total bid price (Both in figures and words). Items for which no rate or price is entered by the bidder will not be paid for by the Bill of Quantities.

13.3 All duties, taxes, and other levies except GST payable by the contractor under the contract, or for any other cause shall be included in the rates, prices and total Bid Price submitted by the Bidder. (GST will be paid extra)

~~13.4 The rates and prices quoted by the bidder are subject to adjustment during the performance of the Contract in accordance with the provisions of Clause 47 of the Conditions of Contract (For contracts more than 18 Monthss period).~~

13.5 The rates and prices quoted by the bidder are subject to adjustment during the performance of the Contract in accordance with the provisions of Clause 47 of the Condition of Contract **(Irrespective of the time limit and Bid Amount)**

14. Currencies of Bid and Payment

14.1 The unit rates and the prices quoted by the bidder shall be entirely in Indian Rupees. All payments shall be made in Indian Rupees.

15. Bid Validity

15.1 Bids shall remain valid for a period of not less than **180 days** after the deadline date for bid submission specified in Clause 20.

15.2 In exceptional circumstances, prior to expiry of the original time limit, the Employer may request that the bidders may extend the period of validity for a specified period. A bidder may refuse the request

without forfeiting his bid security. A bidder agreeing to the request will not be required or permitted to modify his bid, but will be required to extend the validity of his security for a period of the extension, and in compliance with Clause 16 in all respects.

16. Bid Security

16.1. The Bidder shall furnish, as part of his Bid, a Bid security in the amount as shown in column 4 of the table of IFB for this particular work. This Bid security shall be in favor of Employer as named in Appendix and may be in one of the following forms;

- a) Demand draft from any scheduled Indian bank, in the format given in Volume III. ~~(Demand draft is applicable only for Bid Estimated Amount of 01 Crore and above)~~ and Demand draft of Schedule and Private Banks shall be considered as per GoG Finance Department's Circular No. FD/MSM/e-file/4/2023/0057/D.M.O. Date 21/04/2023 or as per their latest amendment.
- b) ~~Fixed Deposit Receipt issued by any Scheduled Indian Bank or a foreign Bank approved by the Reserve Bank of India.~~

OR

~~A Valid Bid Security / EMD Exemption Certificate issued by (1) Road & Building Department or (2) Narmada Water Resources, Water Supply and Kalpsar Department of Govt of Gujarat. Exemption Certificate is applicable only when Registration Certificate of Appropriate Class and Category of Approved Contractors is required as eligible criteria of bidder. (EMD Exemption not allowed)~~

~~16.2. Bank guarantees (and other instruments having fixed validity) issued as surety for the bid shall be valid for 45 days beyond the validity of the bid i.e. total validity of 180+45 = 225 Days~~

16.3. Any bid not accompanied by an acceptable Bid Security and not secured as indicated in Sub-Clauses 16.1 and 16.2 above shall be rejected by the Employer as non-responsive.

16.4. The Bid Security of unsuccessful bidders will be returned within 28 days of the end of the bid validity period specified in Sub-Clause 15.1

16.5 The Bid Security of the successful bidder will be discharged when the bidder has signed the Agreement and furnished the required Performance Security.

16.6. The bid Security may be forfeited

- (a) If the Bidder withdraws the bid after Bid opening during the period of Bid validity.
- (b) If the Bidder does not accept the correction of the Bid Price, if any or
- (c) In the case of a successful Bidders, if the Bidder fails the specified time limit to
 - (i) Sign the Agreement; or
 - (ii) Furnish the requirement Performance Security.
- (d) If found necessary, the bidder will be intimated for negotiation, He will be intimated maximum three times within the validity period for negotiation, If contractor does not respond in time, his Bid Security (EMD) will be forfeited and his tender will be rejected. Punitive action will be taken on such contractors. (As per GoG R&B Dept's Gr. No. S/22/2017/6369/D, Dt.08/06/2018)

17. Alternative Proposals by Bidders.

17.1. Bidders shall submit offers that fully comply with the requirements of the bidding documents, including the conditions of contract (including mobilization advance or time for completion), basic technical design as indicated in the drawing and specifications. Conditional offers or alternative offers will not be considered further in the process of tender evaluation.

18. Format and Signing of Bid

18.1. The Bidder shall prepare documents comprising the bid as described in Clause 12 of these Instructions to bidder as the "Technical Bid" and "Financial Bid" in separate parts to be uploaded.

D. SUBMISSION OF BIDS

19. Sealing and Marking of Bids

19.1. The Bidder shall submit the bid namely, Technical Proposal & Financial Proposal through online by the help of Digital Signature Certificate.

-Technical Bid: To be opened as per Nit Date in the presence of Evaluation Committee.

-Financial Bid: Not to be opened except with the approval of Evaluation Committee The contents of Technical and Financial Bids will be as specified in clause 12.1

~~19.2. The inner, outer, and separate envelopes containing Technical and Financial Bids shall
(A) be addressed to the Employer at the address given in Appendix
(B) bear the identification as indicated in Appendix.~~

~~19.3. In addition to the identification required in Sub-Clauses 19.1 and 19.2, each of the envelopes shall indicate the name and address of the bidder to enable the bid to be returned unopened in case it is declared late, pursuant to Clause 21, or the Evaluation Committee declares the bid as non responsive pursuant to Clause 23.~~

~~19.4. If the outer envelope is not sealed and marked as above, the Employer with assume no responsibility for the misplacement or premature opening of the bid.~~

20. Deadline for Submission of the Bids

20.1. Complete Bids must be received online by the Employer at the tender website specified above not later than the date indicated in appendix.

20.2. The Employer may extend the deadline for submission of bids by issuing an amendment in accordance with Clause 10, in which case all right and obligation of the Employer and the bidders previously subject to the original deadline will then be subject to the new deadline.

~~21. Late Bids~~

~~21.1. Any Bid received by the Employer after the deadline prescribed in Clause 20 will be returned unopened to the bidder.~~

22. Modification and Withdrawal of Bids

22.1. Bidders may modify or withdraw their bids online before the deadline prescribed in Clause 20 or pursuant to Clause 23.

~~22.2 Withdrawal or modification of a bid between dead line for submission of bids and the expiration of the original bid validity specified in Clause 15.1 above or as extended pursuant to Clause 15.2 may result in the forfeiture of the Bid Security pursuant to Clause 16.~~

22.3. No bid shall be modified or withdrawn after the deadline for submission of Bid.

22.4. Withdrawal or modification of a bid between the deadline for submission of bids and the expiration of the original period of bid validity specified in Clause 15.1 above or as extended pursuant to Clause 15.2 may result in the forfeiture of the Bid security pursuant to Clause 16.

E. BID OPENING AND EVALUATION

23. Bid Opening

23.1 The Employer will open all the Bids received including modifications made pursuant to Clause 22, in the presence of the Bidders or their representatives who choose to attend at time, date and the place specified in Appendix in the manner specified in Clauses 20 and 23.3, In the event of the specified date of Bid opening being declared a holiday for the Employer, the Bids will be opened at the appointed time and location on the next working day.

~~23.2. Envelopes marked "WITHDRAWAL" shall be opened and read out first. Bids for which an acceptable notice of withdrawal has been submitted pursuant to Clause 22 shall not be opened.~~

23.3. The "Technical Bid" shall be opened. The amount, form and validity of the bid security furnished with each bid will be announced. If the bid security furnished does not conform to the amount and validity period as specified in the invitation for bid (ref. Column 4 and paragraph 3), and has not been furnished in the form specified in Clause 16, the technical bid will not be opened.

23.4. (i) Subject to confirmation of the bid security by the issuing Bank, the bids accompanied with valid bid security will be taken up for evaluation with respect to the Qualification information and other information furnished in part I of the bid pursuant to Clause 12.1.

(ii) If required, the bidder will be asked in writing to clarify his Qualification Documents with respect to any required clarification.

(iii) The bidders will respond in not more than 7 days of issue of the clarification letter.

(iv) Immediately (usually within 3 or 4 days), on receipt of these clarification the Evaluation Committee will finalize the list of responsive bidders whose financial bids are eligible for consideration.

~~23.5. If, as a consequence of the modifications carried out by the bidder in response to sub-clause 23.4, the bidders desire to modify their financial bid, they will submit the modification in separate sealed envelope so as to reach the Employer's address (refer sub-clause 19.2) before the opening of the financial bid as intimated in the clarification letter (refer sub-clause 23.4). The envelope shall have clear marking "MODIFICATION TO FINANCIAL BID Not to be opened except with the approval of the Evaluation Committee"~~

23.6 At the time of opening of "Financial Bid", the names of the bidders were found responsive in accordance with Clause 23.4(iv) will be announced. The bids of only these bidders will be opened. The responsive Bidders' names, the Bid prices, the total amount of each bid, any discount and such other details as the Employer may consider appropriate, will be announced by the Employer at the opening.

23.7 the time of opening of "Financial Bid", the names of the bidders were found responsive in accordance with Clause 23.4(iv) will be announced. The bids of only these bidders will be opened. The responsive Bidders' names, the Bid prices, the total amount of each bid, any discount, and such other details as the Employer may consider appropriate, will be announced by the Employer at the opening.

23.8 In case bids are invited for more than one package, the order for opening of the "Financial Bid" shall be in order of Estimated amount of Bids from highest to lowest.

23.9 The Employer shall prepare minutes of the Bid opening, including the information disclosed to those present in accordance with Sub-Clause 23.6.

24 Process to be Confidential

24.1 Information relating to the examination, clarification, evaluation, and comparison of Bids and recommendations for the award of a contract shall not be disclosed to Bidders or any other persons not officially concerned with such process until the award to the successful Bidder has been announced. Any effort by Bidder to influence the Employer's processing of Bids or award decisions may result in the rejection of his Bid.

25. Clarification of Financial Bids

25.1. To assist in the examination, evaluation, and comparison of Bids, the Employer may, at his discretion, ask any Bidder for clarification of his Bid, including breakdowns of unit rates. The request for clarification and the response shall be in writing or by e- mail, but no change in the price or substances of the Bid shall be sought, offered, or permitted except as required to confirm the correction of arithmetic errors discovered by the Employer in the evaluation of the Bids.

25.2 Subject to sub-clause 25.1, no Bidder shall contact the Employer on any matter relating to his Bid

opening to the contract is awarded. If the Bidder wishes to bring additional information to the notice of the Employer, it should do so in writing.

25.3. Any effort by the Bidder to influence the Employer in the Employer's bid evaluation, bid comparison or contract award decision may result in the rejection of the Bidders' bid.

26. Examinations of Bids and Determination of Responsiveness

26.1 During the detail evaluation of "Technical Bid", the Employer will determine whether each Bid (a) meets the eligibility criteria defined in Clause 3 and 4; (b) has been properly signed; (c) is accompanied by the required securities and; (d) is substantially responsive to the requirements of the Bidding document. During the detailed evaluation of the "Financial Bid", the responsiveness of the bids will be further determined with respect to the remaining bid conditions, i.e., priced bill of quantities, technical specifications, and drawings.

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

26.3 If a "Financial Bid" is not substantially responsive, it will be rejected by the Employer, and may not subsequently be made responsive by correction or withdrawal of the non-conforming deviation or reservation.

27. ~~Correction of Errors~~

~~27.2 "Financial Bids" determined to be substantially responsive will be checked by the Employer for any arithmetic errors. Errors will be corrected by the Employer as follows:~~

~~(a) where there is a discrepancy between the rates in figures and in words, the rate in words will govern; and~~

~~(b) where there is a discrepancy between the unit rate and the line item total resulting from multiplying the unit rate by the quantity, the unit rate as quoted will govern.~~

~~27.2 The amount stated in the "Financial Bid" will be corrected by the Employer in accordance with the above procedure and the bid amount adjusted with the concurrence of the Bidder in the following manner:~~

~~a) If the Bid price increases as a result of these corrections, the amount as stated in the bid will be the 'bid price' and the increase will be treated as rebate;~~

~~b) If the bid price decreases as a result of the corrections, the decreased amount will be treated as the 'bid price'~~

~~Such adjusted bid price shall be considered as binding upon the Bidder. If the Bidder does not accept the corrected amount the Bid will be rejected, and the Bid security may be forfeited in accordance with Sub-Clause 16.6 (b).~~

28. Deleted

29. Evaluation and Comparison of Financial Bids

29.1. The Employer will evaluate and compare only the Bids determined to be substantially responsive in accordance with Sub-Clause 26.2.

~~29.2. In evaluating the Bids, the employer will determine for each Bid the evaluated Bid Price by adjusting the Bid Price as follows.~~

~~a) Making any correction for errors pursuant to Clause 27; or~~

~~b) making an appropriate adjustments for any other acceptable variations, deviations; and~~

~~c) making appropriate adjustments to reflect discounts or other price modifications offered in accordance with Sub-Clause 23.6~~

29.3. The Employer reserves the right to accept or reject any variation or deviation. Variation and deviations and other factors, which are in excess of the requirements of the Bidding documents or otherwise result in unsolicited benefits for the Employer, shall not be taken in to account in Bid evaluation.

29.4. The estimated effect of the price adjustment conditions under Clause 47 of the Conditions of Contract, during the period of implementation of the Contract, will not be taken in to account in Bid evaluation.

29.5. If the Bid of the successful Bidder is seriously unbalanced in relation to the Engineer's estimate of the cost of work to be performed under the contract the Employer may require the Bidder to produce detailed consistency of those prices with the construction methods and schedule proposed. After evaluation of the price analyses, the Employer may require that the amount of the performance security set forth in Clause 34 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.

29.6. A bid which contains several items in the bill of Quantities which are unrealistically priced low and which cannot be substantiated satisfactorily by the bidder may be rejected as non-responsive.

30. Deleted

F. AWARD OF CONTRACT

31. Award Criteria

31.1. Subject to Clause 32, the Employer will award the contract to the Bidder whose Bid has been determined.

(i) to be substantially responsive to the Bidding documents and who has offered the lowest evaluated Bid Price; and

(ii) to be within the available bid capacity adjusted to account for his bid price which is the lowest evaluation in any of the packages opened earlier than the one consideration.

In no case, the contract shall be awarded to any bidder whose available bid capacity is less than the evaluated bid price, even if the said bid is the lowest evaluated bid. The contract will in such cases be awarded to the next lowest bidder at his evaluation bid price.

32. Employer's Right to Accept any Bid and to Reject any or all Bids

32.1. Notwithstanding Clause 31, the Employer reserves the right to accept or reject any Bid, and to cancel the Bidding process and reject all Bids, at any time prior to the award of contract, without thereby incurring any liability to the affected bidder or Bidder or any obligation to inform the affected Bidder or Bidders of the grounds for the Employer's action.

33. Notification of Award and Signing of Agreement

33.1. The Bidder whose Bid has been accepted will be notified of the award by the Employer prior to expiration of the Bid validity period by cable, telex or facsimile confirmed by registered letter. This letter (hereinafter and in the condition of contract called the "Letter of Acceptance") will state the sum that the Employer will pay the Contractor in consideration of the execution, completion, and maintenance of the Works by the Contractor as prescribed by the Contract (hereinafter and in the Contract called the "Contract Price").

33.2 The notification of award will constitute the formation of the contract, subject only to the furnishing of a performance security in accordance with the provisions of Clause.

33.3. The Agreement will incorporate all agreements between the Employer and the successful Bidder. It will be signed by the Employer and to the successful Bidder, within 28 days following the notification of award along with the Letter of Acceptance. Within 21 days of receipt, the successful Bidder will sign the Agreement and deliver it to the Employer.

33.4. Upon the furnishing by the successful Bidder of the Performance Security, the Employer will promptly notify the other Bidders that their Bids have been unsuccessful.

34. Performance Security

34.1. Within 10 (Ten) days of receipt of Letter of Acceptance, the successful Bidder shall furnish to the Employer an irrevocable and unconditional guarantee from a Bank in the form set forth in Section 8 (the "Performance Security") for an amount equal to 5% (five percent) of its Contract Price. In case of bids mentioned below, the successful Bidder, along with the Performance Security, shall also furnish to the

Authority an irrevocable and unconditional guarantee from a Bank in the same form given at Section 8 towards an Additional Performance Security (The “Additional Performance Security”) for an amount calculated as under:

(a) If the Contract Price offered by the Selected Bidder is lower than 10% but upto 20% of the Estimated Project Cost, then the Additional Performance Security shall be calculated @ 20% of the difference in the (i) Estimated Project Cost (as mentioned in Bid Document) - Minus 10% of the Estimated Project Cost and (ii) Contract Price offered by the selected Bidder.

(b) If the Contract Price offered by the Selected Bidder is lower than 20% of the Estimated Project Cost, then the Additional Performance Security shall be calculated @ 30% of the difference in the (i) Estimated Project Cost (as mentioned in Bid Document) - Minus 10% of the Estimated Project Cost and (ii) Contract Price offered by the selected Bidder.

(c) This Additional Performance Security shall be treated as part of the Performance Security.

(D) The Performance Security shall be valid beyond 60(sixty) days of the Defects Liability Period and the Additional Performance Security shall be valid beyond 28 (twenty-eight) days of Project Completion Date.

34.2. If the performance security is provided by the successful Bidder in the form of a Bank Guarantee, it shall be issued either (a) at the Bidder’s option, by a Nationalized/Scheduled Indian bank or (b) by a foreign bank located in India and acceptable to the Employer. As per GoG Finance Department’s GR. No.: FD/MSM/e-file/4/2025/2859/D.M.O. dated 01/05/2025 or as per their latest amendment.

34.3. Failure of the successful Bidder to comply with the requirement of Sub-Clause 34.1 shall constitute sufficient grounds for cancellation of the award and forfeiture of the Bid Security.

~~35—Advance Payment and Security~~

~~35.1 The Employer will provide an Advance payment on the Contract Price as stipulated in the Conditions of Contract, subject to maximum amount, as stated in the Contract Data.~~

~~36.—Dispute Review Expert~~

~~36.1 The Employer proposes that [name of proposed Dispute Review Expert as indicated in Appendix] be appointed as Dispute Review Expert under the Contract, at a daily fee as indicated in Appendix plus reimbursable expenses. If the Bidder disagrees with this proposal, the Bidder should so state in the Bid. If in the Letter of Acceptance, the Employer has not agreed on the appointment of the Dispute Review Expert, the Dispute Review Expert shall be appointed by the Council of Indian Roads Congress at the request of either party.~~

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37. Corrupt or Fraudulent Practices

37.1 The Employer will reject a proposal if it determines that the Bidder recommended for award has engaged in corrupt or fraudulent practices in completing for the contract in question and will declare the firm ineligible, either indefinitely or for a stated period of time, to be awarded a contract with National Highways Authority of India/ State PWD and any other agencies, if it at any time determines that the firm has engaged in corrupt or fraudulent practices in completing for the contractor, or in execution.

37.2 Furthermore, Bidders shall be aware of the provision stated in Sub- Clause 59.2 of the Conditions of Contract.

16.1.2 APPENDIX TO ITB
Clause Reference with respect to Section –I

1.	The Name of the Employer is Executive Engineer,Ahmedabad Urban development authority,Ahmedabad.	[Cl.1.1]
2.	The last Five years.	
	2025-2026 (Base Year)	
	2024-2025	
	2023-2024	
	2022-2023	
	2021-2022	
	2020-2021	
	2019-2020	
3.	This Annual Financial Turnover Amount is Rs.107,70,12,742.00	[Cl.4.5.3 (a)]
4.	Value of Work is Rs. 107,70,12,742.00	
5.	Deleted	
6.	The cost of electric work is Rs. 2,64,66,707.96	
7.	The cost of water supply / sanitary works is Rs. 0.00	
8.	Liquid assets and / or availability of credit facilities is Rs.	[Cl.4.5.6]
9.	Price level of the financial year 2025-26	[Cl. 4.5.2]
10.	The pre-bid meeting will take place at Office of the “Executive Engineer, Ahmedabad Urban Development Authority, Sardar Vallabhbhai Patel Bhavan, Ashram Road, Ahmedabad – 380 0422, on Date: 12/03/2026 15:30 Hrs.	[Cl. 9.2.1]
11.	The technical Bid will be opened at the office of Executive Engineer, Ahmedabad Urban Development Authority, Sardar Vallabhbhai Patel Bhavan, Ashram Road, Ahmedabad – 380 0422 on Date: 04/04/2026 18:10 Hrs.	
12.	Address of the Employer: Office of the “Executive Engineer, Ahmedabad Urban Development Authority, Sardar Vallabhbhai Patel Bhavan, Ashram Road, Ahmedabad – 380 042	
13.	Deleted	
14.	The bid should be submitted latest by As stated on online NIT	[Cl. 20.1 & 20.2]
15.	The bid will be opened at office of Executive Engineer, Ahmedabad Urban Development Authority As stated on online NIT	[Cl. 23.1]
16.	The Bank Draft in favor of Ahmedabad Urban Development Authority	
17.	Deleted	
18.	Escalation factors (for the cost of works executed and financial figure to a common base value) for works completed	[Cl.4.5.2]

<u>Year</u>	<u>Financial Year</u>	<u>Multiplying factor</u>
Base year of inviting tender	2025-2026	1.00
-1	2024-2025	1.10
-2	2023-2024	1.21
-3	2022-2023	1.33
-4	2021-2022	1.46
-5	2020--2021	1.61
-6	2019–2020	1.77

#LIST OF KEY PLANT & EQUIPMENT TO BE DEPLOYED ON CONTRACT WORK
[Reference CL. 4.5.5]

The contractors shall also give a list of machineries in his possession and which they propose to use on the work.

Sr. No.	Plant or Machinery	Location	Age of Machinery (maximum 15 years)	Make	Capacity	Approximate Value	Remark
1	2(a)	2(b)	3	4	5	6	7

List of Key Personnel to be deployed on Contract Work (Reference Cl. 4.5.4)

Employment of a qualified site Engineer by the Contractor.

The Contractor shall employ full-time technically qualified staff during the execution of this work as under: -

1. Two graduate Civil Engineers and three diploma Civil Engineers when cost of the work to be executed is more than Rs.50 lakhs.
2. One graduate & two Diploma, Civil Engineers when the cost of the work to be executed is more than Rs.15 lakhs but less than Rs.50 lakhs.
3. Minimum one Diploma Civil Engineer when the cost of work is less than Rs.15 lakhs but more than Rs.5 lakhs.
4. Minimum two Diploma Civil Engineers for the work when the cost of work to be executed is less than Rs. 5 lakhs.
5. The Engineer so employed for the Government work must have sufficient experience to handle the work independently. Such an Engineer shall have to stay at the site of work and he shall not be entrusted with other duty except this work.

In case the contractor or partner of the contractor firm is a Civil Graduate Engineer, Employment of a separate Engineer will not be necessary provided that the Engineer partner himself attends the execution of the work on the site.

Within 15 days of issue of work-order the Contractor will have to furnish to the Deputy Executive Engineer-in-charge of the work the Name, Qualifications, copy of marksheet, Colour Photograph and the appointment order issued such engineers engaged for this contract work. If 15 days after issue of work order such designated Site Engineers do not resume or do not remain present on site of work, the recovery at the rate of Rs.15,000-00 per month per Engineer will be made from the bills/deposit/dues of the contractor. Such recovery shall be non-refundable.

Employment of a qualified site Engineer by the Contractor.

The Contractor shall employ full-time technically qualified staff during the execution of this work as under: -

Sr No.	Designation	Minimum in Nos.	Educational Qualification	Min. Year of Experience In Similar Work
1	Team leader	1	M.E in Civil Engineer	15
2	Project manager	1	B.E in Civil Engineer	10
3	Senior Civil Engineer	3	B.E in Civil Engineer	7
4	Junior Civil Engineer	4	B.E in Civil Engineer	5
5	Structural Engineer	1	M.E in Structural Engineer	10
6	Hydraulic Engineer	1	M.E in Water	10
7	Environmental Engineer	1	M.E in Environment	10
8	STP Expert	1	B.E in Civil Engineer	7
9	Safety Engineer	3	B.E in Civil Engineer	7
10	Senior Mechanical Engineer	1	B.E in Mechanical Engineer	7
11	Senior Electrical Engineer	1	B.E in Electrical Engineer	7
12	Senior instrumentation Engineer	1	B.E in Instrumentation Engineer	7
13	Quantity Surveyor	1	B.E in Civil Engineer	7
14	Billing Engineer	1	B.E in Civil Engineer	7
15	Surveyor	2	Diploma in Civil Engineer	3
16	Draftsman	1	Diploma in Civil Engineer/ITI	3
17	Computer Operator	1	BCA	2
18	Liaison officer For Coordination	1	Post graduate in any field	5

Note: The Contractor shall also employ full-time technically qualified staff during the execution of Operation & Maintenance period. The list is attached as a Annexure -1 in Operation & Maintenance Specification.

SECTION - 2
QUALIFICATION INFORMATION

QUALIFICATION INFORMATION

The information to be filled in by the Bidder in the following pages will be used for the purpose of post qualification as provided for in Clause 4 of the Instruction to Bidders. This information will not be incorporated in the Contract.

1. For Individual Bidders

1.1 Constitution or legal status of Bidder (Attach Copy)

Place of registration _____
Principal place of business _____
Power of attorney of signatory of Bid
(Attach)

1.2 Total value of Civil engineering constructions Work performed in the last Five years (in Rs. Lakhs)

2025 - 2026

2024-2025

2023-2024

2022-2023

2021-2022

2020--2021

Work performed as prime contractor, work performed in the past as a nominated sub-contractor will also be considered the sub-contract involved execution of all main items of work described in the bid documents, provided further that all other qualification criteria are satisfied (in the same name) on works of a similar nature over the last five years** and in current year before the submission of the bid.

Project Name	Name of the Employer	Description of work	Contract No.	Value of contract (Rs. Crore)	Date of issue of work order	Stipulated period of completion	Actual date of completion*	Remark explaining reasons for delay & work Completed

*Attach certificate(s) from the Engineer(s)in-charge

** Immediately preceding the financial year in which bids are received.

#1.3.2 Quantities of work executed as prime contractor, work performed, in the past as a nominated sub-contractor, will also be considered provided the sub-contract involved execution of all main items of work described in the bid document, provided, further that all other qualification criteria are called (in the same name and style) in the last five years** and in current year before the submission of the bid.

Year	Name of the work	Name of the Employer	Quantity of work performed (Cum/MT)				Remarks* (indicate contract Ref)
			Cement Concrete (Including RCC & PCC)	Masonry	Earth Works	Bituminous Work	
2019-2020							
2020-2021							
2021-2022							
2022-2023							
2023-2024							
2024-2025							
2025-2026							

1.4 Information on Bid Capacity (works for which bids have been submitted and works which are yet to be completed) as on the date of this bid.

(A) Existing commitments and on-going works:

Description of works	Place & State	Contract No.	Name & Address of Employer	Value Contract (Rs. Cr)	Stipulated Period of Completion	Value of Works* remaining to be completed (Rs. Cr)	Anticipated of completion
1	2	3	4	5	6	7	8

*Attach certificate (s) from the Engineer(s) in-charge

** Immediately preceding the financial year in which bids are received.

1.5 Availability of key items of Contractors Equipment for carrying out the works (Ref. Clause 4.5.5). The Bidder should list all the information requested below.

Item of Equipment	Requirement		Availability Proposals			Remarks (from whom to be purchased)
	NO	Capacity	Owned/ Leased to be procured	Nos/. Capacity	Age/ Conditions	

1.6 Qualifications and experience of key personnel required for administration and execution of the contract. Attach biographical data. Refer also to Sub Clause 9.1 of the Conditions of Contract.

Sr No.	Position	Name	Qualification	Year of Experience (General)	Year of experience in the proposed position
1	Team leader				
2	Project manager				
3	Senior Civil Engineer				
4	Junior Civil Engineer				
5	Structural Engineer				
6	Hydraulic Engineer				
7	Environmental Engineer				
8	STP Expert				
9	Safety Engineer				
10	Senior Mechanical Engineer				
11	Senior Electrical Engineer				
12	Senior instrumentation Engineer				
13	Quantity Surveyor				
14	Billing Engineer				
15	Surveyor				
16	Draftsman				
17	Computer Operator				
18	Liaison officer for coordination.				

1.7 Proposed sub-contract and firms involved

Sections of the works	Value of Sub-Contractor	Sub-Contractor (Name & Address)	Experience in similar work

Attach copies of certificates on possession of valid license for executing water supply/ sanitary work/ building electrification works.

1.8 Financial reports for the last five years: balance sheets, profit and loss statements, auditors' reports (in case of companies/corporations), etc. List them below and attach copies.

1.9 Evidence of access to financial resources to meet the qualification requirements: cash in hand, lines of credit, etc. List them below and attach copied documents.

1.10 Name, address, and telephone, telex, and fax numbers of the Bidders bankers who may provide references if contacted by the Employer.

1.11 Information on Litigation history in which the Bidder is involved.

Other Party (ies)	Employer	Cause of Dispute	Amount Involved	Remarks showing Present Status

1.12. Statement of compliance under the requirements of Sub Clause 3.2 of the instruction to Bidders. (Name of Consultant engaged for project preparations is *)

1.13 Proposed work method and schedule. The Bidder should attach descriptions, drawings and charts as necessary to comply with the requirements of the Bidding documents. (Refer ITB Clause 4.1)

1.14 Programme

1.15 Quality Assurance Plan

2. Deleted

3. Additional Requirements

3.1 Bidders should provide any additional information required to fulfill the requirements of Clause 4 of the Instructions to the Bidders, if applicable.

(i) Affidavit

(ii) Undertaking

~~(iii) Update of original prequalification application. (*)~~

~~(iv) Copy of original prequalification application (**)~~

~~(v) Copy of prequalification letter (***)~~

* Delete, if prequalification has been carried out.

** Fill the Name of Consultant.

*** Delete, if prequalification has not been carried out.

16.1.3 SAMPLE FORMAT FOR EVIDENCE OF ACCESS TO OR AVAILABILITY OF CREDIT FACILITIES

(CLAUSE 4.5.6 OF ITB)

BANK CERTIFICATE

This is to certify that M/s. _____ is a reputed company with a good financial standing.

If the contract for the work, namely _____ is awarded to the above firm, we shall be able to provide overdraft/credit facilities to the extent of Rs. ____ To meet their working capital requirements for executing the above during the contract period.

(Signature)

Name of Bank

Senior Bank Manager

Address of the Bank

16.1.4 **AFFIDAVIT**

16.1.5

1. I, the undersigned, do hereby certify that all the statements made in the required attachments are true and correct.
2. The undersigned also hereby certifies that neither our firm M/s. _____ have not abandoned any work of Government of Gujarat/Government of India/any Board or Corporation under Government of Gujarat/Government of India nor any contract awarded to us for such works have been rescinded, during last five years prior to the date of this bid.
3. The undersigned hereby authorize(s) and request (s) any bank, person, firm or corporation to furnish pertinent information deemed necessary and requested by the Department to verify this statement or regarding any (our) competence and general reputation.
4. The Undersigned understands and agrees that further qualifying information may be requested, and agrees to furnish any such information at the request of the Department/ Project implementing agency.

(Signed by an Authorized Officer of the Firm)

Title of Officer

Name of Firm

Date

16.2 UNDERTAKING

I, the undersigned do hereby undertake..... that our firm M/s
would invest a minimum cash
up to 25% of the value of the work during implementation of the contract.

(Signed by an Authorized officer of the firm)

Title of officer

Name of firm

DATE

SECTION – 3
CONDITIONS OF CONTRACT

Conditions of Contract

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Conditions of Contract

1 General

(i) Definitions

1.1 Terms which are defined in the Contract Data are not also defined in the Conditions of Contract but keep their defined meaning.

Bill of Quantities means the priced and completed Bill of Quantities forming part of the Bid
Compensation Events are those defined in Clause 44 hereunder

The **Completion Date** is the date of completion of the Works as certified by the Engineer in accordance with Sub Clause 55.1

The Contract is the contract between the Employer and Contractor to execute, complete and maintain the Works **till the completion of Defects Liability Period**. It consists of the documents listed in Clause 2.3 below.

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

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

The **Contractor's Bid** is the completed Bidding document submitted by the Contractor to the Employer and includes Technical and Financial Bids.

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

Days are calendar days: **months** are calendar months.

The **Defects Liability Period** is the period named in the Contract Data and calculated from the Completion Date.

The **Employer** is the party who will employ the Contractor to carry out the Works.

The Engineer is the person named in the Contract Data (or any other competent person appointed and notified to the contractor to act in replacement of the Engineer) who is responsible for supervising the Contractor, administering the Contract, certifying payments due to the Contractor, issuing and valuing Variations to the Contract, awarding extensions of time, and valuing the Compensations Events.

Equipment is Contractor's machinery and vehicles brought temporarily to the site to construct the Works.

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

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

Materials are all supplies, including consumables, used by the contractor for incorporation in the works.

Plant is any integral part of the work which is to have mechanical, electrical, electronic or chemical or biological functions.

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

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

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

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

A **Subcontractor** is a person or corporate body who has a Contract with the Contractor to carry out a part

of the work in the Contract which includes work on the Site.

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

A **Variation** is an instruction given by the Engineer, which varies the Works. The **Works** are what the Contract requires the Contractor to construct, install, and turn over to the Employer, as defined in the Contract Data.

2. Interpretation

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

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

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

- (1) Agreement
- (2) Letter of Acceptance, notice to proceed with works
- (3) Contractor's Bid
- (4) Contract Data
- (5) Conditions of Contract including Conditions of Contract
- (6) Specifications
- (7) Drawings
- (8) Bills of quantities and
- (9) Any other document listed in the Contract Data as forming part of the Contract.

3. Language and Law

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

4. Engineers Decisions

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

5. Delegation

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

6. Communications

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

7. Sub-Contracting

7.1 The Contractor may subcontract any portion of work, up to a limit specified in contract data, with the approval of the engineer but may not assign the Contract without the approval of the Employer in writing. Subcontracting shall not alter the Contractor's obligations. **Sub-contracting of supply or specific items of work is not allowed.**

7.2 The sub-contractor must be registered in appropriate class and category for the part of work to be subcontracted.

8. Other Contractors

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

9. Personnel

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

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

10. Employer's and Contractors Risks

10.1 The Employer carries the risk which these Contract states are Employer's risks, and the Contractor carries the risks which these Contracts states are Contractors risk.

11. Employer's Risks

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

12. Contractor's Risks

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

13. Insurance

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

- (a) Loss of or damage to the works, Plant and materials,
- (b) Loss of or damage to Equipment
- (c) Loss of or damages of property (except the Works, Plant, Materials and Equipment) in connection with the Contract; and
- (d) Personal injury or death.

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

13.3 If the Contractor does not provide any of the policies and certificates required, the Employer may

affect the insurance which the Contractor should have provided and recover the premiums the Employer has paid from payments otherwise due to the Contractor or, if no payment is due, the payment of the premiums shall be a debt due.

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

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

14. Site Investigation Report

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

15. Queries about the Contract data

15.1 The engineer will clarify queries on the Contract Data

16. Contractor to Construct the Works

16.1 The Contractor shall construct and install the works in accordance with the specification and Drawings.

17. The Works to be completed by the Intended Completion Date

17.1 The Contractor may commence execution of the Works on the Start Date and shall carry out the Works in accordance with the programme submitted by the Contractor, as updated with the approval of the Engineer, and complete them by the Intended Completion date

18. Approval by the Engineer

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

18.2 The Contractor shall be responsible for design of temporary works.

18.3 The Engineer's approval shall not alter the contractor responsibility for design of the Temporary works.

18.4 The Contractor shall obtain approval of third parties to the design of the Temporary works where required.

18.5 All Drawings prepared by the Contractors for the execution of the temporary or permanent work are subject to prior approval by the Engineer before their use.

19. Safety

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

20. Discoveries

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

21. Possession of the Site

~~21.1 The Employer shall give possession of all parts of the site to the Contractor. If possession of a part is not given by the date stated in the Contract Data the Employer is deemed to have delayed the start of the relevant activities and this will be a Compensation Event.~~

~~21.2 If within 25% of the time limit of the project, 80% of possession of the site is not handed over to the Contractor, then contractor/ Employer may fore close the contract. Contractor/Employer has to foreclose the work within 30 days after lapse of 25% time limit and after 30 days foreclosure option will be closed.~~

22. Access to the Site

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

23. Instructions

23.1 The Contractor shall carry out all instructions of the Engineer pertaining to works which comply with the applicable laws where the site is located.

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

24. Disputes

24.1 If the Contractor is of the view that a decision taken by the Engineer was either outside the authority given to the Engineer by the Contract or that the decision was wrongly taken, the decision shall be referred to #Chief Executive Authority (Higher Authority) within 14 days of the notification of the Engineer's decision. If the issue is not resolved, any party can refer the matter for conciliation within 15 days from the decision given by the # Chief Executive Authority.

24.2

(a) For the work up to Rs.100 Cr., if any of the parties is not satisfied with the decision of the #Executive Engineer, both the parties have to refer to the Chief Executive Authority **concern** for the conciliation process.

(b) For the work more than Rs.100 Cr., if any of the parties is not satisfied with the decision of the # Chief Executive Authority, both the parties have to refer to the **#Chairman A.U.D.A,** for the conciliation process:

If the dispute is not resolved through the conciliation process, he may refer the dispute to Gujarat Public Works Contract Dispute Arbitration Tribunal. If the Contractor fails to refer a claim / dispute to the Higher Authority within 14 days of the notification of the Engineer's decision, the Contractor shall not be entitled to any additional payment/claim if he doesn't follow the above sequence in stipulated time and he should not stop the work.

25. Procedure for Disputers

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

26. ~~Replacement of Dispute Review Expert~~

~~26.1 Should the Dispute Review Expert resign or die, or should the Employer and the Contractor agree that the Dispute Review Expert is not fulfilling his functions in accordance with the provisions of the Contract, a new Dispute Review Expert will be jointly appointed by the Employer and the Contractor. In case of disagreement between the Employer and the Contractor, within 30 days, the Dispute Review Expert, shall be designated by the Appointing Authority designated in the Contract Data at the request of either party, within 14 days of receipt of such request.~~

A. TIME CONTROL

27. Programme

27.1 Within the time stated in the Contract Data the Contractor shall submit to the Engineer for approval a Programme showing the general methods, arrangements orders, and timing for all the activities in the works along with monthly cash flow forecast.

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

27.3 The Contractor shall submit to the Engineer, for approval an updated programme at intervals no longer than the period stated in the Contract data. If the Contractor does not submit an updated programme within this period, the Engineer may withhold the amount stated in the Contract data from the next payment after the date on which the overdue programme has been submitted.

27.4 The Engineer's approval of the programme shall not alter the Contractor's obligations. The Contractor may revise the programme and submit it to the Engineer again at any time. A revised programme is to show the effect of Variations and Compensations events.

28. Extension of the Intended Completion Date

28.1 The Engineer shall extend the Intended Completion Date if a compensation Event occurs or a Variation is issued which makes it impossible for completion to be achieved by the Intended Completion Date without the Contractor taking steps to accelerate the remaining work and which would cause the Contractor to incur additional cost.

28.2 The Engineer shall decide whether and by how much to extend the Intended Completion Date within 35 days of the Contractor asking the Engineer for a decision upon the effect of a compensation event or Variation and submitting full supporting information. If the Contractor has failed to give early warning of a delay or has failed to cooperate in dealing with a delay, the delay by this failure shall not be considered in assessing the new Intended Completion Date.

28.3 The Engineer shall within 14 days of receiving full justification from the contractor for extension of Intended Completion Date refer to the Employer his decision. The employer shall in not more than 21 days communicate to the engineer the acceptance or otherwise of the Engineer's decision. If the employer fails to give his acceptance, the Engineer shall not grant the extension and the contractor may refer the matter under Clause 24.1

29. Deleted

30. Delays Ordered by the Engineer

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

31. Management Meetings

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

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

32. Early Warning

32.1 The Contractor is to warn the Engineer at the earliest opportunity of specific likely future events or circumstances that may adversely affect the quality of the work, increase the Contract price or delay the

execution of works. The Engineer may require the contractor to provide an estimate of the expected effect of the future event or circumstance on the contract price and completion date. The estimate is to be provided by the Contractor as soon as reasonably possible.

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

B. QUALITY CONTROL

• # 33. Identifying Defects/ Defect liability period

33.1 : Defect liability period : The contractor shall be responsible to make good and remedy at his own expense any defect which may develop or may be noticed before the period mentioned hereunder from the certified date of completion. The Engineer in charge shall give the contractor a notice in writing about the defects and the contractor shall make good the same within 15 days of receipt of the notice. In the case of failure on the part of the contractor, the Engineer- in-charge may rectify or remove or re-execute the work at the risk & cost of the contractor. The Engineer-in-charge shall be entitled to appropriate the whole or any part of the amount of security deposit towards the expenses, if any, Incurred by him in rectification, removal or re-execution. The Defects Liability period shall be as under....

(a) ~~For all works costing up to Rs. 50,000 (amount put to tender), the period shall be 3 Months from the certified date of completion.~~

(b) For all works costing more than Rs. 50,000 and up to Rs. 1 crore (amount put tender), the period shall be 36 (Thirty Six) months from the certified date of completion or one monsoon, whichever is later.

(c) For major projects costing more than Rs. 1 crore, the period shall be 36 Months from the certified date of completion which should include three monsoons.

~~(d) For original building works the defect liability period will be 4 years or elapse of 4 monsoon period following date of possession of building taken over by user agency following the certified date of completion, whichever is later.~~

For the purpose of deciding the monsoon period, the 30th September shall be treated as the last date. Modified vide R & B D Circular No. PAC-11-102008-2076-N dated 31/8/2009, PRCH/102013(2976) 2759-N, Dated 27/05/2013 and Circular No.TNC/10/2016/Clause 17A (Correction/(1)C Dated 12/05/2016]

~~33.2 Free maintenance guarantee period for works of Road/Bridge construction~~

~~(a) For resurfacing work of road free maintenance guarantee period one year from the date of completion.~~

~~(b) In case of widening of the road/strengthening of the road/bridge, the contractor shall have to give four years free maintenance guarantee from the certified date of completion. During this period the contractor shall visit the site every six months along with the concerned Section Officer / Deputy Executive Engineer and will examine the work already carried out in this contract like road work, jungle cutting, side shoulders, side gutter, road furniture, patta etc. and will prepare Km. wise inspection report duly signed by all concerned and any defect observed shall be done within 15 days by the contractor at his risk and cost as per the direction of Engineer in charge. The contractor needs to do videography of these visits and require to submit at the time of release of FMG. If B.T. the surface during the maintenance period of 4 years is worn out then agency shall have to provide renewal coating as per tender item as directed by the Engineer-in-charge. The amount equivalent to 5% of each running bill shall be withheld and will be released after the free maintenance guarantee period (i.e. 4 years) is over.~~

~~However, this amount shall be released against fixed deposit or bank guarantee pledged in the name of Executive Engineer after completion certificate of work is issued.~~

~~(1) The flakiness and elongation index (combined) for coarse aggregates under no circumstances shall exceed the allowable limit set forth in the relevant clause for the material in question.~~

~~(2) 2% of the amount eligible for the payment of bituminous items shall be withheld till the miscellaneous items like earthwork in embankment / cutting for side shoulders, side gutters, kilometer / indicator / guard stones, sign boards etc. are completed in all respect by the contractor. After completion of the miscellaneous items, the above said 2% withheld amount shall be released.~~

~~(Govt. of Gujarat's G.R. No.: TNC-10-2013-3(Part-3)/C, Dtd. 13/12/2013).~~

~~(3) Videography for the surface under Maintenance Guarantee is to be done as per Govt. letter No.: SSR/10/2015-16/26/C, Dtd. 26/11/15 for the work costing more than Rs. 5.00 Crore.~~

~~(4) Setting up of adequate laboratory & deployment of quality engineers.~~

~~The contractor shall have to set up the laboratory with adequate equipment. Till the setting up of adequate laboratory is completed & reported of this to the engineer (subject to due verification by engineer's representative) by contractor in writing, Rs.2,00,000/- shall be withheld. The qualified quality Engineer shall be deployed exclusively for this contract by the contractors. If quality Engineer is not deployed by contractor within one month after the date of work order, the amount equivalent to Rs.20,000 per month shall be recovered till the actual deployment of quality engineer. The amount so recovered towards the deployment of quality engineers shall not be refunded.~~

~~(5) Asphalt work will have to be cross checked as per G.R. No.: RGN/60/2006/35/C, dtd.31/05/07 before final bill is paid.~~

~~(6) Maintenance during Construction Period~~

~~During the Construction Period, the Contractor shall maintain, at his own risk and cost, the existing lane(s) of the road so that the traffic worthiness and safety thereof are at no time materially inferior as compared to their condition 10 (ten) days prior to the date of the Agreement, and shall undertake the necessary repair and maintenance works for this purpose; provided that the Contractor may, at his cost, interrupt and divert the flow of traffic if such interruption and diversion is necessary for the efficient progress of works and conforms to Good Industry Practice; provided further that such interruption and diversion shall be undertaken by the Contractor only with the prior written approval of the Executive Engineer which approval shall not be unreasonably withheld. For the avoidance of doubt, it is agreed that the Contractor shall at all times be responsible for ensuring safe operation of the road.~~

~~33.3 The Engineer shall check the Contractor's work and notify the Contractor of any defects that are found. Such checking shall not affect the Contractor's responsibilities the Engineer may instruct the Contractor to search for a Defect and to uncover and test any work that the Engineer considers may have a Defect.~~

34. Tests

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

~~34.2 #1% of the amount of **work done** should be deducted from R.A. Bill of the contractor for testing the quality of material workmanship, irrespective of actual charges.~~

34.3 Agency has to establish testing laboratory on site for the various test to be carried out in the work for this purpose agency shall construct a pukka laboratory building with all facility on site at location specified by the engineer in charge.

35. Correction of defects

35.1 The engineer shall give notice to the Contractor of any defects before the end of the defects Liability Period, which begins at Completion and is defined in the contract data. The Defects Liability Period shall be extended for as long as Defects remain to be corrected.

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

36. Uncorrected Defects

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

C. COST CONTROL

37. Bill of Quantities

37.1 The bill of Quantities shall contain items for the constructions, installation, testing and commissioning work to be done by the Contractor.

37.2 The bill of Quantities is used to calculate the Contract price. The Contractor is paid for the quantity of the work done at the rate in the Bill of Quantities for each item.

38. Change in the Quantities

38.1 The Engineer shall have power to make any alterations in or addition to the original specifications, drawings, designs and instructions that may appear to him to be necessary or advisable during the progress of the work and the contractor shall be bound to carry out the work in accordance with any instruction in this connection which may be given to him in writing signed by the Engineer and such alteration shall not invalidate the contract and any additional work which the contractor may be directed to do in the manner above specified as part of the work shall be carried out by the contractor on the same conditions in all respects on which he agreed to do the main work and at the same rate as are specified in the tender for the main work.

Except that when the quantity of any item exceeds the quantity as in the tender by more than 130%, the contractor will be paid for the quantity in excess of 130%, at the rate entered in the SOR of the year during which the excess in quantity is first executed.

39. Variations

39.1 All Variations shall be included in updated programmed produced by the Contractor.

40. Payments for Variations

40.1 If the additional or altered work includes any class of work for which no rate is specified in this contract, then such class of work shall be carried out as under.

(i) At the rate derived from the item within the contract which is comparable to the one involving additional or altered class of work; where there are more than one comparable items, the item of the contract which is nearest in comparison with regard to class or classes of the work involved shall be selected and the decision of the Executive Engineer as to the nearest comparable item shall be final and binding on the contractor.

(ii) If the rate cannot be derived in accordance with (i) above, such class of works shall be carried out at the rate entered in the Schedule of Rates of the division for the year in which the tender was received, increased or decreased by the percentage by which the tender amount is more or less as compared to the amount arrived at the rates in the "Schedule of Rates" of the Division in the year in which the tender was received. If the Schedule of rates of the Division does not contain all the items, the percentage increase or decrease of the tender shall be calculated considering such items which were included in the "Scheduled Rates" of the division for the year and for materials consumed on such item the rate to be charged would be the basic rate taken into account for fixing the rate in S.O.R. referred to above.

(iii) If it is not possible to arrive at the rate from (i) and (ii) above, such class of work shall be carried out at the rate decided by the competent authorities on the basis of detailed rate analysis after hearing the contractor before a Committee of two Executive Engineers stationed at the same place or the nearest place.

40.2 If the additional or altered work, for which no rate is entered in the "Schedule of Rates" of the Division is ordered to be carried out before the rate is agreed upon, then the contractor shall within seven days of the date of receipt by him of the order to carry out the work, inform the Engineer-in-charge of the rate, which it is his intention to charge for such class of work and if the Engineer in charge does not agree to this rates, he shall by notice in writing be at liberty to cancel his order to carry out such class of work and arrange to carry it out in such manner as he may consider it advisable, provided always that if the

contractor shall commence work or incur any expenditure in regard thereof before the rates shall have been determined as lastly herein before mentioned, then in such cases he shall only be entitled to be paid in respect of the work carried out or expenditure incurred by him prior to the date of the determination of the rate as aforesaid according to such rate or rates as shall be fixed by the Engineer-in-charge. In the event of the dispute, the decision of the Executive Engineer of the Circle shall be final.

Where, however, the work is to be executed according to the designs, drawings and specifications recommended by the contractor and accepted by the competent authority, the alternation above referred to shall be within the scope of such designs, drawings and specifications appended to the tenders.

The time limit for the completion of the work shall be extended in the proportion that the increase in the cost occasioned by alterations bears to the cost of the original work and the certificate of the Engineer-in-charge as to such proportion shall be final and conclusive.

41. Cash Flow Forecasts

41.1 When the programmer is updated, the contractor is to provide the engineer with an updated cash flow forecast.

42. Payment certificates.

42.1 The Contractor shall submit to the Engineer monthly statements of the estimated value of the work completed less the cumulative amount certified previously.

42.2 The Engineer shall check the Contractor's monthly statement within 14 days and certify the amount to be paid to the Contractor after taking in to account any credit or debit for the month in question in respect of materials for the works in the relevant amounts and under conditions set forth in sub-clause 32.3 of the Contract Data (secured Advance).

42.3 The value of work executed shall be determined by the Engineer.

42.4 The value of work executed shall comprise the value of the quantities of the items in the Bill of Quantities completed.

42.5 The value of work executed shall include the valuation of variations and compensation events.

42.6 The Engineer may exclude any item certified in a previous certificate or reduce the proportion of any item previously certified in any certificate in the light of later information

43. Payments

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

43.2 Payment of GST (prevailing rates) on the amount payable under the contract to the Contractor will be made by the Employer. Hence, it is the responsibility of the contractor to pay the GST to the concerned Authority.

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

44. Compensation events

44.1 The following are compensation Events unless they are caused by the Contractor:

(a) The Employer does not give access to a part of the Site by the site Possession date stated in Contract data to the Contractor

44.2 In case of compensation event occurs and it prevents the work being completed beyond the Intended Completion Date then Authority will approve EOT with eligible contractual price escalation.

45. Tax

45.1 The rates quoted by the Contractor must be inclusive of all taxes prevailing on due date of bid submission except GST. However, any subsequent changes in the tax structure by Government after due date of bid submission will be compensated (+/-) on availability or submission of actual documentation. Contractor will have to intimate Engineer regarding changes occurred in the tax structure after bid submission. If the contractor fails to provide such information and if any financial obligation may arise due to change in tax structure, same will be recovered from the contractor.

45.2 GST will be paid separately on the bills. Hence, it is the responsibility of the contractor to pay the GST to the concerned Authority.

46. Currencies.

46.1 All payment shall be made in Indian Rupees.

47. Price Adjustment

47.1 Contract price shall be adjusted for increase or decrease in rates and price of labour, materials, fuels and lubricants in accordance with the following principles and procedures and as per formula given in the contract data:

(a) The price adjustment shall apply for the work done from the start date given in the contract data up to end of the initial intended completion date or extensions granted by the Engineer and shall not apply to the work carried out beyond the stipulated time for reasons attributable to the contractor.

(b) The price adjustment shall be determined during each month from the formula given in the contract data.

(c) Following expressions and meanings during to the work done during each month

R = Total value of work done during the month. It would include the amount of secured advance granted, if any, during the month less the amount of secured advance recovered, if any during the month. It will exclude value for works executed under variations for which price adjustment will be worked separately based on the terms mutually agreed.

47.2 To the extent that full compensation for any rise or fall in costs to the contractor is not covered by the provisions of this or other clause in the contract, the unit rates and prices included in the contract shall be deemed to include amounts to cover the contingency of such other rise or fall in costs.

48. Retention

48.1 The Employer shall retain from each payment due to Contractor the proportion stated in the Contract Data until Completion of the whole of the Works.

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

48.3 On completion of the whole works, the contractor may substitute retention money with an "on demand" Bank guarantee.

In case, Contractor requests for refund of the Retention Money deducted by the Employer under the provision of this clause, Employer shall consider the said request of the Contractor provided that the refund hereunder shall be made in tranches of not less than 1% (One Percent) of the Contract Price and Contractor furnishes an irrevocable and unconditional Bank guarantee for an equal amount substantially in the format of Bank Guarantee for Performance Guarantee enclosed with SBD and valid up to 60 day beyond the scheduled / extended Defects Liability Period. On completion of the whole works, the contractor has however an option to submit a fresh irrevocable and unconditional Bank Guarantee for an amount equal to 5% of the total value of work executed substantially in the format of Bank Guarantee for Performance Guarantee enclosed with SBD and valid up to 60 days beyond the Defect Liability Period and yet refund the Retention Money Bank Guarantee submitted for refund of Retention Money.

49. Liquidated Damages

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

49.2 If the Intended Completion Date is extended after liquidated damages have been paid, the Engineer shall correct any overpayment of liquidated damages by the Contractor by adjusting the next payment certificate. The Contractor shall not be entitled for any interest on the over payment calculated from the

date of payment to the date of repayment.

49.3 If the contractor fails to comply with the time for completion as stipulated in the tender, then the contractor shall pay to the employer the relevant sum stated in the Contract Data as Liquidated damages for such default and not as penalty for everyday or part of day which shall elapse between relevant time for completion and the date stated in the taking over certificate of the whole of the works on the relevant section, subject to the limit stated in the contract data.

The employer may, without prejudice to any other method of recovery deduct the amount of such damages from any monies due or to become due to the contractor. The payment or deduction of such damages shall not relieve the contractor from his obligation to complete the works on from any other of his obligations and liabilities under the contract.

49.4 If, before the Time for Completion of the whole of the Works or, if applicable any Section, a Taking Over Certificate has been issued for any part of the Works or of a Section, the liquidated damages for delay in completion of the remainder of the Works or of that Section shall, for any period of delay after the date stated in such Taking-Over-Certificate, and in the absence of alternative provisions in the Contract, be reduced in the proportion which the value of the part so certified bears to the value of the whole of the Works or Section, as applicable. The provisions of this Sub-clause shall only apply to the rate of liquidated damages and shall not affect the limit thereof.

50—Bonus

~~50.1 If the contractor achieves completion of the whole of the works prior to the intended Completion Date prescribed in Contract Data the Employer shall pay to the contractor a sum stated in Contract Data as bonus for every completed month but subjected to maximum amount as stated in Contract Data; which shall elapse between the date of completion of all items of works as stipulated in the contract, including variations ordered by the Engineer and the time prescribed in Clause 17.~~

~~50.2 Bonus shall be paid only to works amounting to above INR 5 crore with time limit of the works is equal or more than 6 months. The bonus would be paid as under~~

% of Time Saved	% of Initial Contract Price- entitled for Bonus
50 %	5%
40 %	4%
30 %	3%
20 %	2%
10 %	1%
Less than 10%	0%

51.—Advance Payment.

~~51.1 The Employer shall make advance payment (not to be paid less than two installments except in special circumstances for which the reason to be Recorded in writing) to the Contractor of the amounts stated in the Contract Date by the date stated in the Contract Date, against provision by the Contactor of an Unconditional Bank Guarantee in a form and by a bank acceptable to the Employer in amounts and currencies equal to be at least 110% of the advance payment. The guarantee shall remain effective until the advance payment has been repaid, but the amount of the guarantee shall be progressively reduced by the amounts repaid by the Contractor. The Mobilization advance would be deemed as interest bearing advance at an interest rate of 10 % to be compounded, quarterly.~~

~~51.2 The Contractor is to use the advance payment only to pay for Equipment, plant and Mobilization expenses required specifically for execution of the Works. The Contractor shall demonstrate that advance payment has been used in this way by supplying copies of invoices or other documents to the engineer.~~

~~51.3 The advance payment shall be repaid by deduction proportionate amount from payments otherwise due to the Contractor, following the schedule of completed percentages of the Works on a payment basis. No account shall be taken of the advance payment or its repayment in assessing valuations of work done, variations, price adjustments, Compensation Events, or Liquidated damages.~~

~~51.4—Secured Advance~~

~~The Engineer shall make advance payment in respect of materials intended for but not yet incorporated in the works in accordance with conditions stipulated in the contract Data.~~

52. Securities

52.1 The performance Security (including additional security for unbalanced bids) shall be provided to the Employer no later than the date specified in the Letter of Acceptance and shall be issued in an amount and form and by a bank or surety acceptable to the Employer, and denominated in Indian Rupees. The performance Security shall be valid until a date 60 days from the date of expiry of Defects Liability Period and the additional security for unbalanced bids shall be valid until a date 28 days from the date of issue of the certificate of completion.

53. Deleted

54. Cost of Repairs.

54.1 Loss or damage to the Works or Materials to be incorporated in the Works between the Start date and the end of Defects Correction periods shall be remedied by the Contractor at the Contractor's cost if the loss or damages arises from the Contractor's acts or omissions.

D. FINISHING THE CONTRACT

55. Completion

55.1 The Contractor shall request the Engineer to issue a Certificate of Completion of the works and the Engineer will do so upon deciding that the work is completed.

56. Taking Over

56.1 The Employer shall take over the Site and the Works within seven days of the Engineer issuing a certificate of Completion.

57. Final Account

57.1 The Contractor shall supply to the Engineer a detailed final account of the total amount that the Contractor considers payable as full and final settlement of all claims under the Contract for items before the end of the Defects Liability Period. The Engineer shall issue a Defect Liability Certificate and certify any final payment that is due to the Contractor within 56 days of receiving the Contractor's account if it is correct and complete. If it is not, the Engineer shall issue within 56 days a schedule that states the scope of the corrections or additions that are necessary. If the Final Account is still unsatisfactory after it has been resubmitted, the Engineer shall decide on the amount payable to the Contractor and issue a payment certificate, within 56 days of receiving the Contractor's revised account.

57.2 If reversal in characteristic of tender (L1 becoming L2) on account of excesses and savings in final account is observed, the Engineer/Employer shall be at liberty to restrict the final payment of BOQ items to the lowest amount evaluated of the bids considering the final quantities and the rates quoted including the rebates if any. Payment of variation items shall however be made at the rates approved by the Employer, within 90 days from the physical completion of work.

58. Operating and Maintenance Manuals

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

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

59. Termination

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

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

1. The contractor stops work for 28 days when no stoppage of work is shown on the current programme and the stoppage has not been authorized by the Engineer
2. The Engineer instructs the Contractor to delay the progress of the Works and the instructions is not withdrawn within 28 days;
3. The Employer or the Contractor is made bankrupt or goes into liquidation other than for a reconstructions or amalgamation
4. A payment certified by the Engineer is not paid by the Employer to the Contractor within 56 days of the date of the Engineer's certificate
5. The Engineer gives Notice that failure to correct a particular Defect is a fundamental breach of Contract and the Contractor fails to correct it within a reasonable period of time determined by the Engineer;
6. The Contractor does not maintain a security which is required;
7. The Contractor has delayed the completion of works by the number of days for which the maximum amount of liquidated damages can be paid as defined in the Contract data; and
8. If the Contractor, in the judgment of the Employer has engaged in corrupt or fraudulent practices in competing for or in executing the Contract.

For the purpose of this paragraph: "corrupt practice" means the offering, giving, receiving or soliciting of anything of value to influence the action of a public official in the procurement process or in contract execution. "Fraudulent practice" means a misrepresentation of facts in order to influence a procurement process or the execution of a contract to the detriment of the borrower, and includes collusive practice among Bidders (prior to or after bid submission) designed to establish bid prices at artificial non-competitive levels and to deprive the Borrower of the benefits of free and open competition.

59.3 When either party to the Contract gives notice of a breach of contract to the Engineer for a cause other than those listed under Sub Clause 59.2 above, the Engineer shall decide whether the breach is fundamental or not.

59.4 Notwithstanding the above, the employer may terminate the Contract for convenience.

60. Payment upon Termination

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

60.2 If the Contract is terminated at the Employer's convenience or because of a fundamental breach of Contract by the Employer, the Engineer shall issue a certificate for the value of the work done, the cost of balance material brought by the contractor and available at site, the reasonable cost of removal of equipment, repatriation of the Contractor's personnel employed solely on the works, and the Contractor's cost of protecting and securing the Works and less advance payment received up to the date of the certificate, less other recoveries due in terms of the contract and less taxes due to deducted at source as per applicable law.

61. Property

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

62. Release from Performance

62.1 If the Contract is frustrated by the outbreak of war or by any other event entirely outside the control of either the Employer or the Contractor the Engineer shall certify that the Contract has been frustrated. The Contractor shall make the Site safe and stop work as quickly as possible after receiving this certificate

and shall be paid for all work carried out before receiving it and for any work carried out afterwards to which commitment was made.

E. SPECIAL CONDITIONS OF CONTRACT

63. LABOUR

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

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

64. COMPLIANCE WITH LABOUR REGULATIONS

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

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

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

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

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

1. Pension or family pension on retirement or death, as the case may be.
2. Deposit linked insurance on the death in harness of the worker.
3. Payment of P.F. accumulation on retirement/death etc.

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

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

- F) **Minimum Wages Act 1948 :-** The Employer is supposed to pay not less than the Minimum Wages fixed by appropriate Government as per provisions of the Act, if the employment is a scheduled employment. Construction of Building, Roads, Runways are scheduled employment.
- G) **Payments of wages Act 1936:-** It lays down as to by what date the wages are to be paid, when it will be paid and what deductions can be made from the wages of the workers.
- H) **Equal remunerations Act 1979 :-** The Act provides for payment of equal wages for work of equal nature to Male and Female workers and for not making discrimination against female employees in the matter of transfer, training and promotions etc.
- I) **Payments of Bonus Act 1965 :-** The Act is applicable to all establishments employing 20 or more employees. The Act provides for payments of annual bonus subject to a minimum of 8.33% of wages and maximum of 20 % of wages to employees drawing Rs. 3500/- per month or less. The bonus to be paid to employees getting Rs, 2500/- per month or above Rs. 3500/- per month shall be worked out by taking wages as Rs. 2500/- per month only. The Act does not apply to certain establishments. The newly set-up establishments are exempted for five years in certain circumstances. Some of the State Governments have reduced the employment size from 20 to 10 for the purpose of applicability of this Act.
- J) **Industrial Disputes Act 1947 :-** The Act lays down the machinery and procedure for resolutions of Industrial disputes, in what situations a strike or lock-out becomes illegal and what are the requirements for laying off or retrenching the employees or closing down the establishment.
- K) **Industrial employment (standing Orders) Act 1946 :-** It is applicable to all establishments employing 100 or more workmen (employment size reduced by some of the State and Central Government to 50). The Act provides for laying down rules governing the conditions of employment by the Employer on matters provided in the Act and get the same certified by the designated Authority.
- L) **Trade Unions Act 1926:-** The Act lays the procedure for registration of trade unions of workmen and employers. The Trade Unions registered under the Act have given certain immunities from civil and criminal liabilities.
- M) **Child Labour (Prohibition & Regulation Act 1986 :-** The Act prohibits employment of children below 14 years of age in certain occupations and process and provides for regulation of employment of children in all other occupations and processes. Employment of Child labour is prohibited in Building and Construction Industry.
- N) **Inter – State Migrant workmen’s (Regulation of Employment & Conditions of service) Act 1979:-** The Act is applicable to an establishment which employs 5 or more inter-state migrant workmen through an intermediary (who has recruited workmen in one state for employment in the establishment situated in another state). The inter-state migrant workmen, is an establishment to which this Act becomes applicable, are required to be provided certain facilities such as housing, medical aid, traveling expenses from home upto the establishment and back, etc.
- O) **The Building and Other Construction workers (Regulation of employment and Conditions of Service) Act 1996 and the Cess Act of 1996:-** All the establishments who carry on any building or other constructions work and employ 10 or more workers are covered under this Act. All such establishments are required to pay cess at the rate not exceeding 2% of the cost of construction as may be modified by the government. The Employer of the establishment is required to provide safety measures at the Building or construction work and other welfare measures, such as canteens, First Aid facilities, Ambulance, Housing accommodations for workers near the workplace etc. The Employer to whom the Act applies has to obtain a registration certificate from the Registering Officers appointed by the Government.
- P) **Factories Act 1948 :-** The Act lays down the procedure for approval of plans before setting up a factory, health and safety provisions, welfare provisions, working hours, annual earned leave and rendering information regarding accidents or dangerous occurrences to designated authorities. It is applicable to premises employing 10 persons or more with aid of power or 20 or more persons without the aid of power engaged in the manufacturing process.
- Q) **Royalty charges-** The contractor shall pay the royalty to the competent authority as per rule. The royalty charges paid shall be borne by the contractor and shall not be reimbursed by the Employer.

R) **Following Pollution control Acts and amendments made thereof from time to time shall be applicable.**

1. Water (Preservation and control of Pollution) Act, 1974
2. Air (Prevention and Control of Pollution Act 1981
3. Environmental (Protection) Act 1986

The contractor must commit to adopting Environmental management plan for best energy use, waste management, the reduction of pollution as in EMS (Environmental Management system)ISO-14001- 2015

65. ARBITRATION (GCC Clause 24)

The procedure for arbitration will be as follows: -

24.1 If the Contractor is of the view that a decision taken by the Engineer was either outside the authority given to the Engineer by the Contract or that the decision was wrongly taken, the decision shall be referred to **#Executive Engineer** (Higher Authority) within 14 days of the notification of the Engineer's decision. If the issue is not resolved, any party can refer the matter for conciliation within 15 days from the decision given by the **#Executive Engineer**.

24.2

(a) For the work up to Rs.100 Cr., if any of the parties is not satisfied with the decision of the **#Executive Engineer**, both the parties have to refer to the **# Chief Executive Authority/Chairmen** concerned for the conciliation process.

(b) For the work more than Rs.100 Cr., if any of the parties is not satisfied with the decision of the **#CEA A.U.D.A, Ahmedabad**, both parties have to refer to the **#Chairmen A.U.D.A, Ahmedabad** for the conciliation process.

If the dispute is not resolved through the conciliation process, contractor may refer the dispute to Gujarat Public Works Contract Dispute Arbitration Tribunal. If the Contractor fails to refer a claim / dispute to the Higher Authority within 14 days of the notification of the Engineer's decision, the Contractor shall not be entitled to any additional payment/claim if he doesn't follow the above sequence in stipulated time. However, during such period, he would not stop the work in any case.

SECTION - 4

CONTRACT DATA

CONTRACT DATA

Item marked "N/A" do not apply to this Contract. Clause
Reference With respect To section

1.	The Employers is	[CL.1.1]																		
	Name: Executive Engineer, Ahmedabad Urban development Authority																			
	Address: S.V.Bhavan , Usmanpura , Ahmedabad-380014																			
	Name of authorized Representative (will be intimated later)																			
2.	The Engineer is Executive Engineer, Ahmedabad Urban Development Authority																			
	Name of Authorized Representative:																			
3.	The Defects Liability Period is 36(Thirty Six) Months from the date of completion.	[CL.1.1&33]																		
4.	The Start Date shall be 1 st days for the date of issue of the Notice to proceed with the work.	[CL.1.1]																		
5.	The Intended Completion Date for the whole of the works is 24 (Twenty Four) Months (Excluding Monsoon Period) after start of work with the following milestones:	[CL.1.1,17&2]																		
	Milestone dates: Physical works to be completed Period from the start date Milestone 1 i.e. %..... days. Milestone 2 i.e. %..... days. Milestone 3 i.e. %..... days. Milestone 4 i.e. %..... days.	[CL.2.2& 49.1]																		
6.	The Site is located at... TP Schemes Nos. 412A, 412B, 243, 109, 413 & 411	[CL.1.1]																		
7.	The name and identification number of the Contract is:	[CL.1.1]																		
8.	The works consist of..... with items as per B.O.Q. The works shall, inter alia, include the following, as Specified or as directed:	[CL.1.1]																		
9.	Construction of Sewer network under TP Schemes Nos. 412A, 412B, 243, 109, 413 & 411 and construction of 3 Nos.Pumping Stations (MPS 01-11.98 MLD, MPS-2 12.24 MLD & MPS-3 20.55 MLD) and Sewerage Treatment Plant of 30 MLD Capacity within AUDA TP Scheme areas. <table><tr><td>1</td><td>Gravity Network</td></tr><tr><td>2</td><td>House Connection</td></tr><tr><td>3</td><td>Rising main</td></tr><tr><td>4</td><td>Pumping Stations</td></tr><tr><td>5</td><td>STP</td></tr><tr><td>6</td><td>Mechanical Works</td></tr><tr><td>7</td><td>Instrumentation Works</td></tr><tr><td>8</td><td>Electrical Works</td></tr><tr><td>9</td><td>Area Development of Compound wall</td></tr></table>	1	Gravity Network	2	House Connection	3	Rising main	4	Pumping Stations	5	STP	6	Mechanical Works	7	Instrumentation Works	8	Electrical Works	9	Area Development of Compound wall	As per clause 2-3
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	10 Area Development Paver Blocks Works	
	11 Area Development Toilet Block Work (3 Nos.)	
	12 High Tension Pannel Room at MPS (3 Nos.)	
	13 LT Pannel Room at MPS (3 Nos.)	
	14 Steel truss Bridge	
	15 Road Resurfacing & Approach Road	
	16 O&M CIVIL (For 5 Years)	
	17 O&M EMI (For 5 Years)	
	18 O&M of Civil and Electo Mec of STP (For 5 Years)	
10	(B) Other Items Any Other Items as required to fulfill all contractual obligations as per the Bid documents. The following documents also form part of the Contract:	[CL.2.3(9)]
11	The law which applies to the Contract is the law of Union of India	[CL.3.1]
12	The language of the Contract documents is English	[CL.3.1]
13	Limit of subcontracting 25% of the Initial Contract Price	[CL.7.1]
14	The Schedule of Other Contractors	[CL.8]
15	The Schedule of Key Personnel As per Annex – II to Section I	[CL.9]
16	The minimum insurance cover for physical property, injury and death is Rs. 5 lakhs per occurrence with the number of occurrences limited to four. After each occurrence, the contractor will pay an additional premium necessary to make insurance valid for four occurrences always.	[CL.13]
17	Site Investigation report	[CL.14]
18	The Site Possession dates shall be	[CL.21]
19	The period for submission of programmed for approval of the engineer shall be 21 days from the issue of Letter of Acceptance.	[CL. 27.1]
20	The period between program updates will be as per days.	[CL.27.3]
21	The amount to be withheld for late submission of an updated programmer	[CL. 27.3]
22	The following events shall also be Compensation Events Substantially adverse ground conditions encountered during the course of execution of work not provided for in the bidding document. (i) Removal of underground utilities detected subsequently (ii) Significant changes in classification of soil requiring additional mobilization by the contractor, e.g. ordinary soil to rock excavation, (iii) Removal of unsuitable material like marsh, debris dumps, aused by the contractor.	[CL. 44]

	(iv) Artesian conditions (v) Seepage, erosion landslide (vi) River training requiring protection of permanent work (vii) Presence of historical, archeological or religious structures, monuments interfering with the works (viii) Restriction of access to ground imposed by civil, judicial, or military authority	
23.	The currency of the Contract is Indian Rupees	[CL. 46]
24.	The formula (e) for adjustment of prices are as under: If any of the commodities like Cement, Steel or Bitumen are not found applicable in a work, the weight component of that commodities {i.e. 'Cement' (Pc), 'Steel' (Ps) or 'Bitumen' (Pb) as indicated in SBD for the purpose of Price Adjustment} shall be clubbed with the weight component of 'Other Material' (Pm), such that the gross % weight of the components shall remain as 100% . R = value of work as defined in Clause 47.1 of Conditions of Contract Adjustment for labour component (i) Price adjustment for increase or decrease in the cost due to labour shall be paid in accordance with the following formula: $V_L = 0.85 \times (P_l/100) \times R \times (L_i - L_0)/L_0$ V_L = Increase or decrease in the cost of work during the month under consideration due to changes in rates for local labour L_0 = The consumer price index for industrial workers for the State on 28 days preceding the scheduled date of opening of technical Bids as published by Labour Bureau, Ministry of Labour, Government of India L_i = The consumer price index for industrial workers for the State for the month under consideration as published by the Labour Bureau, Ministry of Labour, Government of India. P_l = Percentage of labor component of the work.	[CL.47]
	Adjustment for cement component. (ii) Prices adjustment for increase or decrease in the cost of cement procured by the contractor $V_c = 0.85 \times (P_c/100) \times R \times (C_i - C_0)/C_0$ V_c = Increase or decrease in the cost of work during the month under consideration due to changes in rates for cement. C_0 = The all India wholesale price index for Ordinary Portland Cement on 28 days preceding the scheduled date of opening of technical bid as published by the Office of the Economic Adviser, Department for Promotion of Industry and Internal Trade, Ministry of Commerce & Industry.	

	C_i = The all India average wholesale price index for Ordinary Portland Cement for the month under consideration as published by Office of the Economic Adviser, Department for Promotion of Industry and Internal Trade, Ministry of Commerce & Industry. P_c = Percentage of cement component of the work	
	Adjustment for steel component (iii) Price adjustment for increase or decrease in the cost of steel procured by the contractor shall be paid in accordance with the following formula $V_s = 0.85 \times (P_s/100) \times R \times (S_i - S_0)/S_0$ V_s = Increase or decrease in the cost of work during the month under consideration due to changes in the rates for steel S_0 = The all India wholesale price index for steel (Mild Steel - Long Products Rebars) on 28 days preceding the date of opening of Bids as published by the Office of the Economic Adviser, Department for Promotion of Industry and Internal Trade, Ministry of Commerce & Industry. S_i = The all India average wholesale price index for steel (Mild Steel - Long Products Rebars) for the month under consideration as published by Office of the Economic Adviser, Department for Promotion of Industry and Internal Trade, Ministry of Commerce & Industry. P_s = Percentage of steel component of the work Note : For the application of this clause, the index of Mild Steel- Long products Rebars has been chosen to represent the steel group.	
	Adjustments of bitumen component (iii) Price adjustment for increase in the cost of bitumen shall be paid in accordance with the following formula $V_b = 0.85 \times (P_b/100) \times R \times (B_i - B_0)/B_0$ V_b = Increase or decrease in the cost of work during the month under consideration due to changes in rates for bitumen. B_0 = The official retail price of bitumen at the IOC depot at the nearest center on the day 28 days prior to the scheduled date of opening of technical bid. B_i = The official retail price of bitumen of IOC depot at the nearest center for the 15th day of the month under consideration. P_b = Percentage of bitumen component of the work	
	Adjustment of POL (fuel and lubricant) component	

	(iii) Price adjustment for increase or decrease in cost of POL (fuel and lubricant) shall be paid in accordance with the following formula $V_f = 0.85 \times (P_f/100) \times R \times (F_i - F_0)/F_0$ V_f = Increase or decrease in the cost of work during the month under consideration due to changes in rates for fuel and lubricants. F_0 = The official retail price of High Speed Diesel (HSD) at the existing consumer pumps of IOC at the nearest center on the day 28 prior to the date of opening of Bids. F_i = The official retail price of HSD at the existing consumer pumps of IOC at the nearest center for the 15th day of the month of the under consideration. P_f = Percentage of fuel and lubricants component of the work Note: For the application of this clause, the price of High-Speed diesel Oil has been chosen to represent the fuel and lubricants group.	
	Adjustment for Construction Machinery (iv) Price adjustment for increase or decrease in the cost of plant and Machinery spare procured by the Contractor shall be paid in accordance with the following formula $V_p = 0.85 \times (P_p/100) \times R \times (P_i - P_0)/P_0$ V_p = Increase or decrease in the cost of work during the month under consideration due to changes in rates for plant and machinery spares P_0 = The all India wholesale price index for manufacturer of machinery for mining, quarrying and Construction for the month under consideration as published Office of the Economic Adviser, Department for Promotion of Industry and Internal Trade, Ministry of Commerce & Industry. P_i = The all India average wholesale price index for manufacturer of machinery for mining, quarrying and Construction for the month under consideration as published Office of the Economic Adviser, Department for Promotion of Industry and Internal Trade, Ministry of Commerce & Industry. P_p = Percentage of plant and machinery spares component of the work. Note: For the application of this clause, index of Heavy Machinery and parts has been chosen to represent the Plant and Machinery Spares group	
	Adjustment of other materials Component	

	(v) Price adjustment for increase or decrease in cost of local materials other than cement, steel, bitumen and POL procured by the contractor shall be paid in accordance with the following formula $V_m = 0.85 \times (P_m/100) \times R \times (M_i - M_0)/M_0$ V_m = Increase or decrease in the cost of work during the month under consideration due to change in rates for local materials other than cement, steel, bitumen and POL. M_0 = The All India wholesale price index (all commodities) on 28 days preceding the scheduled date of opening of technical Bids, as published by the Office of the Economic Adviser, Department for Promotion of Industry and Internal Trade, Ministry of Commerce & Industry. M_i = The All India wholesale price index (all commodities) for the month under consideration as published by the Office of the Economic Adviser, Department for Promotion of Industry and Internal Trade, Ministry of Commerce & Industry.																												
	P_m = Percentage of local material components (other than cement, steel, bitumen and POL) of the work. The following percentage will govern the price adjustment for the entire contract: <table border="1"> <thead> <tr> <th>Component</th><th>Average % (All Schedules)</th><th>Notes / Justification</th></tr> </thead> <tbody> <tr> <td>Labour (Pl)</td><td>23.8 %</td><td>Significant across excavation, laying, finishing, shuttering & RCC works</td></tr> <tr> <td>Cement (Pc)</td><td>14.9 %</td><td>Required for RCC, PCC, plastering, masonry, and minor filler works</td></tr> <tr> <td>Steel (Ps)</td><td>19.1 %</td><td>Dominant in Rising Mains, Bridges, MPS, Panel Rooms; minimal in roads</td></tr> <tr> <td>Bitumen (Pb)</td><td>3.1 %</td><td>Limited to road-related items (B10, B15)</td></tr> <tr> <td>POL (Pf)</td><td>9.5 %</td><td>Fuel and lubricants for machinery, mixers, tippers, cranes</td></tr> <tr> <td>Plant & Machinery Spares (Pp)</td><td>6.7 %</td><td>Wear & tear of machinery, mixers, pavers, cranes, vibrators</td></tr> <tr> <td>Other Materials (Pm)</td><td>22.9 %</td><td>Aggregates, sand, bricks, paints, pipes, gaskets, consumables</td></tr> <tr> <td>Total:-</td><td>100.00 %</td><td></td></tr> </tbody> </table>	Component	Average % (All Schedules)	Notes / Justification	Labour (Pl)	23.8 %	Significant across excavation, laying, finishing, shuttering & RCC works	Cement (Pc)	14.9 %	Required for RCC, PCC, plastering, masonry, and minor filler works	Steel (Ps)	19.1 %	Dominant in Rising Mains, Bridges, MPS, Panel Rooms; minimal in roads	Bitumen (Pb)	3.1 %	Limited to road-related items (B10, B15)	POL (Pf)	9.5 %	Fuel and lubricants for machinery, mixers, tippers, cranes	Plant & Machinery Spares (Pp)	6.7 %	Wear & tear of machinery, mixers, pavers, cranes, vibrators	Other Materials (Pm)	22.9 %	Aggregates, sand, bricks, paints, pipes, gaskets, consumables	Total:-	100.00 %		
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25	The proportion of payments retained (retention money) shall be 6% from each bill subject to a maximum of 5% of final contract price.	{CL. 48}																											
26	Amount of Liquidated damages For Whole of work delay in completion of works $(1/2000)^{th}$ of the Initial contract price, rounded off to the nearest Thousand, per day. For sectional Completion (wherever specified In item 6 of Contract data)	{CL.49}																											

	(1/2000) th of initial contract price for #5 km Section, rounded off to the nearest thousand per day.	
27	Maximum limit of liquidated damages 10 percent of the Initial For delay in completion work Contract Price rounded off to the nearest thousand	{CL. 49}
28	Amount of Bonus for early completion Amount of bonus for early completion of work shall be given as per of Section-3	CL.50
29	Maximum limit of bonus for early 5 percent of the Contract- Completion of work Price	{CL. 50}
30	The amount of the advance payment are: Nature of Advances Amount (Rs.) Conditions to Be fulfilled i Mobilization 10% of the contract Price Bank Guarantee. (to be drawn before the end of 20% of the contract period). The contractor may furnish four bank guarantees of 2.5 % of each valid for the full period. ii Equipment After equipment is brought to 90% for new and 50% of depreciated valuesite (provided the Engineer is for old equipment. Total amount will be satisfied That the equipment is subject to a maximum of 5% of the Contract Price required for performance of the contract) and on submission of unconditional Bank Guarantee for amount of advance iii Secured Deleted Advance for Non persish able material Brought to site (The advance payment will be paid to the Contractor no later than 28 days after fulfillment of the above conditions).	{CL. 51 & 52}
31	Repayment of advance payment for mobilization and equipment The advance loan shall be repaid with percentage deduction from the interim payments certified by the Engineer under the Contract. Deduction shall commence in the next Interim Payment Certificate following that in which the total of all such payments to the Contractor has reached not less than 20 percent of the Contract Price or 6 (six) months from the date of payment of first installment of advance, whichever period concludes earlier, and shall be made at the rate of 20 percent (collectively for both Mobilization Advance and Equipment Advance) of the amounts of all Interim Payment Certificate until such time as the loan has been repaid, always provided that the loan shall be completely repaid prior to the expiry of the original time for completion pursuant to Clause 17 and 28.	{CL. 51.3}
32	Deleted	
33	The securities shall be for the following minimum amounts equivalent As a percentage of the Contract Price:	{CL. 52}
34	Performance Security for 5 percent of contract price plus Rs. (to be decided after evaluation of the bid) as additional security in	Clause 29.5

	terms of ITB , The standard form of Performance security acceptable to the Employer shall be an unconditional Bank Guarantee of the type as presented in Section 8 of the Bidding Documents.	
35	The Schedule of Operating and maintenance Manuals.....N/A.	{CL. 58}
36	The date by which “as– built” drawings (in scale as directed) in 2 sets are required within 28 days of the issue of certificate of completion of the whole or section of the work, as the case may be.	{CL. 58}
37	The amount to be withheld for failing to supply “as built” drawings by the Date required	{CL. 58}
38	The following events shall also be fundamentals breach of contract: “The Contractor has contravened Sub- clause 7.1 and Clause 9 of GCC”	{CL.59.2}
39	The percentage to apply the value of the work not completed representing the Employer’s additional cost for completing the Works shall be 20 per cent.	{Cl 60}

SECTION - 5

TECHNICAL SPECIFICATION

TABLE OF CONTENTS

Sr. No.	Description
a	Site Surveys
b	Relocation, Abandonment and Protection of Existing Utilities, Services and Structures
c	Demolition
d	Landscaping
e	Earthwork and Excavation
f	Excavation Dewatering
g	Backfilling and Filling
h	Embankments
i	Sheeting, Shoring and Bracing
j	Anchors to Resist Uplift
k	Anti-Termite Treatment and Pesticides
l	Roads and Pavements
m	Concrete
n	Piling
o	Structural Steel
p	Anchor Bolts
q	Painting and Protective Coating

PART-1: STANDARD BASIC SPECIFICATION

a. Site Surveys

• Confirmatory Topographical Surveys

Where a topographical survey is called for, or is otherwise necessary for the execution of the works, the survey shall establish the following information:

- Site location relative to existing developments
- Location of reference points (temporary benchmarks etc.) and datum levels for setting out and levelling
- Site boundaries
- Contoured plan showing existing site levels
- Drainage patterns
- Features of engineering significance, e.g., unstable ground, vegetation, contaminated lands, previous use for landfill etc.
- Means of access to site Positions of utility service mains, pipelines, cables etc, if any.

• Soil Investigations

Reports of sub-surface examinations made by the Employer will be made available to the Contractor on request, including reports of studies, where available, of the normal ground water level fluctuations. This information is being supplied in good faith but any conclusions drawn from them will be at the Contractor's responsibility.

Prior to designing the foundations for structures that will impose a significant load, the Contractor shall carry out a geotechnical survey in sufficient detail to confirm the validity of the existing geotechnical data. The survey shall include boreholes under every structure that will impose a significant load, including:

- pumping stations;
- water retaining structures;
- treatment plant
- dewatering facilities; and
- all other tanks, silos etc. which will hold liquids or solids in bulk.

Where geotechnical data is unavailable for the area in which a foundation is to be constructed, the Contractor shall carry out a full geotechnical survey and shall establish the following information:

- 1 the sequence, thickness and lateral extent of the soil strata and level of bedrock (if appropriate);
- 2 the soil parameters and soil chemistry, including identification and classification, contamination and toxic substances determined from tests on representative samples of the soils and rock;
- 3 the groundwater conditions, variations and fluctuations; and
- 4 the in-situ load bearing capacity of the soil matrix.

Where off-site materials have to be used on the project, the Contractor shall, if the Employer's Representative so desires, make available certified soil test reports including information regarding sieve analyses, plastic limits, liquid limits, maximum density, optimum moisture contents and the credentials of the testing laboratory. The Contractor shall also submit a testing schedule to ensure uniformity of materials supplied. Certificates, when required, shall be submitted in triplicate.

Survey of Existing Underground Services

The Contractor is wholly responsible for the verification of information regarding existing utilities and their location.

The Contractor shall conduct a detailed survey to accurately define the line location and depth of

existing buried pipes, ducts, cables and other services affected by the works and where required update the drawings.

The Contractor shall establish the location and identify the function of all existing services which:

- pass under the proposed location or within 1.5 metres of any proposed new structure or extension to an existing structure
- cross the proposed route of any new road, footpath, buried pipe, duct, cable or other service
- run within 1 metre of the proposed route of any new road, footpath, buried pipe, duct, cable or other service.

- **Survey of Structures to be Modified or Demolished**

- **Surveys to Establish Strength**

The Contractor shall survey each existing structure for which:

- the structure is to be maintained and incorporated into the new works;
- the loads to which the structure will be subjected will be increased by more than 10% of the current worst case load conditions; or
- the structure itself will be modified in such a way as to affect its ability to withstand loads

For each such structure, the Contractor shall measure structural components on site, expose parts of the foundations, examine the materials of construction etc. to an extent which, in conjunction with any available drawings and design calculations for the structure, is sufficient for the strength of the structure to be confirmed.

Where drawings for the structure are available, the Contractor shall check the key dimensions on site. The Contractor shall check all existing structural design calculations made available to him prior to using the results of such calculations.

- **Structural Condition Survey**

Prior to modifying any existing structure, the Contractor shall carry out a structural condition survey to establish the extent of any of the following parameters:

- 1 settlement and differential settlement
- 2 corrosion
- 3 distortion, abnormal deflections and cracking
- 4 damage to and deterioration of surface finishes
- 5 damage to and deterioration of doors, windows etc

- **Survey to Identify Hazards**

For each structure which is to be modified or demolished under the Contract, in addition to reviewing any available information about the materials used in constructing the structure or which have been handled in the structure, the Contractor shall survey the structure to identify any potentially hazardous materials such as asbestos. Where appropriate, the Contractor shall carry out chemical or other appropriate tests to verify the identity of any materials that it is believed may be hazardous.

The Contractor shall also identify other features, e.g. fragile roofs, flammable materials etc, which could give rise to a hazard during the modification or demolition work.

- **Setting Out**

Setting out and measurement shall comply with the methods and values of accuracy given in ISO 1134: 'Setting Out Buildings'.

b. Relocation, Abandonment and Protection of Existing Utilities, Services and Structures

The buried services survey must be reconfirmed by the Contractor with the utility authorities involved.

The Contractor is responsible for liaison with the relevant authorities responsible for the utilities, services and structures and establishing the authority's technical requirements and the protocols and planning requirements for their relocation, abandonment and protection and incorporating these requirements into the Contractor's programmed.

Unless specifically required by the authority responsible for a particular service, the Contractor is responsible for the relocation (permanent or temporary), abandonment and protection of existing utilities, services and structures required to complete the works.

All utility lines and structures, whether indicated on any drawings or not, which remain in service shall be protected by the Contractor from any damage likely to result from his operations. The Contractor shall be solely responsible for any damage to other utilities as well as any consequential damage/loss as a result of such damage.

The Contractor is responsible for the design of any temporary or permanent works required to temporarily or permanently support or relocate services and structures during the works and demonstrate the adequacy of his designs. Any relocation of services and structures during the works shall be shown on the as-constructed drawings.

Before starting any section of the works, the Contractor shall disconnect or arrange for the disconnection of any utility services designated to be removed, performing such work in accordance with the requirements of the utility company.

The Contractor shall preserve in operational condition any active utilities traversing the site that are designated to remain in operation until the new facilities have been constructed and commissioned.

Where damage is likely to result from his operations, the Contractor shall relocate the utility to the approval of the Employer's Representative and the utility authority.

In the case of any utility whose location or existence is unknown, but which is encountered during the course of the work, the Contractor shall immediately inform the Employer's Representative of such discovery and the Contractor shall either relocate the utility or undertake to have it relocated.

c. Demolition

• General

Demolition work includes, but is not necessarily limited to, the following tasks:

- Demolition, removal and disposal of existing structures, mechanical and electrical installations, pipelines and other buried structures and services described in the Employer's Requirements at the project sites or included within the project working areas.
- Demolition, removal and disposal of those structures, mechanical and electrical installations, pipelines and other buried services encountered during excavation which are not required to be retained for future use.
- Temporary and/or permanent relocation of existing utilities and other buried services to be retained for future use which are either encountered or affected by demolition works.
- Temporary and permanent support and protection of existing utilities and other buried services affected by or encountered during demolition works which are to be retained for future use.
- Temporary and permanent support for existing above ground and buried structures affected by or

encountered during demolition works.

- Filling, backfilling and compaction to grade level further to demolition and removal.

The Contractor shall complete, at a minimum, the tasks included in the following paragraphs in the execution of dismantling, demolition and removal of the required items and shall submit a detailed execution and safety plan to the Employer's Representative for inspection prior to commencing his activities.

- **Existing Services, Utilities and Structures**

Work shall be carried out in such a way that no damage is caused to the adjoining utilities, work or property and precautions shall be taken to minimise dust- nuisance.

- **Temporary Fencing and Hoarding**

The Contractor shall erect a fence around the perimeter of the safe working area required for demolition and shall demonstrate to the Employer's Representative that the extent of this area fulfils safety requirements.

The Contractor shall provide hoarding as required and to the satisfaction of the Employer's Representative, to protect all those who may be affected by those works.

- **Demolition and Reinstatement**

The Contractor shall demolish the required structures in accordance with the detailed execution plan submitted to the Employer's Representative.

Dismantling shall be commenced in a systematic manner. All materials which are to be dismantled at height, such as during the demolishing of roofs, shall be carefully lowered to the ground and not dropped.

The Contractor shall remove and dispose of demolition waste off-site, in accordance with the regulatory requirements.

The Contractor shall backfill excavated areas and voids due to demolition or the removal of materials, immediately. Backfilling and compaction shall be suitable for the final requirements at that location. As a minimum, backfilling shall include compacted hardcore to 300mm below grade level and granular fill or topsoil to grade as appropriate.

- **Removal of Debris**

Any serviceable material obtained during dismantling or demolition shall be separated out and stacked properly. All unserviceable materials shall be disposed of from the site and the site left in a neat and orderly condition, to the satisfaction of the Employer's Representative and in accordance with prevailing regulations.

- **Treatment**

All the demolition areas shall be rendered clean of all debris. After the removal of any doors, windows chowkhats etc and unless otherwise required, the sides of jambs, sills, soffits etc shall be plastered in 1:3 cement mortar with neeru finish to render sides, corners, edges etc. true and square.

- **Asbestos Based Materials:**

Asbestos based materials may be present in buildings to be demolished under this contract.

If any suspected asbestos based materials are discovered during demolition work this shall be

reported immediately to the Employer's Representative.

Removal of asbestos based materials shall be carried out by a specialist, licensed sub-contractor prior to any other works starting in the location.

d. Landscaping

- The site shall be landscaped once the Works are substantially complete. Landscaping area shall be marked in the layout plan of STP site. The area of landscaping shall not be less than 33% of the proposed plant layout area.

- Landscaping shall include planting of suitable trees and development of lawn/grassed areas. Landscaping in general shall meet ecological and environmental conditions of the site. Road widths shall determine the size of the tree height and spread to be selected for planting. Trees suitable for local conditions shall be selected as approved by the Engineer. Medicinal and fruit trees shall be avoided. Landscaping shall be maintained in good condition till the completion of the contract.

- **Clearance of Large Trees, Structures etc**

Clearance of large trees and structures shall include the removal of large trees, stumps and structures or parts thereof lying within the site of the works as demarcated at the site.

- **Removal of Top Soil**

All shrubs, vegetation and other plants shall be removed and cleared from the site and disposed of.

Topsoil shall be carefully stripped and stored at a suitable location on the site, separate from other excavated material. Excess topsoil and topsoil unsuitable for landscaping and grassing shall be removed from the site and disposed of.

All debris and material unsuitable for re-use at the site shall be excavated to a depth of 30 cm shall be removed from the site.

- **Grading**

Areas of exposed soil shall be graded, landscaped and planted to produce a neat and attractive environment not subject to ponding.

Where required, areas shall be refilled to correct grade with selected suitable excavated material from the site, or suitable material imported to the site. The quality and compaction of such fill or embankments shall be in accordance with the requirements of Section 5.

Backfilling and compaction shall be suitable for the final requirements at the given location. As a minimum, backfilling shall include compacted hardcore to 300mm below grade level and granular fill or topsoil to grade as appropriate.

The Contractor shall, where necessary, refill and compact any existing pits, wells, existing dry-wells or other areas where the levels are below the general finished grade.

- **Grassing and Landscaping:**

- 1 In addition to top soiling, landscaping includes the supply, installation, laying-out and stocking of flower beds and rockeries, planting of trees and shrubs and for the seeding or turfing of lawns.

- 2 All parts of the site not covered by buildings or paving shall, as soon as practicable after the completion of the earthworks, be covered with topsoil and sown with grass, all as specified hereafter.

- **Top Soiling:**

As far as practicable topsoil shall be obtained from material generated from excavations and separately

stored in temporary spoil tips as approved.

If, in the Employer's Representative's opinion the Contractor cannot reasonably obtain sufficient topsoil of acceptable quality in this way, the Contractor shall if so approved by the Employer's Representative provide extra material from an approved source off the site.

Topsoil shall be evenly spread and trimmed over embankments and other areas to appropriate slopes and grades. The depth after spreading and trimming shall be 300 mm, measured perpendicular to the surface. All clods and lumps shall be broken up and any rubbish large stones, roots and weeds shall be removed.

- **Grassig:**

The Contractor shall be responsible for maintaining all landscaped areas including grassed areas, flower beds, rockeries, trees and shrubs in good condition throughout the Contract including all watering, rolling, fertilizing, weeding, cutting and re-sowing as necessary.

- **Fencing**

5.4.1 Mild Steel Posts and Struts

Mild steel posts and struts shall be free from rust, scale, cracks, twists and other defects and shall be fabricated to the required shape and size out of the suitably sized sections. The posts and struts shall have split ends for proper fixing and shall be embedded in cement concrete of mix 1:3:6. The exposed surfaces of the posts and struts shall be painted with two coats of synthetic enamel paint of approved make and shade over a coat of approved primer.

5.4.2 Reinforced Concrete Posts and Struts

Reinforced concrete posts and struts shall be of a standard size and be cast in suitable bases in cement concrete 1:2:4 mix and shall have appropriate reinforcement and dimensions. The posts and struts shall be free from honeycombing, cracks and other defects.

After casting, the posts/struts shall be cured for a minimum period of 7 days without being moved. After 7 days curing the posts/struts shall be moved to a levelled area and stacked for 14 days of further curing. After 21 days of curing, the posts/struts may be transported for fixing in position.

5.4.3 Spacing of the Posts and Struts

Posts shall be installed at 3 m. centres unless otherwise specified or as approved by the Employer's Representative, to suit the dimensions of the area to be fenced. Every 10th post, last but one end posts, corner posts and posts where the level of fencing changes in steps and end post when the fencing changes its direction shall be strutted on both sides, or as approved by the Employer's Representative. End posts where barbed wire fencing is discontinued shall be strutted on one side only.

5.4.4 Fixing of Mild Steel/Reinforced Concrete Posts and Struts

Pits of size 45 x 45 x 45 cm. deep, shall first be excavated centrally in the direction of the proposed fencing work, true to line and level to receive the posts. For struts, the pits shall be excavated to receive a minimum of 15 cm concrete cover at any point to suit its inclination.

The pits shall be filled with a 15 cm layer of cement concrete of 1:2:4 mix. The posts and struts shall then be placed in the pits to the required height above ground level and held true to line, plumb and position by providing adequate temporary supports and then filled with cement concrete so that the posts are embedded. The concrete in foundation shall be watered for at least

seven days to ensure proper curing.

5.4.5 Barbed Wire

Barbed wire shall conform to IS 278-1978.

5.4.6 Chain Link

The chain link shall be plastic coated galvanized mild steel of approved manufacture and color and of appropriate size, gauge etc. The base materials of the wire shall be of good commercial quality mild steel. The wire shall be circular in section, free from rust, scale, cuts, welds and other defects and shall be uniformly galvanized.

5.4.7 Fixing of the Chain Link Fencing to Mild Steel/Reinforced Concrete Post

The chain link fencing shall be fixed first to the end post with the approved GI U type clamps threaded at both ends and GI nuts, bolts and washers and with a 6 mm diameter full height galvanized anchor bar. After fixing the chain link at the end post, it shall be stretched tightly and fixed to the next posts sequentially using the clamps and bars etc leaving 50 mm ground clearance, if soil, or 20 mm if surfaced. At points of change in the level of the fencing, the necessary links shall be adjusted suitably as per the manufacturers' recommendations.

5.4.8 Mild Steel Crimpnet Gate

All steel work, pipe frame work and crimpnet shall be galvanized and of suitable sizes and sections and shall conform to relevant IS specifications. The crimpnet shall be minimum 25 x25 mm x 8 g unless otherwise stated and of approved manufacturer.

For each leaf of the gate, the crimpnet shall be welded to an internal angle iron frame of suitable size. The iron frame shall then be fixed to the 50 mm dia. seamless pipe outer frame of by means of 65 mm long angle iron lugs welded together. Suitable cleats for the locking arrangement shall be welded at a convenient height. Both the leaves of the gates shall be fitted with suitable hinges provided on the galvanized mild steel channel posts. The side post shall be welded with mild steel plates 250 x 150 x 5 mm at the bottom. These posts shall be properly embedded in cement concrete foundations of suitable sizes and be allowed to set properly. All the assembly shall be properly erected correct to line, level, plumb and allow easy and proper movement of the gates.

The steel parts shall be thoroughly cleaned and painted with red oxide primer of approved make and shade. Final painting with two coats of synthetic enamel paints of approved shade and make shall be carried out to the approval of the Employer's Representative.

PART 1 - Earthwork and Excavation

1.1 Site Clearance

Before the earthwork is started, the areas coming under cutting and filling shall be cleared of all obstructions, loose stones, shrubs, vegetation, grass, brush-wood, trees and saplings of a girth up to 30 cm. measured at a height of one metre above ground and rubbish removed from of the area under clearance. The roots of trees shall be removed to a minimum depth of 60 cm below ground level, or a minimum of 30cm below formation level whichever is lower and the hollows filled up with compacted earth.

The trees with a girth above 30 cm at a height of one metre above ground shall only be cut after permission of the Employer's Representative is obtained in writing.

Any useful materials obtained from the site will remain the property of the Employer and shall be properly protected and stored. The Contractor shall dispose of other materials off site.

1.2 Setting Out and Making Profiles

The Contractor shall erect masonry or concrete pillars at suitable points in the area to serve as bench marks for the execution of the work. These bench marks shall be connected with GTS or any other permanent bench mark approved by the Employer's Representative. Necessary profiles with pegs, bamboos and strings shall be made to show the correct formation levels before the work is started.

1.3 Excavation

Excavations shall be prepared with shallow side slopes to minimize the risk of slope failure. Where this is not possible and the depth exceeds 0.6m then the trench slopes must be stabilized. Prior to man entry into the excavation the Contractor must ensure the excavation is stable. Further checks should be made following periods of rainfall or when excessive loadings occur within close proximity to the excavation.

No excavated material shall be placed, even temporarily, nearer than three metres to the outer edge of an excavation.

The removal of obstructions that would interfere with the proper execution and completion of the work shall conform to the correct lines and grades or be limited generally to 60 cm beyond the outer limit of the structure. It shall be the Contractor's responsibility to provide all required pumping, ditching or other approved measures for the removal or exclusion of water from excavations.

The Contractor shall notify the Employer's Representative before any ground is disturbed and shall conduct a ground level survey. The ground levels shall be taken at 5 to 15 metres intervals in uniformly sloping ground and at closer distances where local mounds, pits or undulations occur. The ground levels shall be recorded in field books and plotted on plans, which shall be signed by the Contractor and the Employer's Representative, before the earth work commences.

When excavating to the required levels for the foundation of any structure or to the required limits for the face of any structure abutting undisturbed ground, the Contractor shall not excavate the last 150 mm until immediately before commencing the constructional work. Should the Contractor have excavated to within 150mm above these specified levels or to within 150 mm of these specified limits before he is ready or able to commence the construction work, he shall

excavate further to remove not less than 150mm of material immediately before commencing the construction work.

The excavations shall be carried out systematically. No under-pining or undercutting will be allowed. The bottom and sides of excavation shall be dressed to proper levels, slopes, steps, cambers etc by removing high spots and filling and thoroughly as necessary.

The width of excavations shall generally be of the width of the mudmat concrete and depth as required by the design and according to availability of the desired bearing capacity of soil below. The minimum depth of foundations for all structures, equipment, buildings and frame foundations and load bearing walls shall be 1.50 m below average ground level, whether the foundation is in soil or in murrum. For any excavation, if taken below the required depth and level, the Contractor shall fill such over-cut to the specified level with 1:4:8 cement concrete in the case of all types of soils and with 1:2:4 cement concrete in the case of soft or hard rock.

The Contractor shall provide adequate ventilation and efficient apparatus to keep all excavation trenches, tunnels and heading structures, sewers and manholes free from all noxious gases and he shall take precautions to ascertain that they are in a safe condition before allowing workmen to proceed.

After the excavation is completed, the Contractor shall notify the Employer's Representative to that effect and no further work shall be taken up until the Employer's Representative has approved the depth and dimensions and also the nature of the foundation material. Levels and measurements of the excavation shall also be recorded prior to taking up any further work.

1.4 Classification of Earthwork

The earthwork shall be classified under the following main categories:

1.4.1 All types of soils, murrum, boulders.

1.4.2 Soft rock.

1.4.3 Hard rock.

- **All types of Soils, Murrum, Boulders**

This includes earth, murrum, top deposits of agricultural soil, reclaimed soil, clay, sand or any combination thereof and soft and hard murrum, shingle etc which is loose enough to be removed with spades, shovels and pick axes. Boulders of not more than 0.03 m³ in volume found during the course of excavation shall also fall under this classification.

- **Excavation in Soft Rock**

This shall include all materials which are rock or hard conglomerate, all decomposed weathered rock, highly fissured rock, old masonry, boulders bigger than 0.03 m³ in volume but not bigger than 0.5 m³ and other varieties of soft rock which can be removed only with pick axes, crow bars, wedges and hammers with some difficulty.

- **Excavation in Hard Rock**

This includes all rock other than that stated in Sections 5.4.1 and 5.4.2, occurring in masses, boulders having approximate volume of more than 0.5 m³ plain or reinforced cement concrete, which can best be removed by chiselling and wedging.

The excavation of hard rock shall be done by chiselling and wedging or any other agreed method. Blasting shall not be allowed on this project.

All the excavated hard rock obtained shall be stacked properly and neatly by the Contractor as approved by the Employer's Representative.

1.5 Excavation Side Slopes

Loose soil or boulders shall be removed from the sides of the trenches before workmen shall be allowed into the excavation and the trench sides shall be stabilized with screening or other methods approved by the Employer's Representative.

1.6 Undercutting of Adjacent Works

In no case shall the Contractor undercut the foundations of adjacent facilities. Should such a situation be envisaged or develop the Contractor shall provide protection measures as necessary to ensure the safety of the adjacent facility.

The Employer's Representative shall be given every opportunity to review the methods adopted by the Contractor and where he requires, Contractor shall satisfy the Employer's Representative of the adequacy of the methods employed.

1.7 Shoring

The Contractor shall be responsible for the design of shoring for the proper retaining of the sides of trenches, pits etc with due consideration to any traffic or other superimposed loads. Shoring shall be of sufficient strength to resist the pressure and ensure safety from slips and to prevent damage to work and property and injury to persons. Any shoring shall be removed after the items for which it is required are completed. Should slips occur, the slipped material shall be removed and slope dressed to a modified stable slope.

1.8 Trench Excavation

The Contractor shall not keep trenches open for unduly long periods, creating public hazards, such that laying and jointing of pipes can reasonably be expected to be completed and the trench refilled not later than three days after excavation of the trench, except by special permission of the Employer's Representative.

Loose soil or boulders shall be removed from the sides of the trenches before workmen shall be allowed into the excavation and the trench sides shall be stabilized with screening or other methods approved by the Employer's Representative.

Excavation for pipe trenches in hard rock shall be carried out so that the clearance between the pipe, when laid in position and the sides and trench bottom shall be kept to the minimum limits necessary to provide for the thickness of bedding and surround to the pipe.

The minimum width of trenches measured at the crown of the pipe shall permit adequate working space. The trenches may be widened at sockets and other structures as may be necessary.

Care should be taken to avoid excessive trench widths and thereby increasing the load on the pipes. Where this is the case the Contractor shall provide either special bedding or stronger pipes.

16.2.2 Over-excavation of Trench Bottoms:

5 All pipeline trenches shall be excavated to a depth of 150 mm below the bottom of the outside of the pipe and backfilled with the appropriate bedding.

6 All excavation below the required level shall be refilled with compacted bedding material.

1.9 Trenchless Excavation

- **General**

The Contractor shall submit his proposals for excavating and constructing sewers and pipe lines in tunnel and obtain the approval of the Employer's Representative before any work may commence.

The Contractor shall be responsible for the security of any timbering or other temporary tunnel supports. The Contractor shall submit for approval full details of the support and timbering he proposes to use.

The excavation for the tunnel shall be of sufficient size for the proper execution of the construction work, all timbering must be driven and fixed in close contact with the ground to be supported.

Unless otherwise approved by the Employer's Representative, the tunnel shall be closed timbered and the timber shall be left in place on completion of the work. During excavation, securely fixed running boards shall be provided to the floor of the tunnel. On completion and after the formation has been cleaned and dried out, a concrete sealing coat shall be provided. The tunnel shall be driven complete between access points before the permanent work may commence and the work shall, at all times, be carried out as quickly as possible so that the excavation remains open for the shortest possible time.

The working face of the tunnel excavation shall be supported as necessary and shall be fixed up at the end of each point when continuous working is not in progress or whenever required by the Employer's Representative.

When work is in progress, proper access ladders shall be fixed and maintained at the tunnel access points and the tunnel lit by electricity of not more than 110 volts. Lamps shall be provided at not more than 9m intervals and no flame or other naked light shall be used. Proper and adequate ventilation fans and ducts must be provided, maintained and operated at all times.

- **Method for Trenchless Excavation**

- 5 **General**

The Contractor is required to take full cognizance of the physical site condition and available working space and select his method with due regard to the same in addition to other requirements for the method proposed.

There is a high likelihood of heavy seepage of water into the excavation.

If required, the Contractor may use sleeve pipes of a bigger diameter than necessary and lay the carrier pipe inside the sleeve pipe at the required grade and alignment.

The Contractor shall take into account the existing manholes to which the proposed pipeline is to be connected and take every precaution to avoid damage to the manholes and any existing sewers.

Where a connection is to be made to a functioning trunk sewer, the Contractor shall take all necessary steps for plugging the sewer and diverting the flows and restoration of the same after completion of the work.

6 Jacking and Receiving Shafts

The Contractor shall take due cognizance of the available working space and provide jacking and receiving shafts at appropriate locations so not to cause any harm or danger to adjoining structures, as well as to not occupy additional space.

The Contractor must shore the sides of shafts securely as approved by the Employer's Representative.

7 Jacking/Boring/Ramming

The jacking pipe and or carrier pipe should be of suitable length joined by properly designed leak proof joints as required for the method adopted by the Contractor.

The jacking pipe may be provided with arrangements for circulating bentonite solution for stabilization of the surrounding ground.

The grade and alignment of jacking shall be periodically checked by suitable instruments after jacking of individual units and correct grade and level will have to be ensured.

If the jacking pipe is other than the carrier pipe, the annular space shall be grouted with 1:3 cement sand grout.

8 Tolerance

The pipes shall be installed in place, true to line and level. The maximum tolerance allowable in the displacement of the centreline of the laid pipe from the design centreline is 50mm per 30 metres in the horizontal plane and 50mm per 100 metres in the vertical plane. There shall be no back fall at any point.

1.10 Dewatering

The Contractor shall keep excavations clear of water.

1.11 Clean Up

Upon completion of the work in this section, all rubbish and debris shall be removed from the site. All construction equipment and implements shall be removed and the entire area shall be left in a neat, clean and acceptable condition.

1.12 Disposal of Excavated Material

Materials suitable for re-use obtained from the excavation shall be properly stored, as approved by the Employer's Representative, and shall remain the property of the Employer.

Materials shall be stored in a convenient place that will not obstruct the free movement of materials, workers and vehicles or encroach on the area required for constructional purposes. Materials shall be used to the extent required to completely backfill excavations to the finished ground level.

Surplus and unsuitable materials shall be disposed of off-site to an approved location.

1.13 Surface Reinstatement

- **Surface Reinstatement Outside Roads and Footpaths**

In areas outside roads and footpaths, after backfilling trenches, the Contractor shall replace all top soil previously removed, spreading it evenly over the full stripped area. Areas grassed before commencement of work shall be suitably prepared and sown with grass seed of equivalent quality and maintained.

- **Road and Footpath Reinstatement**

6 Unclassified Roads

Backfilling shall be carried out in accordance with this specification to within 300 mm of the finished ground level. The last 300 mm shall be backfilled with material, approved by the

Employer's Representative, and which shall, as far as practicable, match the existing surface both in quality and level.

7 Macadamized and Premixed Roads

Backfill, compaction and finishing of macadamized and premixed roads shall be reinstated in accordance with road and pavement Section of this specification. The finished surface shall match the undamaged sections in quality and level.

PART 2 - Excavation Dewatering

2.1 General

Continuous operation of dewatering systems shall be required to complete all portions of the works where dewatering is necessary to prevent inflow and collection of surface water or groundwater, or to protect adjacent properties or constructions from damage resulting from a rise or fall in groundwater levels.

Dewatering systems shall effectively intercept and remove water from the strata and thus enable the excavations to be kept dry when necessary.

The Contractors shall provide and operate all pumps, engines and machinery necessary to keep excavations clear of water. The pumping shall be continued until after the execution of any portion of the work and continued afterwards as necessary.

Where ground water is encountered or anticipated the Contractor shall provide sufficient pumps to handle the ingress of water and shall provide, and maintain in working order, standby pumping units to be available and employed in the event of mechanical failure. The Contractor shall also arrange for night and day management and operation of the pumps as necessary to ensure that at all times and weather the works may proceed.

The Contractor shall furnish for the Employer's Representative review, the proposed drawings and method statements giving the intended plan for dewatering and re-charging operations. These should include locations and capacities of dewatering wells, well point, pumps, sumps, collection and discharge lines, standby units, recharge system (if any), water disposal methods, monitoring and settlement, measuring equipment and data collection.

2.2 Components of Dewatering Systems

Units of standard manufacture and in good working order shall be used. Unserviceable equipment shall be removed from the site. Major items of equipment for which spare parts are not available from local suppliers shall not be used. Adequate arrangements shall be made for the provision of under drain systems below grade slabs to give relief from hydrostatic pressure during construction activities.

2.3 Execution

7.2.1 Preparation

Coordination: The dewatering installation shall be laid out and installed outside the limits of the permanent works, without interfering with access or other activities.

Barricades, Shelters and Safety: Vital sections of the works shall be protected from accidental damage and barricades and suitable prominent signs shall be provided to indicate and where necessary, isolate hazardous areas.

7.2.2 Performance

Dewatering arrangements shall be adequate to enable underground and below-grade work to be performed in the dry except where sections of the work have been specified to be done in the wet. Dewatering shall, wherever required or approved, be continuous from commencement to completion, including placing and compaction of back-fill.

When and where approved by the Employer's Representative, the Contractor shall provide an approved monitoring system to measure groundwater levels and settlement.

7.2.3 Maintenance of Existing Water Table

Where deep pits and heavy, continuous dewatering have to be maintained for long periods in developed areas, the possible effects of groundwater depletion beyond the range of usual fluctuations shall be given due consideration before commencement. Special methods shall be adopted, as necessary, to avoid such dangers. Any observations or complaints of subsidence in the vicinity shall be promptly brought to the notice of the Employer's Representative and corrective measures adopted immediately.

7.2.4 Protection of Existing facilities

Adequate standby units and spares shall be provided by the Contractor to ensure uninterrupted dewatering. Where any sloped excavation potentially endangers any existing facilities or structures, the Contractor shall provide shoring, sheeting and bracing to the satisfaction of the Employer's Representative.

7.2.5 Drainage

During the entire course of operations at any site, the Contractor shall provide and maintain an effective drainage system to prevent inundation of the site. The effluent from the drainage system shall be disposed of as approved by the Employer's Representative.

Grading in the vicinity of excavations shall be such as to exclude rain/surface water from draining into the excavations. The excavation shall be kept clear of rain or such other water by suitably pumping out.

Care shall be taken to ensure that the water is discharged sufficiently away from existing foundations to keep it free from nuisance to other works.

7.2.6 Removal

When no longer needed for dewatering or control operations, the equipment used for such purposes shall be removed from the site. This shall be done after monitoring and settlement measuring operations, if any, are completed and the removal of the equipment is approved. Any underground components such as well-points may be abandoned in place only to the extent of the approval of the Employer's Representative.

The Contractor shall not allow any accumulation of water either from the discharge of their dewatering pumps or their water connections on the site. If an accumulation is unavoidable, it shall be treated with insecticides to the satisfaction of the Employer's Representative.

PART 3 - Backfilling and Filling

3.1 Materials

Fill material shall be free of rubbish, roots or debris of any sort. Boulders, rock or concrete fragments over 100 mm in size shall not be present in backfill material. The fill material shall be subject to the approval of the Employer's Representative.

Approved fill shall consist of suitable earth or granular material that has been retained from excavations, taken from designated borrow areas or been hauled from an approved off-site source. This material will be acceptably dry, free from roots, large stones, boulders or large broken rocks, refuse, vegetable matter, topsoil, silt or debris.

Pea gravel shall be washed, rounded durable stone, 9.5 mm to 4.74 mm in size with no more than 2% passing a 75 micrometer sieve.

Rip-rap material shall be durable stone with a mass of a single stone being between 25 and 50 kg. Stones smaller than 25 kg mass are unsuitable.

All other materials, not specifically described but required for proper completion of the work of this section, will be subject to the approval of the Employer's Representative.

The Contractor shall reserve, separate and stockpile suitable excavated materials for use in backfilling later.

If the Employer's Representative deems the native material to be unsound for the purpose of backfill and an adequate amount of suitable material cannot be so collected, or if the Contractor fails to collect and preserve the requisite quantity, the Contractor shall furnish the additional quantity required. The additional material shall be natural sand, gravel or crushed murrum and shall be readily incorporated in a 100 mm lift and containing not more than 25% by weight of material passing a No. 200 sieve.

If a portion of the excavated materials is found to be unsuitable for use as backfill, the Contractor shall provide suitable material from another source.

3.2 Execution

9.2.1 General

The use of stones, rocks or concrete fragments of more than 100 mm in their greatest dimension shall not be permitted in any trench backfill and stones, rock or concrete fragments larger than 60 mm shall not be permitted in the backfill within 300 mm of the pavement sub grade or within 300 mm of any utilities.

Some backfilling may have to be carried with sand, as approved by the Employer's Representative. The sand used shall be medium grain, clean, sharp, angular, hard and durable, free from clay, mica and soft flaky pieces and free from other impurities. Sea sand shall not be used except under special circumstances. All sands must be well washed and cleaned before use.

Sand fill shall be kept flooded with water for 24 hours to ensure maximum consolidation. The surface of the consolidated sand shall be dressed to the required level or slope. Construction of floors or other structures on sand fill shall not be started until the Employer's Representative has approved the fill.

Backfilling work shall be suspended at any time when satisfactory compaction results cannot be obtained due to rain, or other adverse conditions in the field. The surfaces of any fill shall be maintained with a slope at all times to provide proper surface drainage.

Materials shall be compacted in maximum 300 mm layers and shall be of the proper moisture

content before compacting to facilitate obtaining the required compaction.

Temporary planking and formwork etc, shall be removed as backfilling progresses to avoid the formation of voids.

Excavated foundations shall be inspected and approved by the Employer's Representative before proceeding with further work, including placing of any mudmat, reinforcing steel etc.

Complete final grading at grassed or seeded areas shall be to within 50 mm.

The Contractor shall repair damage and correct deficiencies that may result from the settlement of backfilled areas.

9.2.2 Foundation Bedding

Unless otherwise specified, new concrete foundation floors and base slabs shall be constructed on a suitably prepared formation and 100mm PCC mudmat.

Bedding material, except for clear crushed stone, shall be compacted by mechanical means at optimum moisture content to a value of 95% standard Proctor maximum dry density (SPD).

9.2.3 Backfill around Structures

Backfill under this item shall be considered as all replaced excavation or new embankments adjacent to structures. No backfill shall be placed against any structural elements until they have been approved by the Employer's Representative. Backfilling shall be done as soon as practicable after the required conditions are satisfied. Backfill against waterproofed surfaces shall be carefully placed to avoid any damage to the waterproofing material.

The scope of work for filling and backfilling shall include filling for all the buildings covered under the contract.

Mechanical tampers or other approved compactors shall be used to compact all backfill and embankments within 1.2m of a structure and heavy compaction equipment beyond 1.2m of this area. The backfill shall be placed in 200 mm un-compacted depth lifts.

Backfilling shall only be carried out after the concrete or masonry has fully set and shall be done in such a way as not to cause under-thrust on any part of the structure.

All timber shoring and formwork left in excavations shall be removed after use and waste materials shall be cleared out from the excavation.

All the space between foundation masonry or concrete and the sides of excavations shall be backfilled to the original surface level with approved materials in layers not exceeding 300 mm in thickness, watered and well consolidated by means of rammers to at least 90% of the consolidation obtainable at optimum moisture content (Proctor density). Flooding with water for consolidation will not be allowed.

Areas inaccessible to mechanical equipment such as areas adjacent to walls and columns etc shall be tamped by hand rammer or by hand held power rammers to the required density.

Tests to establish proper consolidation as required will be carried out by the Contractor. Two tests per 50 m² will be taken to ascertain the proper consolidation.

Unless otherwise specified or approved by the Employer's Representative, the period of time after which the Contractor may place backfill against or on top of any cast-in-place structures is greater than or equal to the time periods as shown in the table below:

Placement of loose backfill	5 days	21 days
Compaction of backfill	7 days	28 days

The Contractor shall observe any special backfilling requirements or materials, such as those for sub-drains and perimeter drain filters and insulation/expansion material where required.

Where walls are waterproofed on the exterior, or where insulation/expansion material has been placed, backfill shall be placed by hand to prevent damage to the waterproofing membrane. Should any damage to waterproofing occur, such areas shall be re-excavated and

the membrane or coatings repaired or replaced to the satisfaction of the Employer's Representative.

Where fill is required on both sides of a wall, foundation or culvert, it shall be deposited layer by layer at each side alternately.

9.2.4 Filling Beneath Plinths and Floors

Construction of floors or other structures on fill shall not be started until the Employer's Representative has inspected and approved the fill.

Suitable fill material shall be placed in 15 cm layers, each layer being well watered and consolidated by approved hand or mechanical tampers or other suitable means to achieve the required density.

Gravel if required to be filled under floors, shall be single washed gravel of approved quality and of size varying from 12 mm to 20 mm it shall be uniformly blended with approved type of soil and/or sand to obtain full compaction. Gravel shall be placed in 15 cm layers and shall be well watered and rammed entirely to the satisfaction of the Employer's Representative.

9.2.5 Slab Base (Rubble Hard Core)

The rubble shall be of the best variety of black trap/granite/basalt or other approved stone available locally. The stone shall be hard, durable, free from defects and of the required size and shall be approved by the Employer's Representative before incorporation in the work.

The stone used for the work shall be broken rubble of fairly regular shape and free from weathered, soft or decayed pieces.

9.2.6 Workmanship

The bed on which rubble soling is to be laid shall be cleared of all loose materials, levelled, watered and compacted and approved by the Employer's Representative before laying the rubble soling. Cable or pipe trenches shall be completed before the soling is started.

Over the prepared surface, the stone shall be set as closely as possible and well packed and firmly set. The stones shall be of full height and shall be laid so as to have their bases of the largest area resting on the sub-grade. Soling shall be laid in one layer of 230 mm or 150 mm or other specified thickness and no stones shall be less than 230 mm or 150 mm depth or specified thickness of soling with a tolerance of 25mm

After packing the stones properly in position, the interstices between them shall be carefully filled with quarry spoils or stone chips, to obtain a hard, compact surface.

The entire surface shall be examined for any protrusions and the same shall be knocked off by a hammer and all interstices shall be filled with approved murrum. Excess murrum over the surfaces shall be removed. The surfaces shall then be watered and consolidated with mechanical or sufficiently heavy wooden tampers and log-rammers, as approved by the Employer's Representative, to give the required slope or level and density of sub-base. After compaction, the surface shall present a clean look.

Adequate care shall be taken by the contractor while laying and compacting the rubble soling to see that concrete surfaces in contact with soling are not damaged.

3.3 Trench Backfilling

7.3.1 General

Backfilling over pipes shall not take place until after the pipes have been successfully hydro tested except for bracing purposes.

Trench backfilling shall start at the top of the pipe or conduit bedding. All materials below this elevation are considered as bedding.

Filling in trenches for pipes shall be commenced as soon as the joints of pipes have been tested and passed.

The bedding between the bottom of the trench and up to a level of 300 mm above the top of the pipe shall consist of granular material or murrum. The maximum size of coarse material or stone shall not exceed 20 mm. The bedding shall be placed in layers not exceeding 150 mm watered and consolidated, taking care that no damage is caused to the pipe. Placing the bedding around thin-walled pipes shall receive special consideration.

The backfill materials shall be suitable excavated material, gravel, crushed stone or murrum or sand, free from any boulders and lumps of hard earth larger than 100 mm in size. Backfill material shall be spread evenly in 225 mm horizontal layers, brought to approximately the optimum moisture content and then tamped or rolled until 95 percent of the maximum dry density is achieved as determined by the standard proctor Test as per IS 2720 (Part VII) or a higher value if one is required in particular circumstances.

When loose layer is placed, levelled and appropriately moistened or dried, it shall be compacted by 8 to 10 tonne power roller or sheep's foot rollers or heavy hauling or dozing equipment, plate compactor or by any mechanical means until 95 percent of the maximum dry density is achieved, as determined by the standard proctor Test as per IS 2720 (Part VII) or a higher. If on testing, the density is found to be less than 95% of the proctor density, the Contractor shall repeat the procedure mention above until the desired value of compaction is achieved.

Backfill for cast-in-place piping, appurtenances or structures such as manholes shall start at the sub-grade for the structure. Backfill shall be brought up simultaneously and equally on all sides of the structure.

Care shall be exercised during backfill operations to prevent damage or dislodging of the pipes or conduits. Any damage or dislodging of pipes or conduits shall be repaired to the satisfaction of the Employer's Representative.

3.4 Site Grading

Generally site grading shall include the grading of un-surfaced areas to the final landscape profile with due allowance for topsoil and turfing or as approved by the Employer's Representative. The grading shall ensure that the ground profile slopes away from the structures and does not create ponding.

The site grading shall be subject to the approved by the Employer's Representative before any landscaping is commenced.

Fill for site grading shall be placed in 300 mm layers and compacted to 90% SPD. Imported fill material shall be used if there is insufficient excavated material on the site.

Ditches and swales shall include trim, grade and slope ditches and swales, to the satisfaction of the Employer's Representative.

3.5 Roads and Parking Areas

The backfill in areas under roads and parking areas shall be filled to the underside of the sub-base using approved granular fill and compacted in layers of 150 mm to 95% SPD. In areas adjacent to structures thinner layers may be required to suit lighter compaction equipment.

In road cut sections, unsuitable material (silt, humus, topsoil etc) shall be excavated and replaced to the level of the sub-base with approved granular fill, ensuring that the minimum excavation in cut sections extends to the depth of the road base.

PART 4 - Embankments

4.1 General

This work shall include the clearing of the site, setting out and preparing the ground and forming the embankments required for the roads, paths etc with approved excavated or imported material, spread in maximum 200 mm layers, watered and compacted to the 95% SPD, to line, curve, grade, camber and cross section and dimensions as approved by the Employer's Representative.

Embankments shall be set out by fixing batten pegs at regular intervals before commencing the earthwork. The pegs shall be fixed 0.5 metres back from the limits of the fill and painted in a distinctive colour.

The size of the coarse material in the fill shall not exceed 50mm unless approved by the Employer's Representative. Such material shall be free of logs, brush, stumps, roots rubbish, organic matter, humus, or any other unsuitable material.

The Contractor shall carry out the tests to determine the maximum density of the material to be used by the proctor method before starting the work.

If the cross slopes are steeper than 1 in 3, steps with reverse slope shall be cut into the slopes to give proper hold and seating to the bank as approved by the Employer's Representative. The top 15 cm. of soil shall be scarified and watered and compacted to 95% SPD density before any embankment material placed.

Fill shall be placed extending to the full width of the embankment, including the slopes at the level of the particular layer, and 300 mm. more on both sides to allow for compaction of the full section. The extra loose earth at the edges shall be trimmed after completion of the embankment leaving the correct section fully compacted.

Each layer of the embankment shall be watered, levelled and compacted as specified before the succeeding layer is placed. The surface of the embankment shall, at all times during construction, be maintained in such a manner to prevent ponding. Water to be used shall be free from all harmful contaminants and approved by the Employer's Representative.

If the material for the embankment contains less than the optimum moisture content, water shall be added to the 100 mm embankment layers to bring moisture uniformly up to the optimum. If the excavated material contain more than required moisture, it shall be allowed to dry until the moisture is reduced to required extent. If due to the wetness, the moisture content of the soil cannot be reduced to the appropriate amount by exposure, embankment work shall be suspended until suitable conditions prevail.

When loose layer is placed, levelled and appropriately moistened or dried, it shall be compacted by 8 to 10 tonne power roller or sheep's foot rollers or heavy hauling or dozing equipment, plate compactor or by any mechanical means until 95 percent of the maximum dry

density is achieved, as determined by the standard proctor Test as per IS 2720 (Part VII) or a higher. If on testing, the density is found to be less than 95% of the proctor density, the Contractor shall repeat the procedure mention above until the desired value of compaction is achieved.

Embankments not accessible to rollers, such as those adjoining bridges, culverts and other works shall be carried out independently of the main embankments and shall have the layers placed in 150 mm height and each layer shall be moistened and thoroughly compacted with mechanical or manual tampers. Before placing the next layer, the surface of the under layer shall be moistened and scarified to provide a satisfactory bond with the next layer.

Embankments shall be finished and dressed to a smooth and even finish, in conformity with the alignment levels and cross sections and dimensions required. On curves, sections shall be provided with super elevations and increased widths as approved by the Employer's Representative.

The joining of old and new embankments shall be done by stepping in an overall slope of 1 to 5.

The surface of the embankment shall, at all times during construction, be maintained at such a cross-fall to shed water and prevent flooding. All rain water shall be drained away from the toe of the embankment. The Contractor shall maintain the embankment in an approved manner throughout the Contract.

Tests on the embankments shall include the following:

S r. N o.	Test	Frequency
1.	Plasticity	As directed by the employer's representative
2.	Density	Each soil type to be tested. 1 test per 8000 m ³ of soil
3.	Deleterious content	As directed by the Employer's Representative
4.	Moisture content	1 test for every 250 m ³ of soil
5.	CBR test	As required by the employer's representative

Density tests shall be carried out for the embankment work during the progress of the work. One set of three core samples for every 1,000 m² area of each layer of embankment work shall be taken and tested. The average density shall not be less than 90% of the proctor density, obtained in the laboratory.

The arrangements for obtaining the samples and transporting to a laboratory shall be made by the Contractor.

PART 5 - Sheet piling, Shoring and Bracing

5.1 General

9.1.1 Description

The Contractor shall supply and install sheet piling, diaphragm walls, bracing, underpinning shoring and dewatering systems to adequately protect existing buildings and facilities and to maintain the excavations required for the construction of facilities.

The Contractor shall be solely responsible for the adequacy of the sheet piling, diaphragm walls, bracing and shoring on the site to maintain safety and prevent damage to existing buildings, facilities, excavation and new construction. The configuration of the proposed shoring and bracing shall be approved by the Employer's Representative.

To obtain the approval of the Employer's Representative, the Contractor shall, if so required, provide drawings of the proposed sheet piling and bracing including sheet piling sizes, walings, rakers, anchor systems, struts, earth anchors, anchor piles, tie rods and other components pertinent to the effectiveness and adequacy of the shoring and bracing.

5.2 Existing Conditions

9.3.1 Soils

Any information provided by the Employer relating to boring logs and soil tests carried out are supplied in good faith. Any conclusions drawn from them, however, shall be the responsibility of the Contractor.

Where slopes steeper than the natural angle of repose or other conditions inconsistent with the safety of personnel required to work within an excavated area are encountered such excavations shall be sheeted or shored as may be needed to provide adequate safety.

The Contractor's attention is specially drawn to the necessity for a thorough study of the site and soil conditions, groundwater levels and other relevant factors, particularly in the case of any wet wells, incoming sewer connections and force mains at great depths, before deciding on the necessity or otherwise of sheet piling, shoring and bracing and if provided, the adequacy of same.

9.3.2 Obstructions

Prior to driving sheet piling etc, the Contractor shall locate existing facilities in service, if any, and avoid sections that may interfere with such. If such avoidance is not possible the Contractor shall relocate the facility or arrange for its relocation as required to clear the interference. Any action proposed in such circumstances shall be subject to the prior approval of the Employer's Representative.

5.3 Products and Materials

9.4.1 Steel Piling and Shoring

Steel sheet piles shall conform to the requirements of IS 2314 and the steel for walls, struts braces and tie rods shall comply with IS 226. Any materials to be incorporated into the permanent works shall be new.

Piles shall be of the types and sizes indicated in the approved shop drawings or as specified herein and shall be of a design that provides continuous interlocking throughout their entire lengths. Standard handling holes shall generally be provided located approximately 100 mm

below the top of each pile.

9.4.2 Timber Shoring

Where the Contractor elects to use timber shoring for trench and structure excavations he shall provide details of the shoring he proposes to adopt, taking into consideration the nature and condition of the soil to be excavated and the depths to which the excavations are to be carried. The quality and strength of the timber and the cross-sectional details and spacing of the shoring, walling and struts together with the calculations, where required or requested by the Employer's Representative, demonstrating the structural adequacy of the proposed shoring and timbering shall be included in the submittals.

Approval of the submittals shall however not relieve the Contractor in any way from his sole responsibility for the stability of the works and the safety of the employees engaged on the work and of the general public.

9.4.3 Dimensions

Piles and ancillary structural members shall be as shown on the approved shop drawings. All procedures shall be subject to the approval of the Employer's Representative approval.

5.4 Execution

• General

Piling shall be accurately located and driven to the required depths, plumb and true to line with each pile interlocking with the adjacent pile throughout its entire length. Frames, temporary walls templates, guide-frames and bracing as are necessary shall be installed to guide and support the sheet piling in the correct position and alignment.

The choice of specific construction procedure appropriate for any works or phase thereof shall be the Contractor's responsibility. The procedure adopted shall meet the requirement of the works and specific procedures adopted such as construction methods, shoring, sheet piling, bracing, dewatering etc are at the option of the Contractor. He shall however submit to the Employer's Representative a detailed construction procedure prior to commencement of work.

• Driving

Piling shall be driven by approved methods in such a manner as not to subject the piles to damage and to ensure interlocking throughout the length of each pile.

Pile hammers shall be of the size and type needed to achieve the required penetration with the minimum damage to the piles. Hammers shall be maintained in a proper alignment with the piles during driving by use of suitable leads or guides. A protective driving cap of approved design shall be used, as required, to minimize the damage to tops of piles. Unless otherwise approved by the Employer's Representative, pile driving shall be done without jetting.

The piles shall be driven plumb and if the sheet piling goes progressively out of plumb, corrective steps shall be taken. If necessary, the piles shall be withdrawn and re-driven so that no part of any pile is more than 75 mm from the design location of the alignment on completion of the work.

Piling shall be driven in stages. No sheet pile, or pair of piles if driven in pairs, shall be driven more than one-third of its length before the adjacent sheet pile is set. Piling that is damaged or driven without interlocking shall be withdrawn and re-placed. The Employer's Representative

is empowered to order withdrawal if he has reasonable grounds to suspect damage. Any encroachment of piles upon concrete piles shall be sufficient grounds for withdrawal and replacement.

If obstructions are encountered during driving, the piles in question shall be driven at least to the specified refusal driving resistance after adjacent piles have been set and driven. However, the number of sheet piles permitted to be driven short of the required depths shall be limited in the field by the Employer's Representative and if so approved, the Contractor shall remove obstructions encountered by whatever means necessary.

- **Splices**

Splices shall be avoided if practicable, but where unavoidable shall be designed to develop the full strength of the piling. Drawings of the proposed splices shall be approved prior to execution. Extreme care shall be exercised to align the spliced sections so that the axis of the pile will be straight and that the interlocks of the piles shall form a straight, smooth and continuous groove.

- **Driving Resistance**

Steam, air or diesel hammers shall be provided with a rated energy not less than the hammer manufacturer's recommendation for the total weight of pile and the type of subsurface material to be encountered. The Employer's Representative may require the Contractor to change the hammer in use to obtain the required minimum penetration.

Piling shall be driven to such depth as required to provide the degree of protection needed.

- **Stressing Rods**

All tie rods shall be stressed to minimum of 10 percent of their design load. The Contractor shall submit to the Employer's Representative for his approval the proposed procedure for pre-stressing tie rods.

PART 6 - Anchors to Resist Uplift

Based on the site condition (if required) the use of rock anchors to resist uplift shall be permitted with the prior permission of the client with proper justification and design submission.

PART 7 - Anti Termite Treatment and Pesticides

7.1 General

Anti-termite treatment shall be applied to structures during the early stages of construction in the foundation trenches for columns, plinth beams, pile caps, brick walls, service trenches, lift pits, steps, ramps, in the top surfaces of plinth filling, at junction of walls and floor, in expansion joints etc in stages as detailed in this specification. Unless otherwise stipulated, the anti-termite treatment will be carried out as per IS6313 (part II) 1981 and/or as per direction of the Employer's Representative.

Soil treatment shall be applied during the construction stages of the sub-structure up to plinth level.

7.2 Products

Pesticide and/or termiticide emulsions, recommended by the Indian Pest Control Association (IPCA) and approved by the Employer's Representative, shall be used uniformly over the area to be treated. The Contractor shall comply with the requirements on Contractor's licensing, certification and record keeping.

The Contractor shall submit certification for the chemicals purchased and obtain verification that the containers of the chemicals are sealed from the Employer's Representative before preparing the emulsion for the treatment.

The pesticide shall be dispersed uniformly in the soil and to the required strength to form an effective chemical barrier.

7.3 Delivery, Storage and Handling

Pesticides shall be delivered to the site in sealed and labelled containers in good condition as supplied by the manufacturer or formulator. The pesticides shall be stored, handled and used in accordance with manufacturer's instructions. Labels shall bear evidence of registration as per the IS or appropriate regulations.

7.4 Site Preparation

In order to ensure uniform distribution of the chemical emulsion and to assist penetration, the following site preparation shall be carried out:

11 Remove all felled trees, stumps, logs or roots from the site.

12 Remove any concrete formwork, levelling pegs, timber off-cuts and other builder's debris from the area to be treated.

13 If the soil to be treated is sandy or porous, preliminary moistening will be required to fill capillary spaces in the soil to prevent the loss of emulsion through piping or excessive percolation.

14 In the event of water logging of foundation, the water shall be pumped out before application of the chemical emulsion and it should be applied only when the soil is absorbent.

15 On clays and other heavy soils where penetration is likely to be slow and on sloping sites, where the treating solution is likely to run-off, the surface of the soil should be scarified to a minimum depth of 75 mm.

16 All sub-floor levelling and grading shall be completed, all cuttings, trenches and excavations shall be completed with backfilling in place. If this is not done, supplementary treatments shall be carried out to complete the barrier.

At the time of application, the soil shall have sufficiently low moisture content to allow uniform distribution of the treatment solution throughout the soil. Application of the chemicals shall not be made during or immediately following heavy rains or when conditions may cause runoff and create an environmental hazard.

7.5 Application

The Contractor shall apply termiticide to the soil material which will be covered by or lie immediately adjacent to the buildings and structures to provide a protective barrier against subterranean termites.

The termiticide shall be applied as a coarse spray and in such manner as to provide uniform distribution onto the soil surface. This treatment shall be applied prior to placement of a vapour barrier or waterproof membrane and prior to concrete pouring. Where treated soil or fill material is not to be covered with a vapour barrier or waterproof membrane, the Contractor shall exercise adequate precautions to prevent its disturbance.

The chemical emulsion will be applied uniformly by sprayers at the prescribed rates as detailed

below in all the stages of the treatment.

- **Treatment in Foundation Trenches**

In case of normal wall load bearing structures, column pits, wall trenches and basements, the treatment shall be at 5 l/m² of surface area of the bottom and sides to a height of at least 300 mm. After the foundation work, the sides shall be treated at 7.5 l/m² of vertical surface of substructure on each side. After the earth filling is completed, treatment shall be by rodding the earth at 150 mm centres close to the wall surface and spraying the chemical at a rate of 7.5 l/m².

In the case of framed structures, the treatment shall start at a depth of 500 mm below ground level. From this depth the backfill around the columns, beams and RCC basement walls shall be treated at a rate of 7.5 l/m² for the vertical surface and at 5 l/m² for horizontal surfaces at the bottom of trenches/pits.

- **Treatment on Top Surfaces of Plinth Filling**

The top surface of filled earth within plinth walls shall be treated with chemical emulsion at the rate of 5 l/m² of the surface area before sub-base to floor is laid. If filled earth has been well rammed and the surface does not allow the emulsion to seep through, holes up to 50 to 75mm deep at 150 mm centres both ways shall be made with crow bars on the surface to facilitate saturation of the soil with the emulsion.

- **Treatment at Junction of Walls and Floors**

Special care shall be taken to establish continuity of the vertical chemical barrier on the inner wall surfaces from the finished ground level (or from level where the treatment has stopped) up to the level of the filled earth surface. To achieved this, a small channel 30 x 30 mm shall be made at all the junctions of wall/column with the floor (before laying sub-grade) and rod holes made in the channel up to the finished ground level at 150 mm spacings and the iron rod moved backward and forward to break the earth and the chemical emulsion shall be poured along the channel at 7.5 l/m² of the vertical wall/column surfaces to soak the soil right up to the bottom. The soil shall be tamped back into place after this operation.

- **Treatment for Expansion Joints**

The soil beneath expansion joints shall be supplemented by treating through the expansion joint after sub-grade has been laid at the rate of 2 l/m length of expansion joint.

- **Precautions during Treatment**

Utmost care shall be taken to ensure that the chemical barrier is complete and continuous. Each part of the area shall receive the prescribed dosage of chemical emulsion.

The treatment should not be carried out when it is raining or when the soil is wet with rain or sub-soil water.

The Contractor shall ensure that these chemicals do not enter water supply systems or potable water supplies or aquifers and that they do not endanger plants and animals. The Contractor shall notify the Employer's Representative at least 48 hours prior to the beginning of treatment and perform any formulating, mixing and application.

Once formed, the treated soil barrier shall not be disturbed. If treated soil barriers are

disturbed, immediate steps shall be taken to restore the continuity and completeness of the barrier system.

If soil or fill material has been disturbed after treatment, the Contractor shall provide further treatment before placement of slabs or other covering structures. Treatment of the soil on the exterior sides of foundation walls, grade beams and similar structures shall be coordinated with final grading and planting operations to avoid disturbance of the treated barriers by such operations.

7.6 Safety Requirements

The manufacturer's warnings and precautions in the handling and use of materials and the manufacturer's method of application shall be followed by the Contractor. Where the manufacturer's method differs from this document then the Contractor shall submit his method statement to the Employer's Representative for approval.

The Contractor shall formulate, treat and dispose of termiticides and their containers in accordance with the manufacturer's instructions. The Contractor shall draw water for formulating only from sites as approved by the Employer's Representative and fit the filling hose with a backflow preventer meeting local plumbing codes or standards. The filling operation shall be under the direct and continuous observation of a Contractor's representative to prevent overflow. Pesticides and related materials shall be kept secure under lock and key when unattended. Proper protective clothing and equipment shall be worn and used during all phases of termiticide application. Used pesticide containers shall be disposed of in accordance with guidelines and to the satisfaction of the Employer's Representative.

All the chemicals are poisonous and hazardous to health. These chemicals can have an adverse effect upon health when absorbed through the skin, inhaled as vapours or spray mist or swallowed. Persons handling or using these chemicals shall be instructed of these dangers and advised that absorption through the skin is the most likely source of accidental poisoning and cautioned to observe carefully, as a minimum, the safety precautions given in this document and as recommended by the supplier, particularly when handling these chemicals in the form of concentrates.

These chemicals are usually brought to the site in the form of emulsifiable concentrates. The containers shall be clearly labelled and kept securely closed.

Particular care shall be taken to prevent skin contact with concentrates. Prolonged exposure to dilute emulsions shall also be avoided. Workers shall wear clean clothing and wash thoroughly with soap and water especially before eating and smoking. In the event of severe contamination, clothing shall be removed at once and the skin washed with soap and water. If chemicals splash into the eyes they shall be flushed with plenty of soap and water and immediate medical attention sought.

The concentrates are oil solutions and present a fire hazard owing to the use of petroleum solvents. There shall be no naked flames in the proximity during mixing.

Care should be taken in the application of chemicals/soil-toxicants to ensure that they are not allowed to contaminate wells or springs.

7.7 Inspections

For the duration of the Contract, following the treatment, the Contractor shall perform annual inspections of all buildings treated.

If during the inspections, or at any other time, live subterranean termite infestation or subterranean termite damage is discovered and the soil and building conditions have not been altered in the interim, the Contractor shall:

12 Excavate the soil and perform other treatment as may be necessary for elimination of subterranean termite infestation;

13 Repair damage caused by termite infestation; and

14 Re-inspect the building approximately 180 days after the additional treatment.

In the event of a reappearance of termites within the building area due to defective materials or workmanship or due to any other reason, the Contractor will carry out the necessary post construction treatment to keep the entire area free from termites once again.

The Contractor shall maintain a Pest Management Maintenance Record, identifying target pest, type of operation, brand name and manufacturer of pesticide, formulation, concentration or rate of application used and submit copies of records when requested by the Employer's Representative.

PART 8 - Roads and Pavements

8.1 General

The construction and reinstatement of roads and parking areas shall be carried out in accordance with the specifications for road works of the related areas.

8.2 A comprehensive network of roadways shall be provided around the treatment plant to link in with the existing road network and permit access to the plant for necessary maintenance, delivery of consumables and personnel access. All roads shall be of asphalt macadam/concrete and internal roads minimum 4.50 metres wide. Approach road and main road shall be minimum 6.0m wide. Vehicular access shall be provided for all Plant structures and buildings. All roads shall be provided with drainage and shall be constructed to prevent standing water.

8.3 Paved pedestrian access ways shall be constructed to provide a network of logical routes interlinking plant areas. Damage to any existing roads on account of their use by the Contractor shall be made good to the satisfaction of the Engineer.

8.4 Hard standing areas with shading facility shall be provided to permit the parking of vehicles involved in the delivery of consumables from blocking site roadways during unloading or loading. The road system shall be designed such that vehicles involved in the delivery of consumables can follow a continuous route through the works and out again.

8.5 Materials

12.7.1 General

All materials shall be obtained from local sources and shall be subject to approval by the Employer's Representative prior to use.

Substitution of material shall be on an approved equivalent basis as determined by the Employer's Representative and shall result in finished roads as designated in this specification.

Material aggregates shall consist of natural or crushed stone, gravel or sands, shall be of reasonably uniform quality throughout and shall be clean and free from soft or decomposed particles, excess clay, foreign, organic or other deleterious matter.

12.7.2 Coarse Aggregate for Sub-Base, Base and Semi-grout

Coarse aggregate shall be crushed or broken stone and shall conform to the physical requirement given in the following table.

Physical requirements of Crushed Stone for Road Work

Sr. No.	Test	Limiting Value	
		For aggregates to be used for Road base and surfacing	For aggregate to be used for sub-grade
1.	Specific Gravity	Not less than 2.6	Not less than 2.0
2.	Water Absorption	Not more than 2%	Not more than 5%
3.	Flakiness Index	Maximum 25%	----
4.	Elongation Index	Maximum 40%	----
5.	Aggregate Impact Value Crushing Value	Not more than 30%	Not more than 40%
6.	Los Angeles Abrasion Value	Not more than 30%	Not more than 50%
7.	Stripping Test	Maximum 15%	----

Crushed or broken stone shall be hard, durable and free from an excess of flat, elongated, soft and disintegrated particles, dirt and other objectionable matter.

Crushed or broken stone shall conform to the grading given in the following table.

16.2.3

G

Grading Requirements of Coarse Aggregates

Grading No.	Size Range	IS. Sieve Designations	Percent by Weight passing the sieve
1.	90 mm to 40 mm	100 mm	100
		80 mm	65 - 85
		63 mm	25 - 60
		40 mm	0 - 15
		20 mm	0 - 5
2.	63 mm to 40 mm	80 mm	100
		63 mm	90 - 100
		50 mm	35 - 70
		40 mm	0 - 15
		20 mm	0 - 5
3.	50 mm to 20 mm	63 mm	100
		50 mm	95 - 100
		40 mm	35 - 70
		20 mm	0 - 10
		10 mm	0 - 5

12.7.3 Screenings

Screenings shall consist of predominantly non-plastic materials such as sandy gravelly murrum or gravel (other than rounded river borne material) with Liquid Limit and Plasticity Index below

20 and 6 respectively and the fraction passing 75 micron sieve not exceeding 10%. The materials shall be sound and hard, of a quality not affected by weather and shall be screened at the quarry and shall be free from all impurities. Any large lumps of murrum shall be broken to pass gradation given in the above table. Gravel shall be composed of large, coarse, silicious grains, sharp and gritty to the touch, thoroughly free from dirt and impurities.

Screenings shall conform to the grading indicated in the following table.

16.2.4

Grading for Screenings

G

Grading Classification	Size of Screenings	IS Sieve Designations	Percent by Weight passing the sieve
A	12.5 mm	12.5 mm 10.0 mm 4.75 mm 150 microns	100 90 - 100 10 - 30 0 - 8
B	10.0 mm	10.00 mm 4.75 mm 150 microns 75 microns	100 85 - 100 10 - 30 0 - 10

12.7.4 Blinding Material

To fill in the voids in the coarse aggregates, any non-plastic material such as gravel/ grit/ sand/ brick powder may be used. The plasticity index of the material shall not exceed six.

12.7.5 Binder

The binder shall be straight run bitumen of grade S35 or S65 and shall conform to the requirements specified in IS 73 and the following table.

16.2.5

Requirements of Bitumen Binder

R

Sr. No.	Characteristic	Requirement		Method of Test Refer to
		S 35	S 65	
1	Specific gravity at 27°C, Min.	0.99	0.99	IS : 1202
2	Water prevent by weight, Max.	0.2	0.2	IS : 1211
3	Flash point, Pensky Martens closed type °C, Min.	175	175	IS : 1209 (Method A)
4	Softening point, °C	50 - 65	40 - 55	IS : 1205
5	Penetration, at 25°C, 100 g, 5 sec in 1/100 cm	30 - 40	60 - 70	IS : 1203
6	Ductility at 20 °C in cm, Min	50	75	IS : 1208
7 (a)	Loss on beating, percent by weight, Max.	1	1	IS : 1212

7 . (b)	Penetration of residue (expressed as percentage of item 5), Min	60	60	IS : 1203
8 .	Matter soluble in carbon disulphide, percent by weight, Min.	99	99	IS : 1216

8.6 Setting Out

The Contractor shall provide all labour and materials such as lines, strings, pegs, nails, bamboo, stones, mortar, concrete etc, required for setting out, establishing benchmarks and giving profiles. The Contractor shall be responsible for maintaining the benchmarks, profiles, alignments and other stakes and marks as long as they are required for the works.

The surface of the installed layers will be parallel and have the same grade as the designed asphalt surface and all subsequent layers.

8.7 Earthworks for Roads

Profiles of road excavation shall be laid at 25 m intervals to conform to the required alignment, sections, grades and side slopes and the lines of cuts shall be clearly marked.

The Contractor shall, on no account, excavate beyond the slopes or below the specified grade on the drawings unless so directed by the Employer's Representative in writing.

• Preparation of Sub-grade

Immediately prior to the laying of the sub-base metal, the sub-grade shall be cleaned of all foreign substances and vegetation etc. Any ruts or soft yielding patches that appear shall be corrected and the sub-grade dressed off parallel to the finished profile. The camber of sub-grade shall conform in shape to that of the finished road surface. Camber boards shall be used to get the required section.

The prepared sub-grade shall be lightly sprinkled with water, if necessary, and rolled with a power roller of 10-12 tonnes. The roller shall pass over the same area of the sub-grade a minimum of five runs. Any undulations in the surface that develop due to rolling shall be made good with approved earth and sub-grade re-rolled.

• Sub-base

(i) General

The sub-base shall not be constructed on a wet sub-grade.

The width of the sub-base course shall be 150 mm more on either side than that of the water-bound macadam wearing course. The finished thickness of the sub-base course shall be 160 mm. The sub-base metal course shall be laid in two layers, each of thickness 120mm and compacted to 80mm

(ii) Spreading and Rolling

The metal shall be spread uniformly and evenly upon the prepared base to a thickness of 120 mm. The spreading shall be done from stockpiles along the side of the roadway. In no case shall the aggregates be dumped in heaps directly on the surface prepared to receive the metal nor shall hauling over an un-compacted or partially compacted base be permitted. The surface

of the aggregate shall be carefully checked, with templates and all high or low spots remedied by removing or adding aggregate as may be required. No segregation of large or fine particles shall be allowed and the coarse aggregates as spread shall be of uniform gradations with no pockets of fine material.

Immediately following the spreading of the metal, rolling shall be started with three wheeled power rollers of 10 to 12 tonnes capacity or tandem or vibratory rollers of approved type. Rolling shall begin from the edges gradually progressing towards the centre. First the edges shall be firmly compacted with roller running forward and backward. The roller shall then move inwards in successive passes uniformly lapping preceding tracks by at least one half width.

Rolling shall be continued until the road metal has been thoroughly keyed and the forward movement of stones ahead of the roller is no longer visible. A slight sprinkling of water may be applied if necessary.

(iii) Application of Screening

After the metal has been thoroughly keyed and set by rolling, screening to completely fill the interstices shall be applied gradually over the surface. These shall be dry at the time of application. Dry rolling shall be carried out while the screening is being spread so that vibrations of the roller cause them to settle in the voids. The screenings shall not be dumped in piles but be spread uniformly by spreading motion of hand shovels.

The dry rolling shall be accompanied with brooming with hand brooms, wire brushes or both. In no case shall the screenings be applied so fast and thick as to form cakes or ridges on the surface in such a manner as would prevent tilling of voids or prevent the direct bearing of the roller on the metal. These operations shall continue until no more screenings can be forced into the voids in the metal.

(iv) Sprinkling and Grouting

The surface shall be copiously sprinkled with water, swept and rolled. Hand brooms shall be used to sweep the screenings into voids and to distribute them evenly. The sprinkling, sweeping and rolling operations shall be continued with additional screenings applied as necessary, until the coarse aggregate has become well bonded and firmly set in its full depth and a grout has been formed of the screenings. Care shall be taken to see that the underlying layers do not get damaged due to the addition of excessive quantities of water during construction. After the first layer of the sub-base has fully set, to the satisfaction of the Employer's Representative, the second layer shall be laid. The construction operation for the second layer will be the same as that specified herein for the first.

• Water-bound Macadam Course

(i) Preparation of Base

The base to receive the water bound macadam course shall be prepared to the specified grade and camber and made free of dust and other extraneous material. Any ruts or soft yielding places shall be corrected in an approved manner and rolled until firm.

(ii) Spreading Coarse Aggregate

The coarse aggregates shall be spread uniformly upon the prepared base and compacted to 80

mm

The spreading shall be from stockpiles along the side of the roadway or directly from vehicles. In no case shall the aggregate be dumped in heaps directly on the surface prepared to receive the aggregate nor shall hauling over un-compacted or partially compacted base be permitted.

The surface of the aggregates spread shall be carefully checked with templates and all high or low spots remedied by removing or adding aggregate as may be required. No segregation of large or fine particles shall be allowed and the coarse aggregate, as spread, shall be of uniform gradation with no pockets of fine material.

The coarse aggregate shall not normally be spread over more than three days in advance of the subsequent construction operations.

(iii) Rolling

Immediately following the spreading of the coarse aggregate, rolling shall be started with three wheeled power roller of 10 to 12 tonne capacity of tandem or vibratory rollers of approved types. The weight of the roller shall depend upon the type of aggregate and shall be subject to the approval of the Employer's Representative.

Except on super elevated portions where the rolling shall proceed from inner edge to the outer, rolling shall begin from the edges gradually progressing towards the centre. First the edge/edges shall be compacted with roller running forward and backward. The roller shall then move inwards parallel to the centre line of the road, in successive passes uniformly lapping the preceding tracks by at least one half width.

Rolling shall be discontinued when the aggregates are partially compacted with sufficient void space in them to permit application of blinding. A slight sprinkling of water may be applied if necessary. Rolling shall not be carried out when the sub-grade or sub-base is soft or yielding or when it causes a wave-like motion in the sub-grade or base course.

The rolled surface shall be checked transversely and longitudinally with templates and any irregularities corrected by loosening the surface, adding or removing necessary amounts of aggregate and re-rolling until the entire surface conforms to the desired camber and grade. In no case shall the use of blinding be permitted to make up depressions.

(iv) Application of Blinding

After the coarse aggregate has been rolled, blinding to completely fill the interstices shall be gradually applied over the surface. These shall be dry at the time of application. Dry rolling shall be done while the blinding is being spread so that vibrations of the roller cause them to settle into the voids of the coarse aggregate. The blinding shall not be dumped in piles but be spread uniformly in successive thin layers either by the spreading motion of hand shovels or by mechanical spreaders or directly from trucks. Trucks operating for spreading the blinding shall be so driven as not to disturb the coarse aggregate.

The blinding shall be applied at a slow and uniform rate (in three or more applications) to ensure filling of all voids. The rate of spreading blinding shall not be less than 3.00 m³ or more than

4.50 m³ per 100 m². This shall be accompanied by dry rolling and brooming with mechanical brooms, hand brooms or both. In no case shall the blinding be applied so fast and thick as to form cakes or ridges on the surface in such a manner as would prevent filling of voids or prevent the direct bearing of the roller on the coarse aggregate. The operations shall continue

until no more blinding can be forced into the voids of the coarse aggregate.

The spreading, rolling and brooming of blinding shall be carried out on only such lengths of the road which could be completed within one day's operation.

(v) Sprinkling and Grouting

After the blinding has been applied, the surface shall be copiously sprinkled with water, swept and rolled. Hand brooms shall be used to sweep the wet blinding into voids and to distribute it evenly. The sprinkling, sweeping and rolling operations shall be continued with additional blinding applied as necessary until the coarse aggregate has been thoroughly keyed, well bonded and firmly set in its full depth and a grout has been formed of blinding. Care shall be taken to ensure that the base or sub-grade does not get damaged due to the addition of excessive quantities of water during construction.

(vi) Setting and Drying

After the final compaction of water bound macadam course, the road shall be allowed to dry overnight. Next morning, areas missing blinding shall be filled with blinding as directed, lightly sprinkled with water if necessary and rolled. No traffic shall be allowed on the road until the macadam has set. The Employer's Representative shall have the discretion to stop hauling traffic from using the completed water bound macadam course if in his opinion it would cause excessive damage to the surface.

Should the sub-grade at any time become soft or churned up with the sub-base material or the water bound macadam course, the Contractor shall remove the mixture from the affected portion, reshape and compact the sub-grade and replace the removed section in accordance with the foregoing requirements.

• Tack Coat

(i) Preparation of Base

The base on which a tack coat is to be applied shall be prepared, shaped and conditioned to the specific line, grade and cross section by repairing all potholes or patches and ruts. The potholes shall be drained of water and cut to regular shape with vertical sides. All loose and disintegrated materials shall be removed. The potholes shall then be filled either with (i) coarse aggregate and screenings and compacted with heavy hand rammers or approved mechanical tampers or (ii) premixed chippings binders (bitumen grade S 35/ S 65) content of 3 percent by weight of total mix, after painting the sides and bottom of the holes with a thin application of bitumen, or a combination of both (i) and (ii) as approved by the Employer's Representative. The surface shall be thoroughly swept and scraped clean and free of dust and other foreign matter.

(ii) Application

The binder used for tack coat shall be bitumen of suitable penetration grade within S35 to S65 conforming to IS: 73. The binder shall be heated to the temperature appropriate to its grade and as approved by the Employer's Representative. The binder shall be sprayed on the prepared base at the rate of 1.0 kg/m². The binder shall be applied uniformly with the aid of either self propelled or towed bitumen pressure sprayer with self heating arrangement and spraying nozzle arrangement capable of spraying bitumen at the above specified rate and

temperature to provide a uniform unbroken spread of bitumen. The tack coat shall be applied just ahead of laying asphalt macadam.

• Asphalt Macadam

12 Brushing

Prior to spreading of the asphalt surface, the water bound surface shall be swept clean to remove blinding to expose the metal surface.

13 Application of Macadam

The bituminous macadam shall be laid by mechanical compactor and finisher, the final consolidation being by means of power roller weighing not less than 10 tonnes. The finished surface shall not vary by more than 12.5mm above or below the designed level and the average thickness shall not be less than 65 mm after consolidation.

The grading, composition and characteristics of the bituminous macadam shall be as follows:

16.2.6

Aggregate Grading

IS Sieve Designation	Percentage passing
50 mm	100
40 mm	60 - 100
25 mm	30 - 70
20 mm	20 - 70
6.3 mm	10 - 20
2.36 mm	0 - 5

Bitumen (Grade S 65) Content: 3.7% to 4.3% by weight of total mix.

The bituminous macadam may be prepared in a hot mix plant or the bitumen may be cut back with a suitable solvent so that the heated cut back bitumen may be mixed with the aggregate. In either case mixing shall be carried out in a power driven pugmill mixer and shall be continued until all the aggregate is coated.

The Contractor shall ensure that the installation temperature is adequate during the rolling / compaction of asphalt.

14 Protection of Pavement

During the period between initial compaction of the coarse aggregate and completion of the sealcoat, the surface shall be protected from all traffic other than that which is absolutely essential to its construction.

15 Premixed Seal Coat

After the full grout has been rolled, the interstices shall be completely filled with pre-coated grit of the following composition.

16.2.7

Aggregate Grading

IS Sieve Designation	Percentage passing
6.3 mm	100
2.36 mm	70 - 100
600 micron	25 - 50

A

A

300 micron	0 - 10
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Bitumen (Grade S 65) Content : 7% to 8% by weight of total mix.

The premixed seal coat may be prepared in a hot mix plant or the bitumen may be cut back with a suitable solvent so that the heated cut back bitumen may be mixed with the aggregate. In either case, mixing shall be carried out in a power driven pugmill mixer and shall be continued until all the aggregate is coated.

The premixed seal must be brushed to fill in the interstices, additional material being applied during rolling if found necessary. The quantity of premixed seal required for this purpose shall be approximately 1.22 m³ per 100 m².

16 Liquid Seal

On the completion of consolidation, which may be assisted by opening the road to traffic, a liquid seal coat of Grade 565 bitumen shall be applied at a temperature of between 163°C to 191°C (325°F to 375°F) at the rate of 1.25 kg/m². The application of bitumen shall be immediately followed with a cover coat of clean dry ¼ cubical chippings at the rate of 1.22 m³ per 100 m². The surface shall then be rolled with a power roller weighing not less than 10 tonnes. The composition of this seal coat shall be as follows :

16.2.8 Aggregate Grading

IS Sieve Designation	Percentage passing
12.5 mm	100
10 mm	70 - 100
4.75 mm	20 - 40
2.36 mm	7 - 20
75 micron	0 - 4

Bitumen (Grade S 65) Content : 4.5% to 5% by weight of total mix.

- **Quality Control**
- **General**

All works performed shall conform to the lines, grades, cross sections and dimensions as specified or as approved by the Employer's Representative subject to the permitted tolerances described hereinafter.

- **Horizontal Alignments**

These shall be reckoned with respect to the centreline of the carriageway as specified. The edges of the carriageway as constructed and all other parallel alignments shall be corrected within a tolerance of 20 mm.

- **Longitudinal Profile**

The level of any point on the various surfaces after compaction shall comply with the following :

Surface	Tolerance from the specified Level
Sub-grade	25 mm
Sub- base	20 mm
Base-course	15 mm
Wearing course	10 mm

The negative tolerance for wearing course, shall not be permitted in conjunction with the

positive tolerance for the base course, if the thickness of the wearing course is thereby reduced by more than 6 mm.

The longitudinal profile shall be checked with a 3.0 m long straight edge, along the centreline of the road. The transverse profile shall be checked with a camber board at intervals of 30m. Permitted tolerances are specified in the table below:

16.2.9

Permitted tolerances of surface regularity for pavement courses

No.	Type of construction	Longitudinal profile (Maximum permissible undulation when measured with a 3 m straight edge) (mm)
1.	Sub-grade	18
2.	Sub- base	18
3.	Base-course	12
4.	Asphalt macadam	10

• Rectification

Where the surface irregularity of the sub-grade and the various pavement courses falls outside the specified tolerances, the Contractor shall rectify these in the manner described below and to the satisfaction of the Employer's Representative.

(i) Sub-grade

Where the surface is high, it shall be trimmed and suitably compacted. Where it is low, the deficiency shall be corrected by adding fresh material.

(ii) Stabilized Sub-base

Where the surface is high, the same shall be suitably trimmed while taking care that the material below is not disturbed due to this operation. Where the surface is low, the same shall be corrected as described below.

When the time elapsed between detection of irregularity and the time of mixing is less than two hours, the surface shall be scarified to a depth of 50 mm, supplemented with freshly mixed material as necessary and re-compacted to the relevant specification. When this time is more than two hours, the full depth of the layer shall be removed from the pavement and replaced with fresh material to the specification. In either case the area treated shall not be less than 5m long and 2m wide.

Where the surface is high or low, the top 75 mm shall be scarified, reshaped with added material as necessary and re-compacted. The area treated shall not be less than 5m long and 2m wide.

(iii) Bituminous Construction

For bituminous construction other than for a wearing course where the surface is low, the deficiency shall be corrected by adding fresh material and compacting in accordance with the specification. Where the surface is high, the full depth of the layer shall be removed and replaced with fresh material and compacted to the specification.

For wearing course where surface is high or low, the full depth of the layer shall be removed and replaced with fresh material and compacted to specifications. In all cases where removal and replacement of bituminous layer is involved, the area treated shall not be less than 5m long and 2 m wide.

• Quality Control Test During Construction

For ensuring the requisite quality of construction, the materials and works shall be subjected to quality control test, as described hereinafter, by the Employer's Representative. The testing frequencies set-forth are the minimum required and the Employer's Representative shall have the authority to carry out tests as frequently as he may deem necessary to satisfy himself that the materials and works comply with the appropriate specifications. The tests and their frequency to be used for different materials and works shall be as detailed in the following Table:

Sr. No.	Type of construction	Test		Frequency
1.	Sub-base	i)	Gradation	1 test per 2000 m ²
		ii)	Plasticity	As required
		iii)	Deleterious Constituents	As required
		iv)	CBR test	As required
		v)	Moisture content prior to compaction	1 test per 250m ²
		vi)	Dry density	1 test per 500 m ²
2.	Water Macadam Bound	i)	Gradation	1 test per 1000 m ²
		ii)	Flakiness index	1 test per 2000 m ²
		iii)	Plasticity of binding material	1 test per 1000 m ²
3.	Bitumen Macadam	i)	Quality of binder	As required
		ii)	Aggregate impactvalue	1 test per 50 – 100 m ² of aggregate
		iii)	Flakiness index	1 test per 50 - 100 m ² of aggregate
		iv)	Grading of Aggregates	2 tests per day plant,both on the individual constituents and mixedaggregates from the dryer (one at plant and one at Municipal Lab)
		v)	Binder content	Periodic subject to 2tests per day per plant
		vi)	Control of temp. of binder andaggregate for mixing and of the mix at the time of laying and rolling	All regular close intervals
		vii)	Rate of spread of mixed material	Regular control through checks onlayer thickness
4.	Seal Coat	i)	Quality of binder	As required
		ii)	Aggregate ImpactValue	1 test per 2000 m ²
		iii)	Flakiness Index	1 test per 2000 m ²
		iv)	Aggregategrading	2 tests per day
		v)	Temp. of application	At regular closeintervals
		vi)	Rate of spread 2 materials	2 tests per day

Where a specific procedure is not indicated for quality control tests in these specifications, the same shall be carried out as per prevalent accepted engineering practice and to the approval of the Employer's Representative.

Control shall be exercised by taking at least one measurement of density for each 1000 m² of compacted area or as required to yield the minimum number of test results for evaluating a day's work on a statistical basis. The determination of density shall be in accordance with IS: 2720 (Part 28). Test locations shall be chosen only through random sampling techniques. Control shall not be based on the result of any one test but on the mean value of a set of 5 – 10 density determinations. The number of tests in one set of measurements shall be five, as long as it is felt that sufficient control over material and the method of compaction is being exercised. If considerable variations are observed in individual density results, the minimum number of tests in one set of measurement shall be increased to ten. The acceptance of work shall be subject to the condition that the mean standard deviation for any set of results is below 0.08 g/cc.

For earth work in shoulders and in the top 500 mm portion of an embankment below the sub-grade, at least one density measurement shall be taken for every 500 square metres of each set of measurements. In other respects the control shall be similar as described earlier.

- **Slab Culvert**
- **General**

Where slab culverts are provided for cross drainage purposes, these shall conform to the following specifications. The concrete works specifications for construction of RCC slab and the rubble masonry specification for the supporting rubble walls are given in this specification.

- **Bitumen at Location of Contact**

Two coats of grade S 35 bitumen shall be applied to the top of the bed concrete at the point of contact with the RCC slab above.

- **Free Draining Graded Gravel Backfill**

On each side of un-coursed rubble walls supporting the slab culvert, a free draining backfill of thickness 200 mm shall be provided. The material 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 or in contact with water. The material shall be free from soft, thin, elongated or laminated pieces and vegetation or other deleterious substances. The material shall be graded and shall meet the grading requirements given above.

- **Weep Holes**

Weep holes as required or as directed by the Employer's Representative shall be provided in the masonry to drain water from the backfilling. Weep holes shall be of PVC pipe in rubble walls with M-15 concrete cushioning 75 mm thick. The weep holes shall extend through the full width of the masonry at a spacing of 1.5 m c/c and with a slope of 1 vertical to 20 horizontal towards the draining face.

- **Rough / Natural Faced Shahabad Stone Pavement**

- **Materials**

Hand cut rough/natural faced Shahabad stone shall be of the best quality and of suitable thickness, size etc and shall be subject to the approval of the Employer's Representative. The

stone shall be hard, sound, durable, tough, free from flaws, cracks, decay and weathering. The edges shall be hand cut and dressed true and squares. The evenness of surfaces and edges of the slabs shall not be marred by careless dressing or handling and no patching up shall be allowed.

The under face may be left as required or rough dressed. Before taking up the work, samples of stone slabs to be used and their dressing shall be subject to the approval of the Employer's Representative. The work shall be carried out strictly in accordance with the approved samples.

- **Bedding/Backing Coat**

In case of plinth protection or other pavements over a concrete sub base, the bedding shall be of 12 mm thick 1:2 cement mortar

In case of pavement work for footpaths, approaches and other similar works, to be laid directly over levelled and consolidated ground, the bedding shall be of 150 mm thick quarry spoil and 60mm thick stone grit or as otherwise approved by the Employer's Representative.

- **Laying and Fixing Stone Slabs and Tiles**

The specifications for Kotah stone flooring/skirting/facia described in this tender shall apply except that the joints shall be pointed with 1:3 cement mortar and finished flush or with grooves as approved. The joints shall be raked out uniformly to a depth of not less than 12 mm before grouting and pointing the same.

- **Curing**

The pavement work shall be kept well wetted for at least seven days.

- **Cleaning**

When the bedding and joints have been completed, set and attained the required strength, the surface shall be thoroughly cleaned and handed over free from any mortar stains, dust, dirt etc.

- **Surface Water Drainage Systems**

- **General**

All surface storm water drains shall be constructed to the correct sizes and shapes as required for a sustained storm of 100 mm per hour. The finished product shall be sound and shall have smooth inside surfaces for optimum flow and be to the approval of the Employer's Representative.

- **Materials**

- 13 Common Bricks**

All common bricks shall be sound, hard, thoroughly baked, clean, of proper rectangular size and give a clear ring when tapped. They shall comply with IS 2212. All bricks shall be obtained from a manufacturer subject to the approval of the Employer's Representative.

Testing of bricks shall be in accordance with IS 2212. Mortar shall be composed of one part cement to three parts sand, mixed thoroughly on a clean watertight platform before the appropriate amount of water is added. Mortar shall be used within one hour of adding water to the mix and no softening or revival of mortar shall be permitted after one hour of mixing.

14 Plaster

Where specified, plaster shall be rendered 20 mm thick in cement mortar consisting of one part cement to three parts sand. Plasticizer may be used with cement with the approval of the Employer's Representative.

- **Setting Out**

As soon as the embankments or fill areas are completed in accordance with the requirements of related Sections of this document, the Contractor shall set out the lines for road-side and surface storm-water drains. The centre lines shall be marked with pegs at not more than 30 metre intervals and at turning points and positions of manholes, with the lines and levels of cut for drain laying clearly set out.

- **Execution**

Surface drains shall be laid in trenches dug to the correct levels and alignment and constructed to produce an even alignment and gradient. Over-excavation shall be made good by selected fill well compacted and to the satisfaction of the Employer's Representative.

1 Concrete

- **Definitions**

Liquid Retaining structures shall be construed to mean any structure of which any part contains water or other process liquids, or which are designed or intended to protect spaces from ground water.

- **Materials**

- **General**

The quality of material and method and control of manufacture and transportation of all concrete work irrespective of mix; whether reinforced or otherwise shall conform to the applicable portions of this specification.

The Employer's Representative shall have the right to inspect the sources of materials, the layout and operation of procurement and storage of materials, the concrete batching and mixing equipment and the quality control system. Such an inspection shall be arranged and the approval of the Employer's Representative obtained, prior to starting any concrete work.

The ingredients to be used in the manufacture of standard concrete shall consist solely of a standard type Portland/Portland pozzolana cement, clean sand, natural coarse aggregate, clean water, ice and admixtures if specially called for.

- **Storage**

All materials shall be stored in the required manner immediately upon delivery to the site. It will be the responsibility of the Contractor to provide and maintain requisite stocks, handle the materials with care and store them in such a manner that the materials will remain fresh for use at the appropriate time.

Cement shall be stored in silos or in dry weather proof and well ventilated structures the floors of which shall be at least 450 mm above ground level with adequate precautions to prevent moisture absorption. The storage arrangements shall be subject to the approval of the Employer's Representative and shall provide easy access for inspection. The different consignments shall be identifiable and shall be utilized in the order in which they are received at site or as instructed by the Employer's Representative.

Aggregates shall be so stored that different specified sizes are kept separate and protected against contamination by soil or other impurities. Adequate storage facilities shall be provided to prevent the possibility of intermixing of the different sizes of aggregates.

The use of wet fine aggregates shall be permitted if the moisture content is uniform and after such content is accurately determined to adjust the batching and the water content of the proposed mix. Wherever possible, the fine aggregate shall be kept dry.

All coarse and fine aggregates shall be stacked separately in stock piles in the material yard near the work site in bins properly constructed to avoid inter mixing of different aggregates. Contamination with foreign materials and earth during storage and while heaping the materials shall be avoided. The aggregate shall be of specified quality, not only at the time of receiving at site but also at the time of loading into mixer. Rakers shall be used for lifting the coarse aggregate from bins or stock piles. Coarse aggregate shall be piled in layers not exceeding 1.00 metre in height to prevent coning or segregation. Each layer shall cover the entire area of the stock pile before succeeding layers are started. Aggregates that have become segregated shall be rejected. Rejected material after remixing may be accepted, if subsequent tests demonstrate conformity with the required gradation.

• **Cement**

Cement shall be as per the latest version of IS 269. Cement for use in concrete for sewage treatment works and pumping stations shall be sulphate resistant. Tests shall be carried out as and when approved by the Employer's Representative. The cement shall be tagged for identification at location for sampling.

Unless otherwise specified or called for in the contract, the cement to be used shall be selected from the following and the type selected shall be appropriate for the intended use and as per the Contract.

- Sulphate resisting Portland cement conforming to IS 12330.
- 53 Grade ordinary Portland Cement conforming to IS 12269
- Portland slag cement conforming to IS 455.
- Portland pozzolana cement (fly ash based) conforming to IS 1489 (Part I)
- Portland pozzolana cement (calcined clay based conforming to IS 1489 (Part 2)

Should the project require specific use of any of the following cements the same shall be used with the prior consent of the Employer's Representative and necessary precautions with regard to their setting and hardening time, time required for removal of shuttering and curing etc shall be taken after carefully complying with specific literature with regard to those types.

- (i) High alumina cement - conforming to IS 6452
- (ii) Low heat cement - conforming to IS 12600
- (iii) Super sulphate cement - conforming to IS 6909
- (iv) Rapid hardening cement - conforming to IS 8041
- (v) Blended cement for finishing work as below

Other combinations of Portland cement with mineral admixtures of quality conforming to relevant Indian Standards laid down may also be used in the manufacture of concrete provided that there are satisfactory data on their suitability, such as performance test on concrete containing them and only in such case where it is specifically called for in the contract.

No pre-hardened cement shall be used on any permanent works.

STANDARD FOR CEMENT CONSUMPTION FOR DIFFERENT ITEM OF WORKS

EXISTING ITEM			AMENDMENT		
Item	Unit	Quantity of cement to be used per unit quantity of work in Kg	Item	Unit	Quantity of cement to be used per unit quantity of work in Kg.
Building, Road & Bridge Items					
Providing & casting in situ ordinary cement concrete M75 for PCC work	Cu.m.	160	Providing & casting in situ ordinary cement concrete M7.5 for PCC work	Cu.m.	160
Providing & casting in situ ordinary cement concrete M100 for PCC work	Cu.m.	220	Providing & casting in situ ordinary cement concrete M10 for PCC work	Cu.m.	220
Providing & casting in situ ordinary cement concrete M150 for PCC work	Cu.m.	320	Providing & casting in situ ordinary cement concrete M15 for PCC work	Cu.m.	290
Providing and casting situ control cement concrete M200 for RCC work	Cu.m	400	Providing and casting situ control cement concrete M20 for RCC work	Cu.m.	360
Providing and casting situ control cement concrete M250 for RCC work	Cu.m.	450	Providing and casting situ control cement concrete M25 for RCC work	Cu.m.	380
Providing and casting situ control cement concrete M350 for RCC work	Cu.m.	500	Providing and casting situ control cement concrete M35 for RCC work	Cu.m.	425
Providing and casting situ control cement concrete M400 for RCC work	Cu.m.	525	Providing and casting situ control cement concrete M40 for RCC work	Cu.m.	440
Providing and casting situ control cement concrete M450 for RCC work	Cu.m.	540	Providing and casting situ control cement concrete M45 for RCC work	Cu.m.	450
New Item					
-	-	-	Providing and casting situ control cement concrete M30 for RCC work	Cu.m.	410

EXISTING ITEM	Unit	Quantity of cement to be used per unit quantity of work in Kg	AMENDMENT	Quantity of cement to be used per unit quantity of work in Kg
Providing & casting in situ ordinary cement concrete M75 for PCC work	Cu.m.	160	Providing & casting in situ ordinary cement concrete M7.5 for PCC work	160
Providing & casting in situ ordinary cement concrete M100 for PCC work	Cu.m.	220	Providing & casting in situ ordinary cement concrete M10 for PCC work	220
Providing & casting in situ ordinary cement concrete	Cu.m.	320	Providing & casting in situ ordinary cement	290

M150 for PCC work			concrete M15 for PCC work	
Providing and casting situ control cement concrete M200 for RCC work	Cu.m.	400	Providing and casting situ control cement concrete M20 for RCC work	360
Providing and casting situ control cement concrete M250 for RCC work	Cu.m.	450	Providing and casting situ control cement concrete M25 for RCC work	380
Providing and casting situ control cement concrete M350 for RCC work	Cu.m.	500	Providing and casting situ control cement concrete M35 for RCC work	425
Providing and casting situ control cement concrete M400 for RCC work	Cu.m.	525	Providing and casting situ control cement concrete M40 for RCC work	440
Providing and casting situ control cement concrete M450 for RCC work	Cu.m.	540	Providing and casting situ control cement concrete M45 for RCC work	450
			Providing and casting situ control cement concrete M30 for RCC work	410

16.2.10 (i) Mineral Admixtures for Cement

Pozzolana: Pozzolanic materials conforming to relevant Indian Standards may be used with the permission of Employer's Representative, provided uniform blending with cement is ensured.

Fly ash (pulverized fuel ash): Fly ash conforming to IS 3812 may be used as part replacement of ordinary Portland cement provided uniform blending with cement is ensured.

Silica fume: Silica fume can be used as part replacement of cement provided it is of sufficient quality approved by the Employer's Representative and uniform blending with the cement is ensured.

Rice husk ash: Rice husk ash giving required performance and uniformity characteristics maybe used with the approval of the Employer's Representative.

Metakaoline: Metakaoline having fineness between 700 to 900 m²/kg may be used as a pozzolanic material in concrete.

Ground Granulated Blast Furnace Slag: Ground granulated blast furnace slag obtained by grinding granulated blast furnace slag conforming to IS 12089 may be used as part replacement of ordinary Portland cement provided uniform blending with cement is assured.

Quality Assurance of Cement: A certified report attesting to the conformity of the cement to IS specifications by the cement manufacturer's chemist shall be furnished to the Employer's Representative, if demanded. The Contractor, shall make his own arrangements for the storage of adequate quantities of cement at the site of work.

Storage of Cement: Cement in bags shall be stored and stacked in a shed, which is dry, leak-proof and moisture proof as far as possible. Storage under tarpaulins will not be permitted. Flooring of the shed shall consist of the two layers of dry bricks laid on well consolidated

earth to avoid contact of cement bags with the floor. Stacking shall be about 150 to 200 mm clear above the floor using wooden planks. Cement bags shall be stacked at least 450 mm clear of the walls and in rows of two bags leaving a space of at least 600 mm between two consecutive rows. In each row the cement bags shall be kept closed together to reduce air circulation. Stacking shall not be more than ten bags high to avoid lumping under pressure. In stacks more than eight bags high, the cement bags shall be arranged in header and stretcher fashion i.e. alternately lengthwise and crosswise to tie the stacks together and minimize the danger of toppling over.

Damaged or reclaimed or partly set cement will not be used and shall be removed from the site. The storage arrangements shall be such that there is no dead storage consignments so cement shall be stored as received and shall be consumed in the order of their delivery.

Cement held in store for a period of ninety days or longer shall be retested before used in work. Should the Employer's Representative have reasons to consider that any cement is defective, then irrespective of its origin and/or manufacturers test certificate, such cement shall be tested immediately at a National Test Laboratory or other approved laboratory and until the results of such tests are found satisfactory, it shall not be used in any work.

• Aggregates

Aggregate in general designates both fine and coarse inert materials used in the manufacture of concrete.

Fine aggregate is aggregate most of which passes through 4.75 mm IS sieve.

Coarse aggregate is aggregate most of which is retained on 4.75 mm IS sieve. Aggregate shall comply with requirement of IS 383. As far as possible preference shall be given to machine broken and graded aggregate.

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

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

The maximum percentages of permissible deleterious materials shall be as follows, subject to total combined impurities, limit of 5 percent by weight.

Impurity	<u>Coarse Aggregate</u>		<u>Fine Aggregate</u>	
	Crushed	Uncrushed	Crushed	Uncrushed
Clay lumps	1	1	1	1
Soft fragments	3	-	-	-
Fine material passing through 75 micron sieve	3	1	3	3
Shale	-	-	1	-
Coal, lignite	1	1	1	1

1 Specific Gravity

Aggregates having a specific gravity below 2.6 (saturated surface dry basis) shall not be used without special permission of the Employer's Representative.

2 Fine Aggregate

Fine aggregate except as noted above and for other than light weight concrete shall consist of natural or crushed sand conforming to IS 383. The sand shall be clean, sharp, hard, strong and durable and shall be free from dust, vegetable substances, adherent coating, clay, loam, alkali, organic matter, mica, salt or other deleterious substances which can be injurious to the setting qualities, strength or durability of the concrete.

Machine Made Sand: Machine made sand will be acceptable, provided the constituent rock composition is sound, hard, dense, non-organic, uncoated and durable against weathering. Machine made sand shall be accepted provided grading and fine particle limits conform to IS 383.

Screening and Washing: Sand shall be prepared for use by such screening or washing or both, as necessary, to remove all objectionable foreign matter while separating the sand grains to the required size fractions. Sand with a silt content of more than 3 percent will not be used unless the same is washed and silt content is brought within 3% by weight.

Foreign Material Limitations: The percentages of deleterious substances in sand, delivered to the mixer shall not exceed the following:

	Foreign Material	Percent by weight	
		Uncrushed	Crushed
i)	Material finer than 75 micron IS sieve	3	15
ii)	Shale	1	---
iii)	Coal and lignite	1	1
iv)	Clay lumps	1	1
v)	Total of all above substances including items (i) to (iv) for uncrushed sand and items (iii) and (iv) for crushed sand	5	2

Gradation: Unless otherwise approved, the grading of sand shall be within the limits indicated. Where the grading falls outside the limits of any particular grading zone of sieves, other than the 600 micron (IS) sieve by not more than 5%, the grading shall be regarded as falling within that grading zone. This tolerance shall not be applied to percentage passing the 600 micron (IS) sieve or to percentage passing any other sieve size on the coarser limit of grading zone I or the finer limit of grading zone IV. Fine aggregates conforming to Grading Zone IV shall not be used unless mix designs and preliminary tests have shown its suitability for producing concrete of specified strength and workability.

IS Sieve Designation	Percentage passing for			
	Grading Zone I	Grading Zone II	Grading Zone III	Grading Zone IV
10 mm	100	100	100	100
4.75 mm	90-100	90-100	90-100	95-100
2.36 mm	60-95	75-100	85-100	95-100
1.18 mm	30-70	55-90	75-100	90-100
600 micron	15 - 34	35 - 59	60 - 79	80 - 100
300 micron	5 - 20	8 - 30	12 - 40	15 - 50

150 micron	0 - 10	0 - 10	0 - 10	0 - 15
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Fineness Modulus: The sand shall have a fineness modulus of not less than 2.2 or more than 3.2. The fineness modulus is determined by adding the cumulative percentages retained on the following IS sieve sizes (4.75 mm, 2.36 mm, 1.18 mm, 600 micron, 300 micron and 150 micron) and dividing the sum by 100.

3 Coarse Aggregate

Coarse aggregate for concrete, except as noted above and for other than light weight concrete, shall conform to IS 383. This shall consist of natural or crushed stone and gravel and shall be clean and free from elongated, flaky or laminated pieces, adhering coatings, clay lumps, coal residue, clinkers, sag, alkali, mica, organic matter or other deleterious matter.

Screening and Washing: Crushed rock shall be screened and/or washed for the removal of dirt or dust coating, if so required by the Employer's Representative.

Grading: Coarse aggregates shall be either single size or graded. The grading shall be within the limits on the table below. The aggregate pieces shall be angular in shape and shall have granular or crystalline surfaces.

Friable, flaky and laminated pieces, mica and shale, if present, shall be only in such quantities that will not, in the opinion of Employer's Representative, affect adversely the strength and/or durability of concrete.

The maximum size of coarse aggregate shall be the maximum size specified, but in no case greater than 1/4 of the minimum thickness of the member, provided that the concrete can be placed without difficulty to surround all reinforcement thoroughly and fill the corners of form.

Cobbles above 160 mm and up to any reasonable size can be used in plain mass concrete work of large dimensions up to a maximum limit of 20% by volume of concrete when specifically approved by the Employer's Representative.

For heavily reinforced concrete members, the nominal maximum size of the aggregate shall be 5 mm less than the minimum clear distance between the reinforcing main bars or 5mm less than the minimum cover to the reinforcement whichever is smaller. The amount of fine particles occurring shall not exceed 1% when determined by laboratory sedimentation tests as per IS 2386. After 24 hours immersion in water, a previously dried sample shall not have gained more than 10% of its oven dry weight in air, as determined by IS2386.

IS Sieve Design	Percentage passing for single sized aggregate of nominal size					Percentage passing for Graded aggregate of nominal size			
	40mm	20mm	16mm	12.5mm	10mm	40mm	20mm	16 mm	12.5mm
63 mm	100	--	--	--	--	100	--	--	--
40 mm	85 - 100	100	--	--	--	95 - 100	100	--	--
20 mm	0 - 20	85-100	100	--	--	30 - 70	95-100	100	--
16 mm	--	--	85-100	100	--	--	--	90-100	--
12.5 mm	--	--	--	85-100	100	--	--	--	90-100
10 mm	0 - 5	0 - 20	0 - 30	0 - 45	85-100	10 - 35	25 - 55	30 - 70	40 - 85
4.75 mm	--	0 - 5	0 - 5	0 - 10	0 - 20	0 - 5	0 - 10	0 - 10	0 - 10

2.36 mm	--	--	--	--	0 – 5	--	--	--	--
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16.2.11 Foreign Material Limitations: The percentages of deleterious substances in the coarse aggregate delivered to the mixer shall not exceed the following:

	Foreign Material	Percent by weight	
		Uncrushed	Crushed
i)	Material finer than 75 micronIS sieve	3	3
ii)	Coal and lignite	1	1
iii)	Clay lumps	1	1
iv)	Soft fragments	3	--
v)	Total of all the abovesubstances	5	5

• Water

Water for mixing concrete shall be clean and free from harmful impurities, such as silt, organic materials, acids, alkalis, salts and oils. In general the water used shall be of potable quality. In case of doubt, the suitability of water for making concrete shall be ascertained by the compressive strength and initial setting time test specified in IS 456 - 2000. The sample of water taken for testing shall be typical of the water proposed to be used for concreting with due account being paid to seasonal variations. The samples shall not receive any treatment before testing other than that envisaged in the regular supply of water proposed for use in concrete. The sample shall be stored in a clean container previously rinsed out with similar water.

Average 28 days compressive strength of at least three 150 mm concrete cubes prepared with water proposed to be used shall not be less than 90% of the average strength of three similar concrete cubes prepared with distilled water as per IS - 516.

The initial setting time of test blocks made with the cement and the water proposed to be used shall not be less than 30 minutes and shall not differ by more than (+/-) 30 minutes from the initial setting time of control test blocks prepared with the same cement and distilled water. The test blocks shall be prepared and tested in accordance with the requirements of IS 4031(Part 5).

Where water contains an excess of acid, alkali, sugar or salt, the Employer's Representative may refuse to permit its use. The following concentrations represent the maximum permissible values:

(i) Limits of acidity: To neutralize 100 ml sample of water, using phenolphthalein as an indicator, it should not require more than 5 ml. of 0.02 normal NaOH. The details of test shall be as per IS 3025 (Part 22)

(ii) Limits of alkalinity: To neutralize 100 ml sample of water, using mixed indicator, it should not require more than 25 ml. of 0.02 normal H₂SO₄. The details of test shall be as per IS 3025 (Part 23).

(iii) Limits for Solids: Permissible limits for solids in the water shall be as below:

Solids	Percent	Method of Test (ref IS : 3025)
Organics	0.02	10 and 11 (organic solids = total solids minus ignited residue)
Inorganics	0.30	11 (ignited residue)

Sulphates (as SO₄)	0.05	20
Alkali chloride (as Cl)	0.20	24
Suspended matter	0.20	12

- (iv) d) pH: The pH value of water shall be not less than 6.

• Admixtures

Admixtures may be used in concrete only with the approval of Employer's Representative based upon evidence that, with the passage of time, neither the compressive strength nor the durability will be reduced. When admixtures are used, the concrete mix design shall be amended accordingly. Admixtures shall be used as per manufacturers' instructions and in the manner and with the control as necessary or as specified by Employer's Representative.

The addition of admixtures during mixing to alter the properties of the concrete mix shall only be with the approval of the Employer's Representative in regard to quality, quantity and redesign of the mix and accompanied by separate preliminary tests.

Admixtures, if used, shall comply with IS 9103. Previous experience with and data on such materials should be considered in relation to the likely standards of supervision and workmanship to the work being specified. Admixtures should not impair durability of the concrete or combine with the constituent to form harmful compounds or increase the risk of corrosion of reinforcement.

The workability, compressive strength and the slump loss of concrete with and without the use of admixtures shall be established during the trial mixes before use of admixtures.

The relative density of liquid admixtures shall be checked for each drum containing admixtures and compared with the specified value before acceptance.

The chloride content of the admixtures shall be independently tested for each batch before acceptance. If two or more admixtures are used simultaneously in the same concrete, mix data should be obtained to assess their interaction and to ensure their compatibility.

1 Calcium Chloride

Calcium chloride shall not be used for accelerating the setting of the cement for any concrete containing reinforcement or embedded steel parts.

2 Air Entraining Agents

Neutralized vinsol resin or any other approved air entraining agent may be used to produce the specified amount of air in the concrete mix and these agents shall conform to the requirements of ASTM standard 6.260, Air Entraining Admixtures for Concrete if approved by the Employer's Representative. The recommended total air content of air entrained concrete is 4% (+/-) 1%. The method of measuring air content shall be as per IS1199.

3 Retarding Admixtures

Where prior approval has been given by the Employer's Representative, retarding agents may be added to the concrete mix in quantities in accordance with the manufacturer's recommendations.

4 Water Reducing Admixtures

Where prior approval has been given by the Employer's Representative, water reducing

lignosulfonate mixture shall be added in quantities in accordance with the manufacturer's recommendations. The admixtures shall be added in the form of a solution.

5 Waterproofing Agents

Where prior approval has been given by the Employer's Representative, chloride and sulphate free waterproofing agents shall be added in quantities in accordance with the manufacturer's recommendations.

6 Other Admixtures

The Employer's Representative may, at his discretion, approve the Contractor to use any other admixture in the concrete.

• Fly Ash

The fly ash should have consistent quality satisfying the requirements of IS 3812 Parts I and II.

The source of fly ash should be so selected that test results of fly ash samples collected from these sources during last one year at a frequency of maximum one month intervals should satisfy the requirements of above codes.

The characteristics of fly ash to be used shall be as per the above two codes for each batch of fly ash.

If more than 15% fly ash is used, IS 3812 shall apply and specific care shall be taken in terms of curing, protecting, repairing, finishing, de-shuttering etc as detailed in Section 13.6.2

• Materials Testing

The Employer's Representative shall have the right to inspect the sources of materials, the layout and operation of procurement and storage of materials, the concrete batching and mixing equipment and the quality control system. The Contractor shall arrange such an inspection and the Employer's Representative approval shall be obtained prior to starting any concrete work.

The Employer's Representative, if he so requires, may order tests to be carried out, at the Contractor's expense, on cement, sand, coarse aggregate, water etc in accordance with the relevant Indian Standards.

• Tests on Cement

Tests on cement shall include (i) fineness tests, (ii) tests for normal consistency, (iii) tests for setting time, (iv) tests for soundness, (v) tests for compressive strength, (vi) tests for heat of hydration (by experiment and by calculations) in accordance with IS269.

• Tests on Sand

Tests on sand shall include (i) sieve tests, (ii) tests for organic impurities, (iii) decantation tests for determining clay and silt content, (iv) specific gravity tests, (v) tests for unit weight and bulkage factor, (vi) tests for sieve analysis and fineness modulus.

• Tests on Aggregate

Aggregates shall be tested before and after the concrete mix is established and when ever there is a change of the source or character of the materials.

Sampling of the aggregates for mix design and determination of suitability shall be taken under the supervision of the Employer's Representative and delivered to the laboratory, well in

advance of the schedule for placing of concrete. Records of tests which have been made on proposed aggregates and on concrete made from this source of aggregates shall be furnished to the Employer's Representative in advance of the work for which it is to be used, in determining suitability of the proposed aggregate.

Tests on coarse aggregate shall include (i) sieve analyses, (ii) specific gravity and unit weight of dry, loose and rodded aggregate, (iii) soundness and alkali aggregate reactivity, (iv) petrographic examination, (v) deleterious materials and organic impurities, (vi) tests for aggregate crushing value.

Additional tests on aggregates would normally only be carried out if the Employer's Representative feels the materials are not in accordance with the specifications or if the specified concrete strengths are not obtained and shall be performed by the Contractor, at the Contractor's expense, at an approved test laboratory.

• Tests on Water Stops

The water stops shall be tested in accordance with the Central Water Commission (India) standards and shall have the following properties:

Sl. No.	Characteristic / Property	Specified Requirement
1	Tensile Strength	116 kg/cm ² minimum (162 kg/cm ² minimum for rubber)
2	Ultimate Elongation	300% minimum (500% minimum for rubber)
3	Tear Resistance	49 kg/cm ² minimum
4	Stiffness in Flexure	25 kg/cm ² minimum
5	Accelerated Extraction Strength	105 kg/cm ² minimum (150 kg/cm ² minimum for rubber)
6	Ultimate Elongation (after extraction)	250% minimum (350% minimum for rubber)
7	Effect of Alkali (7 days) - Weight Increase	0.25% maximum
8	Effect of Alkali (7 days) - Weight Decrease	0.10% maximum
9	Effect of Alkali (7 days) - Hardness Change	+5 points maximum
10	Effect of Alkali (28 days) - Weight Increase	0.40% maximum
11	Effect of Alkali (28 days) - Weight Decrease	0.30% maximum
12	Effect of Alkali (28 days) - Dimensional Change	+1% maximum

• Concrete Grades

The concrete used on the works of this project shall be of one of the following grades:
Minimum Crushing Strength of 150 mm cube at 28 days. N/mm^2

Grade	Preliminary and Trial Mix Tests	Work Tests
M-100	135	100
M-150	200	150
M-200	260	200
M-250	320	250
M-300	380	300
M-350	440	350

1 The characteristic strength is defined as the strength of material below which not more than 5% of the test results are expected to fall.

2 In the designation of a concrete mix, the letter M refers to the mix and the number to the specified characteristic compressive strength of 150 mm size cubes at 28 days expressed in N/mm^2 .

All concrete used on the work shall be dense, sound, homogeneous and durable and free from air voids, bleeding, honeycombing and other allied defects. For grade M-100 the Contractor may be allowed to use an approved nominal mix but for all other grades of concrete, mix designs are obligatory and preliminary test results shall be submitted to the Employer's Representative for approval before the commencement of concreting.

Mixes designed with ordinary Portland cement shall be redesigned if Pozzolona or other cement is to be used. In any event, whether Pozzolona or other cement is used or not, new mix designs shall be submitted for the Employer's Representative's approval for each new batch of cement that is received. To enable this, the cement stocks shall be so stored as to enable easy identification of different batches. Similarly, new mix designs will be required if the source of supply of aggregate is changed or a variation exceeding 10 percent in the sieve analysis is observed from the analysis of the aggregate used in the mix design.

• Standard Deviation

The standard Deviation for each grade of concrete shall be calculated separately.

Standard Deviation Based on Test Results

Number of test results - The total number of test results required to constitute an acceptable record for calculation of standard deviation shall be not less than 30. Attempts should be made to obtain the 30 test results, as early as possible, when a mix is used for the first time.

Standard deviation to be brought up to date - The calculation of the standard deviation shall be brought up to date after every change of mix design and at least once a month.

Determination of standard deviation:

(i) Concrete of each grade shall be analysed separately to determine its standard deviation.

(ii) The standard deviation of concrete of a given grade shall be calculated using the following formula from the results of individual tests of concrete of that grade obtained as specified for test strength of

sample:

(iii) Estimated standard deviation

(iv) Where = Deviation of the individual test strength from the average strength of a sample and n = Number of sample test results.

(v) When significant changes are made in the production of concrete (for example changes in the materials used, mix design, equipments or technical control), the standard deviation value shall be separately calculated for such batches of concrete.

Where sufficient test results for a particular grade of concrete are not available, the value of standard deviation given in the table below may be assumed for a design of mix in the first instance. As soon as the results of samples are available, actual calculated standard deviation shall be used and the mix designed properly. However, when adequate past records for a similar grade exist and justify to the designer a value of standard deviation different from that shown in table below, it shall be permissible to use that value.

Grade of Concrete	Assumed standard Deviation N/mm ²
M 10	3.5
M 15	
M 20	4.0
M 25	
M 30	5.0
M 35	
M 40	
M 45	
M 50	

1 Note: The above values correspond to the site control having proper storage of cement: weigh batching of all materials: controlled addition of water: regular checking of all materials: aggregate grading and moisture content: and periodical checking of workability: and strength. Where there is a deviation from the above, the values given in the above table shall be increased by 1 N / mm².

Mix Designs

The quality of materials and method and control of manufacture and transportation of all concrete work in respect of a mix, whether reinforced or otherwise, shall be Design Mix Concrete as defined in IS 456-2000 and conform to the applicable portions of these specifications.

The different concrete mixes shall be designed by the Contractor for strength, workability and durability of the concrete and shall be strictly in compliance with the relevant standards. If it is found that an increase in the proportion of cement is necessary, the requisite adjustment shall be made. Batching shall be by weight and the combined aggregate shall have a continuous grading. The mixes should produce an average 28 day cube strength not less than that specified in this document for trial mix tests for the relevant grade. In the case of concrete for water retaining structures, the cement content shall be a minimum of 350 kg/m³ of concrete. When admixtures are used, the mixes shall be redesigned with the test strengths conforming to those specified in this document. The workability of the mix shall permit satisfactory compaction with vibration, with no tendency to aggregate during handling, transporting and compaction.

In exceptional cases, where the reinforcement is so crowded that the compaction is difficult, the value of slump may be increased with the explicit approval of the Employer's Representative, but in no case shall it exceed 15 cm. Any increase in the slump beyond the values given shall be obtained by the use of additional cement in such quantities as to restrict the water-cement ratio

to the maximum specified values. Special care shall be taken in the case of M-25 concrete where the water-cement ratio should not exceed 0.45 under any circumstances.

The minimum cement content for Design Mix Concrete shall be as per Appendix-A of IS:456 or as given below(as per government of gujarat circular), whichever is higher in kg/m³ :

Grade	Minimum Cement Contentr (Kg/m³) of concrete
M-15	290
M-20	360
M-25	380
M-30	410
M-35	425

Cement content prescribed in this table is irrespective of the grades of cement and it is inclusive of additions stated in mineral admixtures. The additions of such as fly ash or ground granulated blast furnace slag may be taken into account in the concrete composition with respect to the cement content and water-cement ratio if the suitability is established and as long as the maximum amounts taken into account do not exceed the limit of pozzolona and slag specified in IS 1489 (Part 1) and IS 455 respectively.

Minimum grade for plain concrete under mild exposure condition is not specified.

Adjustment of Minimum Cement Content

The adjustments to minimum cement contents should be made for aggregates other than 20 mm nominal maximum size as shown in the table below:

No.	Nominal maximum aggregate size mm	Adjustments to Minimum cement content Kg/m³
1	10	+40
2	20	0
3	40	-30

For concrete of compressive strength greater than M-55 given design parameters may not be applicable and the values may be obtained from specialized literature and experimental results. The mix shall be designed to produce the grade of concrete having the required workability and characteristic strength not less than the appropriate values given in the table above.

• Degree of Control

Selection of Water Cement Ratio: Since different cements and aggregates of different maximum size, grading, surface texture, shape and other characteristics may produce concretes of different compressive strength for the same free water cement ratio, the relationship between strength and free water-cement ratio should be established for the materials actually to be used. In the absence of such data, the preliminary free water-cement ratio (by mass) corresponding to the target strength at 28 days may be selected from the relationship shown in Fig.1 of IS 10262 .

Alternatively, the preliminary free water cement ratio (by mass) corresponding to the target average strength may be selected from the relationship in Fig.2- IS 10262, using the curve corresponding to the 28 day cement strength to be used for the purpose.

Other relevant items to be used with design of mix should strictly conform to the relevant clauses and appendices of IS 10262.

The calculated mix proportions shall be checked by means of trial batches as per IS 10262.

The free water cement ratio, selected as above, should be checked against the limiting water cement ratio for the requirement of durability and the lower of the two values should be adopted.

Whenever there is a change either in required strength of concrete or water cement ratio or workability or the source of aggregates and/or cement, fresh tests shall be carried out to determine the revised proportion of the mix to suit the altered conditions. While designing mix proportions, over-wet mixes shall always be avoided.

While fixing the value for water cement ratio for the design mix, assistance may be derived from the standard graph showing the relationship between the 28 day compressive strength of concrete mixes with different water-cement ratios and the 7 day compressive strength of cement tested in accordance with IS269.

It will be the Contractor's sole responsibility to establish the concrete mix designs for different grades of concrete required in the work consistent with the workability required for the nature of work and also taking into consideration the assumed standard deviation to be expected at the site or by establishing the standard deviation based on 30 test results for each grade of concrete to produce concrete of the required strength, durability and surface finish. The materials and proportions used in making the tests to be carried out either at site or under laboratory conditions shall be similar in all respects to those to be actually employed in the works, as the object of these tests is to determine the proportions of cement, aggregates and water necessary to produce the concrete of the required consistency to give such specified strength.

• **Proportioning**

1 Aggregate

The proportions to be determined by conducting preliminary tests, shall be by weight. These proportions of cement, fine and coarse aggregates shall be maintained during subsequent concrete batching by means of weigh batchers conforming to IS 2722, capable of controlling the weights within one percent of the desired value. Except where it can be shown to the satisfaction of the Employer's Representative, that supply of properly graded aggregate of uniform quality can be maintained over the period of work, the grading of aggregate shall be controlled by obtaining the coarse aggregate in different sizes and blending them in the right proportions. The different sizes shall be stacked in separate stockpiles. The gradings of coarse and fine aggregates shall be checked as frequently as practicable, as determined by the Employer's Representative, to ensure maintaining of grading in accordance with samples used in the preliminary mix design. The materials shall be stockpiled well in advance of use.

2 Cement

The cement shall be measured by weight. Every facility should be provided to the Employer's Representative for sampling and inspection of stored cement at the site.

3 Water

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

Definition of water cement ratio

The water cement (W/C) ratio is defined as the weight of water in a mix (including the surface

moisture of the aggregates) divided by the weight of the cement in the mix.

Water cement ratio

The actual water cement ratio to be adopted shall be determined in each instance by the Contractor and approved by the Employer's Representative.

Proportioning By Water-Cement Ratio

The W/C ratios as approved by the Employer's Representative shall be maintained. Contractor shall determine the water content of the aggregate as frequently as approved by the Employer's Representative as the work progresses and as specified in IS 2386 part III and the amount of mixing water added at the mixer shall be adjusted as approved by the Employer's Representative to maintain the specified W/C ratio. To allow for the variation in their moisture content, suitable adjustments in the weights of aggregates shall also be made.

4 Concrete in Alkali Soils, Water & Aggregates

Some aggregates containing particular varieties of silica may be susceptible to attack by alkalis (Na_2O and K_2O) originating from cement and other sources, producing an expansive reaction which can cause cracking and disruption of concrete. Damage to concrete from this reaction will normally only occur when all the following are present together.

- A high moisture level, within the concrete;
- A cement with high alkali content, or another source of alkali;
- Aggregate containing an alkali reactive constituent.

Where the service records of particular cement / aggregate combination are well established and do not include any instances of cracking due to alkali-aggregate reaction, no further precautions should be necessary. When the materials are unfamiliar, precautions should take one or more of the following forms:

- 1 Use of non-reactive aggregate from alternate sources
- 2 Use of low alkali ordinary Portland cement having total alkali content not more than 0.6 per cent (as Na_2O equivalent).

Further advantages can be obtained by the use of fly ash (Grade I) conforming to IS 3812 or granulated blast furnace slag conforming to IS 12089 as part replacement of ordinary Portland cement (having total alkali content as Na_2O equivalent not more than 0.6 percent), provided that the fly ash content is at least 20 % or slag content is at least 50 %.

- i) Measures to reduce the degree of saturation of the concrete during service such as the use of impermeable membranes
- ii) Limiting the cement content in the concrete mix and thereby limiting total alkali content in the concrete mix as approved by the Employer's Representative.

5 Chlorides in the Concrete

Whenever there are chlorides in concrete, there is an increased risk of corrosion to the embedded metal. The higher the chloride content, and if subsequently exposed to warm moist conditions, the greater the risk of corrosion. All constituents may contain chlorides and concrete may be contaminated by chlorides from the external environment. To minimise the chance of deterioration of concrete from harmful chemical salts, the levels of such harmful salts in concrete materials, as well as by diffusion from the environment should be limited. The total amount of chloride content (as Cl) in the concrete at the time of placing shall be as given below

in the table.

Sl. No.	Type / Use of Concrete	Maximum Total Acid-Soluble Chloride Content (expressed as kg/m ³ of concrete)
1	Concrete containing embedded metal and steam-cured at elevated temperature, and Prestressed Concrete	0.40
2	Reinforced Concrete or Plain Concrete containing embedded metal	0.60
3	Concrete not containing embedded metal or any material requiring protection from chloride	3.00

The total acid soluble chloride content should be calculated from the mix proportions and the major chloride contents of each of the constituents. The total chloride content of the concrete should be determined to the approval of the Employer's Representative.

6 Sulphates in concrete

Sulphates are present in most cements and in some aggregates. Excessive amounts of water-soluble sulphate from these or other mix constituents can cause expansion and disruption of concrete. To prevent this, the total water-soluble sulphate content of the concrete mix, expressed as SO₃, should not exceed 4 % by mass of the cement in the mix. The sulphate content should be calculated as the total from the various constituents of the mix to the approval of the Employer's Representative.

The 4 % limit does not apply to concrete made with super sulphated cement complying with IS 6909 or as otherwise approved by the Employer's Representative.

• Consistency and slump

Concrete shall be of a consistency and workability suitable for the conditions of the job. After the amount of water required is determined, the consistency of mix shall be maintained throughout the progress of the corresponding parts of the work and approved tests e.g. slump tests, compacting factor tests etc in accordance with IS 1199, which shall be conducted from time to time to ensure the maintenance of such consistency.

The following tabulation gives a range of workability which shall generally be used for various types of construction unless otherwise instructed by the Employer's Representative.

Sl. No.	Placing Condition	Degree of Workability	Slump (mm)
1	Blinding concrete; shallow sections; pavements using pavers	Very Low	<i>See Note 1</i>
2	Mass concrete; lightly reinforced sections in slabs, beams, walls, columns; floors; hand-placed pavements; canal linings; strip footings	Low	25 – 75

Sl. No.	Placing Condition	Degree of Workability	Slump (mm)
3	Heavily reinforced sections in slabs, beams, walls, columns; slip-form work	Medium	50 – 100
4	Pumped concrete	Medium	75 – 100
5	Trench fill; in-situ piling	High	100 – 150
6	Tremie concrete	Very High	See Notes

13 For most of the placing conditions, internal vibrators (needle vibrators) are suitable. The diameter of the needle shall be determined based on the density and spacing of reinforcement bars and thickness of sections. For tremie concrete, vibrators are not required to be used.

14 The 'very low' category of workability where strict control is necessary, for example pavement quality concrete, measurement of workability by determination of compacting factor will be more appropriate than slump (see IS 1199) and a value of compacting factor of 0.75 to 0.80 is suggested.

15 In the 'Very high' category of workability, measurement of workability by determination of flow will be appropriate (see IS 9103).

When tested in accordance with IS 1199, the consistency of the concrete should be such that the maximum slumps, unless otherwise specified or permitted by the Employer's Representative do not exceed the following values.

Sl. No.	Part of Structure	Maximum Slump (mm)
1	Footings and unreinforced mass concrete	76
2	Slabs and floors	76
3	Columns and walls over 200 mm thick	102
4	Walls up to 200 mm thick	102
5	Equipment bases	127

• Batching

To avoid confusion and error in batching, consideration shall be given to using the smallest practical number of different concrete mixes on any site or in any one plant. In batching concrete, the quantity of both cement and aggregate shall be determined by mass; admixture, if solid, by mass; liquid admixture may however be measured in volume or mass; water shall be weighed or measured by volume in a calibrated tank (see also IS4925).

For large and medium project sites, concrete shall be sourced from ready-mixed concrete plants or from on-site or off-site batching and mixing plants (see IS 4926).

Except where it can be shown to the satisfaction of the Employer's Representative that supply of properly graded aggregate of uniform quality can be maintained over a period of work, the grading of aggregate should be controlled by obtaining the coarse aggregate in different sizes and blending it in the right proportions when required, the different sizes being stocked in

separate stockpiles.

The accuracy of the measuring equipment shall be within $\pm 2\%$ of the quantity of cement being measured and within $\pm 3\%$ percent of the quantity of aggregate, admixtures and water being measured.

Volume batching shall be allowed only where weigh-batching is not practical and provided accurate bulk densities of materials to be used in concrete have already been established. Allowance for bulking shall be made in accordance with IS 2386 (Part 3). The mass volume relationship shall be checked as frequently as necessary, the given frequency being subject to the approval of the Employer's Representative to ensure that the specified grading is maintained.

The water-cement ratio shall be maintained at its correct value. To this end, determination of the moisture content in both the fine and coarse aggregates shall be made as frequently as possible, the given frequency being subject to the approval of the Employer's Representative according to weather conditions. The amount of the added water shall be adjusted to compensate for any observed variations in the moisture content. For the determination of moisture content in the aggregates IS 2386 (Part 3) shall be followed. To allow for the variation in the mass of aggregate due to variation in its moisture content, suitable adjustments in the masses of aggregates shall also be made. In the absence of exact data, and in the case of nominal mixes the amount of surface water may be estimated from the values given in table below.

Sl. No.	Aggregate Condition	Approximate Quantity of Water(Percent by Mass)	Approximate Surface Water(litres per m^3)
1	Very wet sand	7.5 %	120
2	Moderately wet sand	5.0 %	80
3	Moist sand	2.5 %	40
4	Moist gravel or crushed rock	1.25 - 2.5 %	20 - 40

No substitutions in materials used on the work or alterations in the established proportions except as permitted as above shall be made without additional tests to show that the quality and strength of concrete are satisfactory.

• Mixing

Concrete shall be mixed in a mechanical mixer. The mixers shall comply with IS 1791 and IS 12119. The mixers shall be fitted with water measuring devices. The mixing shall be continued until there is a uniform distribution of the materials and the mass is uniform in colour and consistency. If there is segregation after unloading from the mixer, the concrete shall be remixed.

The mixing time shall be at least two minutes. For more efficient mixers, manufacturer's recommendations shall be followed.

The dosage of retardants, plasticizers and super-plasticizers shall be restricted to 0.5, 1.0 and

2.0 % respectively by weight of cementations materials unless a higher value is agreed between the manufacturer and the Contractor based on performance tests.

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

1 Cast-in-Place (In-Situ) Concrete

- **Execution**

1 Preparation for Placing

All excess water shall be removed from the forms before concrete is placed. No flow of water shall be admitted to the section being concreted. The interior faces of forms shall be cleaned and any hard concrete, debris or foreign material shall be removed. The inner faces of the mixing and conveying equipment shall be similarly cleaned.

Reinforcement shall be secured, inspected and approved in compliance with the relevant specifications and shall be inspected and approved. Embedded metal shall be clean and free of old mortar, oil, mill scale and other encrustations and coatings. Wheeled concrete handling equipment shall pass over reinforcement nor shall walkways be supported on reinforcement.

Any earth sub-grade on which concrete is to be deposited shall be wetted lightly 24 hours in advance of concreting but not muddled. Re-rolling shall be carried out, where necessary, to create a smooth surface and all loose materials removed.

Where placement of concrete is directly onto a rock base, the rock surface shall be cleaned and washed and loose material removed with air blower or hosed before concreting. All stagnant water collected on the rock surface shall be removed before concreting.

Where a bond between old and new concrete surfaces is required, the steps and precautions stipulated for construction joints shall be adopted. Where no bond is necessary, the existing surface shall be cleaned, removing any dirt or deleterious material which might interfere with the concreting.

Before concrete is poured, the inside of the formwork shall be inspected to ensure that it has been cleaned and oiled. Temporary openings shall be provided where necessary to facilitate inspection, especially at the bottom of columns and wall forms, to permit removal of sawdust, wood shavings, binding wire, rubbish, dirt etc. Openings shall be placed or holes drilled so that these materials and water can be removed easily. Such openings / holes shall be later suitably plugged.

The Contractor shall install drainage and plumbing lines, floor and trench drains, conduits, hangers, anchors, inserts, sleeves, bolts, frames and other miscellaneous embedment to be cast in the concrete as necessary for the proper execution of the work. All such embedment shall be correctly positioned and securely held in the forms to prevent displacement during the depositing and vibrating of concrete.

Slots, openings, holes, pockets etc shall be provided in the concrete work in the positions as necessary.

Prior to concrete placement, all works shall be inspected and approved by Employer's Representative and if found unsatisfactory, concrete shall not be poured until all defects have been corrected.

Approval by the Employer's Representative of any and all materials and work as required herein shall not relieve contractor from his obligations to produce finished concrete in accordance with the Contract.

2 Foundation Bedding and Jointing

All surfaces upon or against which concrete will be placed shall be suitably prepared by thoroughly cleaning, washing and dewatering to meet the various situations encountered in the work.

Soft or spongy areas shall be dug out and back-filled with either a soil cement mixture, lean concrete or clean sand fill compacted to a minimum density of 90% modified Proctor.

3 Preparation of Rock Strata of Foundations

To provide a tight bond with rock foundations, the rock surface shall be prepared and the following general requirements shall be observed:

Concrete shall not be deposited on large sloping rock surfaces. Where required, the rock shall be cut to form rough steps or benches to provide roughness or a more suitable bearing surface.

Rock foundation stratum shall be prepared by picking, barring, wedging or similar methods which will leave the rock in an entirely sound and un-shattered condition.

Shortly before concrete is placed, the rock surface shall be cleaned with high pressure water and air jet even though it may have been previously cleaned in that manner.

Prior to placing concrete, the rock surface shall be kept wet for a period of at least two hours unless otherwise approved by the Employer's Representative.

Before placing concrete on rock surfaces, all water shall be removed from depressions to permit thorough inspection and proper bonding of the concrete to the rock.

4 Preparation of Earth Strata of Foundations

All earth surfaces upon which or against which concrete is to be placed, shall be well compacted and free from standing water, mud or debris. Soft, yielding soils shall be removed and replaced with suitable earth and well compacted and as approved by the Employer's Representative. Where specified, lean concrete shall be placed on the earth stratum for receiving concrete. The surface of absorptive soil against which concrete is to be placed shall be moistened thoroughly.

5 Preparation of Concrete Surfaces

Preparation of concrete surfaces upon which additional concrete is to be placed, shall be scarified and cleaned while the concrete is between its initial and final set. This method shall be used wherever practicable and shall consist of cutting the surface with picks and stiff brooms and by use of an approved combination of air and water jet and as approved by Employer's Representative. Great care shall be taken in performing this work to avoid removal of too much mortar and the weakening of the surface by loosening of aggregate. When it is not practicable to follow the above method, air tools shall be employed to remove laitance and roughen the surface.

The required final result shall be a pitted surface from which all dirt, unsound concrete, laitance and glazed mortar have been removed.

6 Cleaning and Bonding of Formed Construction Joints

Vertical construction joints shall be cleaned as specified above or by other methods and as

approved by Employer's Representative. In placing concrete against formed construction joints, the surfaces of the joints, where accessible, shall be coated thoroughly with the specified bed- joint bonding mortar immediately before being covered with concrete or by scrubbing with wire brushes, dipped into the fresh concrete. Where it is impracticable to apply such a mortar coating, special precautions shall be taken to ensure that the new concrete is brought into intimate contact with the surface of the joint with the aid of vibrators and other suitable tools.

7 Positioning of Water Stops

Water stops shall be provided in the available maximum lengths and as far as possible, jointing shall be avoided. All joints, when unavoidable, shall be field jointed for water tightness as per manufacturer's specifications.

The water stops shall be positioned with suitable temporary supports to render adequate rigidity to the water stops while concreting. The exposed surfaces of water stops revealed after first concreting shall be cleaned thoroughly of all the droppings, mortar splashings etc before the next pour of concrete.

8 Bonding Treatment (Mortar)

All rock or concrete surfaces upon which new concrete is to be placed shall be scarified, cleaned and wetted as specified herein.

Immediately prior to placing new concrete, the scarified surface of the existing concrete shall be thoroughly wetted.

9 Cleaning of Equipment

All equipments used for mixing, transporting and placing of concrete shall be maintained in clean condition. All pans, buckets, hoppers, chutes, pipe lines and other equipments shall be thoroughly cleaned after each period of placement.

10 Conveying and Placing Concrete

Concrete shall be poured or placed only after the forms and reinforcement have been inspected and approved, for which purpose the Contractor shall give the Employer's Representative at least two day's notice. Generally, the use of aluminium equipment shall not be permitted in any operation where the equipment and concrete are likely to come in contact with each other, unless the aluminium surfaces have to be adequately treated to prevent reaction with and having a harmful effect on the concrete.

All buckets, containers or conveyers used for transporting concrete shall be mortar-tight. All means of conveyance shall be adopted to deliver concrete of the required consistency and plasticity without segregation or loss of slump whatever method of transportation is employed. Chutes shall not be used to transport the concrete without the approval of the Employer's Representative and concrete shall not be re-handled before placing.

Conveying - Concrete shall not be released from a mixer, hopper, frame or other conveyance or device through a height exceeding two metres or through reinforcement, in a manner likely to cause segregation. Tremmies discharging close to the point of concreting shall be provided as required. The use of chutes will be restricted to specific locations approved by the Employer's Representative. Concrete shall be deposited directly into the conveyance and

from the conveyance directly into the locations in the structure. Deposition of concrete shall be so done to maintain, as far as possible, a level surface throughout. Manual labour may be used for conveying and placing mixed concrete provided the above requirements are not contravened.

Placing Concrete - Concrete shall be placed in position and compacted within 30 minutes after the first addition of water to the mix and no concrete showing signs of initial set shall be used. Re-tampering of set concrete is prohibited.

- **Lifts:** Concrete shall be poured into forms after mixing in a manner that will prevent segregation of the ingredients and in horizontal layers not exceeding 2,000 mm thick.

a Walls: Concrete for walls of water retaining structures, including tank exterior walls, shall be poured, where practicable, as one continuous operation from footing to top of the wall. Each section shall be left in place at least seven days before the adjoining section in similarly concreted.

b Slabs: Concrete between approved joints shall be poured in one continuous operation in checker-board fashion and shall be allowed to stand at least seven days before adjoining sections are concreted.

c Concreting of beams and slabs shall be continuous and monolithic with the floor.

- **Pumping Concrete:** No increase in the water-cement ratios or specified slumps will be permitted to pumped concrete. The minimum conveyance tube shall be minimum diameter of 100 mm and capable of maintaining the specified pour rates.

- **Pour Rules:**

a Vertical Elements: concrete shall be placed in lifts as specified at a rate that does not cause excessive stresses in the formwork or a hardening of the top layer before next lift is poured.

b Slabs :Concrete shall be poured at an appropriate time that ensures that all new concrete poured is adjoined to concrete that is still plastic and before the initial set of the previous placing.

c Construction Joints: Concreting adjoining a construction joint shall not be until the existing surface has been cured for at least seven days, unless otherwise approved by the Employer's **Representative**.

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

11 Time Interval between Mixing and Placing

Concrete shall be placed in its final position before the cement reaches its initial set and concrete shall normally be compacted in its final position within thirty minutes of leaving the mixer and once compacted, it shall not be disturbed. On no account shall water be added after the initial mixing. Concrete which has become stiff or has been contaminated with foreign materials shall be rejected.

12 Avoiding Segregation

Concrete shall, in all the cases, be deposited as nearly as practicable directly in its final position and shall not be re-handled or caused to flow in a manner which will cause

segregation, loss of material, displacement of reinforcement, shuttering or embedded inserts or impair its strength. For locations where direct placement is not possible and in narrow forms, the Contractor shall provide suitable props and discharge pipes to confine the movement of concrete. Special care shall be taken when concrete is dropped from a height, especially if reinforcement is in the way, particularly in columns and thin walls.

13 Placing by Manual Labour

Except as otherwise approved by Employer's Representative, concrete shall be placed using approved implements and shall not be dropped from a height of more than 2.0 m or handled in a manner which will cause segregation.

14 Placing by Mechanical Equipment

The following specifications shall apply when placing of concrete by use of mechanical equipment is specially called for or is warranted, considering the nature of work involved.

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

All concrete shall be conveyed from the mixer to the place of final deposit in suitable buckets, dumpers or containers which shall be leak-tight. All means of conveyance shall be adopted for delivering concrete to the required consistency/ workability and plasticity without segregation.

Central bottom-opening buckets of a type that provides for positive regulation of the amount and rate of deposition of concrete shall be employed.

In placing concrete in large open areas, the buckets shall be located directly over the position designated and then lowered for dumping. The open bucket shall remain clear of any concrete already in place and the height of drop shall not exceed 2.0 m. The bucket shall be opened slowly to avoid high vertical bounce. The placing of concrete in any manner which results in separation of ingredients or disturbance of previously placed concrete will not be permitted.

15 Placement in Restricted Forms

Concrete placed in restricted forms shall be subject to the requirements for vertical delivery of limited height to avoid segregation and shall be deposited as nearly as practicable in its final position.

16 Chuting

Where it is necessary to use transfer chutes, specific approval of the Employer's Representative must be obtained with regards to the type, length, slopes, baffles, vertical terminal and timing of operations. These shall be arranged so that almost continuous flow of concrete is obtained at the discharge and without segregation. To allow for the loss of mortar against the sides of the chutes, the first mixes shall have less coarse aggregate. During cleaning of chutes, the waste water shall be kept clear of the forms. The concrete shall not be permitted to fall from the end of the chutes by more than 1.0 m. Chutes, when approved for use, shall have slopes not flatter than 1 vertical to 3 horizontal and not steeper than 1 vertical to 2 horizontal. Chutes shall be metal and of rounded cross section. The

slopes of all chute sections shall be approximately the same. The discharge end of the chutes shall be maintained above the surfaces of the concrete in the forms.

17 Placing by Pumping/ Pneumatic Placers

Concrete may be conveyed and placed by mechanically operated equipment e.g. pumps or pneumatic placers, with the approval of Employer's Representative. The slump shall be held to the minimum, necessary for conveying concrete by this method.

When pumping is adopted, before pumping of concrete is started, the pipelines shall be lubricated with one or two batches of mortar composed of one part cement and two parts sand. The concrete mix shall be specially designed to suit pumping. Care shall be taken to avoid stoppages in work once pumping has started.

When pneumatic placing is used, the manufacturer's advice on the layout of pipelines shall be followed to avoid blockages and excessive wear. Restraint shall be provided at the discharge box to cater for the reaction at the end.

The manufacturer's advice shall be followed regarding concrete quality and all other related matters when pumping or pneumatic placing equipment is used.

18 Concrete in Layers

Concreting, once started, shall be continuous until the pour is completed. Concrete shall be placed in successive horizontal layers of uniform thickness ranging between 150 and 900 mm as approved by Employer's Representative. These shall be placed as rapidly as practicable to prevent the formation of cold joints or planes of weakness between each succeeding layer within the pour. The thickness of each layer shall be such that it can be deposited before the previous layer has stiffened. The bucket loads or other units of deposit, shall be located progressively along the face of the layer with such overlap to facilitate spreading the layer of uniform depth and texture with a minimum of shovelling.

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

19 Compaction

Effective compaction of newly placed concrete shall be obtained by vibration, agitation, spading and rodding the concrete within the forms. At least two vibrators in dependable working condition shall be available before commencement of concreting and kept in working condition during the scheduled concreting period, each under the charge of an experience workman.

All concrete, excepting slabs of thickness 10 cm or less, shall be compacted with high frequency, mechanical vibrating equipment supplemented by hand spading and tamping. Concrete slabs 10 cm or less in thickness shall be compacted by wood or metal tampers, spading and settling with a heavy levelling straight edged beam.

Vibrators shall be designed to operate with the vibrating element having a frequency of not less than 7000 impulses per minute. The equipment shall, at all times, be adequate, in terms of units and power, to consolidate the poured concrete. The depth of immersion shall be appropriate for the structure being concreted and the location of concreting.

The vibrators shall not touch the reinforcement. When vibrating a freshly placed layer, the vibrator shall be pushed down vertically into the preceding plastic layers and withdrawn

gradually, producing a dense concrete free of set concrete. The intervals at which the vibrator should be immersed shall not exceed 2/3 of the apparent effective area of vibration of the unit used. Excessive vibration and segregation of aggregates shall be avoided.

For concrete containing an approved retarding admixture for structural walls, each layer of concrete shall be in place and compacted for at least 30 minutes before the next layer is placed. Bleed water on the surface of the concrete shall be removed before additional concrete is placed and the concrete in place shall be re-vibrated before the next lift is placed. At the top of walls and columns, concrete containing excess water or fine aggregates caused by vibration shall be removed while still plastic and the space filled with compacted concrete of the correct proportion and vibrated in place.

20 Slabs

For slabs, screeds shall be set at maximum of 2.5 metres. Centres and the correctness of elevations shall be checked with an instrument level. The concrete shall be compacted and tamped to bring ten mm of mortar to the surface and wood floated to straight edges and screeds. The finished surfaces shall be level or sloped as required and the maximum deviation permissible being 6 mm from 3m straight edge for the exposed finishes. No steel or plastic floats shall be used for initial floating. Unless otherwise specified, special finishes shall be applied only after the surface has sufficiently hardened. All laitance and bleed water shall be removed as it appears.

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

21 Vibrators

Vibrators shall conform to IS specifications. The type of vibrators to be used shall depend upon the structure where concrete is to be placed. Shutter vibrators, to be effective, shall be firmly secured to the formwork which must be sufficiently rigid to transmit the vibrations and strong enough not to be damaged by it. Immersion vibrators shall have load frequency amplitude and acceleration as per IS 2505 depending on the size of the vibrator. Immersion vibrators, in sufficient numbers and each of adequate size shall be used to properly consolidate all concrete. Tapping or external vibrating of forms by hand tools or immersion vibrators will not be permitted.

The exact manner of application and the most suitable machines for the purpose shall be selected and be operated by experienced operatives. Immersion vibrators shall be inserted vertically at points not more than 450 mm apart and withdrawn when air bubbles cease to come to the surface. Immersion vibrators shall be withdrawn very slowly. In no case shall immersion vibrators be used to transport concrete inside the forms. Particular attention shall be paid to vibration at the top of lift in a column or wall.

When placing concrete in layers which are advancing horizontally as the work progresses, great care shall be exercised to ensure adequate vibration, blending and melding of the concrete between the successive layers.

Immersion vibrators shall penetrate the layer being placed and also penetrate the layer

below while the under layer is still plastic to ensure good bond and homogeneity between the two layers and prevent the formation of cold joints.

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

Form attached vibrators shall be used only with specific authorisation of Employer's Representative.

The use of surface vibrators will not be permitted under normal conditions. However, for thin slabs, surface vibration by specifically designed vibrators may be permitted, upon approval of Employer's Representative.

Formation of stone pockets or mortar ponding in corners and against faces of forms shall not be permitted. Should these occur, they shall be dug out, reformed and refilled to a sufficient depth and shape for thorough bonding as approved by Employer's Representative.

22 Placement Intervals

Each placement of concrete shall be allowed to set for a period of 48 hours or longer when required, before the start of subsequent placement. A time gap between the two adjoining pours in the horizontal plane and the two adjacent pours in the vertical plane shall be seven days and three days respectively.

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

23 Special Provision in Placing

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

24 Placing Concrete through Reinforcing Steel

When placing concrete through reinforcing steel, care shall be taken to prevent segregation of the coarse aggregate. Where the congregation of steel makes placing difficult, it may be necessary to temporarily move the top steel aside to get proper placement and then restore the reinforcing steel to design position.

25 Bleeding

Bleeding or free water on top of concrete being deposited into the forms shall require stopping the concrete pour and the conditions causing this shall be corrected before any further concreting is resumed.

26 Rain or Wash Water

No concrete shall be placed in wet weather or on a water covered surface. Any concrete that has been washed by heavy rain shall be entirely removed, if there is any sign of cement and sand having been washed away from the concrete mixture. To guard against damage which may be caused by rain, the works shall be covered with tarpaulins immediately after the

concrete has been placed and compacted before leaving the work unattended. Any water accumulating on the surface of the newly placed concrete shall be removed by approved means and no further concrete shall be placed thereon until such water is removed. To avoid water flowing over or around freshly placed concrete, suitable drains and sumps shall be provided.

27 Concreting in Hot Weather

The Contractor's methods shall comply with the recommendations ACI 305, Hot Weather Concreting, as modified and supplemented below.

The Contractor shall take great care during hot weather to prevent the cracking or crazing of concrete. The Contractor shall arrange for concrete to be placed in the early morning or late evening as directed by the Employer's Representative.

The Contractor shall have particular regard to the requirements specified herein for curing.

Formwork shall be shaded from direct exposure to the sun both prior to placing of the concrete and during its setting. The Contractor shall take appropriate measures to ensure that reinforcement in and projecting from the section to be concreted is maintained at the lowest temperature practicable.

Concrete at placing shall have a temperature of not more than 32 °C. If necessary, the Contractor shall cool the aggregates and mixing water by methods approved by the Employer's Representative.

Where necessary, the Contractor shall design, install and operate a cooling system by which cooling water is pumped through a piping system in order to decrease the heat of hydration during concreting. The proposal for such a cooling system shall be submitted to the Employer's Representative for his approval two weeks prior to the concreting operations.

The temperatures of ambient air, concrete at various levels and at intervals not exceeding 5 metres and cooling water where applicable shall be measured by means of thermocouples and recorded with a Philips type PR 3210 A/00 recorder or similar approved.

28 Placing of Concrete Under Water

Under all ordinary conditions all foundations shall be completely dewatered and concrete placed in the dry. However, when concrete placement under water is necessary, all work shall conform to IS 456 and procedure shall be as follows:

Concrete shall be deposited under water by means of tremies or bottom-drop buckets of approved type.

All work requiring placement of concrete underwater shall be designed, approved and inspected with regard to the local circumstances and purposes. All under water concrete shall be placed according to the specifications and as approved by the Employer's Representative.

29 Protection

All concrete shall be protected against damage.

30 Corrosion Resistant Lining

Where required, corrosion resistant linings shall be applied strictly according to the manufacturer's instructions. The work shall be performed by experienced personnel under

the supervision of a qualified representative of the manufacturer. The completed lining shall be securely bonded to the substrate and provide the required corrosion resistant protection.

31 Installation of Pipes, Electrical Conduits etc Through Concrete Structures

Wherever required, the Contractor shall install in place, before concreting, any pipe, electrical conduit or other special item that passes through or terminates at any concrete wall. Alternatively, the Contractor shall obtain the prior approval of the Employer's Representative of shop drawings of the methods he proposes to adopt, particularly if he intends to leave an opening and install the special item later

After approval that a special item may be concreted in later, the opening shall be accurately fashioned to receive it. Pipes passing through walls or floors of water retaining or earth supporting structures shall be provided with welded puddle flanges and the opening provided shall take this into account.

(i) The opening provided shall be of sufficient size to permit accurate final alignment of the embedded fitting without deflecting any part and allowing adequate space for satisfactory spacing where the pipe passes through openings so formed.

(ii) The box-outs shall be provided with continuous keyways to hold the concrete filling in place and ensure water-tightness.

(iii) The space left within the box-outs and around the special item positioned in place, shall be filled with non-shrink grout or non-shrink concrete as approved by the Employer's Representative.

32 Mass Foundations

Mass foundations shall be poured in lifts not exceeding 1.5 m. in height unless otherwise approved by Employer's Representative.

33 Treatment of Construction Joints on Resuming Concreting

All laitance and loose stones shall be thoroughly and carefully removed by wire brushing/hacking and surface washed.

Just before concreting is resumed, the roughened joint surface shall be thoroughly cleaned and loose matter removed and then thoroughly wetted. The new concrete shall be well worked specially against the prepared face. Special care shall be taken to obtain thorough compaction and to avoid segregation of the concrete along the joint plane.

34 Water

Clean water in pipes under pressure shall be provided by the contractor with all necessary equipment for giving a nozzle pressure of not less than 2.0 kg/cm² for the convenient and effective jetting of rock foundations and concrete surfaces, for cooling aggregate required for concrete, for curing concrete and other requirements.

35 Protecting Fresh Concrete

Fresh concrete shall be protected from the elements, from defacement and damage due to construction operations by leaving forms in place for ample periods. Newly placed concrete shall be protected by approved means, such as tarpaulins, from rain, sun and winds. Steps,

as approved by the Employer's Representative, shall also be taken to protect immature concrete from damage by debris, excessive loading, vibration, abrasion or contact with other materials or otherwise disturbed. If it is necessary that workmen enter the area of freshly placed concrete, bridges shall be placed over the area.

• **Concrete for Large Pours**

This clause applies to large concrete pours where measures need to be taken to deal with the generation of heat and attendant volume change to minimise cracking.

If available, coarse aggregate shall be of limestone or other aggregate with a low coefficient of thermal expansion and of angular shape.

Measures shall be taken to limit the effects of thermal movement in the concrete. The maximum temperature during hydration shall not exceed 65 °C.

The concrete mix may include an approved type of water reducing /workability admixture.

Form-work for the sides shall be of minimum 19 mm thick plywood or equivalent thermal resistant to ensure that the maximum specified thermal gradient is not exceeded during curing.

All formwork for pits, ducts, rebates and holding down bolts shall be constructed so that it can be easily collapsed to facilitate removal after the initial set of the concrete. The top of formwork for holes shall be covered to prevent entry of excess grout or other substances.

Standby plant shall be available for all plant used for the construction of the foundations. For compressors, vibrators, cranes, concrete pumps, lighting equipment and the like, standby plant shall be on site before concreting commences.

Concrete shall be placed in single pours lasting no more than 16 hours. The sequence of placing shall be such, that exposed concrete shall be covered with fresh concrete within one hour of first mixing of the exposed concrete. Re-compaction of the original with the fresh concrete shall be undertaken to ensure a homogenous mass without a cold joint.

The concrete shall be placed and compacted in such a manner as to ensure that cracking due to plastic settlement does not occur.

On completion of a pour, the top surface shall be steel trowel finished and the exposed concrete shall be sprayed with an approved curing compound. Space shall be arranged around the pour to allow the free flow of air during curing.

The poured concrete shall be protected if necessary with insulation to limit the thermal gradient between the core and the surface to below 20 °C. The pour shall contain thermocouples distributed within the concrete in accordance with the Contractor's design. The Contractor shall measure and record the internal and surface concrete temperatures daily until the formwork is stripped.

The formwork and insulation shall be left in place until the surface temperature is at the average ambient daily temperature.

The method statement for the construction of each large pour shall include the following information:

- Details of the mix design and source of supply.
- Full details of the formwork with particular reference to the installation of holding down bolt formers.
- Details of the placing procedure including method of placing, standby arrangements, number

of vibrators and number of supervisors and operatives.

- Details of insulation for the pours and how the pours are to be cured.
- Details of how the concrete is to be placed and compacted without cold joints and without cracking resulting from plastic settlement.

Within six weeks after construction of large pours, the Contractor shall issue a construction report containing full details of the construction, materials testing results and as-built drawings.

• **Concrete for Machine Foundations**

Design and construction of machine foundations shall be carried out in accordance with IS 2974.

After commissioning rotating machines, the Contractor shall carry out a full vibration survey to record the vibrations of the foundations. The results of the survey shall be submitted to the Employer's Representative.

• **Joints in Concrete**

(i) General

Provision shall be made for expansion and contraction in concrete by the use of special joints located as necessary. Construction joint surfaces shall be as specified or as approved by Employer's Representative.

Concrete shall be placed without interruption until completion of the part of the work between predetermined construction joints. The time lapse between the pouring of adjoining units shall be as specified or as approved by Employer's Representative.

Construction joints shall be avoided if possible or their number minimised. Concreting shall be carried out continuously up to construction joints the position and arrangement of which shall be indicated by the Contractor's designer. Construction joints shall comply with IS 11817.

Construction joints shall be placed at accessible locations to permit cleaning out of laitance, cement slurry and unsound concrete in order to create rough/uneven surface. Laitance and cement slurry shall be cleaned out by using wire brushes on the surface of the joint immediately after initial setting of the concrete. The prepared surface should be in a clean saturated surface dry condition when fresh concrete is placed against it. In the case of construction joints at locations where the previous pour has been cast against shuttering, the aggregate of the previously poured concrete shall be exposed using a high pressure water jet or by another appropriate means.

At least 3 weeks prior to commencement of concreting, the Contractor shall supply drawings to the Employer's Representative indicating all expansion or other movement joints both vertical and horizontal including details of the type of joint to be provided, the method of concreting, the concreting lifts to be achieved in a single continuous operation and any other relevant details. One copy of the drawing, approved or modified, shall be returned to the Contractor.

Expansion joints shall be indicated on the Contractor's drawings. The width of the joint shall generally be 13 mm. Except where synthetic rubber (sealant) sealed joints are specified, joint filler and joint sealer shall be provided, with the filler to between 13 mm and 19 mm from the concrete face and then the sealer finished flush with surface. At synthetic rubber

sealed joints, the filler shall be to 13 mm from the concrete face to receive sealant, unless otherwise specified.

All Construction joints shall be provided with suitable keyways or other keying methods. The old surface shall be roughened until the clean aggregate embedded in the mortar matrix is exposed, by chipping, sand-blasting or application of a surface mortar retardant followed by washing and scrubbing with a stiff brush. Reinforcement and water-stops shall be effectively protected. The prepared surface shall be kept wet for at least 24 hours before placing new concrete. Immediately prior to commencement of the new concreting, water shall be deposited on the prepared horizontal surface of the old concrete. If water-stops are not used, the coarseness amplitude of the prepared surface shall be at least 6 mm.

Roof and floor slabs shall be poured in alternating checker-board fashion between approved construction joints. Concreted sections shall be fully cured before adjoining sections are concreted. All construction joints in floor slabs and rafts shall be painted with a 230 mm wide strip of bitumen paint to be applied in two thick layers.

Fresh concrete should be thoroughly vibrated near construction joints so that mortar from the new concrete flows between large aggregates and develops a proper bond with old concrete.

Where high shear resistance is required at the construction joints, shear keys shall be provided.

Sprayed curing membranes and release agents should be thoroughly removed from joint surfaces.

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

(ii) Column Joints

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

(iii) Beam and Slab Joints

Concrete in a beam shall be placed throughout without a joint but if the provision of a joint is unavoidable, the joint shall be vertical and at the centre or within the middle third of the span unless otherwise approved. Where a beam intersects a girder, the joints in the girder shall be offset a distance equal to twice the width of the beam and additional reinforcement provided for shear. The joints shall be vertical throughout the full thickness of the concrete

member. A joint in a slab shall be vertical and parallel to the principal reinforcement. Where it is unavoidable at right angles to the principle reinforcement, the joint shall be vertical and at the middle of span.

(iv) Joints in Liquid Retaining Structures

Vertical construction joints in watertight construction will not be permitted. Where a horizontal construction joint is required to resist water pressure, special care shall be taken in all phases of its construction to ensure maximum water-tightness.

(v) Expansion and Movement Joints

Joint filler shall consist of a proven bituminous compound approved by the Employer's Representative. Application of the filler shall be strictly in accordance with the manufacturer's instructions.

The Contractor shall supply, for the Employer's Representative's approval, details of the proposed materials including the mechanical properties. The manufacturer shall design the width and thickness of the elastomeric compound to accommodate the maximum designed thermal shrinkage movement at the joint.

Joint Sealers shall be of impermeable ductile material providing a water-tight seal through the full joint movement range. Details of joint sealing are given in Section of this tender document.

(vi) Water-Stops

Water bars or water stops shall be extruded from a polyvinyl chloride compound containing the plasticizers, resins, stabilizers and other ingredients needed to impart the required characteristics or from synthetic rubber.

The Contractor shall supply to the Employer's Representative, details of the thickness of the water-stop offered by him to indicate its adequacy to withstand the design pressures.

All water-stop intersections such as ells, tees, crosses etc shall be fabricated by the manufacturer and shall have sufficiently long legs to permit field butt splicing.

Water-stops shall be provided in all expansion and movement joints. Water-stops shall be continuous in joints, following offsets and angles in joints until spliced to water-stops at intersections and thereby completely sealing the structure. The flanges of water-stops shall be secured to the reinforcement with 18 gauge wire ties at a maximum spacing of 45 centimetres or with a PVC binding where that is specifically recommended by the water-stop manufacturer.

PVC water-stops shall be neatly fused and synthetic rubber water-stops vulcanized at joints and connections unless explicitly otherwise specified by the manufacturer.

Water stops shall be provided at all vertical construction joints in walls of water retaining structures and all expansion joints in water retaining structures and wherever specified or directed by the Employer's Representative.

Water stops shall not be exposed to direct sunlight for long periods. Before being concreted, water stops shall be cleaned of all foreign materials. Wherever provided, water stops shall be placed in such a manner that they are embedded in the adjacent sections of the panels for equal width.

The storage, fixing in position, splicing of water stops shall be as per manufacturer's

instructions.

Water stops shall be fully supported in the formwork, be free of nails and clear of reinforcement and other fixtures. Damaged water stops shall be replaced and during concreting care shall be taken to place concrete so that water stops do not bend or distort.

The different type of water stops to be used in liquid retaining structures shall be as follows:

	Type of Joint	Type of Water Stops
1.	Partial/ complete construction joint in walls and slabs	150 mm wide, ribbed with hollow centre bulb and 5 mm minimum thickness
2.	Expansion joints in walls and slabs	225 mm wide, ribbed with hollow centre bulb and 9 mm minimum thickness
3.	Construction joint in raft	225 mm wide, ribbed with hollow centre bulb and 5 mm minimum thickness
4.	Construction joint in wall	150 mm wide, ribbed with hollow centre bulb and 5 mm minimum thickness
5.	Partial/ complete construction joint in raft	225 mm wide, ribbed with hollow centre bulb and 5 mm minimum thickness
6.	Expansion joint in raft	225 mm wide, ribbed with hollow centre bulb and 5 mm minimum thickness

(vii) Dowels

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

• Curing

(i) Curing Formed Concrete

All concrete shall be cured by keeping it continuously damp for the period of time required for complete hydration and hardening to take place. Curing shall be by use of the water curing method, specified liquid membrane forming compound or concrete curing paper, the specified use of any method being subject to the approval of the Employer's Representative.

Preference shall be given to the use of continuous sprays or ponded water, continuously saturated covering of sacking, canvas, hessian or other absorbent materials, or approved effective curing compounds applied with spraying equipment capable of producing a smooth, even textured coat. Extra precautions shall be exercised in curing concrete during hot weather. The quality of curing water shall be the same as that used for mixing the concrete.

Certain types of finish or preparation for overlaying concrete must be made at certain stages of the curing process and special treatment may be required for specific concrete surface finishes.

Curing of concrete made of high alumina cement and super-sulphated cement shall be carried out as approved by the Employer's Representative.

The structural elements with concrete having water binder ratio less than or equal to 0.4 or partial replacement of cement by pozzolanic materials (5% or above replacement by silica fume or high reactivity metakaoline, or 15% or above by fly ash) shall be cured in two stages, initial curing and final curing.

The initial curing should be started not later than three hours or after the initial setting time, whichever is lower, after placement of concrete. The concrete surfaces exposed to the environment shall be covered by plastic sheet or other type of impermeable covers. The initial curing should be continued up to a minimum period of 12 hours or 2 hours plus final setting time of concrete, whichever is higher.

Final curing shall be with water and commence immediately after initial curing and continue for a minimum period of 14 days.

(ii) Continuous Spraying

Curing shall be assured by the use of an ample water supply under pressure in pipes, with all necessary appliances of hose sprinklers and spraying devices. Continuous fine mist spraying or sprinkling shall be used, unless otherwise specified or approved by Employer's Representative.

(iii) Alternative Curing Methods

Whenever, in the judgment of the Contractor's designer and with the approval of the Employer's Representative, it may be necessary to omit the continuous spray method, covering of clean sand or other approved means such as wet gunny bags, which will prevent loss of moisture from the concrete, may be used. Any type of covering which would stain or damage the concrete during or after the curing period shall not be used. The covering shall be kept continuously wet during the curing period.

For curing of concrete in pavements, side-walks, floors, flat roofs or other level surfaces, the ponding method of curing is preferred. The method of containing the ponded water shall be approved by Employer's Representative. Special attention shall be given to edges and corners of slabs to ensure proper protection to these areas. The ponded areas shall be kept continuously filled with water during the curing period.

(iv) Curing Equipment

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

(v) Membrane Curing

Approved curing compounds may be used in lieu of moist curing with the permission of Employer's Representative. Such compounds shall be applied to all exposed surfaces of the concrete as soon as possible after the concrete has set. Impermeable membranes such as polyethylene sheeting covering the concrete surface closely may also be used to provide an effective barrier against evaporation.

For concrete containing Portland pozzolona cement, Portland slag cement or mineral admixtures, an increased period of curing may be required.

• Repair and Replacement of Unsatisfactory Concrete

Immediately after shuttering is removed, the surfaces of concrete shall be very carefully inspected and all defective areas called to the attention of Employer's Representative who may permit patching of the defective areas or else reject the concrete either partially or

entirely. Rejected concrete shall be removed and replaced by the Contractor. Holes left by form bolts etc shall be filled and made good with mortar composed of one part of cement to one and half parts of sand, that passes through a 2.36 mm IS sieve, after removing any loose stones adhering to the concrete. Mortar filling shall be struck off flush at the face of the concrete. The concrete surface shall be finished as described under the particular item of work.

Superficial honey combed surfaces and rough patches shall be similarly made good immediately after removal of shuttering, in the presence of Employer's Representative and superficial water and air holes shall be filled in. The mortar shall be well worked into the surface with a wooden float. Excess water shall be avoided. Unless instructed otherwise by Employer's Representative, the surface of exposed concrete placed against shuttering shall be rubbed down immediately on removal of shuttering to remove fine or other irregularities. Care shall be taken to avoid damaging the surfaces. Surface irregularities shall be removed by grinding.

If reinforcement is exposed or the honey combing occurs at vulnerable positions. Such as at the ends of beams or columns, it may be necessary to cut out the member completely or in part and reconstruct. The decision of Employer's Representative shall be final. If in the opinion of the Employer's Representative only patching is necessary, the defective concrete shall be cut out until solid concrete is reached (or to a minimum depth of 25 mm), the edges being cut perpendicular to the affected surface or with a small undercut if possible, anchors, tees or dowels shall be provided in slots whenever necessary to attach the new concrete securely in place. An area extending several centimeters beyond the edges and the surfaces of the prepared voids shall be saturated with water for 24 hours immediately before the patching material is placed.

(i) Use of Epoxy Mortar

The use of epoxy mortar for bonding fresh concrete used for repairs will be permitted upon written approval of Employer's Representative. Epoxy mortar shall be applied in strict accordance with the instruction of the manufacturer.

(ii) Method of Repair

Small size holes having surface dimensions about equal to the depth of the hole, holes left after removal of form bolts, grout insert holes and slots cut for repair of cracks shall be repaired as follows:

The hole to be patched shall be roughened and thoroughly soaked with clean water until absorption stops.

A 5 mm thick layer of grout of equal parts of cement and sand shall be well brushed into the surface to be patched followed immediately by the patching concrete which shall be well consolidated with a wooden float and left slightly proud of the surrounding surface. The concrete patch shall be built up in 10 mm thick layers. After an hour or more, depending upon weather conditions, it shall be worked off flush with a wooden float and a smooth finish obtained by wiping with hessian. Steel trowels shall not be used for this purpose. The mix for patching shall be of the same materials and in the same proportions as that used in the concrete being repaired, although some reduction in the maximum size of the coarse aggregates may be necessary and the mix shall be kept as dry as possible.

Mortar filling by air pressure (guniting) shall be used for repair of areas too large and/ or

too shallow for patching with mortar. Patched surfaces shall be given a final treatment to match the colour and texture of the surrounding concrete. White cement shall be substituted for ordinary cement, if so approved by Employer's Representative, to match the shade of the patch with the original concrete.

(iii) Curing of Patched Work

The patched area shall be covered immediately with an approved non-staining water-saturated material such as gunny bags, which shall be kept continuously wet and protected against the sun and wind for a period of 24 hours. Thereafter, the patched area shall be kept wet continuously by a fine spray of water for not less than 10 days.

(iv) Approval by Employer's Representative

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

• Finishing

This specification is intended to cover the treatment of concrete surfaces of all structures.

(i) Finishes for Formed Surfaces

The type of finish for formed concrete surfaces shall be as follows, unless otherwise approved by the Employer's Representative:

For surfaces against which backfill or concrete is to be placed, no treatment is required except repair of defective areas.

For surfaces below grade, which will receive waterproofing treatment, the concrete shall be free of surface irregularities which would interfere with proper application of the waterproofing materials which is specified for use.

Surfaces which will be exposed to the weather and which would normally be level, shall be sloped for drainage. Unless a horizontal surface is specially specified or a particular slope required, the tops of narrow surfaces such as staircase treads, walls, curbs and parapets shall be sloped across the width at 1 in 30. Broader surfaces such as walkways, roads, parking areas and platforms shall be sloped at 1 in 50. Surfaces that will be covered by backfill or concrete, sub floors to be covered with concrete topping, terrazzo or quarry tile and similar surfaces shall be smooth, screeded and levelled to produce even surfaces. Surface irregularities shall not exceed 6mm. Surfaces which will not be covered by backfill, concrete or tile topping such as external decks, floors of galleries and sumps, parapets, gutters, sidewalks, floors and slabs shall be consolidated, screeded and floated.

Excess water and laitance shall be removed before final finishing. Floating may be done by hand or power tools and started as soon as the screeded surface has attained a stiffness to permit finishing operations and these shall be the minimum required to produce a surface uniform in texture and free from screed marks or other imperfections. Joints and edges shall be tooled as required or as approved by the Employer's Representative.

(ii) Standard Finish for Exposed Concrete

Exposed concrete shall mean any concrete other than floors or slabs exposed to view upon

completion of the job. Unless otherwise specified on the drawings, the standard finish for exposed concrete shall be of smooth finish.

A smooth finish shall be obtained with the use of lined or plywood forms having smooth and even surfaces and edges. Panels and form linings shall be of uniform size and be as large as practicable and installed with closed joints. Upon removal of forms, the joint marks shall be smoothed off and all blemishes, projections etc removed, leaving the surfaces smooth and unmarred.

(iii) Integral Cement Concrete Finish

When required, an integral cement concrete finish of specified thickness for floors and slabs shall be applied either monolithically or bonded, as specified in IS2571. The surface shall be compacted and then floated with a wooden float or power floating machine. The surface shall be tested with a straight edge and any high and low spots eliminated. Floating or trowelling of the finish shall be permitted only after all surface water has evaporated. Dry cement or a mixture of dry cement and sand shall not be sprinkled directly on the surface of the cement finish to absorb moisture or to stiffen the mix.

(iv) Rubbed Finish

A rubbed finish shall be provided only on exposed concrete surfaces as required. Upon removal of forms, all fins and other projections on the surfaces shall be carefully removed, offsets levelled and voids and/or damaged sections repaired. The surfaces shall then be thoroughly wetted and rubbed with carborundum or other abrasive. Cement mortar may be used in the rubbing, but the finished surfaces shall not be brush coated with either cement or grout after rubbing. The finished surfaces shall present a uniform and smooth appearance.

• Field Quality Control

All concreting shall be supervised by the Employer's Representative and in order to enable the Employer's Representative to make the requisite arrangements, the Contractor shall give him adequate notice of the proposed concreting operations which, except under special circumstances, shall not be less than 24 hours after checking reinforcement and formwork. Any concreting done in the absence of, or without the express permission of the Employer's Representative is liable to rejection.

• Tests

All tests specified in the Indian Standards shall be regularly carried out together with any additional tests the Employer's Representative may require to satisfy himself regarding the quality of the work done.

If the results of any tests indicate the concrete in question is unsatisfactory in any respect, the Contractor shall take any steps indicated by the Employer's Representative to rectify the same and if such rectification is not found to be satisfactory or adequate, the section in question shall be removed and re-concreted.

While all the tests stipulated in the Indian Standards are necessary, the carrying out of the field slump-tests and the making of the specified works test cubes from every batch of concrete, or as otherwise specified by the Employer's Representative, shall be carried out as an invariable general rule.

The following requirements in respect of concrete testing will be rigidly applied throughout the duration of the Contract to all permanent works.

(a) Sampling Procedure

Sampling and testing shall be in accordance with IS 1199 and IS 516. Evaluation of the results and acceptance or rejection of the concrete will be done as described below.

Six cubes shall be obtained from each mix during each working period. Half the number in each sample shall be tested at 7 days and the balance at 28 days. Where the tests are carried out in the site laboratories, companion cubes shall be tested on the dates on which the representative samples are tested at site at an independent laboratory approved by the Employer's Representative. If a significant difference is noticed between the two sets of results all further testing shall be done at the approved laboratory until the site equipment is rectified satisfactorily. No reduction in the frequency or number of samples taken shall be made without the explicit approval of the Employer's Representative who, if agreeing to any reduction, shall have such a decision mainly on the consistency of good results achieved over an acceptable period. Any deterioration in quality will result in the more rigorous schedule being re-implemented.

The values given in table below may be taken for general guidance in the case of concrete made with ordinary cement. In all cases, the 28 day compressive strength specified shall alone be the criterion for acceptance or rejection of the concrete. If however, from tests carried out for a particular job over a reasonably long period, it has been established to the satisfaction of the Employer's Representative that a suitable ratio between 28 days compressive strength and the modulus of rupture at 72 (+/-) 2 hours or 7 days or compressive strength at 7 days may be accepted, the Employer's Representative may suitably relax the frequency of 28 day compressive strength tests, provided the expected strength values at the specified early age are consistently met.

Optional Tests Requirements of Concrete:

Sl. No.	Grade of Concrete	Compressive Strength on 15 cm Cubes (Min.) at 7 Days(N/mm^2)	Compressive Strength at 72 $\pm$ 2 Hours(N/mm^2)	Modulus of Rupture by Beam Test (Min.) at 7 Days(N/mm^2)
1	M 10	7.0	1.2	1.7
2	M 15	10.0	1.5	2.1
3	M 20	13.5	1.7	2.4
4	M 25	17.0	1.9	2.7
5	M 30	20.0	2.1	3.0
6	M 35	23.5	2.3	3.2
7	M 40	27.0	2.5	3.4

2 Test Specimen

Three test specimens shall be made from each sample for testing at 28 days. Additional cubes may be required for various purposes such as to determine the strength of concrete at 7 days or at the time of striking the form work or to determine the duration of curing or to check the testing error. Additional cubes may also be required for testing cubes cured by accelerated methods as described in IS 9013 - 1978. The specimen shall be tested as described in IS 516 - 1959.

3 Frequency

The minimum frequency of sampling of concrete of each grade shall be in accordance with following table:

Quantity of Concrete m ³	Number of Samples
1 – 5	1
6 – 15	2
16 – 30	3
31 – 50	4
51 & above	4 + one per additional 50m ³

At least one sample shall be taken from each shift. Where concrete is in continuous production, such as at a ready-mixed concrete plant, the frequency of sampling may be agreed upon mutually by suppliers and purchasers.

4 Test Strength of Samples

The test strength of the samples shall be the average of the strength of three specimens. The individual variation should not be more than (+/-) 15 percent of the average.

5 Standard Deviation

This section should be read in conjunction with Section 13.3 13.4.1 of this specification.

The standard deviation and coefficient of variation shall be computed for a set of any 10 consecutive tests. The probable minimum strength of the batch, as calculated from the results of the 10 tests, based on failure probability of 1 in 10, shall then be compared with the specified minimum strength for the relevant grade of concrete.

- If the calculated minimum strength exceeds the specified minimum strength by 10 percent or more, the Contractor will be permitted to redesign the mix with a lower cement content, if feasible.
- If the calculated strength exceeds the specified minimum strength by not more than 10 percent, the mix design shall be used for subsequent batches of concrete.
- If the calculated strength falls short of the minimum specified strength but by not more than 10 percent, the decision to accept or reject the representative batch of concrete will be at the sole discretion of the Employer's Representative. The location of the batch in the structure, the maximum stresses likely to occur therein, the calculated strength of the cubes and other relevant factors will be taken into consideration, but his decision, once given shall not be subject to question or dispute nor shall it be subsequently quoted as a precedent.
- If the calculated minimum strength falls short of the specified minimum strength by more than 10 percent, the representative batch of concrete shall be rejected.
- All water retaining structures shall be tested for water-tightness in conformance with the requirements of IS 3370 (Part I) – 1965, section 10 to the satisfaction of the Employer's Representative.

• Acceptance Criteria

The concrete shall be deemed to comply with the strength requirements when both the following conditions are met:

(i) The mean strength determined from any group of four consecutive test results complies with the appropriate limits in column 2 of the table below

(ii) Any individual test result complies with the appropriate limits in column of Table below.

Characteristic Compressive Strength Compliance Requirement:

Specified grade Mean of the group of 4 non-Non-overlapping consecutive
test overlapping consecutive test results results in N / mm² Individual test

in N / mm² results in N / mm²

M 15 = / > fck + 0.825 x established = / > fck - 3 N / mm²

standard deviation (rounded off to

nearest 0.5 N/mm² Or

= / > fck + 3 N / mm² whichever is

greater

M 20 or above = / > fck + 0.825 x established = / > fck - 4 N / mm²

standard deviation (rounded off to nearest 0.5 N / mm²

or

= / > fck + 4 N / mm² whichever is

greater

Note – In the absence of an established value of standard deviation, the values given in (assumed standard deviation) may be assumed and an attempt should be made to obtain the results of 30 samples as early as possible to establish the value of standard deviation.

1 Flexural Strength

When both the following conditions are met, the concrete complies with the specified flexural strength.

- The mean strength determined from any group of four consecutive test results exceeds the specified characteristic strength by at least 0.3 N/mm²
- The strength determined from any test result is not less than the specified characteristic strength less 0.3 N/mm²

2 Quantity of Concrete Represented by Strength Test Results.

The quantity of concrete represented by a group of four consecutive test results shall include the batches from which the first and last samples were taken together with all intervening batches.

For the individual test result requirements given in column 2 of above table or in item (b) of flexural strength, only the particular batch from which the sample was taken shall be at risk.

Where the mean rate of sampling is not specified the maximum quantity of concrete that four consecutive test results represent shall be limited to 60m³.

If the concrete is deemed not to comply pursuant to the above, the structural adequacy of the parts affected shall be investigated and any consequential action as needed shall be taken.

Concrete of each grade shall be assessed separately.

3 Alterations and Concreting against Surfaces

Existing concrete surfaces which are to receive new concrete shall be heavily sand-blasted to expose the coarse aggregate and produce a clean, coarse textured surface. Such prepared surfaces shall be coated with an epoxy bonding or other approved coating immediately prior to concreting. The compound shall be equal or superior to "Sikastix Adhesive" manufactured by the Sika chemical company and shall be mixed and applied strictly in accordance with the manufacturer's recommendations under different conditions.

2 Ready Mixed Concrete

- **General**

Ready mixed concrete (RMC) shall comply with the requirements of IS 4926 or the latest Indian Standard.

Concrete delivered at site shall be in a plastic condition and requiring no further treatment before being placed in the position in which it is to set and harden.

The continuing mixing of concrete during transport shall be at a reduced speed to prevent segregation.

Concrete shall be produced by completely mixing cement, aggregates, admixtures (if any) and water at a stationary central mixing plant and delivered in transit mixers.

Concrete may be produced in a transit mixer at the batching plant, with the mixing being carried out entirely in the transit mixer either during the journey or on arrival at the site of delivery. No water shall be added to the aggregate and cement until the mixing of concrete commences.

- **Manufacturing**

The ready-mixed concrete shall be manufactured and supplied on either of the following bases:

- a. Specified strength based on 28-day compressive strength of 15 cm cubes tested in accordance with IS: 456-2000.
- b. Specified mix proportion.

Where the contract requires using ready mix concrete of designated strength, the Contractor shall procure the same from approved suppliers only and Section of this tender document shall also apply to concreting done with ready mix concrete.

When the concrete is manufactured and supplied on the basis of specified strength, the responsibility for the design of mix shall be that of the manufacturer and the concrete shall conform to the requirements specified.

When the concrete is manufactured and supplied on the basis of specified mix proportions, the responsibility for the design of the mix shall be that of the mix designer and the concrete shall conform to the requirements specified.

- **Supply**

Ready mix concrete prepared and transported will be as per IS 4926 of 1976 or the latest IS Code.

Water is not to be added to ready mixed concrete on site.

Ready mix concrete will be brought to the site from the RMC plant only by transit mixers (agitators).

Every transit mixer will carry a delivery ticket, stating the minimum following details:

- (i) Name of manufacturer and depot
- (ii) Serial number of the ticket.
- (iii) Date
- (iv) Truck number
- (v) Name of Contractor to whom the RMC is being supplied
- (vi) Location of contract
- (vii) Grade of concrete.
- (viii) Specified workability
- (ix) Cement content and grade of cement
- (x) Time of loading
- (xi) Quality of concrete.

When the truck arrives on site, the drum, should always be rotating at about 10 to 15 rev/min, for at least three minutes, to ensure that the concrete is thoroughly mixed and uniform before discharge.

When a truck mixer or agitator is used for the mixing or transportation concrete, no water from the truck-water system or from elsewhere shall be added after the initial introduction of the mixing water for the batch,

Unless otherwise specified, when a truck or agitator is used for transporting concrete, the concrete shall be delivered to the site of the work and the discharge shall be complete within 1

½ hour when the prevailing atmospheric temperature is above 20°C and within 2 hours when the prevailing atmosphere temperature is at or below 20°C of adding the mixing water to the mix of cement and aggregate or adding the cement to the aggregate whichever is earlier.

3 Plain Cement Concrete

For plain cement concrete work, the specification for cement, sand, fine and coarse aggregates and water shall be the same as that specified in reinforced concrete but the proportion of mix will be nominal and the ratio of fine and coarse aggregate may be slightly adjusted within limits, keeping the total value of aggregates to a given volume of cement constant to suit the sieve analysis of both the aggregates. Cement shall not be measured by volume and shall always be used directly from the bags (i.e. 50 kg/bag).

The nominal maximum size of coarse aggregate for 1:2:4 mix shall be as specified for reinforced concrete and for 1:3:6 and 1:4:8 mix shall be 40 mm for concrete 300 mm and more thick and 25mm for concrete less than 300 mm thick.

The quantity of water used shall be such as to produce concrete of the consistency required by the particular class of work and shall be decided by the use of a slump cone. Sufficient care should be taken to ensure that no excess quantity of water is used.

Sl. No.	Mix Proportion	Cement (Bags)	Sand (m ³)	Coarse Aggregate (m ³)	Water (Litres)
				40 mm	20 mm
1	1 : 5 : 10	2.60	0.47 5	0.6623	0.2583
2	1 : 4 : 8	3.40	0.50 0	0.6883	0.6883
3	1 : 3 : 6 (with 40 mm aggregate)	4.40	0.48 5	0.672	0.672
4	1 : 3 : 6 (with 20 mm aggregate)	4.40	0.48 5	–	0.727
5	1 : 2 : 4 (with 20 mm aggregate)	6.40	0.47 0	–	0.705
6	1 : 2 : 4 (with 40 mm aggregate)	6.40	0.47 0	0.544	0.241
7	1 : 1.5 : 3	8.00	0.44 1	–	0.6615
8	1 : 1 : 2	12.2 0	0.45 0	–	0.675

The slump shall be specified for each class of work and shall in general be as follows:

Type of concrete	Max. slump (in mm)
Mass concrete	50
Concrete below water proofing treatment	50
Coping	25
Floor paving	50

All plain concrete shall be mixed in a drum type powder driven machine with a loading hopper which will permit the accurate measure of various ingredients. If hand mixing is authorised, it should be done on a watertight platform.

The mixing of each batch in the concrete mixer shall continue for not less than 1.5 minutes after the materials and water are in the mixer. The volume of mixed materials per batch shall not exceed the manufacturers rated capacity of the mixer. The mixer shall rotate at a peripheral speed of about 60 metres per minute.

STANDARD FOR CEMENT CONSUMPTION FOR DIFFERENT ITEM OF WORKS

EXISTING ITEM			AMENDMENT		
Item	Unit	Quantity of cement to be used per unit quantity of work in Kg	Item	Unit	Quantity of cement to be used per unit quantity of work in Kg.
Building, Road & Bridge Items					
Providing & casting in situ ordinary cement concrete M75 for PCC work	Cu.m.	160	Providing & casting in situ ordinary cement concrete M7.5 for PCC work	Cu.m.	160
Providing & casting in situ ordinary cement concrete M100 for PCC work	Cu.m.	220	Providing & casting in situ ordinary cement concrete M10 for PCC work	Cu.m.	220
Providing & casting in situ ordinary cement concrete M150 for PCC work	Cu.m.	320	Providing & casting in situ ordinary cement concrete M15 for PCC work	Cu.m.	290
Providing and casting situ control cement concrete M200 for RCC work	Cu.m.	400	Providing and casting situ control cement concrete M20 for RCC work	Cu.m.	360
Providing and casting situ control cement concrete M250 for RCC work	Cu.m.	450	Providing and casting situ control cement concrete M25 for RCC work	Cu.m.	380
Providing and casting situ control cement concrete M350 for RCC work	Cu.m.	500	Providing and casting situ control cement concrete M35 for RCC work	Cu.m.	425
Providing and casting situ control cement concrete M400 for RCC work	Cu.m.	525	Providing and casting situ control cement concrete M40 for RCC work	Cu.m.	440
Providing and casting situ control cement concrete M450 for RCC work	Cu.m.	540	Providing and casting situ control cement concrete M45 for RCC work	Cu.m.	450
New Item					
-	-	-	Providing and casting situ control cement concrete M30 for RCC work	Cu.m.	410

EXISTING ITEM	Unit	Quantity of cement to be used per unit quantity of work in Kg	AMENDMENT	Quantity of cement to be used per unit quantity of work in Kg
Providing & casting in situ ordinary cement concrete M75 for PCC work	Cu.m.	160	Providing & casting in situ ordinary cement concrete M7.5 for PCC work	160
Providing & casting in situ ordinary cement concrete M100 for PCC work	Cu.m.	220	Providing & casting in situ ordinary cement concrete M10 for PCC work	220
Providing & casting in situ	Cu.m.	320	Providing & casting in	290

ordinary cement concrete M150 for PCC work			situ ordinary cement concrete M15 for PCC work	
Providing and casting situ control cement concrete M200 for RCC work	Cu.m.	400	Providing and casting situ control cement concrete M20 for RCC work	360
Providing and casting situ control cement concrete M250 for RCC work	Cu.m.	450	Providing and casting situ control cement concrete M25 for RCC work	380
Providing and casting situ control cement concrete M350 for RCC work	Cu.m.	500	Providing and casting situ control cement concrete M35 for RCC work	425
Providing and casting situ control cement concrete M400 for RCC work	Cu.m.	525	Providing and casting situ control cement concrete M40 for RCC work	440
Providing and casting situ control cement concrete M450 for RCC work	Cu.m.	540	Providing and casting situ control cement concrete M45 for RCC work	450
			Providing and casting situ control cement concrete M30 for RCC work	410

4 Pre-Cast Concrete

• General

Pre-cast concrete and pre-cast reinforced concrete shall comply with IS 456 and with the following requirements.

Pre-cast concrete units shall incorporate sufficient lifting points and reinforcement to ensure the safe handling, transport and erection.

Where necessary, the Contractor's shop drawings shall include details of the lifting inserts, methods to be adopted to join the pre-cast units to other structures or parts thereof and the allowances made to receive work of other engineering specialties employed on the works.

Pre-cast concrete cladding panels shall be cast in formwork capable of producing a uniform fair faced finish.

Where appropriate, indelible identification and orientation marks shall be put on pre-cast concrete components in such a position that the marks shall not show or be exposed in the finished work.

• Execution

a) Casting

The pre-cast units shall be cast to the size and configuration required or otherwise specified.

The units shall be reinforced as necessary for the stresses likely to be caused by the methods of handling, transport and installation envisaged by the Contractor.

The longitudinal reinforcement shall have a minimum cover of 12 mm or twice the diameter of the main bar, whichever is more, unless otherwise approved, except for fencing or electric posts where the minimum cover shall be 25 mm.

The units shall be equipped with approved lifting devices for safe handling and easy installation.

Concrete used for pre-casting the units shall be thoroughly compacted by vibration or tamping to give a dense concrete free from voids and honeycombing.

The exposed surfaces shall be finished as specified or with dense, smooth trowel led finish free from flaws and irregularities and true to the required configuration.

All angles of the pre-cast units, with the exception of any angles resulting from the splayed or chamfered faces, shall be true right angles. The arises shall be clean and sharp except those specified or shown to be rounded. The wearing surface shall be true to the required lines. On being fractured, the interior of the units should present a clean homogenous appearance.

Pre-cast units shall be cured to the maximum compressive strength for the specified class of concrete before the units are handled or lifted for transport or installation.

b) Curing

After having been cast in the mould or form, the concrete shall be adequately protected during setting in the first stages of hardening from shocks and from harmful effects of sunshine and wind. The concrete shall be cured at least for 10 days from the date of casting.

All pre-cast work shall be protected from the direct rays of the sun for at least 7 days after casting and during that period each unit shall be kept constantly watered or completely immersed in water if the size of unit so permits. Otherwise curing practices as given in clauses stated earlier shall be followed.

The pre-cast articles shall be matured for 28 days before being incorporated into the Works so that the concrete shall have sufficient strength to prevent damage when handled. Side shutters shall not be struck in less than 24 hours after depositing the concrete and no pre-cast unit shall be lifted until the concrete reaches a strength of at least twice the stress to which the concrete may be subjected at the time of lifting.

Pre-cast units shall be clearly marked to indicate the top of member and its location and orientation in the structure. The reinforced side of the units shall be distinctly marked.

Pre-cast units shall be stored, transported and placed in position in such a manner that they will not be overstressed or damaged. The lifting and removal of pre-cast units shall be undertaken without causing shocks, vibration or being put under bending stresses. Before lifting and removal takes place, the Contractor shall satisfy Employer's Representative that the methods he proposes to adopt for these operations will not overstress or otherwise affect the strength of the pre-cast units.

c) Installation

The installation shall be fully coordinated with the works of the other engineering specialities comprising the Works and the units shall be installed and secured at such times as to prevent any delay in the progress of the works.

Pre-cast units shall be aligned and secured in accordance with the approved shop and working drawings.

The installation shall be in a neat, workmanlike manner. On completion, all surplus materials or debris arising out of the work shall be removed from the site.

d) Marking

Precast units shall be clearly marked to indicate the top of member and its location and orientation in the structure.

e) Mix design proportioning

Pre Mix proportions shall be designed to ensure that the workability of fresh concrete is suitable for conditions of handling and placing, so that after compaction it surrounds all reinforcements and completely fills the formwork. When concrete is hardened, it shall have the formwork. When concrete is hardened, it shall have the stipulated strength, durability and impermeability.

Determination of the proportions by weight of cement, aggregates and water shall be based on design of the mix.

Mix design shall be tried and the mix proportions checked on the basis of tests conducted at a recognized laboratory approved by the Engineer-in-charge.

All concrete proportions for various grades of concrete shall be designed separately and the mix proportions established keeping in view the workability for various structural elements, methods of placing and compacting.

f) Standard Deviation

Standard deviation calculations of test results based on tests conducted on the same mix design for a particular grade designation shall be done in accordance with clause 9.2.4 of IS 456:2000

g) Acceptance Criteria

The acceptance criteria for compressive strength and flexural strength designation shall be done in accordance with the relevant clauses of the IS codes.

h) Destructive tests

1. Load Test: Contractor shall make necessary arrangement for load test of precast nits at manufacturer's site. The load test shall be carried out by Engineer-in-charge.
2. Core test : Core test, if ordered by the Engineer-in-charge, shall be done in accordance with IS 516. Samples for such test shall be taken from locations to be identified by the Engineer-in charge and such samples shall be collected in compliance with IS 1199.

i) Non Destructive tests

In case of doubtful structural strength non-destructive testing of the pre-cast manhole element shall be done as per the instructions of Engineer-in-charge. Such tests may be any one or a combination of the following:-

- 1 REBOUND HAMMER TEST

- 2 WINDSOR PENETRATION PROBE TEST
- 3 PULSE VELOCITY (SONIC OR ULTRASONIC) TEST

Interpretation of Rebound Hammer, Windsor Probe and Pulse-velocity test results shall rest with the Engineer-in-charge.

5 Reinforcement

• General

No re-rolled material shall be accepted. If instructed by the Employer's Representative, the Contractor shall submit the manufacturer's test certificates for the steel. Random tests on steel supplied by the Contractor may be performed by the Employer as per relevant Indian Standards. Each steel bar shall be identified by the number duly moulded on the bar itself.

• Submittals

Bar bending schedules for reinforced concrete works shall be provided by the Contractor. The submittals for extra or modified work shall also be made by the Contractor at least two weeks prior to commencement of bending. Dimensions shown on the submittals furnished by the Contractor shall be his responsibility and approval of the submittals shall not constitute approval of the dimensions thereon.

• Tie Wire

Tie wire shall be of annealed steel, 16 gauge minimum.

• Supports and Accessories

Support blocks shall be of concrete with embedded wire ties or dowels for placement on grade or on membranes. Reinforcement for footings, grade beams and slabs on sub-grade shall be supported on pre-cast concrete blocks as approved by the Employer's Representative. The use of pebbles or stones shall not be permitted. The blocks are to be embedded.

Plastic coated spacers or accurately dimensioned concrete blocks shall be used in all water retaining surfaces, roofs of water retaining structures and in all interior or exterior surfaces exposed to weather after completion of the structure. Plastic cover blocks of approved manufacture will be permitted at the discretion of the Employer's Representative.

• Dowels

Where so required, reinforcing bar dowels shall be provided in new work and for anchorage to existing concrete. Where anchorage to existing concrete is required, a non-shrinking epoxy type grout or approved equal or deferred bolting devices shall be provided in each case, conforming to the relevant requirement specified in the section for cast-in-situ concrete.

• Testing

Testing of materials shall be at the Contractor's expense and as instructed by the Employer's Representative and when so tested, shall conform to the relevant standards. Tests may be ordered on bars as selected by the Employer's Representative from material at the site or from any place of distribution. Each sampling selection shall include at least two pieces, each 500 millimetre long.

The Contractor shall submit the manufacturer's test certificates. Regular tests on the steel supplied shall be performed by the Contractor at an approved laboratory in the presence of the Employer's Representatives as per relevant Indian Standards. The Employer's Representative may require the Contractor to perform tests of samples at random as per relevant Indian Standard. The quality, grade, colour coding embossing marks etc shall all be to the entire satisfaction of the Employer's Representative. Steel not conforming to the above test criteria shall be rejected.

The chemical, physical and mechanical properties of the steel reinforcement bars shall be as per IS 1786. Unless otherwise specified, the selection and preparation of test samples shall be as per the requirements of IS 2062.

All test pieces shall be selected either from the cuttings of bars or from any bar after it has been cut to the required or specified size and the test piece taken from any part of it. In either case, the test piece shall be detached from the bar in the presence of the Employer's Representative.

The test pieces shall be full sections of the bars and shall be subjected to physical tests without any further modifications. No reduction in size by machining or otherwise shall be permissible, except in case of bars of size 28 mm and above. No test piece shall be annealed or otherwise subjected to heat treatment. Any straightening which a test piece may require shall be done cold.

For the purpose of carrying out tests for tensile strength, proof stress, percentage elongation and percentage elongation at maximum force for bars of 28 mm in diameter and above, deformations of the bars only may be machined. For such bars, the physical properties shall be calculated using the actual area obtained after machining.

9. Applicable Test Standards

Sl. No.	Title	IS No.	ISO No.
1	Mechanical testing of metals – Tensile testing	IS 1608	ISO 6892
2	Methods for bend test	IS 1599, IS 7438 & IS 1786	ISO 15630-1
3	Method for re-bend test for metallic wires and bars	IS 1786	ISO 15630-1

10. Chemical Composition Requirements for Reinforcement Bars

(Maximum Permissible Percentage by Mass)

Constituent	Fe 415	Fe 415D	Fe 500	Fe 500D	Fe 550	Fe 550D	Fe 600	Max. Variation
Carbon (C)	0.300	0.250	0.300	0.250	0.300	0.250	0.300	± 0.020 %
Sulphur (S)	0.060	0.045	0.055	0.040	0.055	0.040	0.040	± 0.005 %
Phosphorus (P)	0.060	0.045	0.055	0.040	0.050	0.040	0.040	± 0.005 %
Sulphur + Phosphorus	0.110	0.085	0.105	0.075	0.100	0.075	0.075	± 0.010 %

11. Notes on Chemical Testing

- For welding of deformed bars, the recommendations of **IS 9417** shall be followed.
- In case of deviation from specified limits, **two additional samples** shall be tested from the same batch:
 - If **both pass**, the batch shall be accepted.
 - If **either fails**, the batch shall be rejected.

12. Tolerance on Nominal Mass of High Strength Deformed Bars

Nominal Size (mm)	Batch Tolerance (%)	Individual Sample (%)	Individual Sample for Coils Only (%)
Up to and including 10	± 7	-8	± 8

Nominal Size (mm)	Batch Tolerance (%)	Individual Sample (%)	Individual Sample for Coils Only (%)
Over 10 up to and including 16	± 5	-6	± 6
Over 16	± 3	-4	± 4

13. Important Structural Note (IS 456:2000 – Clause 26)

To satisfy Clause 26 of IS 456:2000, **mixing of different grades or types of reinforcement bars shall not be permitted** in the same structural member as main reinforcement **without prior written approval of the Employer's Representative.**

• Fabrication and Delivery

Tagged reinforcement bundles which can be easily identified shall be stored at the site in sufficient quantities to enable uninterrupted progress of the work. These shall be so stored as to prevent damage or undue exposure to harmful weather conditions.

• Stacking and Storage

Steel for reinforcement shall be stored in such a way as to prevent distorting and corrosion. The steel for reinforcement shall not be kept in direct contact with ground. Fresh / fabricated reinforcement shall be carefully stored to prevent damage, distortion, corrosion and deteriorations. Care shall be taken to protect steel from exposure to saline atmospheres during storage, fabrication and use. This may be achieved by treating the surface of the reinforcement with a cement wash or by other suitable methods. Bars of different classification, size and length shall be stored separately to facilitate their issue in such sizes and lengths to cause minimum wastage in cutting from standard lengths.

• Bending and Forming

Bars shall be fabricated accurately to dimensions, forms and shapes indicated by methods that will not damage the bars. Heating for purposes of bending will not be permitted. Field-bending of bars that are partially embedded in concrete shall not be done unless such procedure is specifically approved by the Employer's Representative.

All bars shall be accurately bent according to the sizes and shapes shown on the approved detailed working drawings and bar bending schedules. Bars shall be bent gradually by machine or other approved means. Reinforcing bars shall not be straightened and re-bent. Bars containing cracks or splits shall be rejected. Bars shall be bent cold unless specifically approved by the Employer's Representative.

Where approved, bars bent hot shall not be heated beyond a cherry red colour (not exceeding 645 °C) and after bending shall be allowed to cool slowly without quenching. Bars incorrectly bent shall be used only after straightening and re-bending, such as shall not, in the opinion of the Employer's Representative, injure the material. No reinforcement bar shall be bent when in position in the work without approval, whether or not it is partially embedded in hardened concrete. Bars having kinks or bends other than those required by design shall not be used.

Where reinforcement bars are necessarily bent aside at construction joints and afterwards bent back into their original position, care shall be taken to ensure that, at no time, the radius of the bend is less than 4 bar diameters for plain mild steel or 6 bar diameters for

deformed bars. Care shall also be taken when bending back bars to ensure that the concrete around the bar is not damaged.

- **Laps**

Laps and splices for reinforcement shall be as shown on the approved Contractor's drawings. Splices in adjacent bars shall be staggered and the locations of all splices shall be subject to the approval of the Employer's Representative. Bars shall not be lapped unless the length required exceeds the maximum available lengths of bars at site.

- **Reinforcing Bars for Masonry**

Reinforcing bars for masonry shall be shop fabricated.

- **Exposure conditions**

Sl. No.	Environment	Exposure Conditions
1	Mild	Concrete surfaces protected against weather or aggressive conditions, except those situated in coastal areas.
2	Moderate	Concrete surfaces sheltered from severe rain; concrete exposed to condensation and rain; concrete continuously under water; concrete in contact with or buried under non-aggressive soil or ground water; concrete surfaces sheltered from saturated salt air in coastal areas.
3	Severe	Concrete surfaces exposed to severe rain, alternate wetting and drying, or severe condensation; concrete completely immersed in sea water; concrete exposed to coastal environments.
4	Very Severe	Concrete surfaces exposed to seawater spray or corrosive fumes; concrete in contact with or buried under aggressive sub-soil or ground water.
5	Extreme	Concrete surfaces in tidal zones; members in direct contact with aggressive liquid or solid chemicals; concrete exposed to sewage, sewage effluent, sewage sludge, and digester gases.

Note: Exposure classification shall be determined in accordance with **IS 456:2000 (Durability of Concrete)** and shall govern **minimum cement content, maximum water–cement ratio, and cover to reinforcement**.

- **Fusion Bonded Epoxy Coating**

Where fusion bonded epoxy coating (FBEC) is to be applied to reinforcement bars, it shall conform to IS 13620.

The coating material shall conform to Annex A1 of IS 13620.

The surface of the steel reinforcing bars to be coated shall be cleaned by abrasive blast cleaning to near white metal.

The protective coatings shall be applied by the electrostatic spray method.

The film thickness of the coating shall be evaluated by bending production-coated bars around a mandrel as prescribed in IS 13620.

Tests, retests and permissible coating damage shall be in accordance with IS 13620. Coating damage shall be repaired with the repair compound supplied by the coating manufacturer.

- ## Nominal cover to reinforcement

Nominal cover is the design depth of concrete cover to all steel reinforcements, including links. The dimension shall be used in the design and indicated on the Contractor's detailing drawings. Cover shall be not less than the diameter of the bar. Unless otherwise specified, cover to reinforcement shall be provided generally as per guidelines of IS 456.

Minimum values for the nominal cover of normal weight aggregate concrete which should be provided to all reinforcement, including links depends on the condition of exposure. The nominal cover to meet durability requirements is shown in the table below:

Environment	Nominal concrete cover in mm not less than
Mild	20
Moderate	30
Severe	45
Very severe	50
Extreme	75

- 1 For main reinforcement of up to 12 mm diameter subject to mild exposure, thenominal cover may be reduced by 5 mm
- 2 Unless specified otherwise, the actual concrete cover should not deviate from therequired nominal cover by +10 mm
- 3 For exposure conditions severe and very severe, a reduction of 5 mm may bemade, where concrete grade is M 35 and above.

Unless otherwise approved by the Employer's Representative, clear concrete cover for reinforcement (exclusive of plaster or other decorative finish shall be as follows:

- 1 At each end of a reinforcing bar not less than 25mm or less than twice thediameter of the bar.
- 2 For a longitudinal reinforcing bar in a column, nominal cover shall in any case notbe less than 40 mm or less than the diameter of such bar. In the case of column of maximum dimensions of 200 mm or less, whose reinforcing bars do not exceed 12 mm, a cover of 25 mm may be used.
- 3 For longitudinal reinforcing bars in a beam cover shall be not less than 25mm, or less than diameter of the bar.
- 4 For tensile, compressive, shear, or other reinforcement in a slab, cover shall be not less than 25 mm, or less than the diameter of the bar.
- 5 For any other reinforcement not less than 15 mm, or less than the diameter of thebar.
- 6 For footings and other principal structural members in which the concrete is deposited directly against the ground, the cover to the bottom reinforcement shallbe 75 mm. If concrete is poured on a layer of lean concrete the bottom cover may be reduced to 50 mm.
- 7 For concrete surfaces exposed to the weather or the ground after removal of forms, such as retaining walls, grade beams, footing sides and tops etc, not less than 50 mm for bars larger than 16 mm diameter and not less than 40 mm for bars 16 mm diameter or smaller.
- 8 Increased cover thickness may be provided when surfaces of concrete members are exposed to the action of harmful chemicals (as in the case of concrete in contact with earth faces contaminated with such chemicals), acid, vapour, saline atmosphere, sulphurous smoke (as in the case of steam-

operated railways) digester gases etc and such increase of cover may be between 15 mm and 50 mm beyond the figures given above (1 to 6) as may be specified by the Employer's Representative. The interior of sludge digestion tanks will fall into this category.

9 For reinforced concrete members, totally immersed in sea water, the cover shall be 40 mm more than specified (1 to 6) above.

10 For reinforced concrete members, periodically immersed in sea water or subject to sea spray, the cover of concrete shall be 50 mm more than that specified (1 to 6) above.

11 For concrete of grade M 25 and above, the additional thickness of cover specified in (8), (9) and (10) above may be reduced to half. In all such cases the cover should not exceed 75 mm

12 Protection to reinforcement in cases where concrete is exposed to harmful surroundings may also be given by providing dense impermeable concrete with an approved protective coating. In such cases, the extra cover, as stated in (7) and (8) above, may be reduced with the approval of the Employer's Representative.

13 The minimum clear distance between reinforcing bars shall be in accordance with IS 456.

The minimum values of nominal cover for normal-weight aggregate concrete to be provided to all reinforcement including links to meet specified period of fire resistance is shown in the table below:

Fire Resistance (Hours)	Beams		Slabs		Ribs		Columns
	<i>Simply Supported</i>	<i>Continuous</i>	<i>Simply Supported</i>	<i>Continuous</i>	<i>Simply Supported</i>	<i>Continuous</i>	<i>(All cases)</i>
0.5	20	20	20	20	20	20	40
1.0	20	20	20	20	20	20	40
1.5	20	20	25	20	35	20	40
2.0	40	30	35	25	45	35	40
3.0	60	40	45	35	55	45	40
4.0	70	50	55	45	65	55	40

1 The nominal covers given relate specifically to the minimum member .

- **Placing of Reinforcement**

Reinforcement shall be accurately fixed by any approved means and maintained in the correct position by the use of blocks, spacers and chairs as per IS 2502 to prevent displacement during placing and compaction of concrete.

Any steel not conforming to the specifications shall be rejected. All reinforcement shall be clean, free from grease, oil, paint, dirt, loose mill scale, loose rust, dust, bituminous material or any other substances that will destroy or reduce the bond. All rods shall be thoroughly cleaned before being fabricated. Pitted and defective rods shall not be used.

Unless otherwise specified, reinforcement shall be placed within the following tolerances :

- (i) For effective depth, 200 mm or less + /- 10 mm
- (ii) For effective depth, more than 200 mm + /- 15 mm

The correct cover shall be maintained by cement mortar blocks or other means approved by the Employer's Representative, as described in Section of this tender.

16.2.12 **Cleaning**

Before placing reinforcement and again prior to concrete placement, the reinforcement shall be cleaned of loose mill scale, rust, oil or other coating that would reduce strength or bond. Steps shall be taken to ensure that the reinforcement shall not contact form coatings, release agents, bond breaker or curing compounds.

1 Positioning of Reinforcement

Reinforcement shall be kept in the correct position using the following methods:

For beam and slab construction, pre-cast cover blocks in cement mortar 1:2 (1 cement : 2 coarse sand) about 4 x 4 cm section and of thickness equal to the specified cover shall be placed between the bars and shuttering, to secure and maintain the requisite cover of concrete over reinforcement.

For cantilevered and doubly reinforced beams or slabs, the vertical distance between the horizontal bars shall be maintained by introducing chairs, spacers or support bars of steel at 1.0 metre or shorter spacing to avoid sagging.

For columns and walls, the vertical bars shall be kept in position by means of timber templates with slots accurately cut in them; or with 1:2 cement mortar blocks (1 cement : 2 coarse sand) of the required size suitably tied to the reinforcement to ensure that they are in correct position during concreting.

For other RCC structures such as arches, domes, shells, storage tanks etc a combination of cover blocks, spacers and templates shall be used as approved by Employer's Representative.

2 Tying in Place

The reinforcement shall be accurately placed and tied securely with tying wire at all points where bars cross. Stirrups shall be tied to bars at both the top and bottom. The loose ends of the tying wire shall be bent inwards to prevent them projecting out of the concrete cover provided, taking special care at surfaces where a form finish has been specified. Bars and fabric shall be supported as described in Section of this tender.

Bars intended to be in contact at crossing points shall be securely bound together at all such points with 16 gauge annealed soft iron wire. When epoxy coated reinforcement is used, the wire shall be plastic coated. The vertical distances required between successive

layers of bars in beams or similar members shall be maintained by the provision of spacer bars at such intervals that the main bars do not perceptibly sag between adjacent spacer bars.

3 Splices

Unless otherwise approved, splices shall be wired contact lap splices and conform to the relevant local standard or to IS 2502.

No splicing of vertical bars will be allowed except at approved horizontal construction joints.

Splices in horizontal bars shall be lapped with at least one continuous bar between adjacent splices. The minimum spacing of splices in any one run of bar shall be 6 m and in slabs which contain two layers of reinforcement, splices in opposite layers shall be offset by at least 1.5 m.

4 Welding

Welding of reinforcement shall not be permitted unless specifically approved. If welding is approved, the work shall be carried as per IS 2751, according to best modern practices and as approved by the Employer's Representative. Where permitted, the bars shall be shop or field welded by experienced welders by the direct electric arc process, using low hydrogen electrodes. In all cases of important connections, tests shall be made to prove that the joints are of the full strength of bars welded. The completed weld shall develop a minimum strength of 125 percent of the bar yield strength.

All surfaces close to the weld shall be cleaned free of loose mill scale or other foreign material. The same precautions shall be taken each time an electrode is charged. Chip burned edges shall be cleaned before welds are deposited.

When wire-brushed, completed welds shall exhibit uniform section, smoothness of welded metal, feather edges without undercuts or overlays, freedom from porosity and clinker and good fusion, with penetration into the base metal. Defective welds or parts of welds shall be cut out and re-done satisfactorily. Defective welds or parts thereof shall not be removed by using a cutting torch.

5 Welded Wire Mesh

Welded fabric shall be placed on approved supports to hold it in place during concreting. The fabric shall be laid flat in one plane and bent as required to fit the work. Laps shall be a minimum of one mesh. At laps, alternate wires shall be tied with tying wire.

6 Additional Reinforcement

Additional reinforcement shall be provided at sleeves and openings as required.

7 Inspection

Erected and secured reinforcement shall be inspected and approved by the Employer's Representative prior to placement of concrete.

• Field Quality Control

The Contractor shall appoint an experienced officer to make continuous inspections of the reinforcement during cutting, bending, placing in position, tying and cleaning before the pouring of concrete. He shall effect any corrections or irregularities noted or requested by the Employer's Representative.

Welding for all shop and field welded reinforcing steel bars shall be inspected by the assigned Contractor's officer and regular inspections may be required by the Employer's Representative who shall be given the fullest opportunity to witness the welding

operations.

2 Formwork

- **General**

The Contractor shall submit to the Employer's Representative sufficient details of the proposed shoring and formwork to enable the Employer's Representative to satisfy himself about their general adequacy and effectiveness. Forms, shoring and false work shall be adequate for imposed live and dead loads, including equipment, the height of concrete drop, concrete and foundation pressures, stresses, lateral stability and other safety factors during construction.

The formwork used in the works shall, unless otherwise specified herein, or approved or permitted by the Employer's Representative, comply with IS 14687.

- **Materials**

All formwork shall be constructed of timber, sheet metal or other approved materials, capable of providing the required finish. Where a special finish is required, the Contractor shall provide, before commencement of fabrication, all details of the materials and means he proposes to adopt to obtain the finish. All materials used shall be dimensionally stable on exposure to extremes of weather. Sliding forms and slip forms may be used with the approval of Employer's Representative.

- **Formwork Requirements**

The design of formwork shall take into account all the vertical and lateral loads that the forms will be carrying including live and vibration loadings.

Forms shall conform to the shapes, lines, grades and dimensions including camber of the concrete as necessary. Ample studs, waler braces, straps, shores etc shall be used to hold the forms in proper position without any distortion whatsoever until the concrete has set sufficiently to permit removal of the forms. Forms shall be strong enough to permit the use of immersion vibrators. In special cases, form vibrators may also be used. The shuttering shall be close boarded. Timber shall be well seasoned, free from sap, loose knots, worm holes, warps or other surface defects in contact with the concrete. Faces coming in contact with concrete shall be free from adhering grout, plaster, paint, projecting nails, splits or other defects. Joints shall be sufficiently tight to prevent loss of water and fine material from the concrete.

Plywood shall be used for exposed concrete surfaces, where called for. Sawn and wrought timber may be used for unexposed surfaces. Inside faces of forms for concrete surfaces which are to be rubbed finished shall be planed to remove irregularities or unevenness in the face. Form work with lining will be permitted.

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

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

Formwork, during any stage of construction, showing signs of distortion or distorted to

such a degree that the intended concrete work will not conform to the exact contours required, shall be repositioned and strengthened. Poured concrete affected by faulty formwork shall be entirely removed and the formwork corrected prior to placing new concrete.

Excessive construction cambers to compensate for shrinkage settlement etc that may impair the structural strength of members will not be permitted.

Forms for substructure concrete may be omitted when, in the opinion of Employer's Representative, the open excavation is firm enough to act as the form. Such excavations shall be slightly larger than required by the drawings to compensate for irregularities in excavation and to ensure the design requirements are met.

Forms shall be so designed and constructed that they can be stripped in the order required and their removal does not damage the concrete. Face formwork shall provide true vertical and horizontal joints conforming to the architectural features of the structure as to location of joints and be as approved by Employer's Representative.

The formwork shall be so constructed that up and down vertical adjustment can be made smoothly. Wedges may be used at the top or bottom of timber shores, but not at both ends, to facilitate vertical adjustment or dismantling of formwork.

Where exposed smooth or rubbed concrete finishes are required, the forms shall be constructed with special care so that the desired concrete surfaces can be obtained which require a minimum finish.

- **Form Coating**

Form coating shall be non-grain raising and non-staining resin type coating or other suitable non-staining mould oil which will not leave residual matter on the surface of the concrete or adversely affect bonding to concrete of paint, plaster, mortar, protective coatings, waterproofings or other applied materials. The coatings shall not contain any mineral oils, paraffin, waxes or other non-drying ingredients, nor, in the case of surfaces in contact with potable water, any toxic ingredients of any type whatsoever.

- **Metal Forms**

Metal forms shall be true to detail in condition, clean, free from dents, bends, rust and oil or other defects likely to impair the specified finish.

- **Round Column Forms**

Forms for round columns shall be of metal tubes of materials described for metal forms, fibre glass reinforced plastic or other approved material.

- **Tie Bolts**

Only tie bolts which avoid embedding any metal parts permanently within 50 mm of the concrete surface, shall be permitted. Voids remaining after the removal of all or part of each tie bolt shall be filled flush with the surrounding concrete using a freshly prepared non-shrink cement and fine aggregate paste.

In the case of structures designed to retain an aqueous liquid, the Contractor shall ensure that the measures adopted shall not impair the water tightness of the structure. Tie bolts which form a continuous hole through a structure designed to retain an aqueous liquid

shall not be used.

- **Form Joint Sealers**

Effective precautions shall be taken to ensure that joints between form panels are sufficiently water tight to prevent honey combing resulting from the escape of mortar during the placing and vibration of concrete. The joints shall be sealed with resilient foam rubber strips, non hardening plastic type caulking compound free from oil or other such material or compound as may be approved by the Employer's Representative. Form tie holes shall be plugged with plastic caulking compound, tight fitting rubber plugs or equal.

- **Moulds**

Moulds for grooves, drips, rebates, profiles, chamfers and other similar items shall be of a smooth-milled approved timber or standard extruded polymer plaster units of the required shapes.

- **Bracing Shuttering and Props**

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

The shuttering for beams and slabs shall be so erected that the shuttering on the sides of beams and under the soffits of slabs can be removed without disturbing the beam bottoms.

Re-propping of beams shall not be done except when props have to be reinstated to support construction loads anticipated to be in excess of the design load. Vertical props shall be supported on wedges or other measures shall be taken whereby the props can be gently lowered vertically while striking the shuttering.

If the shuttering for a column is erected for the full height of the column, one side shall be left open and built upon sections as placing of concrete proceeds, or windows may be left for pouring concrete from the sides to limit the drop of concrete to 1.0 m. or as otherwise approved by Employer's Representative.

- **Chamfers & Fillers**

All corners and angles exposed in the finished structure shall be formed with mouldings to form chamfers or fillers on the finished concrete. The standard dimensions of chamfers and fillets, unless otherwise specified, shall be 20 x 20 mm. Care shall be exercised to ensure accurate mouldings. The diagonal face of the moulding shall be planed or surfaced to the same texture as the forms to which it is attached.

- **Vertical Construction Chamfers**

Vertical construction joints on faces which will be exposed at the completion of the work shall be chamfered as above except where not permitted by Employer's Representative.

- **Form Types for Surface Finishes**

Concrete surface finishes shall generally be of the following types

- (i) All interior faces of walls and exposed roofs of structures of above and below grade and exterior surfaces above finished grade shall have a smooth form finish.

- (ii) All exterior walls below finished grade and other surfaces not included in category (1) above, shall have a rough finish, unless otherwise specified.
- (iii) Metal, plywood or forms of other approved material shall be used to provide a smooth finish.
- (iv) Plywood or board forms of lesser quality may be used to provide rough finishes.

- **Shoring and Falsework**

Shoring and false work shall be designed to distribute loads safely over the base area on which the shoring is erected. Adequate precautions shall be taken against undermining or settlement particularly against wetting of soils, when cleaning forms or curing concrete or by any other cause.

- **1 Alignment and Camber**

All forms shall be constructed to produce the required lines, grades and camber as required, in the finished structure. The tolerance on line and level shall not exceed 3 mm. In the absence of any specific camber, the forms for soffits of beams, other than pre-stressed beams, shall under normal circumstances be constructed to provide an upward camber of 6 mm for every 3 metres of clear span.

- **2 Means Adopted**

S-Jacks, wedges or similar approved means shall be used to induce the required camber in the forms and to correct any settlement which may occur either before or during the placing of concrete.

- **Construction**

Form windows shall be provided as necessary to provide access for placement and vibration of concrete. The windows shall be adequately sized to admit chutes and vibrators and should generally be spaced at 2 metre intervals. The windows shall be firmly closed and braced before placing concrete at higher levels.

Temporary openings shall be provided in wall and column forms for inspection and cleaning. All inner surfaces of forms shall be cleaned before any concrete is poured.

Reglets and rebates to receive flashing, frames and other equipment shall be properly formed. Dimensions, details and precise positions of all such reglets and rebates shall be ascertained from the suppliers of the flashings, frames or equipment, if supplied under a separate contract.

If form materials are found to be fit for reuse, they shall be cleaned and re-conditioned before re-erection.

- **Embedded Piping and Other Hardware**

Before the commencement of fabrication of the formwork, all trades requiring openings for the passage of pipes, electrical conduits and other inserts shall be consulted and the necessary pipe sleeves, anchors or other inserts shall be properly and accurately installed by the representative trades or adequate details obtained which would enable the requisite openings to be correctly positioned. Pipes and conduits, when embedded shall not weaken the construction and no pipes, other than electric conduits, shall be permitted to be embedded within a slab not exceeding 12 cm thick. Conduits placed in a concrete slab shall not have an outside diameter exceeding 1/3 the thickness of the slab and shall be placed between the upper and lower layers of reinforcement. Conduits may be embedded in walls if the outside diameter is less than 1/3 the wall thickness and they are not spaced closer than at three diameters centre to centre and do not otherwise weaken the wall.

- **Field Quality Control**

Tell-tale devices or other methods shall be adopted, where approved, to detect movements and deflection of forms during concrete placement. The required slab and beam cambers and verticality and the specified batter of column sides shall be regularly checked, corrected and maintained as concrete loads are applied on the forms. Workmen shall be assigned to check forms and seal all mortar leaks discovered during concreting.

- **Inspection of Formwork**

Any member which is to remain in position after the general dismantling is completed should be clearly marked.

Material used should be checked to ensure that, wrong items / rejects are not used.

If there are any excavations nearby which may influence the safety of the formwork, corrective and strengthening action shall be taken.

The bearing soil must be sound and well prepared and sole plates shall bear well on the ground;

- 1 Sole plates shall be properly seated on their bearing pads or sleepers.
- 2 The bearing plates of steel props shall not be distorted.
- 3 The steel parts on the bearing members shall have adequate bearing areas.

Safety measures to prevent the impact of traffic, scour due to water etc should be taken. Adequate precautionary measures shall be taken to prevent accidental impacts etc.

Bracing, struts and ties shall be installed along with the progress of formwork to ensure the strength and stability of the formwork at intermediate stages. Steel sections (especially deep sections) shall be adequately restrained against tilting, over turning.

When adjustable steel props are used, they shall:

- (i) Be undamaged and not visibly bent;
- (ii) Be complete with the steel pins provided by the manufacturers;
- (iii) Be restrained laterally near each end; and
- (iv) Have means for centralising beams placed in the fork-heads.

Screw adjustment of adjustable props shall not be over extended.

Double wedges shall be provided for adjustment of the form to the required position wherever any settlement / elastic shortening of the props may occur. Wedges should be used only at the bottom end of single props. Wedges should not be too steep and one of the pair should be tightened / clamped down after adjustment to prevent shifting.

The number of nuts and bolts shall be adequate.

All provisions of the design shall be complied with. Cantilever supports shall be adequate.

Props shall be directly under one another in multistage constructions as far as possible. Guy ropes or stays shall be properly tensioned.

There shall be adequate provision for the movement and operation of vibrators and other construction plant and equipment.

The required camber shall be provided over long spans.

Supports shall be adequate and in plumb within the specified tolerances.

- Removal of Forms and Shoring and Striking**

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

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

The striking of formwork shall be as approved by the Employer's Representative.

Generally, however, the following table gives the minimum periods that must elapse before the formwork is removed, reckoned from the time the pouring of concrete was completed.

Position of Formwork and Props	Minimum days for Removal
Walls	1
Sides of beams and columns	1
Slabs (props left under)	3
Props to slabs (spans not exceeding 4 1/2 metres)	7
Props to slabs (spans exceeding 4 1/2 metres)	14
Beam soffits (props left under)	7
Props to beams (spans not exceeding 6 metres)	14
Props to beams (spans exceeding 6 metres)	21

The stripping time recommended above may be modified subject to the approval of the Employer's Representative.

The number of props left under beams and slabs and their sizes and the position shall be such as to safely carry the full dead load of the slab, beam or arch together with any live load likely to occur during curing or further construction.

Where the shape of an element is such that the formwork has re-entrant angles, the form work shall be removed as soon as possible after the concrete has set, to avoid shrinkage cracking occurring due to the restraint imposed.

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

Reinforced temporary openings shall be provided, as approved by Employer's Representative, to facilitate removal of formwork which otherwise may be in-accessible.

Tie rods, clamps, form bolts etc which shall be entirely removed from walls or similar structures shall be loosened not sooner than 24 hours nor later than 40 hours after concrete has been deposited. Ties, except those required to hold forms in place, may be removed at the same time. Ties withdrawn from walls and grade beams shall be pulled towards the inside face. Cutting ties back from the faces of walls and grade beams will not be permitted.

- **Restrictions**

No permanent load or loads from construction equipment shall be imposed on columns, supported beams or supported slabs until the concrete has attained at least twice the compressive strength necessary to sustain the imposed loads.

3 Construction Tolerances

- **General**

Tolerances are a specified permissible variation from the designed lines, grade or dimensions as approved by the Employer's Representative. No tolerances specified for horizontal or vertical building lines or footings shall be constructed beyond the legal boundaries. Unless otherwise approved by the Employer's Representative, the following tolerances shall be permitted:

- **Tolerances for Reinforced Concrete Buildings**

2 Variation from plumb

In the line and surfaces of columns, piers, walls and in buttresses: 5 mm per 2.5 m, but not more than 25 mm.

For exposed corner columns and other conspicuous lines.

In any bay or 5 m maximum: (+/-) 5 mm

In 10 m or more: (+/-) 10 mm

3 Variation from the design levels or grades

In slab soffits, ceilings, beam soffits and in arises.

1 In 2.5 m.: (+/-) 5 mm

(i) In any bay or 5 m. maximum: (+/-) 8 mm

(ii) In 10 m. or more: (+/-) 15 mm

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

(iii) In any bay or 5 m. maximum: (+/-) 15 mm

(iv) In 10 m or more (+/-) 10 mm

4 Variation in linear building lines

In any bay or 5 m. maximum: (+/-) 10 mm

In 10 m. or more: (+/-) 20 mm

5 Sizes and locations of sleeves, openings in walls and floors

Allowable tolerance (+/-) 5 mm (excludes anchor bolts)

6 Variation in cross-sectional dimensions of columns, beams slabs and

walls

Allowable tolerance +10 mm/- 5 mm

7 Footings

Variation in dimensions in plan: +50 mm/-5 mm

Misplacement or eccentricity: 2% of footing within the direction of misplacement but not more than 50 mm

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

8 Variation in steps

Rise in a flight of stairs (+/-) 3.0 mm

Tread in a flight of stairs (+/-) 5.0 mm

Rise in consecutive steps (+/-) 1.5

mmTread in consecutive steps (+/-) 3 mm

• Tolerances in other Concrete Structures

(i) All structures:

Variation of the constructed linear outline from established position in

plan. In 5 m.: (+/-) 10 mm

In 10 m. or more: (+/-) 15 mm

Variation of dimensions to individual structure features from established positions

in plan. In 20 m. or more: (+/-) 25 mm

In buried constructions: +/- 150 mm

Variation from plumb, from specified batter or from curved surfaces of all

structures. In 2.5 m.: (+/-) 10 mm

In 5.0 m.: (+/-) 15 mm

In 10.0 m. or more: (+/-) 25 mm

In buried constructions: (+/-) Twice the above limits.

16.2.13 Variation from level or grade indicated on drawings in slabs, beams, soffits, horizontal grooves and visible arises.

In 2.5 m.: (+/-) 5 mm

In 7.5 m. or more: (+/-) 10 mm

In buried constructions: (+/-) Twice the above limits.

Variation in cross-sectional dimensions of columns, beams, buttresses, piers and similar members.

Allowable tolerance (+) 12 mm / (-) 6 mm

Variation in the thickness of slabs, walls, arch sections and similar

members.

Allowable tolerance (+)12 mm/(-) 6 mm

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

Variation of dimensions in plan: (+)50 mm/(-)12 mm

Misplacement or eccentricity: 2% of footing within the direction of misplacement but not more than 50 mm

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

(iii) Other Tolerances

Tolerances in other types of structures shall generally conform to those given in Clause 2.4 of Recommended Practice for concrete form work IS 14687.

4 Cement Grouting

- **General**

These specification clauses refer to grouting where required in excavated rocky strata.

- **Requirements**

The Contractor shall furnish all tools, equipment, materials and labour for furnishing and placing grout to stop leaks and permanently control the inflow of water through rock faces when necessary for the proper construction of the Works or if instructed to do so by the Employer's Representative.

The Contractor shall carry out the works in accordance with the requirements of IS 6066 – 1971,

- **Construction Plant and Products**

1. Equipment

The equipment used shall be of type, capacity and mechanical condition suitable for satisfactorily completing the work. The power and equipment and their layouts shall conform to all relevant regulations and safety codes applicable to the particular area. All motors shall be equipped with suitable mufflers and scrubbers.

Standard drilling equipment of the rotary type shall be used to perform the drilling. Rotary percussion drills of any type will not be permitted to be used. The drilling equipment utilized within subsurface structures shall be capable of drilling at any orientation to a maximum depth of 7.5 metres.

Holes shall be grouted using the shortest practicable length of line. Fouling of the equipment shall be prevented by maintaining a continuous flow of grout and by periodically flushing with water. A water supply shall be directly connected into the grout supply line. Pressure gauges and adequate valves required for by-pass and shut-off shall be attended constantly by qualified operators at the collar of the hole being grouted.

Additional grout headers, to a maximum of six, shall be available to interconnect holes. Such interconnected holes shall be grouted simultaneously as long as the capacity of the

mixing and pumping system permits the design grouting pressure to be maintained.

The Contractor shall be equipped to continuously flush with fresh water, as approved by the Employer's Representative, those interconnected holes he is not able to grout, if the grout take in a series of interconnected holes exceeds the pump capacity.

The general requirements for the cement grout plant shall include two independent, operational grout pumps connected to allow switching from one to the other in the event of mechanical failure without interrupting the grout flow, operational stand-by equipment for each element of the operation shall be available at the job site.

2. Materials

Mixes consist of cement, water, sand and an approved fluidifier in the proportions as designated by the Contractor's designer and approved by Employer's Representative. The mix may, from time to time, be amended to suit the conditions encountered in particular locations. The water cement ratio by volume shall be varied to meet the characteristics of each hole as revealed by the grouting operation and may range between 10.0 and 0.6. If after mixing, the grout cannot be placed for any reason whatsoever, it shall be wasted.

The proportions of grout shall produce a flowable mixture consistent with a minimum water content and shrinkage. The grout proportions shall be limited as follows:

	Use	Grout thickness	Mix. proportions	W/C. Ratio in (Max.)
Fluid mix	Under 25 mm cement	One	part Portland to one part sand.	0.44
	• General	more than 25 mm but less than 50 mm	One part Portland cement to 2 parts of sand.	0.53
Stiff mix.	50 mm and over cement to 3 parts of sand.	One	part Portland	0.53

Variations in grout mixes and procedures shall be permitted if approved by the Employer's Representative.

Special grout shall be provided in strict accordance with the manufacturer's instructions.

(i) Cement Water and Sand

All cement, water and sand shall be as that used in concrete.

(ii) Fluidifier

Fluidifiers shall be compounds possessing characteristics which will improve the fluidity of the mixture and assist in dispersing shrinkage of the grout. Bentonite or other clay like materials are not acceptable as fluidifiers. Fluidifiers shall be furnished in moisture resistant sacks, shipped in dated sealed containers and shall be handled and stored to avoid absorption of moisture, damage or waste. Material which has become caked due to moisture absorption shall not be used in the work. No fluidifier shall be used that has exceeded the manufacturer's recommended shelf life.

(iii) Pipes

All metal pipes and fittings required for grouting operations shall be furnished, cut, threaded, fabricated and embedded by the Contractor. The pipes shall conform to IS 6631 – 1972.

• **Execution**

14 General

All holes for cement grouting shall be drilled at the locations, in the directions and to the depths approved by the Employer's Representative, as the grouting operations proceed. Grouting shall be performed in the presence of the Employer's Representative. The actual number, depth sequence and spacing of holes and the pressures, pumping rates and grout mixes to be used for grout injections will depend upon the nature of the rock, the results of the water pressure tests or observations and the results of previous grouting operations. They will be determined by the Contractor and subject to the approval of the Employer's Representative.

15 Supervision

The Contractor shall have an experienced supervisor directing his grouting operations. The supervisor shall be experienced in cement grouting in rock.

16 Grout Hole Drilling and Preparation

The holes at the maximum required spacing are referred to as primary holes, hereafter. The number of grout holes shall be increased progressively by split spacing between the primary holes as approved by the Employer's Representative. The type of bit used for drilling shall be at the discretion of the Contractor. The minimum diameter of the hole shall be 38 mm at the point of maximum penetration. Only clean water may be used as a circulating medium when drilling grout holes. Recirculated water shall not be used. Grout hole drilling ahead of the grouting operation shall be limited to the extent that can be grouted within two calendar weeks.

Grout pipes shall be installed in a workman like manner and shall be thoroughly cleaned of all dirt, grease, oil grout and mortar immediately before embedment. All grout pipes shall be sealed to the rock. On completion of grouting, grout pipes shall be cut off flush with the rockline and the holes shall be thoroughly washed before grouting, to the approval of the Employer's Representative. Drill cuttings, fragments and slurry shall be removed from the hole by an air/water jet applied at the bottom of the hole and returned through the hole to the surface. Washing shall continue until all debris is removed from the hole and the return water is clear.

Surfaces to be grouted shall be thoroughly roughened and cleaned of all foreign matter and laitance. Prior to grouting, hardened concrete surfaces to be grouted shall be saturated with water.

The cleaning of bedding planes, joints and fractures shall be accomplished by pumping water through the grout connection at the anticipated grouting pressure. Such pressure washing shall continue at the desired pressure as long as there is an increase in the rate of water intake.

Holes in which the optimum pressure cannot be reached shall be washed for as long as the

fracture filling is being removed, as will be revealed by the escape of muddy water through nearby openings and for not less than five minutes unless otherwise approved. Open holes in which no pressure can be built up shall be washed for a minimum of five minutes or for such a period as fractures or joint filling, as determined by the Employer's Representative.

Each grout hole shall be water pressure tested immediately prior to grouting. Water shall be injected through the test apparatus and through the grout connection. All holes shall be tested at pressures to be determined by the Employer's Representative, but not to exceed 7 kgf/cm². Water tests shall consist of water absorption under designated grouting pressures for a maximum of 10 minutes. This procedure is designated as the water pressure check. Expandable rubber packers shall be provided to seal off the portion of the hole to be tested as instructed. Atmospheric or open hole testing may be required in addition to the pressure testing. A selected number of holes will be utilized for water pressure check holes to determine the grouting effectiveness after the primary holes are grouted.

17 Grouting under equipment and base plates

Anchor bolts, anchor bolt holes and the bottom of equipment and column base plates shall be cleaned of all oil, grease, dirt and loose material. The use of hot, strong, caustic solution for this purpose shall be permitted.

Water in anchor bolt holes shall be removed before grouting is started. Forms around base plates shall be tight to prevent leakage of the grout.

Adequate clearance shall be provided between forms and base plates to permit grout to be worked properly into place.

18 Grouting

Unless specifically approved by the Employer's Representative, each grout hole shall be grouted individually. Approval may be given to grout adjacent holes penetrating the same geologic stratum up to a maximum of six, if communication is established between the holes during grouting and if the water pressure test results in each hole have revealed similar requirements for grout mix and pressure.

Grouting, once started, shall be done quickly and continuously to prevent segregation, bleeding and breakdown of initial set. Grout shall be worked from one side of one end to the other to prevent entrapment of air. To distribute the grout and to ensure more release from entrapped air, link chains shall be used to work the grout into place.

Grouting through holes in base plates shall be by pressure grouting.

Grouting pressure to be used in the work will vary with conditions encountered in different holes and the pressures used for each holes will be as approved by the Employer's Representative. It is anticipated that pressures will range from 0.7 to 7 kgf/cm², but in no event will pressures exceeding 10.5 kgf/cm² be required.

19 Grout Inspection

Once started, the grouting of a hole shall not be interrupted without approval of the Employer's Representative. If necessary to prevent premature stoppage, periodic applications of water under pressure shall be made. Under no conditions shall the pressure or rate of pumping be increased or decreased suddenly. The grouting of any hole shall not be considered complete until refusal. Refusal is defined as a grout injection rate of zero litres per minute measured over a five-minute interval at 100 percent grouting pressure, although in no case will the Contractor be required to pump into a hole in which the grout takes below 30 litres per hour for more than four hours.

The Contractor shall caulk all grout leaks as they develop, as approved by the Employer's Representative. Caulking shall begin on the leaks with the highest volume and progress to those of lesser volume until all leaks are caulked. Prior to grouting, the Employer's Representative may require caulking of leaks which have shown high volume during water pressure testing. If due to the size and continuity of fractures, it is found impossible to reach therequired pressure after pumping a reasonable volume of grout at the minimum workable water- cement ratio, or a mortar grout with the maximum volume of sand at the minimum workable water-cement ratio, the speed of pumping shall be reduced or pumping shall be stopped temporarily and intermittent grouting shall be performed, allowing sufficient time between grout injections for the grout to stiffen. If the desire result is still not obtained, grouting the hole shall be discontinued when approved. In such an event, the hole shall be cleaned, the grout allowed to set and additional drilling and grouting shall then be continued to the this hole or in the adjacent area as approved until the desired resistance is developed.

After grouting refusal is reached, the pressure on the hole shall be maintained by means of a stop-cock or other suitable device until the grout has set.

Grout check holes shall be drilled after the primary hole has been grouted to assess the grouting effectiveness. Additional grouting and drill holes shall be placed between the primary holes as approved by the Employer's Representative.

20 Clean-up

During grouting operation, the Contractor shall take such precautions as may be necessary to prevent drill cuttings, equipment oil, wash water and grout from defacing or damaging the permanent structure. The Contractor shall furnish such pumps as necessary to care for waste water and materials from his operations and clean up waster water and materials from his operations. The clean-up procedure shall be to the satisfaction of the Employer's

Representative.

21 Records

The Contractor shall keep records of all grouting operations including:

- 21.1** logs of grout holes;
- 21.2** hole locations and depths;
- 21.3** results of washing and pressure testing operations;
- 21.4** time of each change of grouting operation;
- 21.5** pressure;
- 21.6** rate of pumping;
- 21.7** amount of cement for each change of water cement ratio; and
- 21.8** any other data which he considers pertinent and important.

All records shall be in a form approved by the Employer's Representative and shall contain all data as required by the Employer's Representative.

5 Damp Proof Courses

The surface to receive a damp proof course shall be cleaned and carefully swept to remove all dust, laitance etc and shall be approved by the Employer's Representative. Damp proof courses shall be cement concrete. An approved waterproofing compound at 3% by weight of cement or as otherwise approved by the manufacturer shall be mixed into the cement mortar for this concrete. The damp proof course shall be laid to the full width of the wall and the edges shall be straight, even and truly vertical. Wooden forms shall be used to obtain good edges. No masonry work shall be commenced onto a freshly laid damp proof course until it has cured for 48 hours but the curing of cement concrete shall be continued along with the masonry work. Specifications for cement, sand, aggregate and water shall be as described for concrete works.

The concrete of ground floors shall be laid in two layers. The top of the lower layer of concrete shall be painted with two coats of A-90 grade bitumen (conforming to IS: 1580) applied at the rate of 1.5 kg/m². The top surface of the lower layer shall be finished smooth while laying the concrete so that the bitumen can be applied uniformly. The bitumen shall be applied after the concrete has set and is sufficiently hard. Bitumen felt conforming to IS: 1322 shall be sandwiched in the sub-floor laid in two layers.

6 Bunds

Bunds shall be provided around every storage vessel may contains materials potentially harmful to the environment.

The capacity of every bund shall be at least 120% of the volume of the largest vessel contained in the bund.

Each bund floor shall drain to a sump into which a portable submersible pump could be lowered.

The bund lining shall be resistant to the chemical being stored. The walls of the bund shall be a maximum of 1200 mm high and designed to support any load induced by the bund being full.

No pipe, cable or duct shall pass through the floor or walls of a bund.

7 Testing of Structures

- **Inspection of Structures**

Immediately after stripping formwork, all concrete shall be carefully inspected and any defective work or small defects, either removed or made good before concrete has thoroughly hardened, as instructed by Employer's Representative.

In case of doubt regarding the grade of concrete used or results of cube strength are observed to be lower than the designed strength as per specifications at 28 days, compressive strength test of concrete based on core test, ultrasonic test and/or load test shall be carried out by the digital ultrasonic concrete tester as approved by the Employer's Representative.

The Contractor shall also conduct conclusive tests such as ultrasonic pulse test, core test etc to prove the suitability of concrete, in case cube tests give unsatisfactory results.

- **Core Test**

The points from which cores are to be taken and the number of cores required, shall be at the discretion of the Employer's Representative and shall be representative of the whole of the concrete concerned. In no case shall fewer than three cores be tested. Cores shall be prepared and tested as described in IS 516

Concrete in the member represented by a core test shall be considered acceptable if the average equivalent cube strength of the cores is equal to at least 85% of the cube strength of the grade of concrete specified for the corresponding age and no individual core has a strength of less than 75%.

In case the core test results do not satisfy the requirements as above, or where such tests have not been done, load testing may be resorted to.

- **Load Tests on Parts of Structures**

Load tests should be carried out as soon as possible after expiry of 28 days from the time of placing of concrete. The structure should be subjected to a load equal to the full dead load of the structure plus 1.25 times the imposed load for a period of 24 hours and then the imposed load shall be removed.

The deflection due to imposed loads only shall be recorded. If, within 24 hours of removal of the imposed load, the structure does not recover at least 75% of the deflection under the imposed load, the test may be repeated after a lapse of 72 hours. If the recovery is less than 80%, the structure shall be deemed to be unacceptable.

If the maximum deflection in mm during 24 hours under load is less than $40L^2/D$, where L is the effective span in metres and D the overall depth of the section in mm, it is not necessary for recovery to be measured and the recovery provision as above will not apply.

- **Other Non-destructive Test Methods**

Other non-destructive test methods may be adopted, in which case the acceptance criteria shall be agreed upon between the Employer's Representative and the Contractor and the test shall be done under expert guidance.

Non-destructive tests are used to obtain an estimation of the properties of the concrete in the structure. The methods adopted include ultrasonic pulse velocity [see IS 13311 (Part 1)] and rebound hammer [IS 13311 (Part 2)], probe penetration, pull out and maturity.

Non destructive tests provide alternatives to core tests for estimating the strength of concrete in a structure, or can supplement the data obtained from a limited number of cores. These methods are based on measuring a concrete property that bears some relationship to strength. The accuracy of these methods, in part, is determined by the degree of correlation between strength and the physical quality measured by the non-destructive tests.

Any of these methods may be adopted, in which case the acceptance criteria shall be agreed upon prior to testing.

Members other than flexural members should be investigated by analysis.

- **Hydraulic Testing of Water Retaining Structures**

For a test of liquid retention, concrete structures should be cleaned and initially filled to the normal maximum level with the specified liquid (usually water) at a uniform rate of not greater than 2 m in 24 hours.

When first filled, the liquid level should be maintained by the addition of further liquid for a stabilizing period while absorption and autogenous healing take place. The stabilizing period may be 7 days for a maximum design crack width of 0.1 mm or 21 days for 0.2 mm or greater. After the stabilizing period, the level of the liquid surface should be recorded at 24 hour intervals for a test period of 7 days. During this 7-day test period the total permissible drop in level, after allowing for evaporation and rainfall, should not exceed 1/500 of the average water depth of the full tank, 10 mm or another specified amount.

Notwithstanding the satisfactory completion of the test, any evidence of seepage of the liquid to the outside faces of liquid-retaining walls should be assessed against the requirements of the specification. In the case of tanks whose external faces are exposed or can be left exposed prior to testing, all leakages, wet patches and the like, shall be marked out on the outside of walls during test. The tank shall then be emptied and any necessary remedial treatment of the concrete, cracks or joints shall be carried out from the liquid face by grouting, waterproofing, plastering etc as necessary to the entire satisfaction of the Employer's Representative. The tank shall again be tested for leakage after rectification. The work shall not be accepted unless the water tightness is established.

16.2.14 When a remedial lining is applied to inhibit leakage at a crack, it shall have adequate

flexibility and have no reaction with the stored liquid.

Should the structure not satisfy the 7-day test, then after the completion of the remedial work it should be refilled and if necessary left for a further stabilizing period; a further test of 7 days' duration should then be undertaken in accordance with this clause.

The external surfaces of the structure shall then be plastered and cured as per the specification. The water from the compartments shall then be drained and the inner surface of the tank in all compartments be checked and any defects rectified. After satisfactory completion of checks, internal coatings shall be applied as required.

Backfilling, in case of underground sumps, and waterproofing the roof where specified, shall be carried out after testing and rectification of defects.

- **Unsatisfactory Tests**

Should the results of any test prove unsatisfactory, or the structure shows signs of weakness, undue deflection or faulty construction, the Contractor shall remove and rebuild

the member or members involved or carry out such other remedial measures as may be required to the approval of the Employer's Representative.

The completion certificate shall not be given unless the test for water tightness as described above is carried out to the entire satisfaction of the Employer's Representative.

1. Piling

- **General**

Pile foundations may be necessary for supporting structures where the subsoil is considered to have insufficient bearing capacity. The Contractor shall carry out the detailed design of these structures in accordance with the Contract Conditions and Employer's Requirements and shall determine the type of foundation required, the number of piles and their working loads and the optimum arrangement of piles required for supporting the structures.

Piles shall be designed, constructed and tested in accordance with the relevant sections of IS 2911.

Excavation, concrete, steel reinforcement and steel casing, where applicable, shall conform to the relevant Clauses of the Specification. At least 21 days before the Contractor intends to commence piling work on the Site, the Contractor shall submit for the Employer's Representative's approval full details of his proposed piling system including the type and dimensions of piles, reinforcement details and full design and driving calculations. The details to be submitted shall include the Contractor's proposals for equipment, temporary works and construction methods.

No work on piling shall commence on the Site until the Employer's Representative's approval to the Contractor's proposal has been received.

Notwithstanding the requirements outlined in this section, the design shall be entirely the Contractor's responsibility.

- **Types of Piles**

Bearing piles shall be driven reinforced pre-cast concrete or cast in-situ concrete piles.

All concrete for piles shall be in sulphate resisting cement, unless the Contractor can document that a lesser quality complies with the actual aggressiveness of soil and ground water. The use of a lower quality is subject to the approval of the Employer's Representative.

- **Design of Piles**

Piles shall be designed to sustain the required loads with settlements not exceeding those specified. Allowance shall be made in the design for the incidence of negative skin friction where appropriate and for resisting the necessary tensile forces due to the swelling and heave of any soil stratum.

Piles shall be designed to have a bearing capacity of at least 2.5 times the working load (working load = design load).

The permissible loading of piles shall be modified where necessary to allow for particular conditions: piles in close proximity or in groups, soil strength, groundwater level and other relevant factors.

The piles shall be of sufficient cross-section and length, and configured in a way to sustain the loads designed or specified without settlement (of single piles combined with additional settlements due to group action) exceeding the following:

- Working load allowable settlement 8 mm
- 1.5 × Working load allowable settlement 10 mm
- 2 × Working load allowable settlement 12 mm

These settlements shall include both permanent and elastic deflections. Measurement of the settlement shall be made on first achieving the specified load. Measurement of the settlement shall be made at the point of application of the load.

Where piles in place are subjected to handling, stacking and pitching or bending moments and/or shear forces, these shall be combined with the vertical loads (either in compression or tension) to satisfy the design requirements of BS 8110 Parts 1, 2 and 3.

The average compressive stress in the concrete of bearing piles under working load shall not exceed 25% of the characteristic cube strength at 28 days, calculated on the total cross sectional area of the pile shaft.

• **Preliminary Test Piles**

After the Employer's Representative has approved the Contractor's proposals and calculations for the piling system, preliminary test piles shall be constructed to the approval of the Employer's Representative.

These shall be loaded to two times the working load to prove the design and system and to demonstrate that the safe load requirements can be achieved by the piling method proposed.

The preliminary test piles shall be located in places proposed by the Contractor and approved by the Employer's Representative. The Employer's Representative shall be given at least 48 hours notice of commencement of construction of the preliminary pile which is to be test-loaded.

The preliminary test piles shall be constructed and installed in a manner similar to that to be used for the construction of the working piles by the use of similar equipment and materials. Any variation will only be permitted with the prior approval of the Employer's Representative.

For the preliminary piles that are to be test loaded, a detailed record of the progress during construction/installation shall be made and submitted to the Employer's Representative daily.

The pile shafts shall be terminated at the normal cut-off level or at some other level as required by the Employer's Representative.

The pile shafts shall be extended where necessary above the cut-off level of working piles so that gauges and other apparatus to be used in the testing process will not be damaged by water or falling debris and to permit exposure of the reinforcement.

Where the pile shaft is extended above the cut-off level of the working piles in soils that would influence the load bearing capacity of the pile, a sleeve shall be left in place during testing to eliminate friction that would not arise in working piles.

If the cut-off level is below ground level and the shaft is not extended and there is a risk of the borehole collapsing, a sleeve shall be left in place or inserted above the pile shaft or other means satisfactory to the Employer's Representative shall be employed. Adequate clearance shall be given between the top of the pile shaft and the bottom of the sleeve to permit unrestricted movement of the pile.

For a pile that is tested in compression, the pile head or cap shall be formed to give a

plane surface, which is normal to the axis of the pile and sufficiently large to accommodate the loading and settlement measuring equipment. The pile head or cap shall be adequately reinforced or protected to prevent damage due to the concentrated application of load from the loading equipment.

The pile cap shall be concentric with the test pile and the joint between the cap and the pile shall have a structural strength equivalent to that of the pile.

A sufficient clear space shall be made under any part of the cap projecting beyond the section of the pile so that at the maximum anticipated settlement, load is not transmitted to the ground except through the pile.

The connection between the pile and the loading equipment shall be constructed in such a manner as to provide strength equal to the maximum load that is to be applied to the pile during the test with an appropriate factor of safety on the structural design.

If the preliminary test pile fails to meet the requirements, the piling system proposed will be considered unsatisfactory. The Contractor shall then submit revised proposals and calculations for the approval of the Employer's Representative. Unless otherwise agreed by the Employer's Representative, any test pile that has failed the preliminary test will be rejected and the Employer's Representative and the Contractor shall provide one or more further test piles and tests to prove his modified system.

- **Lengths and Tolerances**

The Contractor shall determine the approximate lengths of piles by examination of the available geotechnical information.

In case the available geotechnical information does not describe the ground conditions to a sufficient depth to ensure safety, additional soil investigations shall be carried out by the Contractor to the Employer's Representative's approval.

Piles shall be constructed within the following tolerances:

- in plan, at the working level of the piling rig $0.15 \times B$ in any direction from the designed position; B = pile dimension (diameter or side);
- 1 in 75 from the vertical for a vertical pile;

The cross-sectional dimensions of the pile shall not be less than those proposed by the Contractor nor shall they exceed them by more than $0.015 \times B$ (B = pile dimension, diameter or side).

No face of a pre-cast pile shall deviate by more than 6 mm from a straight edge 3 m long joining two points on that face, nor shall the centre of area of the pile at any cross section deviate more than $1/500$ of the pile length from a line joining the centres of area of the ends of the pile.

- **Sequence for Constructions**

The sequence of construction of piles shall be to the approval of the Employer's Representative and shall be arranged to minimise the vertical and lateral displacement of piles already installed. Levels of the tops of adjacent piles or the structures founded upon them or any other structures shall be measured at intervals while a pile is being installed. Driven piles which have risen, shall be re-driven or forced down to the original resistance.

- **Driving Piles**

The Contractor shall submit for the Employer's Representative's approval, details regarding the suitability, efficiency and energy of his driving equipment.

Pre-cast concrete piles shall not be driven until the concrete has achieved the specified characteristic strength.

Cast-in-situ piles driven with steel casing shall be bottom driven using a casing that shall not distort or buckle during driving. Concrete casing shall be driven on the pile shoe using a mandrel.

Each pile shall be driven continuously until the approved set and/or depth has been reached except that the Employer's Representative may permit the suspension of driving if he is satisfied that the rate of penetration prior to cessation of driving will be substantially re-established on its resumption or if he is satisfied that the suspension of driving was beyond the control of the Contractor.

A follower (long dolly) shall not be used except with the approval of the Employer's Representative who will then require the set to be revised to take into account the reduction in the effectiveness of the hammer blow.

The final set of each pile shall be recorded either as the penetration in millimetres per 10 blows or as the number of blows required to produce a penetration of 25 mm.

When a final set is being measured the following requirements shall be met:

- 14 The exposed part of the pile shall be in good condition without damage or distortion;
- 15 The dolly and packing, if any, shall be in sound condition;
- 16 The hammer blow shall be in line with the pile axis and the impact surfaces shall be flat and at right angles to the pile and hammer axis;
- 17 The hammer shall be in good condition, delivering adequate energy per blow and operating correctly; and
- 18 The temporary compression of the pile shall be recorded, if required by the Employer's Representative.

The Contractor shall give adequate notice and provide all facilities to enable the Employer's Representative to check driving resistances. A set for purposes of the Contract shall only be taken in the presence of the Employer's Representative unless otherwise agreed.

At the start of the work and in new areas or sections, a detailed driving record shall be obtained over the full length of the first pile and during the last 3 m of driving of subsequent piles to establish the behaviour of the piles.

The Contractor shall inform the Employer's Representative without delay if an unexpected change in driving characteristics is noted. A detailed record of driving resistance over the full length of the nearest available pile shall be taken.

Re-drive checks, if required, shall be carried out by a procedure to be agreed by the Employer's Representative.

Piles shall be driven in an approved sequence to minimise the detrimental effects of heave and lateral displacement of the ground.

Measurements shall be taken to determine the movement of ground or any pile resulting from the driving process when required by the Employer's Representative.

Where piles have risen as a result of driving adjacent piles, the Contractor shall submit to the Employer's Representative his proposals for correcting detrimentally affected piles and for avoidance or control of heave effects in subsequent work

Jetting may be carried out only when approved by the Employer's Representative and the Contractor shall submit detailed proposals and it shall not normally be undertaken over the last 3 m of penetration.

- **Repair and Lengthening of Piles**

In preparation for repairing the head of a pile, the concrete shall be cut off square at sound concrete to expose the reinforcement and all loose particles shall be removed by wire brushing followed by washing with water.

If the pile is to be subjected to further driving the head shall be replaced with concrete of an approved class.

If the pile has been completely driven but the sound concrete is below cut-off level, the pile shall be made good to cut-off level with concrete of a class not inferior to that of the concrete of the pile.

In preparation for lengthening a normal reinforced pile, the concrete shall be cut off square to expose a sufficient length to ensure that the full strength of the bars will be developed across the joint.

For lap or splice joints, sufficient link bars shall be provided to resist eccentric forces.

If the pile is to be subjected to further driving the additional length shall be of an approved grade of concrete.

Other methods of lengthening shall be subject to approval by the Employer's Representative.

Repaired or lengthened piles shall not be driven until the added concrete has reached the specified characteristic strength of the concrete of the pile.

- **Reinforcement**

Unless otherwise required by the design, cast in situ piles shall be reinforced over the whole of their length.

The minimum longitudinal reinforcement shall be 1.0% of the gross concrete area in the top 3 m of the pile and 0.8% of the gross concrete area in the remainder of the pile. Lateral ties shall be provided to maintain the alignment of the longitudinal reinforcement at centres not closer than 150 mm.

Unless otherwise required by the design, reinforcement in pre-cast concrete piles shall comply with the following minimum requirements:

Area of longitudinal reinforcement of 12 mm diameter minimum shall be at least 1% of the gross concrete area (cast in-situ and pre-cast concrete piles);

Lateral reinforcement shall be in the form of hoops or links not less than 6 mm diameter. Over a distance of 3 times the width of the pile measured from each end of the pile the volume of lateral reinforcement shall be not less than 0.6% of the gross volume. In the body of the pile, the lateral reinforcement shall not be less than 0.4% spaced at not more than half the width of the pile. The transition between the close spacing near the ends and the maximum spacing shall be made gradually over a length equal to 3 times the width.

Piles of rectangular cross section shall have a minimum of 4 longitudinal reinforcement bars and piles of circular cross section shall have a minimum of 6 longitudinal reinforcement bars. Bars shall be 12 mm diameter minimum. The main longitudinal bars shall be level at the top of the pile and fit tightly into the shoe if one is used.

Hoops and links shall fit tightly against longitudinal bars and be bound to them by

welding or soft iron wire with the free ends turned inwards. The longitudinal bars shall be held apart by spreader forks not more than 1.5 m apart.

The main longitudinal reinforcing bars in piles not exceeding 12 m in length shall be in one continuous length unless otherwise required. In piles exceeding 12 m in length, joints will be permitted in main longitudinal bars at 12 m nominal intervals. Joints in adjacent bars shall be staggered at least 1 m apart along the length of the pile. Joints shall be such that the full strength of the bar is effective across the joint.

The cover to the outermost reinforcement, including binding wire shall not be less than 60 mm measured to the inside of the casing. Lap or splice joints shall be provided with sufficient link bars or other elements to resist eccentric forces. Laps shall have a minimum length of 40 times the diameter of the main longitudinal reinforcement.

Main longitudinal reinforcement shall project a minimum of 40 times the bar diameter above the cut-off level of the pile. For pre-cast piles, compliance with this requirement will necessitate breaking down of the pile head after driving.

- **Pile Shoes**

Driven piles shall be provided with flat or pointed co-axial shoes of cast iron if driving is liable to damage the concrete at the tip of the pile.

- **Records**

The Contractor shall maintain a complete record of all piling works that shall include the following where relevant:

- pile type and number
- nominal diameter or dimension, pile length
- date of casting and date driven
- depth from ground level to toe of pile
- depth from ground level to bearing stratum
- set of pile or pile tube in mm per 10 blows or blows per 25 mm of penetration for first piles in new areas or sections, sets taken at intervals during the last 3 m of driving for subsequent piles
- final set, weight and drops of hammer
- details of any obstructions observed.
- ground level at pile position at commencement of pile installation
- pile cut-off level
- length of temporary or permanent casing
- length and details of reinforcement
- concrete mix
- volume of concrete supplied to pile where this can be measured in practice

All records shall be accurately kept in duplicate as the work proceeds and one copy shall be handed to the Employer's Representative at the completion of each day's work.

- **Pre-cast Reinforced Concrete Piles**

Pre-cast reinforced concrete piles shall be designed cast and cured to develop the strength necessary to withstand the transporting, handling and driving stresses without

damage. Square piles shall have chamfered corners.

- **Cast-In-Situ Piles**

14.14.1 Driven or Bored Cast-in-situ Piles

Driven or bored cast-in-situ piles shall comprise a temporary or permanent casing of steel, or a permanent casing of pre-cast concrete, augured or driven to a set and completely filled with dense concrete reinforced with steel bars.

All joints in the casing and between the casing and shoes, where applicable, shall be watertight during driving and completion of driven cast-in-situ piles. Permanent casing shall be inspected, by using a light lowered from the top after installation to ensure that the casing is neither damaged nor deformed and that all loose soil has been removed from the bottom of bored piles.

Drilling mud shall not be used unless otherwise approved by the Employer's Representative.

14.14.2 Casing for Cast-in-situ Piles

The casing shall be suitable for the method of installation and for the purpose of jointing piles. The casing may either be permanent or temporary.

Steel casing shall be delivered to Site in as a long length as can be conveniently handled. Ends shall be prepared for butt-welding and designed to maintain true alignment of the pile.

Joints between steel casings shall be made by butt-welding so that the full strength of the original section is developed. Welded joints shall be watertight.

14.14.3 Concreting Cast-in-situ Piles

Concrete in cast-in-situ piles shall be in accordance with the requirements. The slump for the concrete shall be agreed with the Employer's Representative prior to concreting preliminary test piles. Concrete filling in cast-in-situ piles shall be placed continuously. Removal of temporary casings must be complete before the placed concrete loses its workability to ensure that the concrete is not lifted, but placing of concrete shall keep in advance of withdrawal of casing to prevent necking.

Pile heads shall be stripped down and bonded into the pile caps as specified for pre-cast concrete piles.

- **Pile load tests**

- **General**

Pile load tests shall be carried out in the following situations:

- when using a type of pile or installation method that is outside comparable experience and which has not been tested under comparable soil and loading conditions;
- when using a piling system which is outside the experience of the operatives carrying out the work;
- when the piles will be subject to loading for which theory and experience do not provide sufficient in the design. The pile testing procedure should then provide loading similar to the anticipated loading; and

- when observations during the process of installation indicate pile behaviour that deviates strongly and unfavourable from the behaviour anticipated on the basis of the site investigation or experience when additional ground investigations do not clarify the reasons for this deviation.

Load test can be as a static test or a dynamic test.

If one pile load test is carried out, it shall normally be located where the most adverse ground conditions are believed to occur. If this is not possible, an allowance shall be made when deriving the characteristic value of the bearing resistance.

If load tests are carried out on two or more test piles, the test location shall be representative of the site of the pile foundations, and one of the test piles shall be located where the most adverse ground conditions are believed to occur.

Between the installation of the test pile and the beginning of the load test, adequate time shall be allowed to ensure that the required strength of the pile material is achieved and the pore pressures have regained their initial values.

• **Static Load Tests**

(i) Loading procedure

The pile load test procedure, particularly with respect to the number of loading steps, the duration of the loading steps and the application of load cycles, shall be such that conclusions can be drawn about the deformation behaviour, creep and rebound of a pile foundation from the measurements on the pile. For trial piles, the ultimate loading shall be such that conclusions can also be drawn about the ultimate failure load.

Devices for the determination of forces, stresses or strains and displacements shall be calibrated prior to the test.

The direction of the applied force to compression or tension pile tests shall coincide with the longitudinal axis of the pile.

In general, pile load tests for the purpose of designing a tensile pile foundation should be carried out to failure. Extrapolation of the load-displacement graph for tension tests should normally not be used, especially in the case of transient loading.

(ii) Trial piles

The number of trial piles required to verify the design shall be selected on the following aspects:

- the ground conditions and their variability across the site;
- type of structure;
- documented evidence of the performance of the same type of pile in similar ground conditions; and
- the total number and types of piles in the foundation design.

The ground conditions at the test site shall be investigated thoroughly. The depth of borings or file tests shall be sufficient to ascertain the nature of the ground both around and beneath the pile tip. It shall include all strata likely to contribute significantly to pile deformation behaviour, at least five times the diameter beneath the pile tip, unless

sound rock or veryhard soil is found at a lesser depth.

The method used for installation of the trial piles shall be fully documented.

(iii) Working piles

The number of working pile load tests shall be selected on the basis of the recorded findings during construction.

The load applied to working test piles shall be at least equal to the design load governing the design of the foundation.

• Dynamic Load Tests

• General

The results of dynamic load tests may be used for design provided an adequate site investigation has been carried out and the method has been calibrated against static load tests on the same type of pile of similar length and cross-section, and under comparable soil conditions.

Dynamic test results shall always be considered in relation to each other.

Dynamic load tests may be used as an indicator of the consistency of the piles and to detect weak piles (integrity testing).

In a dynamic load test the pile is instrumented with accelerometers and strain gauges within two pile diameters of the top of the pile.

The gauges are connected to a recording and data processing device. During blows on the pile signals from the gauges are recorded and processed for assessment of pile bearing capacity. The data processing will be of two kinds: one simple (CASE or likewise method) and one more exact method based on signal matching (CAPWAP or likewise program).

In the CASE method or likewise the following data shall be registered and reported:

- (i)** bearing capacity;
- (ii)** toe resistance and skin friction;
- (iii)** maximum compression stress, acceleration, velocity and displacement;
- (iv)** maximum tension stress in pile;
- (v)** pile structural integrity; extent and location of damage;
- (vi)** maximum energy transferred to the pile;
- (vii)** blows per minutes for hammer check;
- (viii)** blow number;
- (ix)** input and reflection of force, velocity, upward and downward force waves; and
- (x)** load versus deflection of cushions and of pile toe bearing'

CAPWAP or likewise program determines that set of soil resistance parameters which produces the best match between measured and computed pile top force and velocity. After CAPWAP analysis, additional information produced than from CASE is:

- (xi)** deformation properties, ultimate capacities and soil damping parameters for each soil segment of normally 1 m length;

- (xii) unit skin friction for each segment and end bearing;
- (xiii) maximum of tension and compression forces and stresses;
- (xiv) pile structural damping;
- (xv) dynamic pile toe displacement; and
- (xvi) graph on bearing capacity and pile stresses versus blow count.

An introductory program (WEAP) can be utilised before pile driving to assess preliminary combinations of sets and bearing capacities for specified pile driving equipment and soil conditions.

Well-experienced experts shall carry out the data processing.

• **Dynamic Load Test Procedure**

The Contractor shall notify the Employer's Representative at least two weeks prior to dynamic testing

The Contractor shall submit a qualified testing consultant and his experience to the Employer's Representative for approval.

The Employer's Representative shall determine if the test is to be performed or if some pile waiting periods at the proposed site is required before a decision will be made.

The Employer's Representative will establish a date for the tests and will also determine the location of all piles to be dynamically load tested.

• **Dynamic Load Test Procedure on Driven Piles**

The Contractor shall supply all personnel and equipment needed to strike the test pile with the hammer.

The Contractor shall provide the hammer (drop, diesel, etc) or the crane to lift a steel ram weight by a single non-twisting cable and be able to strike the pile top by means of full-gravity-fall.

The testing consultant personnel will drill holes into the pile to be tested so that transducers (two accelerometers and two strain gauges) can be attached.

When the transducers have been placed in position and the recording and processing equipment has been made ready to receive the acceleration and strain measurement, the Contractor shall strike the driven pile with the hammer as many times as is required to obtain adequate measurements as determined by the Employer's Representative.

The Employer's Representative may ask the Contractor to provide surveying instrument to monitor the pile set after each strike.

After the dynamic testing measurements have been obtained and analysed the Contractor shall prepare and submit a complete report to the Employer's Representative.

• **Dynamic Load Test Procedure on Bored Piles.**

The Contractor shall prepare the pile top and, if necessary, improve the structural integrity of the pile top to resist a sharp impact force. All loose concrete at the pile top shall be removed. The top portion of the bored pile shall be extended a length of at least two times the diameter of the bored pile with the same diameter as the bored pile. The

extended portion of the bored pile shall be cast with concrete having a minimum compressive strength of 40 MPa.

Additional shear reinforcement such as spiral hoops at the pile top is recommended for the impact force. The Contractor shall provide the windows for the installation of instruments by means of burring $0.35 \times 0.35 \text{ m}^2$ to the steel casing using a cutting torch.

On top of the bored pile, a timber cushion shall be placed under a steel plate to act as a hammer cushion. Adhesive material may be applied between the pile top and the timber.

The Contractor shall provide an additional steel casing inserted into the pile top. This casing shall act as a guide for the steel ram weight, having a length not less than the summation of the drop height and the length of the steel ram weight. A vibrating hammer shall be used to secure and stabilise the steel casing.

The Contractor shall supply all personnel and equipment needed to strike the test pile with the steel ram weight. The Contractor shall provide a crane which has the capability to lift the steel ram weight by a single non-twisting cable and be able to strike the pile top by mean of full-gravity-fall.

The testing consultant personnel will drill holes in the windows of the left-in-place steelcasing into the pile to be tested so that transducers (two accelerometers and two strain gauges) can be attached.

When the transducers have been placed in position and the recording and processing equipment has been made ready to receive the acceleration and strain measurement, the Contractor shall strike the driven pile with the hammer as many times as is required to obtain adequate measurements as determined by the Employer's Representative.

The Employer's Representative may ask the Contractor to provide surveying instrument to monitor the pile set after each strike.

After the dynamic testing measurements have been obtained and analysed the Contractor shall prepare and submit a complete report to the Employer's Representative.

• **Load Test Report**

The Contractor shall, within 24 hours of the completion of the tests, submit to the Employer's Representative a complete record of each pile test. Where appropriate, this report shall include:

- a description of the site;
- the ground conditions with reference to ground investigations;
- the pile type;
- a description of the loading and measuring apparatus and the reaction system;
- calibration documents of the load cells, the jacks and the gauges;
- the installation record of the test piles;
- photographic records of the pile and the test site;
- test results in numerical form;
- time settlement plots for each applied load when a step loading procedure is used;
- the measured load-settlement behaviour; and
- justification of the reasons for any departures from the recommendations.

• Piles in Compression

(i) Ultimate Bearing Resistance from Static Pile Load Tests

Trial piles to be tested shall be installed in the same manner as the piles that will form the foundation and shall be founded in similar stratum.

In the case of a very large diameter pile, it is often impractical to carry out a load test on a fullsize trial pile. Load tests on smaller diameter trial piles may be considered provided that:

- the ratio of the trial pile/working pile diameter is not less than 0.5;
- the smaller diameter trial piles are fabricated and installed in the same way as the piles used for the foundations; and
- the trial pile is instrumented in such a manner that the base and shaft resistance can be derived separately from the measurements.

In the case of a pile foundation subjected to down drag, the pile resistance at failure or at a displacement which equals the criterion for the verification of the ultimate limit state determined from the load test results shall be corrected by subtracting the measured or the most unfavourable design positive skin friction force in the compressible stratum from the forces measured at pile head.

When deriving the ultimate characteristic bearing resistance R_{cc} from values R_{cms} measured in one or several static pile load tests, an allowance shall be made for the variability of the ground and the variability of the effect of pile installation. As a minimum, both conditions of the table below shall be satisfied using the equation:

$$R_{cc} = \frac{R_{cms}}{\gamma_{ns}}$$

16.2.15 Factors γ_{ns} to derive R_{cc} :

Number of load tests	1	2	>2
γ_{ns} on average R_{cms}	1,5	1,35	1,3
γ_{ns} on lowest R_{cms}	1,5	1,25	1,1

In order to derive the ultimate design bearing resistance, the characteristic value, R_{cc} , should be divided into components of base resistance, R_{cbc} , and shaft resistance, R_{csc} , such that:

$$R_{cc} = R_{cbc} + R_{csc}$$

The design bearing resistance, R_d , shall be derived from

$$R_{cd} = \frac{R_{cbc}}{\gamma_{bs}} + \frac{R_{csc}}{\gamma_{ss}}$$

where γ_{bs} and γ_{ss} are taken from the table below.

Values of γ_{bs} , γ_{ss} and γ_{ts} :

Component factors	γ_{bs}	γ_{ss}	γ_{ts}
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Driven piles	1,3	1,3	1,3
Bored piles	1,6	1,3	1,5
CFA piles	1,45	1,3	1,4

Normally the load test only provides the pile load test versus settlement and time versus settlement diagrams without distinction between point and shaft resistance. Therefore, it is often not possible to distinguish between partial factors for the assessment of the design value of base resistance and shaft resistance. Instead a partial factor on the ultimate characteristic pile resistance R_{cc} may be taken as the γ_{ts} values given in the table above.

(ii) Ultimate Bearing Resistance from Pile Driving Formulae

If pile-driving formulae are used to assess the ultimate bearing resistance of individual compression piles in a foundation, the validity of the formulae shall have been demonstrated by previous experimental evidence of good performance or static load tests on the same type of pile of similar length and cross-section and in the similar ground conditions.

Pile driving formulae shall only be used if the stratification of the ground has been determined.

In the design, the number of piles to be re-driven shall be specified. If re-driving gives lower results, these shall be used as the basis for ultimate bearing resistance assessment. If re-driving gives higher results, these may be taken into consideration. Re-driving should usually be carried out in silt soils, unless local comparable experience has shown it to be unnecessary.

(iii) Ultimate Bearing Resistance from Dynamic Load Tests

Dynamic load tests and their evaluation can be used to assess pile-bearing resistance of individual compression piles. The validity of the evaluation shall have been demonstrated by previous evidence of acceptable performance or static load tests on the same pile type of similar length and cross-section and in similar soil conditions. The input energy level during the dynamic load testing shall be high enough to allow for an appropriate interpretation of the pile capacity at a correspondingly high enough strain level.

When deriving the ultimate characteristic bearing resistance R_{cc} from values R_{cmd} measured in two or several dynamic pile load tests, an allowance shall be made for the variability of the ground and the variability of the effect of pile installation. As a minimum, both conditions of the table below shall be satisfied using the equation:

$$R_{cc} = \frac{R_{cmd}}{\gamma_{nd}}$$

Factors γ_{nd} to derive R_{cc} :

Number of load tests	2	4	>4
a) γ_{nd} on average R_{cmd}	1,5	1,35	1,3
b) γ_{nd} on lowest R_{cmd}	1,5	1,25	1,1

In order to derive the ultimate design bearing resistance, the characteristic value, R_{cc} , should be divided into components of base resistance, R_{cb} , and shaft resistance, R_{cs} , such that

$$R_{cc} \gamma R_{cbc} \gamma R_{csc}$$

The design bearing resistance, R_{cd} , shall be derived from

$$R_{cd} = \frac{R_{cbc}}{\gamma_b} \gamma_{sd} \frac{R_{csc}}{\gamma_{td}}$$

where γ_{bd} and γ_{sd} are taken from the table below.

Values of γ_{bd} , γ_{sd} and γ_{td}

Component factors	γ_{bd}	γ_{sd}	γ_{td}
Driven piles	1,4	1,4	1,4
Bored piles	1,7	1,4	1,6

In case R_{cbc} and R_{csc} are not known the design bearing resistance R_{cd} is derived from

$$R_{cd} = \frac{R_{cc}}{\gamma_{td}}$$

• Piles in Tension

(i) Ultimate tensile resistance from static pile load tests

Pile load tests to determine the ultimate tensile resistance R_{tc} of an isolated pile shall be carried out in accordance with Clause of the tender.

When deriving the ultimate characteristic resistance R_{tc} from values R_{tms} measured in one or several static pile load tests, an allowance shall be made for the variability of the ground and the variability of the effect of pile installation. As a minimum, both conditions of the table below shall be satisfied using the equation:

$$R_{tc} = \frac{R_{tms}}{\gamma_{nt}}$$

Factors γ_{nt} to derive R_{tc} :

Number of load tests	1	2	>2
a) γ_{nt} on average R_{tms}	1,5	1,35	1,3
b) γ_{nt} gnt on lowest R_{tms}	1,5	1,25	1,1

Normally when piles are loaded in tension, more than one pile shall be tested. In the case of a larger number of tension piles, at least 2% shall be tested.

The design tensile resistance, R_{td} , shall be derived from

$$R_{td} = \frac{R_{tc}}{\gamma_m}$$

where $\gamma_m = 1.6$.

•Supervision of construction

A pile installation plan shall be the basis for the construction work. The plan should give the following design information:

- the pile type with designation if standardised or technical approval otherwise;
- the location and inclination of each pile and tolerances on position;
- pile cross-section;
- pile length;
- number of piles;
- required pile load carrying capacity;
- pile toe level or the required penetration resistance;
- installation sequence;
- known obstructions; and
- any other constraints on piling activities.

The installation of all piles shall be monitored and records shall be made at site and as the piles are installed. A record signed by the supervisor of the work and the pile manufacturer shall be kept for each pile.

The record for each pile shall include the following, where appropriate:

- pile type and installation equipment;
- pile number;
- pile cross-section, length and reinforcement;
- data and time of installation (including interruptions to the construction process);
- concrete mix, volume of concrete used and method of placing for cast-in-situ piles;
- pumping pressures of the grout or concrete, internal and external diameters, pitch of screw and penetration per revolution (for continuous flight auger piles or other injection piles);
- for driven piles, the values of driving resistance measurements such as weight and drop or power rating of hammer, blow frequency and number of blows for at least the last 0.25 m penetration;
- the power take-off of vibrators (where used);
- the torque applied to the drilling motor (where used);
- for bored piles, the strata encountered in the borings and the condition of the base, if the performance of the base is critical;
- obstructions encountered during piling; and
- deviations of positions and directions and as-built elevations.

Records shall be kept for at least a period of five years after completion of the works. As-built record plans shall be compiled after completion of the piling and be kept with the construction documents.

If site observations or inspection of records reveal uncertainties with respect to the quality of installed piles, additional investigations shall be carried out to determine the as-built conditions of the piles and whether remedial measures are necessary. These investigations shall include either re-driving or pile integrity tests, in combination with soil mechanics field tests adjoining the suspected piles and static pile load tests.

Tests shall be used to determine the integrity of piles for which the quality is sensitive to the

installation procedures if the procedures cannot be monitored in an alternative reliable way.

Dynamic low-strain integrity tests can be used for a global evaluation of piles that might have severe defects or that may have caused a serious loss of strength in the soil during construction. Since defects like insufficient quality of concrete and thickness of concrete cover, affecting the long-term performance of a pile, often cannot be found by dynamic tests, other tests such as sonic tests, vibration tests or coring may be needed in supervising the execution.

2. Structural Steel

• Materials

All structural steel shall be of standard sections and shall be free of scale, blisters, laminations, cracked edges and defects of any sort. The Contractor shall furnish duplicate copies of all mill orders and/ or the test report received from the mills, to the satisfaction of the Employer's Representative.

All structural steel and electrodes shall comply in all respects with IS for structural steel.

Any other quality may be used only if approved by the Employer's Representative. Such permission shall be preceded by yield point stress, ultimate tensile stress, ductility, weld- ability tests or any other characteristics as required by the Employer's Representative.

Steel castings shall conform to Grade III of IS 1030- Specifications for steel casting for general engineering purposes.

16.2.16 15.1.1 Dimensions and Tolerances

15 General

The dimensional and weight tolerance for rolled shapes shall be in accordance with IS: 1852 for indigenous steel and equivalent applicable codes for imported steel.

An acceptable deviation from flatness in girder webs in the length between the stiffeners or in a length equal to the girder depth shall be 1/150 th of the total web depth.

A reasonable limit for combined warping and tilt on the flange ends of a built up member is 1/200 th of the total width of flange or 3 mm whichever is smaller measured with respect to centreline of flange.

Lateral deviation between centreline of web plates and centreline of flange plates at the contact surface, in the case of built up sections, shall not exceed 3 mm

Columns bearing on each other or resting on base plates and compression joints designed for bearing shall be milled true and square to ensure proper bearing and alignment. Base plates shall also have their surfaces milled true and square.

16 Rolled Shapes

The dimensions, form, weight and tolerances of all hot rolled shapes (and other members) shall comply with the relevant Indian Standards.

17 Cold Formed Sections

The dimensions and tolerances of all cold formed light gauge structural steel sections shall conform to clauses 4 and 5 of I.S 811- Specification for cold formed light gauge structural steel sections.

18 Castings

All steel castings shall conform to IS 4899 and grey iron castings shall comply with IS 210 and

malleable castings with IS 2108 or latest version.

•Execution

• General

In general, fabrication shall conform to the requirements of IS 800.

The Contractor shall deliver the component parts of the steelwork in an undamaged state at the site of the works and the Employer's Representative shall be entitled to refuse acceptance of any portion which has been bent or otherwise damaged before actual delivery.

•Workmanship

All workmanship shall be of first class quality in every respect to the greatest accuracy being observed to ensure that all parts fit together properly on erection.

All ends shall be cut true to planes and shall fit the abutting surfaces closely. All stiffeners shall fit tightly at both ends.

All butt ends of compression members shall be in close contact through the area of the joints.

All holes in plates and section between 12 mm and 20 mm thick shall be punched to such diameter that 3 mm of metal is left all around the hole to be cleaned out to correct size by reaming.

Base connections shall be provided as required and the greatest accuracy of workmanship shall be ensured to provide the best connections.

•Erection and Marking

Erection and fabrication shall be according to IS 800-1984 section-11. During erection, the work shall be securely braced and fastened temporarily to provide safety for all erection stresses etc. No permanent welding shall be done until proper alignment has been obtained.

Any parts which do not fit accurately or which are not in accordance with the approved fabrication drawings and specifications shall be liable to rejection and if rejected.

•Straightening

All materials shall be straight and free from twists. If rectification is necessary, this shall be affected by cold working and applying pressure, but not by hammering or any other method that will affect or damage the metal. Material with sharp kinks or bends shall be rejected.

•Cutting

Cutting shall be effected by shearing, sawing, cropping or gas cutting and shall be reasonably square and free from distortion with all burrs removed. If approved by the Employer's Representative the edges shall be ground afterwards.

For gas cutting of high tensile steel, sufficient steel shall be left over beyond the required profile to enable all metal hardened by heat to be removed by machining.

Except where material is subsequently joined by welding, no load transmitting surface shall be gas cut.

Plates in built-up members shall be end edge planed, except where flats with square edges are used. Plates specified to be planed milled or chipped, shall be cut in the first instance to such a size as to allow

3 mm to be planed, milled or chipped from the sides or ends.

Edges or gussets not exceeding 8 mm thickness may be sheared in a machine which can take the full side in one cut. Edges of thicker gussets shall be prepared by planning milling or grinding.

Edge preparation for welding of surfaces shall be carried out by grinding, planing or milling but not by shearing or cropping.

•Holing

Holes for rivets or bolts shall not be formed by gas cutting. Drilled or reamed holes shall be cylindrical and perpendicular to the surface. Finished holes shall not be more than 1.5mm larger than the specified diameter of bolts and rivets up to 25 mm diameter. For larger sizes the finished holes shall not be more than 2 mm larger than the specified diameter of the bolts and rivets.

Holes for turned and fitted bolts shall be drilled to a slightly smaller diameter and reamed to a diameter equal to the nominal diameter of the shank or barrel subject to H8 tolerances specified in IS 919.

Holes through more than one thickness of material shall, where possible, be drilled after the members are assembled and tightly clamped or bolted together. Punching may be permitted before assembly provided the holes are punched 3 mm less than the required size and reamed after assembly to the full diameter. The thickness of material punched shall not be more than 16mm

When holes are drilled in one operation through two or more separable parts, these parts shall be separated after drilling and all burrs removed.

Matching holes for rivets or black bolts shall register with each other so that a gauge 1.5mm or 2mm, depending of bolt size, less in diameter than the diameter of the hole shall pass freely through the assembled members in a direction perpendicular to the member surface.

For parts connected with turned and fitted bolts or close tolerance barrel bolts, the matching holes shall be drilled through all the thickness in one operation after securing the parts firmly together and subsequently reamed to size. Where this is not practicable, the parts shall be drilled and reamed separately through hard bushes steel jigs. All holes not drilled through all thicknesses at one operation shall be drilled to a smaller size and reamed out after assembly.

All holes, whether for shop or field connections, shall be accurately centred and matched to render reaming or drifting unnecessary during erection. Members with poorly matching holes shall be rejected.

•Bolting

Installation of high strength friction grip bolts in joints shall comply with IS: 4000. The diameter of the bolt holes must not be more than 1.5mm larger than the nominal diameter of the bolt. All contact surfaces in a connection including those associated with the nut heads, nuts and washers shall be free of scale, burrs, dirt and other foreign matter tending to inhibit uniform sealing of the joint components.

•Riveting

Rivets shall be heated uniformly throughout their lengths and shall, when driven, completely fill the holes.

Riveted members shall have all parts firmly drawn and held together before and during riveting, for multiple riveted connections, a service bolt shall be provided in every third or fourth hole.

All loose, burred or otherwise defective rivets shall be cut out and replaced before loading the structure.

•Testing and Inspection

All structural steel and other materials supplied by the Contractor shall be supported by a manufacturer's test certificate conforming compliance with the relevant specifications. The Employer's Representative may order further sampling and testing on any item brought to site.

The Employer's Representative shall have free access at all reasonable times to the Contractor's manufacturer's fabrication shop or yard and shall be provided with all co-operation and facilities for inspection and no work shall be taken down, painted or despatched until it has been inspected and passed. All gangs, templates, tool etc required shall be supplied by the Contractor.

Inspection by the Employer's Representative and testing by approved authorities will not relieve the Contractor of his liability to fulfil his contractual obligations.

•Tolerances for Steel Structures

Tolerances stated below shall be achieved after the entire structure, or part thereof, is in line, level and plumb.

Deviation of column axes at foundation top level with respect to true axes

a) In longitudinal direction ± 5 mm

b) In lateral direction ± 5 mm

Deviation in the level of bearing surface of columns at foundation top with respect to true level

± 5 mm

Out of plumbness (verticality) of column from true vertical axis, as measured at column top

1 For columns up to and including 15 m in height

height in mm or $\pm$

15 mm

whichever is less

$\pm 1/1000$ of column

2 For columns exceeding 15 m in height

$\pm 1/1000$ of column

height in mm or $\pm$

20 mm

whichever is less

Deviation in straightness in longitudinal transverse planes of column at any

$\pm 1/1000$ of column height and or ± 10 mm whichever is

less

point along the height

Difference in erected position of adjacent length or across

± 10 mm pairs of columns along

width of building, prior to connecting trusses/beams with respect to true /distance

Deviation in any bearing or seating

level with respect to true level

± 5 mm

Deviation in differences bearing levels

± 10 mm of a member on

adjacent pair of

columns both across and along the building

16.2.17 B

ea Deviation in difference of bearing levels
ms: beams from the true difference

Depth < 1800 mm ± 6 mm of
Depth > 1800 mm ± 10 mm

Deviation	sweep of beams in the in horizontal plane	1/1000 of span in mm subject to a maximum of 10 mm
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16.2.18 Crane girders and rails:

Shift in the centreline of crane rail centreline of web of crane girder	± 5 mm with respect to
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Shift in plan of alignment of crane axis of crane rail at any point	± 5 mm rail with respect to true
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Differences in alignment of crane between any two points 2 metres apart along rail	± 1 mm rail in plan measured
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16.2.19 Deviation in crane track with respect to true gauge:

For track gauges up to and including 15 metres	± 5 mm
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For track gauges more than 15 metres where S metres is true gauge	± $[5 + 0.25 (S - 15)]$ in
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Deviation in the crane rail level at any distance point from true level	1/1200 of the gauge or +10 mm whichever is less
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Difference in the crane rail actual levels between any two points 2 metres apart along the rail length between crane tracks rails at:	± 2 mm Difference in levels
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Supports of crane girders crane girders	± 15 mm Mid span of ± 20 mm
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Relative shift of crane rail surfaces joint in plan and elevation smooth transition	2mm subject to grinding of at a surfaces for
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Relative shift in the location of crane (end buffers) along the crane 20mm tracks with track gauge S in m	1/1000 of track gauge S stops subject to maximum of
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3. Anchor Bolts

• Materials

Anchor bolt materials shall be as specified in the table below.

16.2.20 **Anchor Bolt Materials**

Material	Specification
Steel bolts	ASTM A307, Grade A
Fabricated steel bolts	ASTM A36
Stainless steel bolts, nuts, washers required	ASTM A320, Type 304/316 as required

Anchor bolts for equipment frames and foundations shall be designed in accordance with the project seismic zone requirements.

Anchor bolt holes in equipment support frames shall not exceed the bolt diameters by more than 25 percent, up to a limiting maximum over sizing of 6 mm. Minimum anchor bolt diameter shall be 12mm. Anchor bolts for equipment mounting and vibration isolation systems shall be provided as required.

Tapered washers shall be provided where the mating surface is not square with the nut.

Expansion, wedge or adhesive anchors set in holes drilled in the concrete after the concrete is placed will not be permitted in substitution for anchor bolts except where otherwise specified. Upset threads are not acceptable.

The following information shall be provided for all bolt systems not cast-in-place:

16 Data indicating load capacities.

17 Chemical resistance

18 Temperature limitations

19 Installation instructions

20 Evaluation report for expansion and wedge type anchors.

• **Execution General**

A Fieldwork, including cutting and threading, shall not be permitted on galvanized items. Dissimilar metals shall be protected from galvanic corrosion by means pressure tapes, coating or isolators, grouting of anchor bolts with non epoxy grouts as required.

17.1.1 Cast-In Place Anchor Bolts

Anchor bolts to be embedded in concrete shall be placed accurately and held in correct position while the concrete is placed or, if specified, recesses or blackouts shall be formed in the concrete and the metalwork shall be grouted in place in accordance with Section 13. The surface of metalwork in contact with concrete shall be thoroughly cleaned.

After anchor bolts have been embedded, their threads shall be protected by greasing and placing the nuts.

17.1.2 Adhesive Anchor Bolts

Use of adhesive or capsule anchors shall be subject to the following conditions;

1 Use shall be limited to locations where exposure, on an intermittent or continuous basis, to acid concentrations higher than 10 percent, chlorine or to machine or diesel oils, is extremely unlikely.

2 Use shall be limited to applications where exposure to fire or exposure to concrete or rod temperature above 120°F is extremely unlikely. Overhead applications (such as pipe supports) shall not be allowed because of the above concerns.

3 Approval from the Employer's Representative for specific application and from the supplier of equipment to be anchored, if applicable.

4 Anchors shall be threaded or deformed for the full length of embedment and shall be free of rust, scale, grease and oils.

5 Embedment depth shall be as per manufacturer's recommendations. Adhesive capsules of different diameters may be used to obtain proper volume of the embedment, but no more than two capsules per anchor may be used. When installing different diameter capsules in the same hole, the larger diameter capsule shall be installed first. No extension or protrusion of the capsule from the hole is acceptable.

6 All installation recommendations by the anchor system manufacture shall be followed carefully.

7 Holes shall have rough surfaces.

8 Holes shall be cleaned with compressed air and be free of dust or water prior to installation.

9 Anchor shall be left undisturbed and unloaded for the adhesive curing period.

10 Concrete temperature (not air temperature) shall be compatible with curing requirements of the adhesives.

1 Painting and Protective Coating

Applications for Anti-Corrosive Internal Lining (Epoxy Coating) protection of Concrete Surfaces

• Application limits of Anti-Corrosion Internal Lining and/or coatings of appropriate material and thickness – to be approved by Employer for Concrete Surfaces contact with sewage and/ or sludge upstream of the Aeration Basins. This also applies to all concrete structures in contact with any type of sewage sludge anywhere in the plant.

• All units upstream of and including Primary Clarifiers will have to be provided with internal lining for the full internal surface area (Walls and base slab).

• For Aeration Basins, interior lining shall extend from the top of wall down to 1.0 meter below the lowest operating liquid level.

• This also applies to all concrete structures in contact with any type of sewage sludge anywhere in the plant.

• For the units handling the solids part such as: Gravity Sludge Thickener, Anaerobic Sludge digester and Digested Sludge Storage tank, internal lining shall be provided for the entire internal surface area.

• General

• Surfaces to be Painted

The following, in general, are the surfaces to be painted.

- All exposed piping and other metal surfaces, interior and exterior.
- All submerged metal surfaces.
- All Structural and Miscellaneous steel, including tanks.
- Exterior, above ground concrete and brick masonry as specified.
- The interior of structures as specified.
- Equipment furnished with and without factory finished surface except as specified hereafter.
- Door woodwork and architectural trim work.

• Surfaces Not to be Painted

Unless otherwise approved by the Employer's Representative, the following surfaces shall in general not be painted.

(i) Concrete surfaces subject to pedestrian traffic

(ii) Plastic surfaces, except for colour code labelling.

(iii) Non-ferrous metals (galvanised metal shall not be considered as a non-ferrous metal in this context).

(iv) Mechanical equipment and electrical equipment with approved factory finishes.

(v) Non-ferrous piping.

(vi) Chain link fencing

• Products

• Materials

Paints, oils, varnishes etc of approved brand and manufacture shall be used. Ready mixed paints as received from the manufacturer without any admixture shall be used.

If for any reason, thinning is necessary in case of ready mixed paint, the brand of thinner recommended by the manufacturer or as instructed by the Employer's Representative shall be used. Approved paints, oils or varnishes shall be brought to the site of work by the Contractor in their original containers in a sealed condition. The materials shall be brought in at a time in adequate quantities to suffice for the whole work or at least a fortnight's work. The empty containers shall not be removed from the site of work until

the relevant item of work has been completed and permission obtained from the Employer's Representative.

The Contractor shall consult with the paint manufacturer before commencement of the work to certify the suitability of the surface to receive paint and the paint to be used.

•Service Conditions and Applicable Systems – Non-Architectural
(vi) General

This clause refers to the painting of items other than items of mechanical and electrical plant and equipment.

The painting systems specified herein have been chosen with regard to the different service conditions and shall not be changed except with the explicit permission of the Employer's Representative. All paint materials shall be first quality products of the required type and composition. Trade names, where given; are only meant to clarify the quality required and are not meant to be restrictive in any other sense. Products of other reputed manufacturers complying with the following requirements shall be eligible for use.

(vii) Service Condition A

Service condition A includes ferrous metals other than stainless steel, subject to corrosive moisture or atmosphere and condensation.

Surface preparation shall be carried out so that all metal surfaces are field sand blasted to near-white metal blast cleaned quality. Weld surfaces, edges and sharp corners shall be ground to a curve and all weld splatter removed.

A near-white metal blast cleaned surface finish is defined as a surface with a grey-white, uniform metallic colour, slightly roughened to form a suitable anchor pattern for coatings. The surface, when viewed without magnification, shall be free of all oil, grease, dirt, visible mill scale, rust, corrosion products, oxides, paint or any other foreign matter.

Coat	Description	Thickness
Primer	Zinc rich epoxy primer, equal or superior to Apcodur CP 686 of Asian paints or Epilux 4 zinc rich primer	50 microns
Intermediate	Universal type primer, same as above acceptable	
Finish	Epoxy enamel, equal or superior to Apcodur CF 697 or Epilux 4 High Build.	50 microns
		100 microns
Total Minimum Thickness		200 microns

A minimum of 12 hours shall elapse prior to the application of additional coats to the prime coat. A minimum of 2 hours shall elapse prior to the application of the intermediate coat and a minimum of 2 hours for the finish coat.

(viii) Service Condition B

Service condition B includes ferrous and other metals other than stainless steel, not subject to chemical attack, normal indoor and outdoor exposure, except as specified for buildings.

Surface preparation shall be carried out so that all surfaces shall be free of dirt, dust, grease and other foreign matter before coating. Surfaces shall be cleaned to brush-off blast cleaning quality and weld surfaces and rough edges shall be ground and weld splatter removed.

Coatings shall include the following:

Coat	Description	Thickness
Primer	Zinc rich epoxy primer, equal or superior to Apcodur CP 686 of Asian paints or Epilux 4 zinc rich primer	50 microns
Intermediate	Universal type primer, same as above acceptable	
Finish	Epoxy enamel, equal or superior to "ApcodurCF 697" or "Epilux 4 High Build"	50 microns
		100 microns
Total Minimum Thickness		200 microns

Coatings shall be applied in strict accordance with the manufacturer's recommendations. All sharp edges, nuts bolts and other items difficult to coat shall receive a brush-applied coat of the specified coating prior to application of each coat.

(ix) Service Condition C

Service condition C includes ferrous metals and other metals other than stainless steel wholly or intermittently submerged in water or corrosive liquid.

Surface Preparation shall be carried out so that all metal surfaces shall be field sand blasted to near-white metal blast cleaned quality. Weld surfaces, edges and sharp corners shall be ground to a curve and all weld splatter removed and welds neutralized with thinner.

Coatings shall include:

Coat	Description	Thickness
Primer	Zinc rich epoxy primer, equal or superior to Apcodur CP-686 or Epilux 4 zinc rich primer	75 microns
Intermediate	Coal tar epoxy polyamine coating equal or superior to Apcodur CF 651 or Epilux 5	Adequate coats to aggregate dry film thickness 400 microns
Finish	As intermediate	

Total Minimum Thickness microns	475
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Coatings shall be applied in strict conformance with the manufacturer's recommendations. All sharp edges, nuts, bolts and other items difficult to coat shall receive a brush-applied coat of the specified coating prior to application of each coat.

(x) Service Condition D

Service condition D includes concrete surfaces subject to intermittent submergence including the entire interior surfaces of wet wells and manholes.

Coatings shall include:

Coat required	Description	Thickness	Primer	Not
Intermediate & Finish Coats	Coal tar epoxy polyamine coating equal or superior to Apcodur CF 651 or Epilux 5 adequate number of coats to give total dry film thickness	400		
Total Minimum Thickness microns		400		

(i) Service Condition E

Service condition E includes exterior or interior concrete surfaces exposed to view, not subject to immersion and designated for painting and not covered under architectural painting.

Surface preparation shall be carried out so that all surfaces shall be free of dust, grease and other foreign matter before coating. Cracks and voids shall be repaired or filled with suitable material compatible with the paint used.

Coatings shall include:

Coat	Description	Thickness	1 st	Coat
Equal or superior to Snowcem, or Durocem microns		224		
Intermediate Coat	Best quality plastic emulsion paint available dry film thickness of not less than 38 microns.	38 microns		
Finish Coat	As above	38 microns		
Total Minimum Thickness microns		400		

Time between coats -The filler coat may be recoated in 12 hours, the finish coat if dry for arecoat in 2 hours.

A minimum of 12 hours shall elapse prior to the application of additional coats to the filler coat, a minimum of 2 hours shall elapse prior to the application of the finish coat.

(ii) Service Condition F

Service condition F includes interior and exterior metal not painted under service conditions A, B and C, but designated for painting.

Surface preparation shall be:

1 Ferrous Metals - Prepare surface as for Service Condition B.

2 Non-Ferrous Metals - Wash surfaces with solvent thinner

16.2.21 Coatings for Ferrous Metals shall include:

Coat	Description	Thickness
Primer	Red lead primer, equal or superior to	50 microns
Bisow	Synthetic Red Lead Primer	
Intermediate	Exterior synthetic enamel equal or	50 microns
superiorto	Apcolite or Luxol	
Finish	As intermediate	50 microns
Total Minimum Thickness		150 microns

16.2.22 Coatings for Non-Ferrous Metals shall include:

Coat	Description	Thickness
Primer	A wash primer equal or superior to	10 microns
Apconil	WP-636 or Bison Wash Primer	
Intermediate and Finish	As for ferrous metals above, adequate coats	140 microns
	to give 140 microns	
Total Minimum Thickness		150 microns

(iii) Service Condition G

Service Condition G includes plastic pipes, coating for purpose of colour coding and label- stencilling. Coatings to be used for this category shall be certified by pipe manufacturer and to be completely acceptable and non-injurious to pipe.

Surface preparation shall be to lightly sand the pipe and wipe with a solvent to degrease and clean surface.

Coating shall include two coats of paint approved by the Employer's Representative and certified by pipe manufacturer as non-injurious to the pipe, of total dry thickness not less than 150 microns.

Application shall be in strict accordance with manufacturer's recommendations.

(iv) Service Condition H

Service condition H includes interior and exterior wood. Unless already properly hand- sanded, surface preparation shall include sand-paper smooth by hand and clean off dust. Neatly fill nail holes, cracks and depressions with approved filler, coloured to match the wood. When dry, sandpaper smooth and flush.

Coatings shall include:

Coat	Description	Thickness
Primer	White or pink primer equal or superior to	n/a
Parrot Wood Primer or Woodrite		
Intermediate	Synthetic enamel coating equal or	50 microns
superiorto	Apcolite or Luxol High Gloss	
Finish	As intermediate	50 microns
Total Minimum Thickness		100 microns

•Coating Schedule

The following list specifies the coating system required for each item. The list shall not be construed as complete, list of all surfaces to be coated but as a guide as to the coating systems applicable.

Where reference is made to ferrous metal in this schedule it does not include stainless steel and galvanized iron pipes. Coatings and finishes for architectural work and items are given separately on the drawings.

Description Condition	Service
16.2.23 General	
Exposed ferrous metal	A
Exposed plastic pipe	G
Galvanized metals to be painted	F
Designated Interior concrete walls	E
Designated Exterior concrete walls	E
Submerged ferrous metals	C
All non-submerged structural steel and miscellaneous	Bmetals
16.2.24 (Unless A is specified)	
Interior of surge tanks	D
16.2.25 Screenings and wet well Area	
Structure above floor level	A
Screenings hopper	A
Interior of wet wells and all Screen Chambers	D
Walls and roof slabs of all channels	D
Exposed ferrous metals	A
F	
16.2.26 Pump Rooms	
Exposed ferrous metals	A

•Painting and Coatings - Architectural

1General

The painting and coatings required for architectural work including doors windows and trimwork. The systems required for different items and service conditions are given below.

2Service Condition I

Service condition I includes un-plastered interior or exterior concrete surfaces designated for painting shall conform to requirements of service condition E.

3 Service Condition J

Service Condition J includes interior plastered brickwork and concrete surface or concrete block work. All concrete block surfaces to be painted shall be filled with putty of a composition approved by the manufacturer of the paint to be used. Service condition K includes five alternative specifications

Alternative 1 is for synthetic enamel paint and is specified below:

- Surface preparation shall be that all surfaces shall be free of dirt, dust, grease and other foreign matter before

coating. Cracks and voids shall be repaired with a suitable compound compatible with the paint to be used.

- Coating shall include:

Coat	Description	Thickness
Primer	Cement primer, equal or superior to Total dry film thickness	
Decoprime or Bison cement primer solventor water thin-able.	not less	
Intermediate Synthetic enamel paint with matt finish equal or superior to than	75	
Apcoliteor a Luxol synthetic enamel paint	microns	
Finish	As intermediate	
Total Minimum Thickness		75 microns

- Each coat shall be completely dry before subsequent coat is appliedAlternative 2 is for emulsion paint and shall be as specified below:

- 1Surface preparation: As for Alternative 1.
 - 2Coatings: Three coats of an emulsion paint equal or superior to Pentalite Emulsion Paint A 383 line or Luxol Silk Acrylic Emulsion. Total dry thickness should not be less than 190 microns.
 - 3Application: as for Alternative 1 and conforming to requirements of the manufacturer.
- Alternative 3 is for an approved brand of oil-bound distemper or vinyl wall paint. Surface preparation, application and minimum dry thickness shall be as for Alternative 1. The paint shall be of a quality acceptable to the Employer’s Representative and shall have been used extensively under similar circumstances satisfactorily.
- Alternative 4 is for an approved brand of water-bound distemper such as Castle Dry Distemper. Surface preparation, application and minimum dry thickness shall be as for Alternative 1. The minimum dry film thickness shall be 100 microns, obtained by applying an adequate number of coats.
- Alternative 5 is for colour wash of approved tint. The surface shall be prepared as for Alternatives 1 and an adequate number of coats of an approved tint of colour wash shall be applied in accordance with the best current practice to ensure a minimum dry film thicknessof 100 microns.

4Service Condition K

Service Condition K is for exterior plastered brickwork and concrete surfaces or concrete block work and is specified below:

- 5Surface Preparation - The preparation of surface shall be as for ServiceCondition E.
- 6Coatings - Shall be the same as for Service Condition E.
- 7Application - Shall be as recommended by the paint manufacturer.

5 Service Condition L

Service Condition L is for the woodwork of doors and windows and is as for Service Condition H unless woodwork is to be varnished or French polished.

Where varnishing is specified, the varnish used shall be the best quality copal varnish mixed with turpentine if required and applied in three even coats.

French polishing, if specified, shall be in accordance with the requirements of I.S 348 Frenchpolish.

- Execution
- Manufacturers Recommendations

Unless otherwise specified or approved by the Employer’s Representative, the paint and coating manufacturer’s printed recommendations and instructions for thinning, mixing, handling applying and

protection of the coating materials, preparation of surfaces for coating and for all other procedures relating to coating shall be strictly observed.

•**Delivery and Storage**

Materials shall be delivered in manufacturer's original sealed containers, with labels and tags intact and decipherable. Coating materials and equipment shall be stored in designated areas. Coating containers shall be opened only when required for use. Coating shall be thoroughly stirred or agitated to uniformly smooth consistency and prepared and handled in a manner to prevent deterioration and inclusion of foreign matter. Unless otherwise specified or approved, no materials shall be reduced changed, or used except in accordance with the manufacturer's instructions.

•**Safety Requirements**

Respirators shall be worn by all persons engaged in and assisting in spray painting.

Cloth and cotton waste that might constitute a fire hazard shall be placed in closed metal containers or destroyed at the end of each day's work.

•**Storage Mixing and Thinning**

Paint and coating materials shall be shall be thoroughly stirred, strained and kept at a uniform consistency during application. Materials of different manufacturers shall not be mixed together. Packaged materials may be thinned immediately prior to application in accordance with the manufacturer's directions.

•**Preparation for Painting and Protective Coating**

All surfaces to receive paint and protective coating shall be cleaned as specified prior to application of coating materials. The Contractor shall examine all surfaces to be coated and shall correct all surface defects before application of any coatings. All marred or abraded spots on shop-primed and factory finished surfaces shall be touched –up prior to application of any other coating.

•**Workmanship**

Skilled craftsmen and experienced supervisor shall be employed on all work.

All paint and coatings shall be applied in a workman like manner to produce an even film of specified uniform thickness. Edges, corners, crevices and joints shall receive special attention to ensure that they have been thoroughly cleaned and receive an adequate thickness of paint. The finished surface shall be free of runs, drops, ridges, waves, laps, brush marks and variations in colour, texture and finish. All coats shall be applied to produce a film of uniform thickness. Special attention shall be given to ensure that edges, corners, crevices, welds and similar areas receive a film thickness equivalent to adjacent areas. Installation shall be protected by the use of drop cloths or other approved precautionary measures.

Painting, except the priming coat, shall generally be taken in hand after all other builderswork is completed.

The rooms should be thoroughly swept and the entire building cleaned at least one day in advance of the paint work being started.

Hardware, hardware accessories, machined surfaces and similar items not to be coated but which are in contact with coated surfaces shall be removed or masked prior to surface preparations and painting operations. Following completion of coating of each area or unit, removed items shall be re-installed by workmen skilled in the respective trades.

Doors, windows, floors, articles of furniture and such items not to be painted or coated shall be protected from being splashed. Splashes and droppings, if any, shall be removed by the Contractor and the surfaces cleaned.

•**Application**

Each paint application shall be carried out strictly in accordance with the manufacturer's instructions.

•Application of Protective Coating

(i) Shop Coatings

Fabricated metal work and equipment which requires coating may be shop-primed with specified primer. Any such work delivered to the site with any other shop coat shall have this coat removed and the specified coating applied in the field if so instructed by the Employer's Representative. Manufactured equipment with approved corrosion resistant factory finishes and galvanized finishes shall be exempt from this requirement.

•Thickness of Coating

Where a dry film thickness (in micron) has been specified, such thickness shall be achieved and verified for each coat.

•Testing and Inspection

The Contractor shall conduct thickness measurements and inspection of the coated surfaces with equipment supplied by him and acceptable to the Employer's Representative and shall recoat and repair as necessary for compliance with these specifications.

Any surfaces or parts thereof found to be unsatisfactory shall be rectified by the Contractor to the satisfaction of the Employer's Representative.

**TECHNICAL SPECIFICATION
ELECTRO-MECHANICAL WORKS
INSTRUMENTATION WORKS
ELECTRICAL WORKS**

SR.NO.	PARTICULAR
1	INFORMATION OF THE TENDER
2	EXTENT OF WORK
3	TECHNICAL SECTION
4	ITEM WISE SPECIFICATION PROJECT WISE

CONTRACTORS TO READ CAREFULLY

- i. Guarantee: All the materials / equipment shall be governed by guarantee of 12 months from the date of taking over of installation against any manufacturing defects, design & workmanship. Also, any malfunctioning of equipment / system due to faulty installation / design manufacturing process etc. shall be rectified free of cost by Contractor.
- ii. Tenderers are requested to furnish the information required in TECHNICAL DATA SHEET without fail. In case of not furnishing the details, tenders will be out rightly rejected.
- iii. Delivery of pumps within **45 days from the date of successful inspection** shall be confirmed by the Original Manufacturers.
- iv. The quantities indicated in the minimum BOQ are tentative to appraise the bidder about magnitude of the work & likely to vary during execution and the contractor shall have no objection to such minor or major changes or deletion or addition of the item. The sizing indicated in the minimum BOQ is binding to contractor and size smaller/ lower than this shall not be permitted. However, in case higher/ larger size is required as per Conceptual Design Report, it shall be provided at no extra cost. Quantities given for electro-mechanical items are indicative but minimum required to be supplied. However, bidder shall execute the items as per requirement in field. Payment shall be made on the unit rate determined for particular item on the basis of ratio of estimated cost put to tender and rate approved for award of contract. This being turnkey tender, any item specifically not mentioned in the BOQ but required for approval of the competent authority is deemed to be covered in the project.
- v. Contractor has to maintain minimum pump efficiency as offered by them at the time of tendering for all works under this project throughout their contractual period. Contractor has to produce certificate along with results for efficiency every six month from ERDA Baroda. If efficiency is found less then penalty will be levied & it will be binding to the contractor. Expenditure for measuring the efficiency, if any shall have to be borne by the contractor; no extra claim will be given.
- vi. Contractor has to provide make of pump, motor, valves, panel etc. from A.U.D.A approved make prior to submit the document for approved of drawings amongst approved vendor list and Quality Assurance Procedure etc. make will be finalized by competent authority. Quantity of items in schedule can be deleted as per site requirement/ at the time of execution. Contractor has no right to claim for deletion of items.

SPECIFICATIONS FOR MECHANICAL WORKS

SECTION: 5

(A) SPECIFICATIONS FOR MECHANICAL WORKS (GENERAL)

16.3 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 specifications' clauses shall apply where appropriate, except where redefined in the particular sections of the technical specifications which shall be applicable.

List of Standards

Titles of various standards referred to in the specifications are indicated below. This list does not necessarily cover all the standards referred to.

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 for stainless steel and heat resisting steel bars and shapes
ASTM A-351	Specification for castings, Austenitic – Ferritic (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 1710	Specification for Pumps – Vertical Turbine Mixed and Axial Flow, for Clear, Cold Water
IS 5120	Technical requirements of roto dynamic special purpose pumps
IS 5600	Horizontal / vertical non clog type centrifugal pump for sludge handling
IS 6595	Horizontal Centrifugal Pumps for Clear, Cold Water
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, sludge
Part-I	Drying beds, sand, gravel and under drains
IS 6280	Specification for Sewage Screens
IS 3938	Electric Wire rope hoists

Further, following codes and standards unless specified herein shall be referred to for pipe lines, pipe works and fittings.

IS 210	Specification for grey iron casting
IS 290	Specification for coal tar black paint
IS 456	Code of practice for plain and reinforced concrete
IS 458	Specification for pre cast concrete pipes (with and without reinforcement)
IS 516	Method of test for strength of concrete
IS 638	Specification for sheet rubber jointing and rubber insertion jointing
IS 783	Code of practice for laying of concrete pipes
IS 816	Code of practice for use of metal arc welding for general construction in mild steel
IS 1367	Technical supply conditions for threaded steel fasteners
IS 1387	General requirements for the supply of metallurgical materials
IS 1500	Method for Brinell hardness test for metallic materials
IS 1536	Specification for centrifugally cast (spun) iron pressure pipes for water, gas and sewage
IS 1537	Specification for 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 1916	Specification for steel cylinder pipes with concrete lining and coating
IS 2078	Method for tensile testing of grey cast iron
IS 3589	Specification for MS Spirally Welded Pipes
IS 3597	Method of tests for concrete pipes

IS 3658	Code of practice for liquid penetrant flow detection
IS 5382	Specification for rubber sealing rings for gas mains, water mains and sewers
IS 5504	Specification for spiral welded pipes
IS 6587	Specification for spun hemp yarn
IS 7322	Specification for specials for steel cylinder reinforced concrete pipes
IS 8329	Specification for DI pipes
IS 9523	Specifications for DI fittings
IS 4984	Specifications for HDPE pipeline
IS 14846	Specifications for valves
IS 783	Code of practice for laying of concrete pipes
IS 3114	Code of practice for laying of cast iron pipes
IS 3764	Excavation work - Code of Safety
IS 4127	Code of practice for laying of glazed stoneware pipes
IS 5822	Code of practice for laying of electrically welded steel pipes for water supply.
IS 6530	Code of practice for laying of asbestos cement pressure pipes.

16.3.1

16.3.2 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.**

Design and Construction

- a. The plant design, workmanship and general finish shall be of sound quality in accordance with good engineering practice. Design shall be robust and rated for continuous service, at the specified duties, under the prevailing operational site conditions.
- b. The general design of mechanical and electrical plant particularly that of wearing parts, shall be governed by the need for long periods of service without frequent attention but shall afford ready access for any necessary maintenance.
- c. Similarly items of Plant and their component parts shall be completely interchangeable. Spare parts shall be manufactured from the same material specification as the originals.
- d. No welding, filling or plugging of defective work will be permitted without the written permission of the Engineer. All welding spatter shall be removed.
- e. It shall be the responsibility of the contractor to ensure that all the equipment selected is fully compatible, mechanically, electrically and also with respect to instrumentation, control and automation.
- f. It shall be the responsibility of the contractor to ensure his equipment interfaces with any existing equipment correctly. Any interfaces must not affect the integrity of the equipment, or invalidate any warranties or guarantees.
- g. Each component or assembly shall have been proven in service in a similar application and under conditions no less than those specified therein.
- h. The equipment shall be compatible with the civil structure, when installed, with sufficient space for operator access and maintenance procedures.

- i. All materials shall be of the best commercial quality and free from any flaws, defects or imperfections.
- j. Materials shall be selected to eradicate or reduce corrosion to a minimum.

16.4

16.5 Tropicalization

Equipment is to be designed for tropical climate suitable for Indian conditions and the city/location where it is to be installed and the following shall apply.

- i. Tropical grade materials should be used wherever possible. Some relaxation of these provisions may be permitted where equipment is hermetically sealed.
- ii. Iron and steel and in general to be painted or galvanized as appropriate in accordance with the specification. Small iron and steel parts (other than stainless steel) of all instruments and electrical equipment, the cores of electro-magnets and the metal parts of relays and mechanisms are to be treated in an approved manner to prevent rusting. Cores etc. which are built up of lamination or can not for any other reasons be anti rust treated, are to have all exposed parts thoroughly cleaned and heavily enameled, lacquered or compounded.
- iii. The use of iron and steel is to be avoided in instruments and electrical relays whenever possible. Steel screws, when used, are to be zinc, cadmium or chromium plated or, when plating is not possible owing to tolerance limitations, shall be corrosion resisting steel. Instruments screws, except those forming part of a magnetic circuit, are to be of brass or bronze. Springs are to be of brass, bronze or other non-rusting material. Pivots and other parts for which non-ferrous material is unsuitable are to be of an approved stainless steel.
- iv. Fabrics, cork, paper and similar materials, which are not subsequently to be treated by impregnation, are to be adequately treated with an approved fungicide. Sleeving and fabrics treated with linseed oil or linseed oil varnishes are not to be used.

Climate

- i. All part and materials used shall in all respects be suitable for the climatic conditions of the city/location where it is to be installed. The following maximum conditions shall be used for all design.

Maximum Ambient Temperature for Design Purpose	:	50 °C
Maximum Relative Humidity	:	95%

In damp situations and wherever exposed to the weather, precaution shall be taken against corrosion of metal work, cable armour conduit and the like.

De-Rating due to the Climatic Conditions

- i. All electrical equipment including cables shall be de-rated for continuous operation in an ambient temperature of 50 °C in accordance with the appropriate regulations unless otherwise specified.
- ii. All materials and equipment which are subject to certification by testing authorities etc. shall be certified as being tested at 50 °C ambient unless other higher temperature specified elsewhere for specific equipment/product.

Packing and Delivery

- a. All part and equipment as necessary shall be packed in first quality containers or packing; no second hand timber shall be used. All packing must be suitable for several stages of handling via sea or air freight, inland transport and movement on site.
- b. Flanged pipes are to have their open ends protected by adhesive tape or jointing and are then to be covered with a wooden blank flange secured by service bolts.
- c. The sleeves and flanges of flexible couplings shall be bundled by wire ties. Cases containing rubber rings, bolts and other small items shall not normally weigh more than 500 kg gross.
- d. Precaution is to be taken to protect shafts and journals where they rest on wooden or other supports likely to contain moisture. At such points wrappings impregnated with anti-rust composition or vapour phase inhibitors are to be used of sufficient strength to resist changing and indentation due to movement which is likely to occur in transit. **The form of the protective wrappings and impregnation are to be suitable for a minimum period of twelve months.**
- e. Lids and internal cross battens of all **packing cases are to be fixed by screws and not nails.**

Hoop metal bindings of cases are to be sealed where ends meet and if not of rust less material are to be painted. Contents of cases are to be bolted securely or fastened in position with struts or cross battens and not with wood chocks, unless they are fastened firmly in place. All struts or cross battens are preferably to be supported by cleats fixed to the case above and below to form ledges of which the batten may rest. Cases are to be up-ended after packing to prove that there is no movement of contents.

Where parts are required to be bolted to the sides of the case, large washers are to be used to distribute the pressure and the timber is to be strengthened by means of a pad.

Contents of cases are to be bolted securely or fastened in position with struts or cross battens and not with wood chocks, unless they are fastened firmly in place. All strut or cross battens are preferably to be supported by cleats fixed to the case above and below to form ledges on which the batten may rest. Cases are to be up-ended after packing to prove that there is no movement of contents.

Where parts are required to be bolted to the sides of the case, large washers are to be used to distribute the pressure and the timber is to be strengthened by means of a pad.

All stencil marks on the outside of the casings are to be either of a water proof material or protected by Shellac or varnish to prevent obliteration in transit.

- f. Wood wool is to be avoided as far as possible. Waterproof paper and felt linings are to overlap at seams at least 12mm and the seams secured together in an approved manner, but the enclosure is to be provided with screened openings to obtain ventilation.
- g. Where applicable, indoor items such as electric motors, winch and control gear, instruments and panels, machines components etc. are to be ‘cocooned’ or covered in

polythene sheeting, selected at the joints and the enclosures provided internally with an approved desiccators.

- h. Bright metal parts are to be covered before shipment with an approved protective compound or coating and protected adequately during transport to site. After erection these parts are to be cleaned by the Contractor.
- i. Each crate or package is to contain a packing list in a waterproof envelope and copies in duplicate are to be forward to the Engineer; prior to dispatch. All items of material are to be clearly marked for ready identification against the packing list.

All cases, packages, etc. are to be clearly marked on the outside to indicate the total weight, to show where the weight is bearing and to indicate the correct positions for slings and are to bear an indelible identification mark relating them to the appropriate shipping documents.

- j. Structural steel work, pipes, valves, encased fittings and metal work shall be similarly marked. In addition, one in every ten repeated articles shall bear the dispatch marks in suitable paint or other approved medium. When in the opinion of the Engineer, the dispatch marks can not be applied satisfactorily to any item, they shall be stamped on a petal label attached to the item they shall be stamped on a metal label attached to the item or part by means of a piece of wire passing through holes at either end of the label and secured so that it lies flat with the item.
- k. The Engineer may require inspecting and approving the packing before the items are dispatched but the **contractor is to be entirely responsible for ensuring that the packing is suitable for transit and such inspection will not relieve the Contractor for any loss or damage due to faulty packing.**

Finish

Workmanship and general finish shall be of first class commercial quality and in accordance with best practice. All covers, flanges and joints shall be properly faced, bored, fitted, fixed, hollowed, mounted or chamfered as the case may be, according to the best approved practice and all working parts of the plant and other apparatus, shall similarly be well and accurately fitted, finished, fixed and adjusted.

Wrought Steels

Where not otherwise specified wrought steel shall be selected from the appropriate grade of IS: 1570 and be free from blemishes, short or hammer marks.

The Contractor shall submit for the approval of the Engineer-in-charge, the grade number selected for each component.

Castings

All casting shall have a homogenous structure and be free from blow holes, flaws and cracks. Any casting having a thickness in parts in excess of 3 mm to that which it is purported to be shall be rejected. No repairs or patchwork to castings shall be allowed other than that approved

by the Engineer-in-charge.

Castings subject to hydraulic pressure shall be tested to 1.5 times the maximum working pressure. Certified copies of Test Reports shall be forwarded to the Engineer as soon as the test is completed.

Steel Castings

Where not otherwise specified, steel castings shall be selected from the appropriate grade of BS 3100.

Grey Iron Castings

All grey iron castings supplied shall be to the appropriate grade of IS: 210. The Contractor shall replace any casting which the Engineer considers is not of first class appearance or is not in any way the best which can be produced, although such a casting may have passed the necessary hydraulic or other tests. No plugging, filling, welding or "burning on" will be acceptable.

Spheroidal Graphite Iron Castings

All spheroidal graphite or modular graphite iron shall be to the appropriate grade of BS 2789.

Bronze

Where not otherwise specified, the bronze used shall be made of a strong and durable zinc free mixture to IS: 318.

Aluminum and Aluminum Alloys

Bars and extruded sections shall be to designation EN 8 or BS 1474. Aluminum and aluminum alloys shall not be utilized unless alternative materials are considered unacceptable. The use of aluminum requires the approval of the Engineer in all cases.

Aluminum and Aluminum alloy Castings

Castings shall be manufactured from LM5 to BS 1490 and subjected to a chill cast to increase tensile strength. Aluminum and aluminum alloys shall not be utilized unless no other materials is considered suitable. Immersed structures or structures that are periodically immersed shall not be constructed from aluminum or aluminum alloys.

Painting and Metal Protection

All bright metal parts shall be covered before shipment with an approved protective compound and adequately protected during shipment to site. **After erection these parts are to be cleaned.**

All exposed metal parts of the equipment including piping, structures, etc. wherever applicable, after installation unless otherwise surface protected shall be first painted with at least one coat of suitable Zinc rich epoxy primer which matches the shop primer paint used, after thoroughly cleaning all such parts of all dirt, rust, scales, greases, oils and other foreign materials by wire brushing, scraping or sand blasting and the same being inspected and approved by the Engineer for painting. After wards, the above parts shall be finished with two coats of epoxy/coal tar

epoxy coating/paint. The quality of the finish paint shall be as per the standards of ISI or equivalent and to be of the colour as approved by the Engineer. The paint shall be suitable for use in industrial corrosive works atmosphere.

All bright metal parts shall be covered before shipment and transportation with approved protective compound and protected adequately during shipment and transportation to the site. After erection, these parts are to be cleaned.

All pipe services wherever applicable are to be painted in accordance with the Owner's standard colour code scheme, by the Contractor.

MS/GI Hand Rails shall be painted with synthetic enamel paint or as specified in Scope of Work/ process description/Process Design Criteria and detailed Specifications and of shade approved by engineer-in charge.

Chromium Plating

All chromium plating shall comply with IS: 1986.

Galvanizing

Where steel or wrought iron is to be galvanized, it shall be carried out by the hot-dip process and shall conform in all respects with IS: 2629.

Attention shall be paid to the details of members in accordance with BS: 4479. Adequate provision for filling, venting and draining shall be made for assemblies fabricated from hollow section. Vent holes shall be suitably plugged after galvanizing.

All surface defects in the steel including cracks, surface lamination, laps and folds shall be removed in accordance with IS: 6159. All drilling, cutting, welding, forming and final fabrications of unit members and assemblies shall be complete before the structures are galvanized. The surface of the steel work to be galvanized shall be free from welding slag, paint, oil, grease, and similar contaminants. The articles shall be pickled in dilute sulfuric or hydrochloric acid, followed by rinsing in water and pickling in phosphoric acid. They shall be thoroughly washed, stoved and dipped in molten zinc and brushed, so that the whole of the metal shall be less than 610 grams per square meter of surface galvanized, except in the case of tubes to BS 1387 when it shall be 460 grams per square meter.

On removal from the galvanizing bath the resultant coating shall be continuous, adherent, as smooth and evenly distributed as possible, and free from gross imperfections such as bare spots, lumps, blisters and inclusions of flux ash or dross etc. and free from any defect that is detrimental to the stated end use of the coated article. Edges shall be clean and surfaces bright.

Bolts nuts and washers shall be hot dip galvanized and subsequently centrifuged in accordance with IS: 2669. Nuts shall be tapped up to 0.4mm oversize before galvanizing and the threads oiled to permit the nuts to be finger turned on the bolt for the full depth of nuts.

During off-loading and erection, the use of nylon slings shall be used. Galvanized work which is to be stored in works or on site shall be stacked so as to provide adequate ventilation to all surfaces to avoid wet storage staining.

Small areas of the galvanized coat damaged in any way shall be restored by following.

- i. Cleaning the area of any weld slag and thoroughly wire brushing to give a clean surface.
- ii. The application of two coats of zinc-rich paint (not less than 90% zinc dry film), or the application of a low melting point zinc alloy repair rod or power to the damaged area, which is heated at 300 °C.

Where surfaces of galvanized steel work are to be in contact with aggressive solutions and/or atmospheres the galvanizing shall receive further protection by painting.

Fasteners

Bolts, nuts and studs and fasteners with nominal diameters up to and including 39 mm required to be made in carbon steel shall conform to BS 6104 and threaded in accordance with IS: 1363 and 1367. Bright steel washers 3.0mm in thickness shall conform to BS 4320 and shall be provided beneath bolt head and nut.

The above items required to be supplied in stainless steel shall conform to IS: 1570. These items together with holding down bolts and anchor plates required to be supplied in high tensile steel shall conform to BS 970 Ref. Symbol T.

Drilled anchor fixings fasteners for use on concrete structures shall be of an approved type by the Engineer's Representative. The Positions of all drilled anchors shall be approved by the Engineer's representative and a Contractor proposing to use such fixings shall be deemed to have undertaken to supply, mark off, drill and fit. All exposed bolt heads and nuts shall be hexagonal and the length of all bolts shall be such, that when fitted and tightened down with a nut and washer, the threaded portion shall fill the nut and not protrude from the face thereof by more than a half diameter of the bolt. Rivets shall conform to BS 641 and tested in accordance with BS 1109.

Forgings

Carbon steel forgings shall be manufactured heat treated forgings and tested in accordance with BS 29.

Foundation and Settings of Machinery

The Contractor shall arrange for the provision of all foundation and plinths required for the plant and shall be responsible and setting for ensuring that all foundations and plinths are constructed and boxed out for Machinery holding down bolts in accordance with the approved drawings.

The Contractor shall provide all necessary templates for suspension of the holding down bolts during grouting of same.

The Contractor shall visit the site during the course of construction and check the Civil Works to ensure that the foundation and/or plinths are at correct required location and height for the acceptance of the machinery. When the foundations and/or plinths have been complete and are in a satisfactory condition, the machinery shall be installed as directed by the Engineer's representative.

The machinery shall be mounted on flat steel packing of a thickness selected to take up variations in the level of the correct foundations. The packing shall be bedded by chipping or grinding of the concrete surface.

Only one packing of selected thickness shall be used at each location, which shall be adjacent to each holding down bolt. The number of shims shall not exceed two at each location and the thickness of each shim shall not exceed 3mm.

The machinery shall be alighted, leveled and pulled down by the nuts of the holding down bolts with a spanner of normal length, and no grout shall be applied until the machinery has been run and approved by the Engineer for stability and vibration. The Civil Works Team shall then carry out the grouting and building in of the machinery. However, the Contractor shall take responsibility for the satisfactory nature of this work, and shall have a representative present.

Built In Items

The Contractor shall include in the relevant Schedule of the Specifications, details of all the items of equipment to be “Built in” by the Civil Works Team, together items with details of the period in which these items could be delivered to site.

The Contractor shall provide to the Civil Works Team full details of the box outs and plant fixing and foundation requirements for incorporating in the Civil Work. The Contractor shall liaise closely with the Civil Work and shall obtain from him a program of the civil works, clearly showing the dates when box-out and plant foundation details will be required. The Contractor will be responsible for co-coordinating and program his work schedule with the Civil Work so as to ensure an optimum arrangement with the minimum of disturbance to the progress of the Works as a whole. The Contractor shall deliver all items of equipment that are required to be built in the civil works, as required by the construction program and shall arrange for a representative from the equipment supplier to be in attendance during the progress of such works. The Civil Works team shall grout up and make good when instructed by the Engineer’s representative.

Location and Alignment

Where individual items of equipment and mechanically located and coupled, such as alignment motors, gear boxes and similar items depended upon correct alignment for satisfactory operation, each shall be mounted on a common bed plate and when alighted shall be located by means of dowels to ensure that correct re-alignment can be easily achieved when re-assembling the items after removal for overhauls.

Coupling

Flexible couplings shall be couplings rated at not less than the stalling torque load of the motor. Couplings liable to impregnation by oil shall be of the all metal flexible type.

General Service coupling shall be of the flexible multi-pin and resilient bush type, having not less than six bushes and each bush shall have an inner sleeve to allow rotation on the pin (bushes shall not be in direct contact with the pin). All pins shall have shoulders to allow positive location and securing to the half coupling face.

Flexible couplings shall be supplied in matching balanced sets machined, balanced and marked before leaving manufacturer’s works. The couplings shall be a tight fit on the shafts and secured with hand fitted keys and fully checked for alignment shall be a tight fit on the shafts and secured the hand fitted keys and fully checked for alignment. All necessary equipment for checking alignment shall be supplied by the Contractor.

Where flexible coupling are used, the Contractor shall fully describe the arrangements proposed for ensuring that the desired freedom of relative movement between the shafts is obtained when transmitting a torques corresponding to the continuous maximum rating of the motor.

Solidly bolted couplings shall be subject to accurate alignment and the Contractor's proposed alignment procedure shall be subject to the approval of the Engineer. In particular, the alignment procedures which involve rotating one half coupling only will not be accepted.

Overload release couplings shall not rely on shear pins. Release torque shall be adjustable over a wide range and preferably without the need to change components. The coupling shall be capable of angular alignment of 1 degree maximum and 1mm displacement of shafts.

Hydraulic couplings shall be oil filled with thermal overload protection device. The coupling shall be fully rated to transmit the motor full load power without exceeding normal working temperature and due regard shall be taken to ambient temperatures. An enclosure around the coupling shall be provided to prevent oil spray in the event of operation of the thermal overload device.

Final alignment of all types of coupling shall be checked by the Contractor in the presence of the Engineer's Representative.

Bearings and Lubricators

The size of bearing shall be not less than that calculated for bearings and a minimum L10 basic rating life in accordance with BS 5512 Lubricators Part 1, taking into account all considerations of reliability materials of manufacture and operating conditions. All bearings shall be rated and sized to ensure satisfactory running without vibration under all conditions of operation for a minimum life of 50,000 hours running.

They shall be efficiently lubricated and adequately protected from ingress of moisture, dust and sand and the particular climatic condition prevalent at the site. All bearings shall be to ISO standard SI unit dimensions where practicable.

All ball or roller bearings, except those supplied and "sealed for life" shall be arranged for grease gun lubrication and a suitable high pressure grease gun shall be supplied.

Adequate "Stauffer" screw top pressure grease lubricator with 'tell tale' stems or 'Tat' grease nipples shall be provided for all moving parts. The position of all greasing and oiling points shall be arranged so as to be readily accessible for routine servicing. Wherever necessary, suitable access platform shall be provided.

The type of lubricant and intervals of lubrication, which shall be kept to a minimum (not less than nine days), for each individual item of plant shall be entered on a working schedule, which shall form part of the Operation and Maintenance instructions.

A list of recommended Lubricants and their equivalents Bearings shall be entered in the Operation and Maintenance instructions.

Gear boxes

The gear boxes shall be totally enclosed dust, water and hose proof. Suitable lifting lugs shall be provided. They shall be robustly constructed and arduous duty.

The gear case shall be manufactured from grey cast iron to IS: 210 and of a grade to ensure high strength and wear resistance. Inspection covers shall be provided together with protected oil level indication, breather with oil mist preventer and drain plugs.

The gear boxes shall be designed for operation at the ambient temperatures specified without the assistance of a cooling fan.

The **mechanical service factor shall be not less than 1.5** when applied to the rated motor power or higher as recommended by equipment manufacturer.

The gears shall be manufactured from steel to BS 970 of grade selected by the Contractor and entered in the Schedule of Particulars. The teeth shall be profile ground and lapped to a high standard of accuracy and finish.

Rolling bearings shall be adequately rated to ensure a running life of not less than 50,000 hours L10 life.

The input and output shafts shall have oil seals fitted to prevent the ingress of lubricant when the gearbox is mounted in the required orientation. For example, inclined when applied to screw pump installations.

The seals shall also prevent the ingress of dust, sand and moisture.

Lubrication of the gears shall be by a splash or forced system.

An anti-run back device shall be supplied and fitted to all gearboxes involved in screw pump installation.

Each gear unit shall be subjected to a full load test at the inclinations specified for duration of 3.00 hour during which time temperature, vibration and noise levels together with oil tightness shall be recorded in the presence of the Engineer's representative.

After satisfactory completion of the tests, each unit shall be drained of lubricant. All internal surfaces shall then be coated with suitable preservative.

A metal label shall be securely wired to the gear case to clearly state that the gear case requires to be coated with a suitable preservative.

The gear box shall be securely wired to the gear case to clearly state that the gear case requires to be filled with lubricant, the type and grade of which shall be clearly identifiable.

A metal label shall be securely wired to the gear case to clearly state that the gear case requires to be filled with lubricant, the type and grade of which shall be clearly identifiable.

Steelwork General

The Contractor shall provide and fix all the steel work, including stairways, ladders, hand railing, checkered plate and open mesh flooring frames and curbing as detailed in the specification and/or as shown on the contract drawings or as directed by Engineer.

All steel work shall be constructed in mild steel and shall be galvanized after manufacture or shall be provided with finish as specified in the specifications of specific equipment/work.

For all pre-fabricated metal work, including multiple duct covers, external ladders, open mesh flooring, checkered plating, hand railing, staircase, structural steel work and the like, the Contractor shall submit fabrication drawings for the approval of the Engineer prior to the manufacture of any of these items.

Hand Railing and Safety Chains

Hand Railing

Hand railing shall be of MS ERW Medium Class of circular hollow section and shall comply with the relevant requirements of BS 1387, BS 6323 Part I or BS 4360. Mild steel toe boards shall be

provided, 100mm high by 3mm thick positioned above the platform level and fixed securely to the standards. All items shall be painted with epoxy paint & epoxy primer.

Standards shall not be less than 38mm external diameter and rails shall not be less than 32mm external diameter.

Horizontal handrails shall be 1000mm high with an intermediate rail at mid height. Handrail height shall be measured vertically from finished floor level to the hand rail centerline.

Handling and fixings shall be designed to withstand a horizontal force of 740 N/m run without permanent distortion or failure of components. When a horizontal force of 360 N/m is applied at handrail level the deflection at any point on the handrail shall not exceed 1/125 of the distance between the center lines of adjacent standards or 10mm whichever is the least.

All mounting flanges shall be of substantial construction, with horizontal flanges drilled for not less than three bolts with two bolts on a line parallel to and on the walkway side of the line of the hand railing and vertical flanges drilled for less than two bolts and line through the bolts being vertical. Fittings shall be screwed or secured with grub screws. The standards shall be set at not more than 1.5 m. centers. When provided in sections, hand railing shall be joined together with purpose made fittings secured by screws or grub screws.

All ladders, stairway or other openings shall be guarded on three sides by hand railing conforming to the requirements stated above.

The Contractor shall ensure that unless specified hereinafter to the contrary, all hand railing shall be of uniform appearance and manufacture.

Safety Chain

Mild steel safety chain shall be 8mm nominal size grade (M 4) non calibrated chain Type 1, complying with BS 4942 Part 2. After manufacture, mild steel safety chains shall be hot dipped galvanized in accordance with BS 729.

Stainless steel safety chains shall be manufactured from grade 316S31 steel complying with ISO 570 Part 1. Chain links shall be welded and have an internal length not exceeding 45 mm and an internal width of between 12mm and 18mm. The fins caused by welding shall be removed and the weld shall be smoothly finished all round. When tested in accordance with clause 7.3 of BS 4972 Part 2, each chain shall with stand a breaking force of 30kN and a proof force of 15kN.

Open Mesh and Chequer Plate Flooring

Open mesh flooring and gratings shall generally comply with BS 4592 except where otherwise specified hereinafter. Such flooring and gratings shall be of rectangular mesh and non-slip and shall be mild steel galvanized.

Flooring shall be provided to span between the supporting members as shown on the Contract Drawings.

Where necessary intermediate support members shall be provided and fixed.

Galvanized mild steel toe plates 100 mm high and not less than 3mm thick shall be provided and fixed at all cut-outs except where otherwise shown on the approved drawings.

Both the load bearing and transverse bars in rectangular flooring panels shall be obtained systemically

around the centre lines of the panels in both directions, so that when the panels are fixed in extensive areas or in long runs, the bars of all panels are in line.

Chequer plate flooring shall be galvanized and of the non-slip type, not less than 10mm thick measured excluding the raised pattern. The flooring shall be secured to its frame by stainless steel countersunk set screws.

All flooring shall be designed to carry a loading of 750 kg/sq. meter and the deflection shall not exceed 1/200 of the span or 10mm whichever is the least.

All flooring shall be removable and set flush in mild steel galvanized frames. All frames shall be provided with lugs for building in.

Flooring shall be provided in sizes suitable for lifting and removal by one man and with the appropriate cutouts to permits its removal without disturbing or dismantling spindles, supporting brackets, cables or pipe work. Flooring spanning wide openings shall be supported on removable bearers and fixings to provide the required rigidity and these shall be supplied and fitted by the Contractor. These members shall be removable to afford clear access to the openings which includes ducts.

Lifting keys shall be supplied for each location and the type of key shall be such that inadvertent release is avoided.

Stairways

Stairways shall be detailed, fabricated and erected to the dimensions shown on the drawings and in accordance with BS : 449 Part 2 to carry a load of 750 kg/sq. meter. Treads shall be rectangular open mesh fixed to the stringers, not directly to concrete. Sloping hand railing shall be as specified for horizontal hand railing but with the top rail 850mm vertically above the line of pitch and standards vertical and spaced at not more than 1500mm., measured parallel to the line of pitch.

Staircases shall be constructed to the size and position shown on the drawings or as instructed by the Engineer. They shall be steel galvanized at works after manufacture and shall comprise stringers supporting the open mesh stair treads and shall be supplied complete with handrails and stanchions conforming to the above except the height which shall be 900mm above the pitch line.

Ladders

16.5.1 Ladders shall conform to BS 4211 except where the specified here after. They shall be in mild steel galvanized as specified in. The stringers shall be flat section not less than 65mm x 10mm spaced 380mm apart and shall be flanged and drilled for wall fixing at both ends. The stringers shall be radiuses over the top where they shall be not less than 600mm apart. Ladders over 3.0 m long shall have additional intermediate stays at not more than 2.5 m centers.

16.5.2 Rungs shall be 20mm diameter round bar at 250 mm c-c distance shouldered at each end and securely riveted into countersunk holes. Rungs shall be not less than 225mm from the wall.

All ladders shall have safety cages which shall be constructed of three flat vertical strips supported by flat hoops, with a diameter of 750mm. The hoops shall be at approximately 70mm centers and the first hoop shall be 2400mm. above ground or lower platform level.

Where the rise exceeds 6000mm, an intermediate landing shall be provided.

Multiple Duct Covers and Frames

Multiple duct covers and frames shall be of cast iron, water proof, non-rocking and recessed for filling with concrete or similar material.

They shall be of the type incorporating integral, removable, intermediate beams to give the required clear pit opening as shown on the approved drawings.

A heavy grease seal is to be formed between the cover and frame to prevent ingress of grit.

16.6

16.7 **General Requirements for Pipe work**

The Contractor shall supply, deliver and erect all pipe work and fittings within the structures and externally to the limits indicated on the approved drawings and in accordance with each section of specification.

Pipe work and fittings shall be suitable for a safe working pressure equivalent to the maximum working pressure of the system. The safe working pressure of the pumping mains shall be the closed valve head of the pump plus the maximum suction static head. The maximum surge pressure shall be limited to 125% of the maximum working pressure. All pipe work and fittings shall be of adequate strength to accommodate the maximum surge pressure of the system.

The minimum pressure rating of pipe work and fittings shall be 10 Bar or higher as per process requirement.

There shall be a sufficient number of mechanical joints to enable mechanical plant and valves to be disconnected from built-in pipe work. Such joints shall be tied and shall not be allowed to sustain the weight of any pipe work.

All pipe work and fittings shall be sized for the required capacity at a velocity limits depending on the nature of the fluid or substance to be conveyed.

All pipe work shall be adequately supported by purpose made fixings. Support shall not be provided by plant or equipment.

The position of any thrust blocks required shall be indicated on the Contractor's details drawing together with the position of any sleeping required through partition walls in buildings. Puddle flanges shall be provided for building at locations in which pipes 80mm diameter and above pass through structural concrete below ground level.

Where pipe work is connected to plant and equipment readily demountable fittings in the form of unions or flanged adapters shall be provided. The flanged adapter on the delivery pipe of pumps shall be located upstream of the reflux valve where appropriate.

Flexible joints shall be provided in all pipe work subjected to linear constraint.

All jointing work including the provision of suitable full face gasket not less than 5mm in thickness and galvanized fastenings or fastening as specified shall be included.

Pump suction bell mouths shall be standard castings in either cast iron or ductile iron.

Unless otherwise specified, the pieces shall have a radial branch to enable a more streamlined flow from

branch to body. Due allowance shall be made for reinforcement in the vicinity of the branch.

Prior to dispatch, each item of pipe work or associated fitting shall be clearly identified in paint with the plant item number indicated on the Contractor's arrangement drawing.

Puddle flanges shall be provided on all pipes where they pass through pumping station walls/water retaining structure walls. Each puddle flange shall be continuously welded to the pipe on both sides of the flange.

Pipe jointing surfaces and components shall be kept clean and free from extraneous matter until the joints have been made or assembled. Care shall be taken to ensure that there is no ingress of grout of other extraneous material into the joint annulus after the joint has been made.

The dimensions of gaskets shall comply with BS 4865 Part I. Gaskets shall be manufactured from material complying with BS 2494 for Type 1 rings.

Pump suction and delivery manifolds shall be provided with a drain valve where natural drainage does not occur.

Hydraulic testing shall not be carried out until all fabrication has been completed. When the pressure applied and sustained without further pumping shall be twice the working pressure.

The Contractor shall be responsible for cleaning the internal surface of all pipes prior to erection particularly the removal of weld deposits. Initial capping of the ends for protection during transport and storage shall not be removed until erection takes place.

16.8 Grey Iron Pipe work and Fittings

16.9

- 16.10 Grey Iron flanged pipe work shall conform to BS 4622 – not less than Class 3 with flanges to BS 4504 Part 1 – table 16.

- **Spheroidal Graphite Cast Iron Pipe work and Fittings**

All spheroidal graphite or modular graphite cast iron pipe work and fittings shall be to the appropriate grade of BS 4772.

16.11 Carbon Steel Pipe Work

- 16.12 Carbon Steel Pipe work for pressure purposes shall be to BS 3601 and assemblies shall be manufactured from pipe to this specification. The type of pipe shall be hot finished seamless steel. The wall thickness shall be not less than that required in BS 534 Table – 1.

- **ABS Pipe Work**

- ABS Pipe work shall be provided and installed for special purposes where hereinafter specified. The pipe work shall conform to BS 5391 and the fittings to BS 5392.
-

- **Fabrication of Carbon Steel Pipe Work and**

Fittings

The Contractor shall fabricate the pipeline by butt-welding without utilizing a backing ring in accordance with BS 2971 Class II metal arc welding of carbon steel pipe work. Branches shall be formed in accordance with BS 2971 (Class I or Class II, depending on operating conditions) and shall be welded before so that at any point along the bend, ovality will not reduce the bore by more than 21%. Radii of hot bends for all pipes shall not be less than five times the outside diameter. Gusseted "Cut and Shut" and wrinkle. All pipe flanges shall be of the wrought steel slip on type conforming to BS 4504 PN 16, welded on in accordance with BS 2971 (Class I or Class II, depending on operating conditions). No flanged joints shall be located within a backfilled trench. Flexible joints shall be bolted gland or Victaulic coupling as necessary.

16.13

16.14 Welder Qualification

Before welding work commences on pipe work, the Contractor shall satisfy the Engineer's representative that the welders have previously carried out similar welding work within recent months. When instructed by the Engineer's representative, the Contractor shall arrange for the welder to produce test welds in accordance with the provisions of BS 2971.

16.15

16.16 Pipe Work Installation

All pipe work, pipe fittings, jointing materials etc. shall be of the best quality free from defects and obtained from a supplier approved by the Engineer. The installation of the pipe work shall be carried out using skilled personnel and pipe work shall be installed according to the drawing approved by the Engineer. Where valves are incorporated in pipe work, the valves shall be provided with their own supports, such that no excess loading is exerted on pipe work. All pipe work materials shall have no excess loading is exerted on pipe work. All pipe work materials shall be off-loaded, stored on site and handled thereafter in such a manner that they are adequately protected for damage or deterioration.

16.17 Underground Pipes

Unless otherwise state all underground pipes shall be buried in trenches which have been excavated in accordance with the relevant section of the specification.

16.18 Examining Pipes

Before being used, each pipe casting or fitting shall be properly examined and should appear defective in any way, it shall be set apart and not used until it has been examined and passed by the Engineer. All metal pipes which shall be buried in the ground shall, prior to their installation, be slung and sounded in an approved manner. Any pipe found to be faulty by this method, shall be set aside for examination by the Engineer.

16.19

16.20 Cutting Pipe Work

All pipe work shall be cut with proper pipe cutting tools. The use of hammer and chisel for this purpose shall not be permitted. Great care shall be exercised when cutting concrete/bitumen lined spun iron and ductile iron pipes, to ensure that there is no damage to the lining. Should any damage to the lining take place which is to an extent which the Engineer deems to be undesirable, then the pipe shall be rejected. The Contractor shall then prepare another pipe for incorporation into the works. All pipes which have been cut shall have the edges dressed and deburred.

Labels

The Contractor shall arrange for the supply and fitting of engraved identification labels to all valves and items/equipment of plant. The reference numbers of all valves shall be as indicated on the schematic diagram to be supplied under the Contract.

All warning labels shall comply with BS 5378 parts 1, 2 and 3 and screw fixed rigid construction.

Designation labels shall be of 5mm trefoil with black lettering on white background. Embossed materials and techniques shall not be accepted.

The Contractor shall provide 2 nos. enameled iron plates worked "Men Working of Plant". The plates shall be 200mm x 75mm with red lettering on a white background.

N. B.: All identification and warning labels shall be in ("Hindi Language") and English.

Guards

Adequate guards shall be supplied and installed throughout the installation to cover drive mechanisms. All rotating and reciprocating parts, drive belts, etc. shall be securely shrouded to the satisfaction of the Engineer to ensure the complete safety for both maintenance and operating personnel. However, whilst all such guards shall be of adequate and substantial construction, they shall also be readily removable for gaining access to the plant, without the need for first removing or displacing any major item of plant. The guards shall be of the open mesh type except where retention of fluid spray is required.

Suppression of Noise

All plant equipment offered shall be quiet in operation. The noise level within the building shall not be more than 85 dB (+5 percent on this over the audible frequency spectrum measured at mid-band), "A" scale when measured along a contour 3 meters from any single item of plant during starting, running and stopping. The noise level outside the building shall not be more than 60 dB (+5 % on this over the audible frequency spectrum measured at mid-band), "A" scales when measured along a contour 3 meters from the external wall. Noise test measurement shall be made on completion of the installation of the plant at Site to verify that it complies with this Clause. Plant which fails to comply with the noise level limits when tested which render it liable for rejection unless it is satisfactorily modified at the Contractors expense by the programmed commissioning date.

Trolley and Chain Pulley Block

- a. The chain pulley block shall be operated on the lower flange of the bridge girder.
- b. The load chain shall be made of alloy steel as per IS: 3109. It shall be heat treated to give ductility and toughness so that it will stretch before breaking. It shall be of welded construction with a factor of safety not less than 5.
- c. 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 and shall be provided with roller type guarding to prevent snagging and fouling of the chain.

- d. 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 be as per BS 436/IS: 4460.
- e. The trolley track wheel 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 track joints.
- f. The traveling trolley frame shall be made of rolled steel conforming to IS: 2062. The side plate 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.
- g. Axles and shafts shall be made of carbon steel and shall be accurately machined and properly supported.
- h. The lifting hooks shall be forged, heat treated alloy or carbon steel of rugged 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.
- i. The brake for the lifting gear shall be automatic and always in action. It shall be of screw and friction disc type self-actuating load pressure brake. Brakes shall offer no resistance during hoisting.
- j. If the weight of offered pump set/equipment is more than the craned capacity specified, the contractor shall offer the crane capacity 1.5 times higher than the weight of the pump set/ equipment or as per latest IS.

16.21 Pipes and Fittings

16.22

- a. The cast iron pipes shall generally conform to class B IS: 1537/IS: 1536/IS: 7181 and pipe fittings shall conform to IS: 1538. Ductile Iron pipes shall conform to IS 8329/BS: 4772.
- b. The material for cast iron pipes and fittings shall be of grey cast iron conforming to IS: 210, Gr. FG 200.
- c. The pipes shall be of uniform bore and straight in axis. Length of the straight double flanged pipes shall be within a tolerance as specified in IS standard.
- d. The flanges of the straight pipes shall be square to the axis of the pipe. The faces of the flanges shall be parallel. The bolt holes in one flange shall be located in line with those in order.
- e. The faces of the flanges of the fittings shall be square to the directional axes. The holes shall be located symmetrically off the centerline. The intersecting axes of the tees shall be perpendicular to each other.
- f. The bolt holes on flanged pipes and fittings shall be drilled with the help of drilling jig. The blank flanges are to be machined and drilled.
- g. The dismantling joints shall be of cast iron with EPDM seal ring.

Ventilation Systems

These specifications are common to all dry well/wet well effluent, sewage and water pumping stations and treatment plants. The scope of ventilation system includes following.

- a. Supply Air Fans
- b. Exhaust Fans
- c. Associated Ducting

Wherever the drawings provided for ventilation system, indicate proposed ventilation fans and the routing of ducting. It is the responsibility of the contractor to study and analyse the adequacy of the system and suggest any improvement at the same time taking into consideration all the requirements of the public authorities including safety orders and Fire Protection Rules & Regulations and IS Codes. The necessary permits shall be obtained by the contractor and all payments towards license inspections etc.

paid before starting the work.

Supply Air Fans

Air fans shall be of centrifugal type and fan housing shall be hot-rolled steel of thickness 3/8". End flanged shall be fixed to the casing by continuously welding over the entire circumference. The flanges shall have bolt holes for bolting to inlet bell, companion flanges or ducts as the case may be. Housing shall be continuously welded and shall be expanded by suitable mechanical means to insure concentricity. Motor support shall not be less than 3/9" thick steel plate. Support ring shall be continuously welded to the support plate.

Fan rotor and blades shall be made from cast aluminum with suitable corrosion resistant coating. Belt driven fans shall have multi V belts on pulleys with suitable guards. V belts shall be 150% of rated HP duty.

The fan rotor shall be whirl-tested to 125% or operating speed and shall be statically and dynamically balanced on fan motor shaper to maximum tolerance in one (1) mil double amplitude at design operating speed.

The fans shall have inlet screen at inlet bell cone and carbon steel bolts for existing discharges cone with flanges on both ends attachment to fan and to discharge ducting.

Fan motor supports shall be of adequate strength, constructed from 1/4" carbon steel angles. All the external fasteners shall be stainless steel.

Motors

Motors selected for the fan shall be of adequate rating with a safety factor of 1.5 or greater. If the fans are belt-driven the motor shall be mounted on slide rails for belt tension and adjustment. The complete assembly shall be mounted on Neoprene Vibration Isolators. The motor shall conform to the relevant latest Indian Standards of British Standards. It shall have permanently lubricated ball bearings. The motor shall be suitable for 415 V, 3 Phase 50 Hz supply.

The bearing life shall not be less than 20,000 hours at design conditions and motor shall be of class 'F' insulation to allow for operation up to 95 °C rise over the ambient temperature of 45 °C. External copper grease leads for lubrication of motor bearings shall be provided by the manufacturer.

Fan motor shall be standard totally enclosed fan cooled (TEFC) foot mounted squirrel cage induction motor with single speed, single winding, continuous duty variable torques.

A conduit box shall be mounted on the exterior of fan casing and lead wires from the motor conduit box shall be protected from the air stream by being encased in a tight metal conduit pipe.

The belt drives shall have stainless steel wire cage guards.

Supply of air fans in dry well shall have air flow switches and pressure switches fitted in the ducting. The selection of these switches is left to the contractor to suit the fan units being supplied.

Exhaust Fans

Exhaust fans shall be of direct drive, impeller propeller type, having maximum speed of 1450 rpm.

All the exposed parts shall be of aluminum, with transparent anodic, anti-salt spray coating. All external fasteners shall be of stainless steel. Hood shall be hinged for accessibility and servicing. Fans shall be complete with aluminum bird screens, Plastic or light weight aluminum back draft compels and electrical

disconnecting means beneath the hood and protective grid guard below fan motor.

Motors shall be of relevant Indian Standards or British standards and shall have permanently lubricated ball bearings. The rating shall be adequate with service factor of 1.50 based on rated horsepower. All motor shall be TEFC and be suitable for continuous operation without exceeding a temperature rise of 50 °C over ambient.

The motor shall be of constant speed and squirrel cage type, operating on 415 V, 3 phase, 50 Hz supply. Roof mounted motors shall have electrical disconnects.

Contractor shall submit all catalogues showing the sizing and rating of fans with the size of openings to be provided for approval before proceeding with the work.

Dampers

All dampers shall be of louver type, robust construction, and tightly fitted suitable for the location and service required.

Dampers shall have suitable links, levers and quadrants as required for the proper operations, control or setting in any desired position. Dampers and these operating devices shall be made robust, easily operable and accessible through access doors in the ducts. Every damper shall have an indicating device clearly showing the damper position at all items.

Dampers shall be placed in ducts and every branch supply or return air duct connection whether or not indicated on the drawings for the proper volume control and balancing the system.

Grilles and Diffusers

All grilles shall have vertical and horizontal adjustable bars and controlled from the front of the grill.

Installation

The duct fabrication and installation shall generally conform to IS: 655 latest. It is the responsibility of the Contractor to provide and neatly erect all the sheet metal work as shown on the drawings or as required at site to the satisfaction of the Engineer.

All necessary allowances and provisions shall be made by the contractor for beams, pipes or other obstructions in the building, whether or not the same are shown on the drawings. All necessary modifications as required shall be carried out by the Contractor, however maintaining the same area.

All co-ordination with other agencies/contractor working simultaneously at the site to avoid repetition of work shall be the responsibility of the Contractor.

The ducting shall never be hung from the ceiling and only support of beams and columns shall be taken. The ducts shall be rigid and adequately supported and braced with beams or columns. All joints shall be made tight and all interior surfaces smooth bends shall be made with radius not less than one half the width of the duct. All the sheet metal connections, partitions and required to confine the flow of air and through the filters and fans shall be constructed from No. 18 galvanized iron thoroughly stiffened with 25mm x 25mm angle iron braces and fitted all necessary doors, to give access to all parts of the equipment. Doors shall be set conveniently where required. At the connection of ducting and inlet/outlet of fans, a double-fiber glass reinforced canvas sleeve shall be used.

All fans shall be protected and painted to avoid corrosion.

Lubrication

All blower bearings shall be provided with adequate facilities for lubrication. Exhaust fan unit bearings shall be sealed lubricated type. All oiling devices, grease fittings shall be readily accessible. All bearings shall be lubricated upon completion of the work using lubricants specified by the manufacturer.

NOTES / PROVISIONS

Bidder to take note of following provisions applicable for specifications for various mechanical equipment.

1. See the “GENERAL REQUIREMENT FOR MECHANICAL ITEMS/EQUIPMENT” at end of equipment specifications for painting/coating, minimum documentation requirement for approval during execution and prior to manufacturing and inspection requirements.
2. For all imported equipment, the motors, gearbox, switchgear, PLC controls, etc. items and components as per manufacturers’ standards and makes shall be acceptable.
3. For items like mechanical screens, grinding screens, belt filter press, turbo/centrifugal blowers, centrifuge/decanter, SBR decanter, electric actuator, floating / slant mixers (anaerobic, anoxic, aerobic), etc. the motors, gearbox as per manufacturers’ standards and makes shall be acceptable.
4. For items like screw pumps, dosing pumps, valves, gates, EOT Cranes/Hoist/Material handling equipment etc. the gear box as per manufacturers’ standards and makes shall be acceptable.
5. Make of Crane Duty (S4) motor of small capacity ($\leq 5.5\text{kW}$) for EOT Crane/Electric Hoist as per manufacturers’ standards shall be acceptable.
6. The construction and general requirements for starter/control panel supplied by vendor along with equipment (applicable for equipment with max. motor rated $\leq 15\text{kW}$) can be accepted as under.
 - The control panel shall be generally be free standing, floor / wall mounting type, totally enclosed and dust, damp and vermin proof. Enclosure shall have IP-42/IP-52 or better degree of protection to be mounted indoor or under shed with suitable protection unless better protection class specified in specifications of respective equipment or in BOQ or in tender specifications elsewhere (such as Scope of Work or Process Description or Process Design Criteria and Detail Specifications etc.). Cubicle sheet steel shall be CRCA minimum 1.6mm for load bearing and non-load bearing members. Gland plate shall be CRCA sheet minimum 2.0mm thick unless higher thickness or better MOC (SS 304 or such better MOC enclosure) specified in specifications of respective equipment or in BOQ or in tender specifications elsewhere (such as Scope of Work or Process Description or Process Design Criteria and Detail Specifications etc.). For motors rated $\leq 15\text{ kW}$, the common equipment panel with multiple starters up to 6 numbers within single cubicle can be accepted. However for motor rated $>15\text{ kW}$, individual starter cubicle only shall be provided. For panel offered with multiple starters, the main incomer breaker shall be MCCB of suitable rating.
 - Starter shall be fuse less type. Incomer shall be with ammeter, voltmeter, indicating lamps etc. Start/Stop (Mushroom head stay put type with padlocking facility)/Overload Reset Push Button and Auto-Off-Manual, local-remote selector switches etc. shall be provided. Ammeter with Y-Phase CT shall be provided for all starters with motors rating **ranging from 7.5 kW to < 30 kW**, and ammeter with selector switches shall be provided for all starters with motors rating of $\geq 30\text{ kW}$. Control and power wiring shall be with minimum 1.5 sq. mm. FRLS Copper flexible. CTs, wherever provided shall be resin cast.

The breaker (MCCB/MCB) and other switchgear (MPCB, contactor etc.) shall be as per approved makes specified in tender/specifications for electrical works except for panels imported from outside the country for which makes as per manufacturer standard shall be accepted. However makes of rest all items like wires, selector switches, push buttons, CT/PT, etc. as per manufacturers’ standards are acceptable.

- For equipment starter required with/provided with VFD based starting or with Soft Starter based starting following to be noted:

- ✓ VFD shall be selected such that the de-rated current of VFD/Soft Starter for 50 °C continuous operating temperature shall be equal to or greater than 110% of the rated current of driven motor. Alternatively, VFD shall be provided of at least one rating higher than the motor rating.
 - ✓ The VFD for sewage/STP and industrial effluent or such application shall be with 3C3 conformal coating and for raw/drinking water or rest applications shall be with 3C2 conformal coating.
 - ✓ The Fast Acting (Semi-conductor) fuse for VFD/Soft Starter protection are not required for motors rated less than **75 kW**.
 - ✓ The series contractor in line of VFD/Soft Starter after breaker is not required for motors rated less than **75 kW**.
 - ✓ VFD shall be with communication port (RS 485 Modbus or suitable) and shall be connected with plant PLC/SCADA for remote data, power monitoring and diagnostic data.
- Shall be suitable for remote monitoring and control from PLC/SCADA system. Required potential free contacts shall be provided for On/Off, Trip and L/R selector switch status as a minimum. In case of PLC based control offered, the PLC shall be with communication port (Modbus protocol or suitable) to communicate with plant/main PLC/SCADA for remote monitoring and control.
 - For PLC based control provided in control panel supplied along with equipment by vendor, the PLC with specification and make as per manufacturers' standards are acceptable.
 - Bidder to refer the specifications for electrical works and instrumentation works for rest all requirements.
7. The detail specifications for various mechanical equipment provided below are general specifications/general requirements. Operation philosophy and construction methodology may vary for each manufacturer and for the type of equipment offered and can be accepted keeping the design philosophy/application requirement as specified in tender or as per process requirement and such minor variation in specifications can be accepted subject to review (if required with justification/supporting documents) and Client's approval.

(B) DETAILED MECHANICAL SPECIFICATIONS

1.0 SEWAGE SUBMERSIBLE NON CLOG PUMP SET

A. General

The Pump shall be submersible, non-clog, single stage, centrifugal, wear resistance with vertical shaft suitable for permanent installation in wet-pit/sump along with submersible motor and submersible cable of specified length. The pump and motor shall be as one unit together with impeller mounted on extended shaft of motor.

The pump shall be designed to pump sewage/wastewater or sludge or such fluids having impurities / solids and operate satisfactorily without detrimental surges, vibration, noise or dynamic imbalance over the required Head-Capacity range. The head-capacity curve of the pump shall have continuously rising head characteristics with decreasing capacity over the whole performance range of pump. The shut off head of the pump shall be at least 120% of the total head.

The pump shall be selected in such a way so that the operating point shall lie on best efficiency point (BEP) or within 15% of BEP flow on either side meeting minimum submergence requirement.

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 resistance indicated. All pumps shall have identical performance.

The pump shall be designed to start with the delivery valve fully open to the extent possible.

The pump shall be designed to operate safely at the maximum speed attainable in the reverse direction of rotation due to liquid returning through the pump at times when the power supply to the motor is interrupted and the discharge valve fails to close.

Pumps' rotating parts and assembly shall be statically and dynamically balanced as per ISO 10816/ latest IS standards and shall run smooth without undue noise and vibration.

The auto coupling unit with foundation plate shall be grouted with the RCC foundation with the help of "J" type foundation bolts or as per manufacturer's recommendation/approved size. Minimum height of RCC foundation height shall be "Pockets" Height (Depth) and additional 50 mm".

The power rating of motor to drive pump shall be suitable to meet maximum requirement of power for the rated impeller throughout its performance range and specific gravity of the liquid.

B. Features of Construction

PUMP

Pump shall be vertical submersible centrifugal, single stage, non-clog suitable for permanent installation in wet-pit/sump. The pump shall have bottom suction and side discharge nozzle. The pump and motor shall be as one unit together with impeller mounted on extended shaft of motor.

The pump having delivery size of 50mm, shall be designed to handle solids of minimum 35-40 mm, for pump having delivery size 100mm shall be designed to handle solids of up to 80 mm size, for pump having delivery size above 100mm shall be designed to handle solids of up to 100 mm size.

Casing

Pump casing shall be volute type of robust construction and designed for high efficiency. Liquid passages shall be designed to allow free passage and finished smooth. The tongue shall be straight across and filed to a smooth rounded edge. Casing can be provided with wearing rings/wear plates.

Casing shall have facility for removal of clogged material from impeller vanes without dismantling the whole pump.

Impeller

Impeller shall be semi-open or suitable as per manufacturers' design, single suction with smooth and large ways so as to allow free passage to the fluid being pumped. Impeller shall have two/three vanes maximum and be capable to handle solids of specified size. It shall be free from sharp corners and projections likely to catch and hold rags and stringy materials. Typical sewage has high content of sand, silt and ash, hence the pump design shall be of wear resistant type.

Impeller shall be statically and dynamically balanced preferably at rated speed as per applicable standard so as to avoid vibration. The Impeller shall have back vanes or suitable features to balance axial thrust.

Suitable mechanisms should be provided to avoid accumulation of grit/silt for enhanced life of mechanical seal.

Impeller Nut

Impeller shall be fixed on rotating shaft with the help of SS 316 impeller screw or cap top type impeller nut with helicoil insert and washer in such a way that impeller doesn't get loose during rotation of pump in either direction.

Shaft Seal / Mechanical Seals

Double mechanical seals shall be provided to protect the motor from ingress of water along the shaft. The preliminary and secondary seals shall be oil-lubricated. The seal faces of the preliminary seal shall be of either tungsten carbide or silicon-carbide faces while the secondary seal can be of carbon versus chrome steel or tungsten carbide. Pumps shall be equipped with moisture detection sensor for seal failure detection. Use of Lip seals or back to back seals is not allowed. The mechanical seals shall be bi-directional.

Bearings

The pump set shall have double anti friction grease lubricated bearings. The bearings life shall be minimum 40,000 hours of operation. Bearings shall be greased for life i.e. shall not require any re-greasing.

Auto Coupling/Guide Pipe/Lifting Chain

Each pump shall be supplied with pump connector unit in order to connect connector unit to pump support bracket & provide leak proof joint and fixing it to the concrete floor of the suction well. The design of the automatic coupling system shall be such that the joint between the pump discharge flange and the delivery piping shall be made by merely lowering the pump into guide rails/wire rope from access level. The pedestal of the automatic coupling system shall be integrally cast with the delivery bend thereby obviating the need of separately bolted CI duck foot bend. It shall be provided with all necessary fixtures like guide wire/guide pipe for guiding the pumps during lifting/lowering.

Each pump shall be provided with stainless steel lifting chain in conforming to relevant standards. The lifting chain shall be provided with dual 'O' rings/shackles in SS 304 at every about 1.5m C-C for intermediate level support of pump and changeover of hoist hook during lowering and lifting.

Pump Rated 7.5kW & above must be with Double Guide Pipe. For Pump with Motor Rating less than 7.5 kW Guide Pipe can be single / double as per Pump Manufacturer Standard.

For Pump Rating 15kW and above Guide Pipe shall be min. 50mm Dia. or higher as required as per pump load / vendor requirements. For pump with motor rated less than 15kW Guide Pipe shall be as per manufacturer standard / as pump design requirements.

Lifting Hook

To "fish out" a vertical submerged pump set from the wet well (even if a chain has not been attached to the lifting hook prior to the pump set being lowered) the pump shall have a self-centering lifting hook. Its design shall be such that the lifting chain's hook can be engaged to the pump's lifting hook without the need for man to enter the wet well.

INDUCTION MOTOR (Submersible)

The submersible motor shall be induction, squirrel cage and dry type, designed for continuous operation (S1 duty) capable of working satisfactorily in water immersion. Motor shall be capable of giving rated output without reduction in the expected life span when operated continuously under the following electric supply conditions:

Supply voltage	:	415 Volts, 3 Phase, 50 Hz AC supply	
Voltage variation	:	± 10%	Frequency variation : ± 5%
Combined variation of Voltage and Frequency	:	± 10%	

The motor shall be generally designed to have performance characteristics like nominal efficiency, locked rotor current etc. in line with IS:12615 (2018) (Efficiency Equivalent to IE2 of IS:12615)

Degree of protection of motor shall be IP 68. The power rating of the motor shall be minimum 110% of power required by the rated impeller on its entire performance range. Further, the minimum power ratings for motors to drive pump should be selected as per table of multiplying safety factor provided for squirrel cage induction motors under electrical specifications and higher of the two ratings shall be provided.

Motor shall be suitable for full voltage & DOL/Star-delta/Soft Starter/VFD starting. Motor shall be capable to start and accelerate the load with the applicable method of starting, without exceeding acceptable winding temperature, when the supply voltage is in the range 85% of the rated motor voltage to maximum permissible voltage. Motors shall be designed to withstand 120% of rated speed for two minutes without any mechanical damage, in either direction of rotation. The motor vibration shall be within the limit specified in applicable standard unless otherwise specified for the driven equipment. Except as mentioned herein, the guaranteed performances of the motor shall be met with tolerances specified in applicable standards.

Any joints in the motor insulation such as at coil connection or between slot and end winding section, shall have strength equivalent to that of the slot section of the coil. The insulation shall be given tropical and fungicidal treatment for successful operation of the motor in hot, humid and tropical climate. The tropical treatment shall be as per the applicable standard.

The stator winding shall be made from high conductivity annealed copper conductor, super enameled insulated winding wires conforming to IS:8783 (1978) for dry type motors. The stator winding shall be of high conductivity annealed copper enameled insulated wires conforming to IS 4800 Part VII (1970) for dry type motors. The corresponding class of insulation shall be class F with temperature rise limited to class B. However, for motors to be operated on VFDs, only class H insulation with temperature rise limited to class F is allowed and motor shall be inverter duty type and to suit for speed variation from 50% to 100% or higher.

As the cable resistance method, due care is taken to account for the correct hot and cold resistance of windings.

If these pump's motors are to be used with Variable Speed Frequency Drives than:

- ☐ The motor insulation shall be vacuum varnish impregnated instead of dip varnishing or trickle varnishing with double insulation coating.
- ☐ The motor insulation is to be of class H only with temperature rise limited to class F.
- ☐ Current insulated bearings (preferably NDE) required for motor ratings above 200kW.
- ☐ The motor shall be suitable for speed variation from 50% to 100% or higher.

Terminal chamber shall be of IP 68 type construction to eliminate entry of storm water and dust. The Terminal chamber should be isolated from the motor chamber to prevent entry of liquid/moisture in the motor chamber through the terminal chamber. The terminal shall be the stud type with necessary plain washer, spring washers and check nuts. They shall be substantially designed for the current carrying capacity and shall ensure ample phase to phase to ground clearance.

Protection

Protection against increase in bearing & stator winding temperature shall be provided. Thermostats/bimetallic switches shall be provided to sense the stator winding temperature.

Sensors are to be provided to detect if leakage of water into the oil housing. Bimetallic thermal switch to trip the motor against increase in temperature shall be provided.

The required control unit to process these safety signals and with potential free contact o/p for alarm/trip shall be provided by pump vendor for suitable interlocking in starter circuit and/or PLC.

Manufacturer shall provide Pump Monitoring Unit (PMU) & temperature scanner (as per electrical specification requirements) with each pump set.

Submersible Cable

A watertight cable junction box sealed from the motor shall be provided for the motor power and signaling cables. The cable shall be of sufficient length and shall be brought out of the submerged motor without joint to terminate in junction box/control panel, located in LV panel room/outside the wet well.

Power as well as control cables shall be of dual sheathed EPRS/PVC, armoured type with required numbers. of Copper core, round type and of required size as per design requirement.

The power cable shall be PVC insulated and PVC sheathed, flexible, copper 3.5/4.0 core round type. The size of the conductor shall be adequate for continuous use under water and air. Cable half/full core as per design to be provided for earthing. The size of the conductor considering length of cable shall be suitably selected so that the voltage drop at motor terminals does not exceed 3 percent of the rated voltage.

The control cable shall be PVC insulated PVC sheathed, flexible, copper, round type and shall be adequate for continuous use under water and air. The control cable for stator winding temperature sensor, bearing temperature sensor, sensor for leakage of water into the oil, level sensor (thermostats/bimetallic switches/RTD) of 1.5/2.5 sq. mm, multi strand copper conductor of required number shall be provided or as required as per design. Control cable shall be with minimum 1 number of spare core.

The cable connection to the motor entry should be such that cable fitment should be possible at the site. Control cable termination details as per pump design / requirements shall be provided by manufacturer.

Earthing of the motor & pump set shall be done in accordance with the relevant provisions of IS:3043:(2018) for the purpose of earthing the motor & pump set. Earthing connection may be made to discharge pipe.

Motor Cooling

The motor cooling shall be normally by surrounding water. However jacket cooling with in-built overflow or such suitable design of other method of jacket cooling shall be provide as specified in process data sheet/scope of work or if specified in BOQ.

C. Materials of Construction

The specific requirement shall be considered as under:

Pump Casing	: CI IS 210 Gr. FG 260
Casing Wear Ring / Wear Plate	: CI IS 210 Gr. FG 260
Suction cover/Oil Chamber/Motor Casing	: CI IS 210 Gr. FG 260
Shaft	: AISI 410
Shaft Sleeve	: AISI 316 (if applicable) Impeller/Impeller Nut
: CF8M	
Auto Coupling Unit	: CI / WCB Hardware (Nuts, Bolts, Fasteners, etc.)
: SS 304	
Motor Jacket (if applicable)	: SS 304
Guide Rail Pipe	: SS 304 of suitable length & size as specified above in pump specifications.
Lifting Chain	: SS 304, Minimum equivalent to sump depth + 3m, with dual 'O' rings/shackles at every about 1.5m center to center.
Bolts, Nuts, Fasteners etc.	: SS 304 (All, Wetted and Non-wetted)
Cable length (each run)	: As per BOQ or Minimum equivalent to sump depth + 10 m, whichever is higher.
Maximum Permissible Solid Size	: As specified above in pump specifications

The above MOC is minimum requirement and if process requirement is higher as indicated in process data sheet the stringent MOC to be provided.

2.0 VALVES

General

Valves shall be as per internationally recognized standards. Flanges shall be machined on faces and edges to ISO 7005, IS: 6392 or BS 4504. Flange drilling should confirm to IS: 1538.

Valves shall be double flanged type (unless the end connection is permitted otherwise as specified in specifications for each valve below/in process data sheet) and the face shall be parallel to each other and flange face should be at right angles to the valve centerline. Back side of valve flanges shall be machined or spot faced for proper seating of the head and nut.

Generally, valves shall be rated for nominal pressure of PN 1.0 as a minimum or PN 1.6 if required as per process application or as specified in tender specifications/SOQ/BOQ. Further, higher pressure rating valves shall be offered if required as per process application and in MOC as specified in specifications elsewhere for such applications or suitable for such pressure ratings if not specified explicitly. The CI/DI MOC specified are generally for water/sewage/sewage sludge applications. However for industrial effluent and certain chemical applications the valve MOC shall be offered to suit to the process fluid.

Valve buried or installed in underground chamber, where access to a hand wheel would be impractical, shall be operated by means of extension spindle and/or keys.

Valve shall be suitable for frequent operation as well as operation after long periods of idleness in either open or closed position. For all type of valves/gates (including open channel, thimble mounted, etc.) gear mechanism design and makes shall be as per manufacturer standard

The valve stem, thrust washers, screws, nuts and all other components exposed to water/sewage shall be of a corrosion resistant grade of stainless steel.

Valves shall be free from sharp projections.

For valves with extended spindle/shaft following shall be considered/provided.

- Extended spindle MOC and size to be confirmed by valve manufacturer.
- Head stock/bracket supply shall be in valve vendor scope only. Valve manufacturer also to provide details and MOC of the same in GAD.
- For extended spindle the coupling and guide bracket details shall be provided by manufacturer. Generally it is desired to have two numbers universal couplings (one on top/ below headstock and one in bottom above gear box/valve body). In case of long spindle lengths muff couplings at about every 3m distance. Shaft guide bracket/support shall be provided if extension spindle is more than 3m long.

2.1 SLUICE/GATE VALVES

Design Requirements and construction Features

Sluice valve shall be non-rising spindle type resilient seated (Manually operated) confirming to IS: 14846/BS 5163 having PN 1.0/PN 1.6 rating free from sharp projections which are likely to catch and hold stringy materials.

Sluice valve shall be rising/non-rising spindle type when operated through electric actuators confirming to IS: 14846/ BS 5163 having PN 1.0/PN 1.6 rating.

For valve size 50mm and above end connection shall be flanged and for sizes below 50mm shall be flanged/threaded type.

Body of the valve shall be designed for 1.5 times the rating of the valve.

Valve flange face shall be parallel to each other and flange face should be at right angle to the valve centerline.

Back side of valve flange shall be machined or spot faced for proper seating of bolt head and nut.

Wherever extension spindle is provided, the valve shall also be provided with suitable headstock.

Valve shall close with clockwise rotation of the hand wheel. The direction of closing shall be marked on the hand wheel.

Valve shall be non-rising or rising spindle type and rated for nominal pressure of PN 1.0/PN 1.6 as per SOQ/BOQ or as specified in tender specification or as per application requirement.

Stem sealing shall be done with NBR wiper ring in case of resilient seated and bonnet gasket shall be of EPDM. Valve shall be powder coated electrostatically internally as well as externally by RAL blue colour.

Accessories shall be provided as under.

1. Valves 300mm and above size shall be provided with repacking arrangement as per IS: 14846.
2. The valves 600mm and above size shall have channel and shoe arrangement as per IS: 14846.
3. The valves 350mm size and above shall have spur/bevel gear arrangement as per IS: 14846.
4. All valves shall have valve's OPEN/CLOSE indicator arrangement as per IS: 14846.

Materials of Construction

a) Body and Bonnet	:	CI IS: 210 FG 200 OR DI IS: 1865 Gr. 500/7
b) Wedge	:	CI IS: 210 FG 200 OR DI IS: 1865 Gr. 500/7 and core fully Encapsulated with EPDM rubber with integral wedge nut (For non-rising resilient seated valves)
c) Spindle Nut	:	Bronze IS: 318 Gr. LTB2
d) Spindle	:	SS BS 970 Gr. 304 S16
e) Seat Rings	:	SS BS 970 Gr. 304 S16
f) Back Seat Bush	:	Bronze IS: 318 Gr. LTB2
g) Shoe and Channel Linings	:	SS to BS 970 Gr. 304 S16

For valve size 50mm and above end connection shall be flanged and for sizes below 50mm shall be flanged/threaded type.

However, valves 15mm to 40mm size shall be generally as per API 6D/API 602 and having Carbon Steel Body (Body: forged carbon steel A105/cast carbon steel Gr WCB, Trim: 13% Cr) in class 150 or higher rating and shall be screwed/flanged ended.

2.2 SWING CHECK TYPE REFLUX VALVES (NON-RETURN VALVES)

Design Requirements and Construction Features

Non return valve i.e. reflux valve swing check type confirming to IS: 5312 having PN 1.0/PN 1.6 rating free from sharp projections which are likely to catch and hold stringy materials.

For valve size 50mm and above end connection shall be flanged and for sizes below 50mm shall be flanged/threaded type. The valve shall be suitable for mounting on horizontal pipe line.

The internal parts shall be easily accessible for inspection through inspection hole.

Hydraulic passages and doors shall be designed to avoid cavitation.

Valve body shall be designed for 1.5 times the rated pressure.

Valve shall be of swing type or ball type. Ball type valve must house a freely moving ball in such a way that return flow is effectively prevented.

Valve shall be quick closing type with non-slam characteristics in case of swing type. The non-slam characteristics shall be achieved by providing suitable combination of door and hydraulic passages without any external lever/dampening arrangement.

Flow direction shall be clearly embossed on the valve body.

Valve flange face shall be parallel to each other and shall be at right angles to valve centerline. Flange back shall be machined or spot faced for proper seating of bolt head and nut.

Valve shall be rated for nominal pressure of PN 1.0/PN 1.6 as per SOQ/BOQ or as specified in tender specification or as per application requirement.

Accessories shall be provided as under.

1. Valves 300mm and above size shall be provided with by-pass arrangement as per process requirement as per IS: 5312.
2. Valves 300mm and above size shall be provided with drain plugs as per IS: 5312.
3. Valves 450mm size and above shall have support foot as per IS: 5312.

Materials of Construction

a) Body, Cover, Doors and Hinge	:	CI IS: 210 FG 200 OR DI IS: 1865 Gr. 500/7
b) Body Ring	:	SS BS 970 Gr. 304 S16
c) Disc Ring	:	SS BS 970 Gr. 304 S16
d) Bearing Bushes	:	Bronze IS: 318 Gr. LTB2/SS BS 970 Gr. 304 S16
e) Gasket	:	Grafoil Filler SS 304 Spiral Wound
f) Ball (if applicable)	:	To Be with EPDM Rubber

However, valves 15mm to 40mm size shall generally as per API 6D/API 602 and having carbon steel body (Body: forged carbon steel A105/cast carbon steel Gr WCB, Trim: 13% Cr) in class 150 or higher rating and shall be screwed/flanged ended

2.3 DUAL PLATE CHECK VALVES

General

All double flanged dual plate check valves shall conform to API 594 (1997) and API 598 or its latest amendment for pressure rating PN1.0/PN 1.6/Class 300 as specified in technical data sheet/BOQ. All the parts of the valve shall be designed so as to withstand the test pressure as specified in the standard. Valve shall be free from sharp projections which are likely to get clogged with stringy materials.

The internal dimensions and shape of the body, plates etc. shall ensure that the area for flow passage at any cross section in the valve is not less than the area of the nominal bore of the valve as per manufacturing standard.

The designs of the plates, hinge pin, stop pins etc. shall ensure free swinging of the plates. The spring action shall optimize the equal closing rates of each plate. The dual plates face shall have close face contact with the body seat ring in close position. Valves shall be designed for horizontal and vertical mounting position. The plates shall not vibrate under full or partial flow condition.

Valve shall be quick closing type with non-slam characteristics. The non-slam characteristics shall be achieved by providing suitable combination of plates, springs and hydraulic passages.

B. Features of Construction

Body

Valve body shall be double flanged. The minimum thickness of metal for body shall be as per directives given in the API 594 and shall be maintained throughout any section uniform. The flange to flange dimensions shall be in accordance with manufacturing standard (Tables 2A and 2B).

Body of the valve shall be fitted with removable seat ring securely fixed in machined recesses by proper engineering practice. Rear side of valve flanges shall be machined or spot faced for proper seating of bolt head, washer and nut.

Each check valve shall carry an embossed ARROW to indicate the direction of flow.

Flanges

Valve flange faces shall be parallel to each other and shall be at right angle to the valve centerline. The finish on facing shall comply with MSS SP-6/ASME B 16.5. The flanges and their dimensions of drilling shall be in accordance with the requirements of IS: 1538, Table IV and VI.

Plates and Hinges

Plates and hinges shall be designed so as to withstand satisfactorily the repeated impacts likely to occur during service. Plates shall be securely positioned on body seat face with the assistance of required nos. of spring or other devices. Plate seating face shall be renewable or uniformly deposited weld metal machined and lapped using good manufacturing process so as to provide leak less seating on body face ring.

The spring action shall optimize the equal closing rates of each plate. The plates shall be totally vibration free under full or partial flow condition.

Internal Wetted Parts

Internal wetted parts shall be suitable for the specified service conditions. The term shall include but not

be limited to hinges, pins, bolts, bearings and any other part in contact with the fluid medium other than the body, plates, trim, springs and pipe plugs.

Optional Items

1. Valves 150mm and above size shall have lifting eyebolts.
2. Valves 600mm and above size shall have support foot.
3. Valves 600mm and above size shall have bypass arrangement as per process requirement.

Materials of Construction

a) Body	:	CI to IS: 210 FG 200 OR DI IS: 1865 Gr. 500/7
b) Disc (Closure Plate)	:	Cast Steel (ASTM A216 Gr. WCB)
b) Seat	:	Nitrile
c) Spring	:	Spring Steel
d) Stop/Hinge Pin and Space Washers	:	SS 304

2.4 BUTTERFLY VALVE

Butterfly valve shall be as per IS: 13095/BS 5155. Valve shall be suitable for mounting in any position. Valve shall be rated for nominal pressure as specified above in general requirements.

For valve size 150mm and above end connection shall be flanged and for sizes up to and including 125mm shall be flanged/full lug wafer type.

The valve seat shall be of integrally cast or replaceable design. When the valve is fully closed, the seal shall seat firmly so as to prevent leakage. The seat surfaces shall be machined smooth to provide a long life for the seal.

All fasteners shall be set flush so as to offer the least resistance possible to the flow through the valve.

Valve shall be suitable for throttling purpose.

All valve, spindles and hand wheels shall be positioned to give good access for operational personnel.

Valve of diameter 200mm 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.

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.

Butterfly valve where specified shall be electrically operated.

Materials of Construction

Sr. No.	Component	Material
(a)	Body	Cast Iron IS: 210 FG 260 OR Ductile Iron IS: 1865 Gr. 500/7
(b)	Body Ring	Stainless Steel BS 970 Gr. 431 S29
(c)	Disc	Ductile Iron IS: 1865 Gr. 500/7
(d)	Shaft	Stainless Steel BS 970 Gr. 431 S29
(e)	Disc Ring	EPDM Rubber
(f)	Bearing	Teflon

2.5 BALL VALVES (if Applicable)

General

Ball valve shall be manufactured as per BS EN ISO 17292 and Inspection and testing standard shall be BS EN 12266-1. Valve shall be rated for nominal pressure as specified above in general requirements.

Ball valve shall be supplied with a lever/wrench unless it is gear or electric actuator operated.

Soft-seated ball shall be with antistatic devices.

Soft-sealed BW/SW end ball valves shall have a 100mm long seamless pipe nipple welded to each end of the valve. Nipples are to be welded prior to assembling Teflon seats/seats.

The face-to-face dimensions of all ball valves shall be same as those of gate valves of the corresponding ANSI class up to 200mm NB size. Valves 200mm NB onwards shall be in class 150 where the face-to-face dimensions shall be as per API 6D long pattern.

The ball of ball valve shall not protrude outside the end flanges of valve and shall provide 100% through passage to the flow of liquid.

Ball valve shall be of floating ball/trunnion mounted type as per following.

Class 150	200mm and below	Floating Ball
Class 150	250 mm and above	Trunnion Mounted

Unless otherwise specified, bore of all reduced bore ball valve shall be limited to one size lower than the nominal bore.

Valve Design	:	3 Piece Ball Valve
Type of Bore	:	Full Bore

Materials of Construction

Body and End Caps	:	ASTMA-351 Gr. CF8M
Ball/Stem	:	AISI- 316
Seat	:	PTFE
End Connection	:	Less than 50mm – Socket Weld End (SW)/Threaded (Screwed End) 50mm and above - Flanged end, 150#
Operation of Valve	:	By Lever/Gear/ Electric Actuator as per SOQ/BOQ

2.6 AIR VALVE WITH ISOLATION SLUICE VALVE (If Applicable)

DI temper proof flanged air valve with isolation sluice valve as per IS: 14845 PN 1.6 and IS: 14846 PN 1.6 respectively with SS 304 float, gun metal nozzle, complete hardware, bolts, nuts and washers, gaskets etc. Sluice valve shall meet the requirements as specified in sluice valve specifications here in.

KINETIC AIR VALVE

General

The double acting kinetic air valve shall be manufactured as per IS: 14845 (2000) or its latest amendment suitable for the specified pressure rating. All the parts of the valve shall be designed so as to withstand the test pressure as specified in the standard. Valve shall be free from blow hole, flaw burr or other defects and sharp projections which are likely to get clogged with stringy materials.

The valve shall be capable of releasing air from pipe automatically when the pipe is being filled by liquid without generating high air pressure in pipe and shall remain closed once the pipe is filled to prevent spillage and loss of liquid and maintain rising main's pressure. Similarly, the valve shall be capable to admit air automatically to prevent development of vacuum while the pipe is being emptied.

Features of Construction

Body

Body of the air valve shall be flanged type and shall have high pressure and low pressure chambers to accommodate high pressure and low pressure float respectively. The chambers shall be designed and have proper guide for small orifice float and guide ribs with minimum clearance to large orifice float so as to allow wobble free upward and downward movement of floats in the chamber when required for releasing or admitting air without any obstruction.

Body shall be designed to avoid prematurely closing of the valve by the air whilst being discharged.

The cone angle of the low-pressure chamber shall be such that even at critical velocity of air escaping at 344 m/sec the total impact force on the float is less than the suction force on the annular area between the float and cone. Cone angle and the minimum body thickness shall be as specified in IS: 14845 (2000). The low-pressure cover shall be designed to withstand full operating thrust in working Conditions.

The seat ring shall be held securely in place under the low pressure cover by a joint support ring to prevent it from sagging when the ball is not sealing the orifice.

High Pressure Orifice

The high-pressure orifice shall be so designed that the orifice is effectively sealed in working condition. The orifice shall be of size not less than 2.5mm and tapering to 10mm suitable to release accumulated air within the pipe. The edge of orifice shall be carefully profiled to avoid damage to the float surface. The orifice shall be protected by a Suitable plug of stainless steel.

Flanges

All valve flanges shall be designed to withstand the stresses to which they would be subjected under hydraulic tests. Flanges shall be machined flat and drilled in accordance with IS: 1538, Table 4 and 6. Flange bolt shall be drilled off center.

Floats

The float size shall be as per individual design subject to minimum as specified in IS: 14845 (2000). The buoyancy of the floats shall ensure effective sealing of large orifice even at low pressure. The float shall be made of seasoned wood or any other material having bearing strength and equivalent specific gravity. The floats shall be externally coated with vulcanite or rubber having required shore hardness as per IS. The floats shall be non-clogging and self-sealing type for trouble free operation.

Low Pressure Seat Ring

Low pressure seat ring shall be of natural or synthetic rubber having required shore hardness. The central orifice shall be profiled for maximum discharge in any given condition of pressure differential between the chamber and atmosphere. The float shall make contact with inner profile of the seat ring and seat ring shall withstand the bearing load under working condition without any deterioration in the quality.

Joint Supporting Ring

Low pressure seat ring shall be held securely in place under low pressure cover by a joint support ring to prevent it from sagging when the float is not sealing the orifice.

Cowl

A cowl shall be temper proof and designed to provide protection to low pressure, large orifice chamber, seat ring and float. It shall be designed to prevent direct ingress of foreign matter inside. There shall be sufficient clearance between the orifice and the cowl to ensure easy passage of air under a given pressure differential.

Materials of Construction

Body and Cover	:	DI IS: 1865 Gr. 500/7 OR CI to IS: 210 FG 200
Floats	:	Stainless Steel 304
Gasket	:	EPDM or Nitrile Rubber ASTM D 1418
Cover Bolts and Nuts	:	Carbon Steel

Accessories

1. Isolating DI DF sluice valves manufactured as per IS: 14846 of identical size and rating.

Sluice valve shall meet the requirements as specified in sluice valve specifications here in.

MARKING:

The following information shall be embossed on each valve body:

- ISI Certification Mark.
- The manufacturer's name or Trade Mark.
- Type of Valve.
- Pressure Rating of valve.
- The size of valve in mm.
- Heat number of cast.

2.7 ELECTRIC ACTUATOR (APPLICABLE FOR VALVES/GATES)

All local controls shall be protected by a lockable cover.

Electric actuators with 90 degree rotary operation (Quarter Turn Actuator) with the required torque shall be provided for various type of rotary valves like plug valves, ball valves, butterfly valves and dampers or baffles etc.

Multi-turn actuators shall be provided for linear type valves/for sliding stem valves like globe valves, gate valves, knife gate valves, sluice gates etc.

Each actuator shall be adequately sized to suit the application and be continuously rated to suit the modulating control required. The gear box shall be oil or grease filled and capable of installation in any position. All operating spindles, gears and headstocks shall be provided with adequate points for lubrication.

The valve actuator shall be suitable for ON-OFF type of service and duty shall be S-2 minimum 15 minutes of continuous operation. It should be capable of producing not less than 1½ times the required valve torque i.e. selected actuator rating in Kgm (Nm) shall always be 1.5 times the maximum valve torque in Kgm (Nm).

The operating speed shall be such as to give valve closing and opening within 120 seconds maximum up to 700 mm dia. /height of SV/KGV/sluice gates. However for SV/KGV/SG exceeding 700 mm dia. /height shall be maximum within 240 seconds subject to fulfilment of actuator torque rating be 1.5 times that of maximum valve torque. Moreover number of turns for valve close to valve open shall be comfortably less than 200. Only in very high sizes the same may be permitted up to 250 maximum. The operating speed shown here are for ready reference only. Care must be taken by the valve manufacturer to choose such model of actuator so as to keep the opening & closing time to as low as possible.

The actuator starters shall be integrally housed with the actuator in robustly constructed and totally enclosed weather proof housing of IP 68. The motor starter shall be capable of starting the motor under the most severe conditions.

The starter housing shall be fitted with contacts and terminals for power supply, remote control and remote positional indication, and shall also be fitted with internal heaters so as to provide protection against damage due to condensation. Heaters shall be suitable for single-phase operation. The heaters shall be switched “ON” when the starters are “OFF” and shall be switched “OFF” when the starters are “ON”.

Each starter shall be equipped as follows as a minimum.

- a) AC electric motor.
- b) Reduction gear unit (with thrust bearing if required).
- c) Torque switch mechanism complete with set of torque switches for “Open” and “Close” position.
- d) Limit switch mechanism complete with set of limit switches for “Open” and “Close” position.
- e) 2 numbers of auxiliary limit switches to be provided for each direction in the switch mechanism in addition to the torque/limit switch for travel termination (if specified for any application in scope of work/process description & specifications).
- f) Hand wheel for manual operation.
- g) Hand-auto changeover lever with suitable locking arrangement.
- h) Local control switch/push buttons.
- i) Forward/Reverse integral starter.
- j) 1 Set “Open”, “close” and “Stop” buttons as applicable.
- l) 1 number Local – Off –Remote switch with padlocking facilities as applicable.
- m) Space heater, 220V rated.
- n) Position indicator.

- o) Position transmitter with 4-20 mA analogue output for valve open/close position if requirement specified elsewhere in tender as per application.

The following relays/potential free contact shall be provided.

- Full open
- Full close
- Torque switch open
- Torque switch closed
- Thermo-switch/thermal overload relay tripped
- Selector switch position local-remote-off
- Single phasing power supply failure.
- Remote position feedback in the form of 4-20 mA (if required/specified).

The actuator shall be suitable for operation in the climate conditions and power supply conditions given in the specification. The actuator shall be capable of producing not less than 1½ times the maximum required torque and shall be suitable for at least 15 minutes continuous operation.

AC Electric Motor

Each motor shall be fully tropicalized and suitable for operation in the prevailing climate conditions. They shall also be suitable for operating satisfactorily under variations of electric supply specified.

The motors shall be of appropriate rating for 3 phase, 50 Hz AC electric supply of required speed (RPM) of minimum class 'F' insulated with temperature limited to that of class B, high torque low inertia motors of 15 minutes rating, squirrel cage induction type with 'O' ring seal to provide complete environmental protection during long period of inactivity. The winding shall be impregnated to render them non-hygroscopic and oil resistant. All internal metal parts shall be painted. Motor shall be capable of at least 60 starts per hour. Make of electric motor shall be as per latest governing standards and manufacturers' standards.

Motor Protection

Following motor protection shall be provided.

- a) The motor shall be de-energized in the event of a stall when attempting to unseat a jammed valve.
- b) Motor temperature shall be sensed by a thermostat to protect against overheating.
- c) Single phasing protection.

Motor Controls

The reversing contactor starter and local controls shall be integral for actuator. The starters shall comprise mechanically and electrically interlocked reversing contactor of appropriate rating fed from a 220V control transformer (120V AC for energization of contactors and 24V DC rectifier supply for local control for integral starter is also acceptable). The common connection of the contactor coils at the transformer shall be grounded. HRC type primary and secondary fuses shall be provided.

Local control shall comprise push buttons for open close and stop operations, and a local/remote selector switch lockable in the three positions as below.

Local control only,
Remote control plus local stop only,
Stop locked off - No electrical operation.

Vendor should also make a provision for transmitting the mode selected to control panel and control panel will have corresponding indication lamps.

Wiring and Terminals

Internal wiring shall be of grade PVC insulated stranded cable of 650V and of minimum 1.5 mm² copper for control circuits and of minimum 4 mm² for the power circuit. Each wire shall be number identified at each end. The terminals shall be of stud type and they shall also be identified by numbers. Cable entries shall be suitable for suitably sized PVC cables.

Enclosure

The actuator enclosure shall be weather proof to IP 68.

Reduction Gear Unit

Reduction gear unit shall be of the totally enclosed oil bath/grease lubricated type. The gear box shall be provided with the first charge of oil lubricants and appropriate filling and drain connections. Gearing shall be adequate to open and close the sluice gates under full indicated maximum operating pressure differential at a speed sufficient to cover the full extent of travel.

The sluice gate operating equipment shall have a hammer-blow device to loosen stuck sluice gate or retrieve jammed sluice gate position.

The gearbox shall have suitable stops to prevent movement of shaft beyond fully open/close position. The gearbox shall also be designed for 15% more torque than maximum sluice gate/valve torque.

Torque and Position Limit Switch Mechanism

Each actuator shall be provided with both open and close torque limit switches, open and close (end position) limit switches for remote indication and interlocking plus two sets of auxiliary limit switches in each direction for intermediate position indication and interlocking if specified above for minimum provision in starter. Means shall be provided to prevent the open torque switch tripping during initial hammer blow effect. Torque protection reset shall not allow repeated starting in same direction when the control signal is maintained.

The torque switch mechanism shall function as follows to stop the motor on closing or opening of the sluice gate, upon actuation by the torque when the sluice gate disc is restricted in its attempt to open or close.

The torque switch in the closing direction shall interrupt the control circuit if mechanical overload occurs during the closing cycle or when the sluice valve is fully closed. The torque switch in the opening direction shall interrupt the control circuit if mechanical overload occurs during opening cycle or when the valve is fully open.

The mechanism shall facilitate adjustment of the torque at which the switches are required to operate.

Hand Wheel

A hand-wheel shall be provided for emergency operation. The hand-wheel drive shall be mechanically independent of the motor drive and any gearing should be such as to permit emergency.

3.0 METALLIC EXPANSION BELLOWS.

Expansion bellow shall be fabricated in accordance with the EJMA/ASME standard.

The bellows shall be metallic corrugated design of MOC as specified and shall have flanged ends on both sides with liner/internal sleeve. The fatigue life expectancy considered for EB shall be minimum 3000 cycles. The drilling standard of EB flange shall be matched on piping side to ensure proper alignment and bellows is not subjected to torsional forces due to misalignment. It shall be single bellow design and suitable for axial movement of up to total 30mm (20mm axial compression and 10mm axial extension). Further it shall be suitable accommodate angular misalignment of piping for up to minimum 5mm/3 degrees for installation. The overall length of expansion joint for up to 300mm dia. size shall be 250mm, for above 300mm and up to 1000mm it shall be 300mm and for above 1000mm the same shall be 350mm. The austenitic stainless steel shall be welded using the TIG welding method. The shipping bracket of bellows shall be removed only after installation of the bellows at site.

To achieve maximum flexibility coupled with required resistance to pressure, bellows shall be formed with single or multiple walls using a number of concentric cylinders (multi-ply construction) of specified MOC, each longitudinally welded. However for the blower application the bellows shall be of multi-ply construction only.

Generally the expansion joint is provided of single bellow design as a dismantling/disassembly joint in piping near valve or pump or flow meter or such device or equipment for ease of removal and jointing. Tie rods/threaded draw bars attached to expansion joint assembly shall be provided for this application.

In case of bellows used for air piping application/in air blower discharge piping or such application witnessing vibration and temperature variations the expansion joint shall be single bellow with or without limit rods as recommended by manufacturer suitable to absorb axial movement and to suit this requirement. In case of bellows used for diaphragm type dosing pump or such pulsating service the expansion joint shall be single bellow with or without limit rods as recommended by manufacturer suitable to absorb axial movement and to suit this requirement.

The weld end pipe shall be suitable for design pressure (Minimum PN 10 or higher as per design) and for CS/MS weld end pipe shall be with minimum corrosion allowance of 3mm for water/waste water application. However for blower application the bellows shall be designed for a working pressure of minimum 1 Bar or higher as per design and for a temperature of minimum 115°C or higher as per design and for velocity of minimum 25 m/sec or higher as per design and the liner thickness shall be suitable for the same.

During installation the bellows as a practice shall always to be placed between two fixed points. Thrust block or saddle welded to pipe to make it fixed must be provided on both sides of EB. For blower application generally after the bellow the first support (saddle or suitable) shall be provided at 4D distance and second support 14D distance from bellows to dampen the vibrations.

Materials of Construction

Component Description	Water / Sewage / Sec. Treated Indl. Effluent / Air Application	Indl. Effluent / Bio-Gas / Chemicals or Corrosive Application
Bellows	SS 304 (ASTM A 240 Tp. 304)	SS 316 (ASTM A 240 Tp. 316)
Internal Sleeves / Liners	SS 304 (ASTM A 240 Tp. 304)	SS 316 (ASTM A 240 Tp. 316)
Weld End Pipe	CS / MS	SS 316L
Flanges	IS:2062 with drilling as per IS:1538, PN10	IS:2062 with drilling as per IS:1538, PN10 with SS lining (all wetted portion with SS lining)
Tie / Limit Rods	Carbon Steel (CS) as per IS 1367	SS 316

Nut, Bolt , Hardware	CS as per IS 1367	SS 316
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Note: For Chemical (Alum, polyelectrolyte, etc.) or Corrosive application the above specified MOC are minimum and higher / better / suitable MOC shall be provided as per the nature of chemical / fluid.

4.0 CI / MS / GI / uPVC (Every Type) PIPE & FITTINGS

4.1 CI PIPES AND SPECIALS / FITTINGS (If Applicable)

The scope includes manufacture, delivery at site, storage at site, installation, testing and commissioning of double flanged cast iron pipe with fittings, flanges, nuts, bolts and gaskets at suction, delivery & header pipe.

This specification gives the general requirement of pipes/fittings. However, **it is the responsibility of the bidder to take the actual measurement and obtain client's approval prior to the placement of orders** to the main supplier / manufacturer as per site conditions during execution of work.

Quantity shall be verified as per actual site condition. Bidder shall be paid only for installed quantity as per actual measurement at site. In case if pipes/fittings are not used or installed, bidder shall not be paid for the same and bidder shall take back the same without any dispute.

In case of tender quantity is less than the actual, bidder has to arrange for the excess quantities and rate for the same shall be as per original tender rate.

All pipes and fittings shall be flanged.

Pipe work

The pipe works for the plant involves manufacturing, supplying, laying and jointing of suitable size cast iron, ductile iron pipes along with matching special etc as required. All piping / fittings within the pump house shall be of cast iron / ductile iron as specified. The specifications for manufacturing, supplying, laying and jointing of pipes shall generally conform to the standard specification.

All pipe work and fitting shall be of class rating in excess of the maximum pressure attained in service including any surge pressure.

The pipe work installation shall be so arranged to offer ease of dismantling and removal of pumps or other major items of equipments. C.I. dismantling joints which can take radial and axial misalignment of minimum 1 percent of valve nominal size with tie bolts shall be provided. All pipe work shall be adequately supported with purpose-made fittings. When passing through walls, pipe work shall incorporate a puddle flange. Flange adapters and unions shall be fitted in pipe work runs, wherever necessary, to permit the simple disconnection of flanges, valves and equipment.

The Contractor shall be responsible for ensuring that the internal surface of all pipe work is thoroughly clean before and during erection and before commissioning. Cleaning shall include removal of all dirt, rust, scale and welding slag due to Site welding. Before dispatch from the manufacturer's work, the ends of the pipe, branch pipe, etc., shall be suitably be removed until immediately prior to connecting adjacent pipes, valves or pumps. All small bore pipes shall be blown through with compressed air before connection is made to instrumental and other equipment. No point of passage of pipes through floors or walls shall be used as a point of support, except with the approval of the Engineer-in-Charge.

CAST IRON PIPING:

Providing and supplying lowering, laying to line, level and slope, cast iron pressure pipes (Class B conforming to IS : 1537 / IS : 1536 with latest amendment) and jointing with specials such as Tees, Bends, Reducers including and other safety provision, cutting the pipes and making joints and hydraulic testing after laying etc. comp.

The Cast Iron pipes shall be Class B conforming to IS:1537 / IS:1536 with latest amendments bearing ISI Mark.

The pipes shall be free from the defects resulting from raw materials, loading, handling, carting and unloading. The pipes shall be free from load, bents or bulges greater than 3 mm in depth and extending over a length in any directions greater than twice the thickness of barrel.

Each lot of pipes supplied by the contractor must be accompanied by the test certificates as specified in IS 1537 / 1536 with latest amendments. The contractors shall have to make arrangement for inspection/testing of the pipes at manufacturer's factory at contractor's own risk and cost.

Each pipe shall have cast, stamped or indelibly painted on it the following marks.

- a) Manufacturer's name, initials or identification mark.
- b) The nominal diameter.
- c) Class reference.
- d) The last two digits of the year of the manufacture.
- e) I.S. Certification mark.

The materials shall be carted to the site by the contractor very carefully. The handling, while carting the pipes, specials, valves etc. shall be done carefully.

In case of heavy pipes, specials etc. lowering shall be done with the help of the chain pulley block.

Caulking:

After a section of convenient length has been leaded, caulking shall be commenced. The lead shall be free from the leading pipe, outside of the socket of the other pipe with flat chisel, and then caulked round 3 separate times with the proper caulking tools of increasing thickness and hammer 4 to 5 lbs. in weight in such manner as to make the joints sound and water tight.

Joints under water shall be made with lead wool inserted in strings not less than 6 mm thick and very thoroughly caulked.

New Flanged Joints:

Flanged joints should be made by painting the facing of the flanges with red lead freely and belting up evenly on all sides.

A thin fibre, of lead wool may be very useful in making the joints water tight, where facing of the pipes is not true.

Where packing must be used, it should be of rubber insert cloth three ply and of approved thickness. The packing should be of the full diameter of the flange with proper pipe hole and bolt holes cut and even at both inner and outer edges.

Where the flange is not fully faced, the packing may be of the dimension of the facing strip only. Its proper placing should be tested before another pipe is jointed on.

Testing:

After each section of the pipe line has been completed, it shall be tested for water tightness before being covered in. This can be done by closing each end by means of a reliable guage. When the pipe is laid on any appreciable gradient, the test should be carried out at the lower end of the section. Any leaking joints should be made good, and the above test reapplied until no further leaks are apparent.

Tyton Joints:

After the pipes are examined for line and levels, the C.I pipes shall be jointed with rubber gaskets (tyton joints) as follows:

The socket and spigot end shall be cleaned with kerosene oil, then grease has to be applied to the spigot and socket ends, duly after inspection of rubber gasket. Then the rubber gasket shall be jacked and fixed in perfect condition such that the gasket will fall in groove correctly and the joint become water tight.

Tyton / Lead jointing shall be carried out after the C.I. pipes and specials are properly laid and approved by the Engineer-in-charge.

The lead shall be more than 99%. It shall be soft bluish grey pig lead free from admixtures of tin or other impurities. The lead shall conform to the Indian Standard 3114/1965.

The spun yarn shall be clean hemp and soaked in hot tar or bitumen, cooled and dried before use.

The outside of the spigot and the inside of the socket shall be thoroughly cleaned with a brush. The spigot shall be carefully centered in the socket by spun yarn twisted into ropes of uniform thickness. The rope shall be well caulked in to the back of the socket to leave a sufficient depth for lead as directed by Engineer-in-charge. The lead shall be used as specified in Table-1 of Indian Standard 3114/1965.

The proper depth of each joints shall be as specified and tested before running the lead by passing completely around it a wooden gauge notched out to the correct depth of lead.

The leading of joints shall be done by means of ropes covered with clay or a by using special leading rings. The lead shall be melted rendering it thoroughly fluid and each joints shall be filled in one pouring.

After a section of convenient length has been leading pipe outside of the socket of the other pipe, with a flat chisel and then caulked round three separate time with the proper caulking tools of increasing thickness and hammer 2 to 3 kg. weight in such a manner as to make the joints sound shall be left flush neat and even with the socket.

The item includes all materials tools, tackles etc. required to carry out the work including fire wood etc.

After each section of the pipe line has been completed it shall be tested for water tightness. The ends shall be suitably closed with a valve, cap or plug or a blank flange. The pipe line shall then be filled with water, pressure shall then be applied with a hand force pump or suitable method up to required test pressure as per IS 3114 or its latest addition. If the pipe is laid on an appreciable gradient, the test shall be carried out at the lower end of the section.

Any leaking joints shall be made good and the test repeated until a perfectly leak proof pipe line obtained.

Consumption of lead for jointing of pipe lines:

The purity of lead must be more than 99% and the contractor shall have to furnish the test certificate and get approval from Engineer-in-charge. The consumption of lead and the depth of jointing shall be as per table listed below:

Sr. No.	Size of pipe line for joint	Consumption of lead in kgs.	Depth of lead joint in cm.
1.	80 mm	1.86	5.00
2.	150 mm	3.62	6.00
3.	200 mm	5.00	6.00
4.	250 mm	6.12	7.75
5.	300 mm	7.70	8.00
6.	350 mm	10.45	8.12
7.	400 mm	11.20	8.25
8.	450 mm	14.30	8.40
9.	500 mm	16.25	8.50
10.	600 mm	19.00	9.15
11.	700 mm	21.00	10.00
12.	800 mm	31.50	10.50
13.	900 mm	41.00	10.50

HYDRAULIC TEST:

It shall be incumbent upon the contractor to give a successful hydraulic test of each and every pipe line before filling of the trench. The test shall be carried out in the approved manner by an approved testing machine and pressure gauge to be supplied by the contractor. All the arrangements for such test shall be made by the contractor at his cost including filling the pipe with water etc. and giving a successful hydraulic test.

Testing of the pipe line in the field shall be carried out after the completion of whole length or in parts as directed by Engineer-in-charge. The trenches shall be partially refilled except at the joint before starting the test. In each case, the contractor has to plug the both ends of the section of pipeline to be tested either by providing caps or by sluice valves as per direction of Engineer. No extra payment will be made for providing, fixing and removing caps used for testing purpose. If necessary, both the ends shall be properly anchored by providing 1:3:6 c.c. blocks of required dimensions. Contractors shall provide required number of plug points with ferrules of required diameters to serve as injection points, air relief points etc. No payment shall be made for this work. On the completion of the test these points shall be closed by plugs by the contractors without any extra cost.

Testing will be carried out by the contractors under the guidance of Engineer-in-charge. Contractors shall arrange for required machinery, equipments and technical staff for testing the pipe line. Contractors shall also arrange for labour, other materials and tools required to attend the leakage etc. during the test.

The pipe line shall be subjected for following test:

Leakage Test:

The test shall be conducted after satisfactory completion of the pressure test.

There shall not be any leakage in the pipe or at the joint. A seepage allowance of a 2.5 liters per kilometer per hour per centimeter diameter of the pipe shall be permissible and that quantity will not be considered as leakage.

If the retest is delayed for more than 48 hours after any test has proved unsuccessful the Engineer-in-charge, after giving 24 hours notice, shall have every right to get all defects rectified and carry out other necessary works and take hydraulic test/leakage test to the contractor. Any damage done to the pipes, materials, the other labour cost, etc. incurred there under shall be recoverable from the contractor either from his bill or deposit.

The responsibility of the contractor as specified above in case of unsuccessful hydraulic test shall not cease to exist by his pleading that any materials used by him in the pipe line was having cracked or was otherwise defective, as if he has a reason to believe so, he must refuse to accept such materials right at the stores.

If the first test is not found satisfactory, repeated tests will be taken and procedure mentioned above should be followed for testing till a satisfactory test is given. All testing shall be done at the risk of the contractors and they have to attend be done at the risk of the contractors and they have to attend all defects including repairing bursts, leaks at joints, sluice valve ends, caps etc. removing and replacing cracked pipes etc. These unserviceable articles shall be the property of the contractors and they shall arrange to remove the same from the site as directed by the Engineer.

Any portion of the pipe line that does not stand the specified pressure, shall be rectified by the contractor. Who should make his own arrangement for the water required for the testing.

When the section of the pipe line is tested successfully the contractor shall remove the blank flanges, pump out water from the pipes and back fill the portion as per directions of the Engineer.

The items include all materials and labour required to carry out the work as detailed above.

CAST IRON FITTING & SPECIALS:

Providing and supplying at site of work C.I. fittings/specials conforming to IS 1538/1993 with latest amendments.

The contractor shall have to procure required cast iron specials such as Tees, Bends of required degrees, reducers, collars, caps, plugs, tail pieces, etc. necessary for completion of this item as per site conditions. The C.I. fittings and specials shall conform to IS 1538/1993 with latest amendments.

The fitting shall be stripped with all the precautions necessary to avoid warping or shrinking defects. The fitting shall be free from defects other than any unavoidable surface imperfection which results from the method of manufacture and which do not affect the use of the fittings.

The fittings shall be such that they could be cut, drill or machine.

The mass of C.I. fittings/specials shall strictly conform to IS 1538/1993 with latest amendments.

The contractor shall have to procure the required C.I. fittings or specials as per the site conditions and as per direction of Engineer-in-charge.

4.2 MS PIPES AND SPECIALS / FITTINGS

MS PIPES

Provide, fabricate, test, paint, supply and installation of M.S. Pipes of specified ID / OD and wall thickness conforming to IS 3589-1981.

Pipes shall be erected on rollers / saddles / supports as required.

All the pipes shall be supplied by the contractor as per actual measurement at site jointly with client's representative.

QUALITY OF STEEL:

Pipes shall be fabricated from steel plates conforming to IS 2062.

MANUFACTURE OF THE PRODUCT:

Pipes shall be made from steel plates or strips by butt welding longitudinally or spirally. The weld shall be continuous. Prior to welding, edges of plates or strips may be prepared suitably where required by the process of manufacture.

ORIGINAL CROSS - SECTIONAL AREA OF THE SPECIMEN: OUTSIDE DIAMETERS:

The outside diameters of the finished pipes shall be as given below:

Nominal size (in mm)	Outside Diameter (in mm)
200	219.1
400	406.4
500	508.0
600	610.0
700	711.0
900	914.0
1000	1016.0
1200	1219.0
1400	1422.0

Pipes of outside diameter other than those covered in above clause shall be permissible as agreed to between the manufacturer and the purchaser.

TOLERANCE:

OUTSIDE DIAMETER

a) Pipe Body - The tolerance on the pipe body shall be as shown below:

<u>Nominal Size</u>	<u>Tolerance</u>
Up to 500 mm	0.75 Percent
Over 500 mm	1.00 Percent

Note: Measurements may be made by any suitable instrument, such as outside calipers, diameter tapes, micrometers, etc.

b) Pipes Ends - The tolerance on outside dia. for distance of 100 mm from the end of the pipe shall be as follows:

Up to and Including 250 mm	+ 1.6 mm - 0.50 mm
Above 250 mm	+ 2.4 mm - 0.8 mm

c) Thickness - The tolerance on specified wall thickness shall be as follows:

Pipe	+ 10 %
------	--------

d) Straightness - Finished pipe shall not deviate from straightness by more than 0.2% of the total length.

Checking shall be carried out using a taut string or wire from end to end along the side of the pipe to measure the greatest deviation.

e) Length - Straight pipe shall not vary from the specified overall length by +10 mm or up to 0 mm

for length up to and including 6 mt.

THICKNESS OF PIPES:

The pipe shall have minimum specified wall thickness as per mentioned in Table-3.

TABLE – 3

MINIMUM SPECIFIED THICKNESS OF PIPES.

Nominal Size (mm)	Minimum Specified Thickness of pipe mm
Up to 300	4
above 300 to 500	5
above 500 to 600	6
above 600 to 850	7
above 850 to 950	8
above 1000 to 1500	10

HYDRAULIC PRESSURE TEST:

Each pipe shall be hydrostatically tested at the manufacturer's works before the pipe is coated, wrapped or lined at the manufacturer's work.

The Hydraulic test pressure shall be the pressure calculated from the following formula, except that the maximum test pressure shall not exceed 5 Mpa.

$$P = \frac{2 \times S \times t}{D}$$

- P = Test pressure
S = A stress in MPa which shall be taken as 40% of the specified minimum tensile strength.
t = Specified thickness in mm and
D = Specified outside diameter in mm.

Test pressure shall be applied and maintained for sufficiently long time for proof and inspection.

Carbon Steel/MS pipe after installation at site with respective joints, piping shall be tested for joint tightness at 150 % of Maximum working / system pressure it is likely to subject to.

SPECIFICATION FOR INSIDE / OUTSIDE COATING:

The pipe internal and external surface shall be coated with Zinc rich epoxy primer and asphaltic bitumen paint of approved quality. No primer shall be applied without prior approval of the owner. The mix of zinc rich epoxy primer shall be prepared at works site not earlier than 15 min. before applying the same on pipes and special surfaces. One coat of zinc rich epoxy primer shall be applied by spray giving a film thickness of approximately 1 ml. No thinner shall be added to ready mix paints without previous approval of the owner and the finishing coats on top of the primer coat shall only be applied after allowing the film to cure for at least 48 hours.

After application of zinc rich epoxy primer, the surface shall be cleaned by duster and inspected. If during inspection any portion is found rusting the same shall be removed by emery paper and coated with zinc rich epoxy primer. When complete section is checked as above, first coat of Inertol or equivalent shall be applied, when one coat is applied, the date of application of this coat shall be written on either end of section.

The painting shall be done by cross brushing, i.e. one coat shall be given vertically and another coat shall be given horizontally so as to get required thickness, a good looking surface and also to avoid sagging of

paint. Every successive coat of paint shall be given only after 48 hrs. of painting the previous coat. Before applying the next coat, the surface shall be properly cleaned by duster. Each coat of interol 49 W thick or equivalent shall give a film thickness of 3-4 mils.

The painting / coating shall be such that it shall not impart any taste or smell to water. Only Food Grade paint shall be used for painting pipes intended for drinking water supply.

LAYING OF PIPELINE:

The laying, jointing and testing of welded steel pipes conform to latest and relevant IS:5822.

Pedestals shall be constructed by the civil contractor before commencing the pipe laying work in any section.

The welded joints shall be tested as per IS 3600 of 1966.

M. S. SPECIALS:

Scope shall include providing, fabricating, testing and installing M. S. Specials suitable to M. S. pipes, valves and other fittings from steel plates. MS Specials shall be confirming to IS 7322 / IS 1538 dimensionally. MS specials and fittings shall be fabricated at site of work tested to specified test pressure and including providing flanges required, painting inside zinc epoxy coating and outside anti corrosive red primer, coated with three coats of anti corrosive water proof paint including freight, loading, unloading, carting, stacking as directed, and including all taxes, insurance etc. The sizes and types of specials shall be as per requirements taking into consideration in tender items like pumps, sluice valves, non return valves, scour valves, expansion joints, dismantling joints etc.

FLANGES:

All MS flanges conforming to IS 6392, PN 1.0 and their dimensions of drilling be in accordance with IS-1538 / IS 6392 suitable for pressure 10 kg/cm² (specification for M.S. fittings for pressure pipes for water, gas and sewage) or its latest revision. The flanges shall be flat faced with off centre bolt holes. Prior to manufacturing process, the contractor shall have to obtain approval of Engineer in charge for all sizes and types of flange drawings.

JOINTING MATERIAL:

Each valve shall be supplied with all necessary joint ring , nuts, bolts and washers for completing the joints on all the flanges of valve supplied under this contract including those flanges which will be jointed to pipe system. The lengths of bolts shall be assumed to be suitable for jointing M.S. pipes. The cost of all jointing material supplied under the contract shall be included in rates. Joint rings shall be of flat section at least 3 mm. thick. They shall be of rubber in accordance with IS 638-1965.

4.3 G.I. PIPES & FITTINGS

All G.I. piping and Fitting shall conform to IS:1239.

The screwed end of all GI pipes shall be thoroughly cleaned and painted with a mixture of red and white lead or Teflon before jointing. The joint shall be made by winding a few threads of hemp round the ends of tubes and then screwing them into sockets to the full depth of threads. Exposed threads shall be coated with approved anticorrosive paint. No pipe shall be bent/offset to save fittings. The offset in GI pipes shall be made only after the permission of the Engineer-in-charge . If threaded end of pipe is damaged, the contractor shall cut the end with hacksaw and shall prepare new threads confirming to IS 554 to required length.

All fittings shall be malleable galvanised iron approved by the Engineer-in-charge. Fitting in GI line shall include all couplings, elbows, tees, bends, unions, nipples, reducers, flanges with nuts and rubber

insertion and all other fittings to make a complete job.

Flanged joints shall be made by painting the faces of the flanges with red lead and bolting up evenly on all sides with compressed asbestos gasket as per piping material specification.

Flanged or screwed valves shall be installed in locations as directed by engineer-in-charge and/or as shown on the execution drawings after placement of order as per specification for screwed or flanged joints. All completed G.I. lines shall be hydrostatically tested to a test pressure of 5Kg/cm²g.

4.4 uPVC Pipe

uPVC pipes made of unplasticized polyvinyl chloride shall be conforming to IS: 15328 with socket(s) suitable for elastomeric sealing ring type joints for conveyance of water under pressure. The pipes are intended to be used for buried water mains with ambient atmospheric temperature reaching up to 45 °C and soil surface temperature rising more than 65°C. The stipulations given in this document for uPVC pipe which are not covered by any other code/standard, shall be governed by the provisions of IS 4985. The pipes will be supplied with plain ends or one end plain with chamfer and other end socket suitable for elastomeric sealing ring type joints in accordance with IS: 4985 as per requirement. Each pipe shall be supplied along with one suitable elastomeric sealing ring with 5% extra rings on overall number of pipes.

- **Material**

The material from which the pipes are made shall consist substantially of unplasticized polyvinyl chloride conforming to IS: 10151, to which may be added only those additives that are absolutely needed to facilitate the manufacture of the polymer, and the production of sound, durable pipes of good surface, finish, mechanical strength and opacity. The pressure rating of pipes shall be of class-3 and class-4 in accordance with IS: 4985 with a maximum continuous working pressure at 27°C of 6 and 10 kg/cm².

Dimensions of the pipes and the sockets

The dimensions and tolerances of pipes shall comply with IS: 4985. The tolerance on outside diameter and wall thickness of pipe shall be as per Table given in IS: 4985. The dimensions of the socket for elastomeric sealing ring type joint shall be in accordance with IS 4985. The pipe shall be supplied in straight lengths of 6 m with tolerance of + 20 mm and -0 mm. The effective length of socket pipe shall be considered as shown in IS: 4985.

- **Physical & chemical properties**

The pipe shall confirm to the Clause 10 of IS 4985-2000 for its physical and chemical properties except for the density and ash content provisions which shall be as per the stipulations made above. The colour of the pipes shall be dark grey. Influence on water intended for human consumption shall be governed by IS: 12235. All plastic and non plastic material for components of the uPVC piping system e. g. Elastomeric sealing ring, lubricants, when in permanent or in temporary contact with water which is intended for human consumption, shall not adversely affect the quality of the drinking water.

- **Mechanical Properties**

The pipes and integral sealing ring will confirm to internal hydrostatic pressure in accordance with Clause 11.1 and sampling as per annexure D of IS 4985.

4.4 DI DF Pipe

- Kindly Refer Civil Technical Specification

5.0 WALL THIMBLE MOUNTED CAST IRON SLUICE GATES: -

A. General

The construction of cast iron sluice gates shall be strictly in accordance with the specifications mentioned hereunder. The sluice gates shall be capable of performing the isolation duties in water/waste water treatment plant and pumping stations for isolation of flow in and out of a closed conduit as well as in those applications where water head is more than the height of shutter/opening. They shall be so constructed that there is no undue wear or deterioration during its operative life and so designed that the maintenance is kept to a minimum.

The Sluice gates shall be wall thimble mounted only except for shallow channels. For shallow channels of up to 3.5-meter depth with water head not exceeding 2.0meter and Gate/Shutter area not exceeding 1.5 m² wall mounted gates can be accepted instead of wall thimble.

The gates shall be so selected that effective area (shutter area) of each gate does not exceed 1.5m² and if effective area of gate exceeds 1.5m² then multiple gates shall be provided such that effective (shutter) area of each gate is less than 1.5m² unless otherwise specified in SOQ / Price Bid / Scope of Work / Process Design Criteria of tender.

The gate shall be designed for seating and unseating head of minimum 5m liquid depth or as per design requirement (except for shallow channels/units < 5m total height for which it shall be subject to top of channel/unit and accordingly head shall be as per actual full height).

B. Design and Construction

The sluice gates shall be manufactured generally as per IS: 13349 (1992). The constructional features and details of components of the required gates are to be as under:

Gate Frame

- a) The gate frame will be made from cast iron and shall be sufficiently rigid to withstand the designated water head. The gate frame shall either be flat back type or flange back type to suit the designed head and site condition.
- b) Back flange of the gate aperture frame to be precisely machined flat and drilled to engage with the Cast iron wall thimble mounted on the wall. A rubber gasket will be provided between the wall thimble and the gate for ease in future dismounting of the gate for repairs/replacement and seal any leakage between the flange of frame and wall thimble.
- c) The gate frame of these sluice gates shall either be self contained type or non self-contained type depending upon site requirement. In case of non self-contained gates the frames shall have short length extension guides and shall be without yoke at their top. The length of extension guides in such cases shall be sufficient to engage at least half the overall vertical height of door when the gate is full open and shall be in accordance with the relevant provisions of IS: 13349. In case of self contained gates the frames shall have full length extension guides and shall be provided with a yoke at their top. The length of extension guides in such cases shall be sufficient to engage the overall vertical height of door when the gate is fully open position.

Wall Thimble

- a) The wall thimble will be made from cast iron for placement in the concrete wall. Its front flange will be machined, drilled and tapped to match with the frame flange.

- b) The cross section of the thimble shall be F shaped and the depth of thimble shall be minimum 200 mm long or more as per manufacturer's standards. Gates subjected to high unseating heads shall have thimble cross section shaped E.
- c) To permit entrapped air to escape as the thimble is being encased in concrete, cast holes of 40mm diameter shall be provided at the bottom of wall thimble in each entrapment zone.

Gate Slide/Shutter/Door

- a) The gate slide/shutter/door will be made from cast iron and shall be sufficiently ribbed to withstand the designated water head.
- b) The gate slide/shutter will be provided with integral pocket to house the thrust nut used to connect the stem with the slide.

Seating/Sealing Faces

- a) Materials: These should be of Stainless steel or Bronze or as specified.
- b) Fitment: The facings shall be attached to flat/rectangular/dovetailed machined faces of gate frame and door, depending upon the applicable water head, and be secured in place using taper screws. The taper screws adopted for facings shall be of same material as that of the seat facings.
- c) The front faces of integral extension guides which can come in contact with the sealing faces of door while opening, shall also be fitted with sealing faces of the same material as that of the sealing faces on door. This is required to offer non corroding smooth sliding surfaces to the sealing faces of door/shutter during its vertical travel for opening and enhance the effective life of gate.
- d) Finish: The mating seating/sealing faces on the gate frame and door shall be precisely finished for proper contact. They should be so finished that the clearance or gap, if any, between the mating sealing faces, in gate closed position, does not exceed 0.1mm.

Wedging Devices

- a) The sluice gates shall be provided with individually adjustable wedging devices to ensure forced contact between frame and shutter seat facings, when the gate is in closed position.
- b) The gates meant for seating head shall be provided only with side wedging devices. Gates meant for unseating head of sizes larger than 600mm, shall be provided with side, top and bottom wedging devices or with side and top wedging devices and flush bottom closing arrangement as required.
- c) The wedging devices comprise of wedge brackets fitted on gate aperture frame and door. The wedge bracket on frame shall remain in fixed position and those on door shall be adjustable or vice versa. A sort of slot and tannen arrangement shall be provided on base of wedge brackets to prevent any tendency to shift. Provision shall be made to clamp the adjustable brackets firmly in adjusted position.
- d) The wedging devices shall be made of cast iron. If the wedges/wedge blocks of wedging devices are of cast iron, then these are to be lined with contacting faces of the same material as that of sealing faces attached to the gate frame and door.

Conventional OR Flush Bottom Closing

The sluice gates shall be provided with conventional or flush bottom closure arrangement as required.

Generally, as a standard, the **gates shall be provided with flush bottom closing only especially for gates mounted on bottom of channel** etc. Only the gates mounted above the floor level and having required clearance below for applications like inlet pipe isolation at elevated level, etc. shall be with conventional bottom closing.

The sluice gates provided with conventional bottom closing arrangement involve corrosion resistant metallic contacting sealing faces at the bottom sill of gate. In such cases, the invert of the gate is required to be kept above the floor of the channel/chamber by at least 150mm to 250mm depending upon the size and type of gate. The contractor should verify whether this clearance is available at the site of installation for fitting a conventional bottom closure gate.

In case of conventional closing gate, if the invert of the gate is kept at the same level as that of the channel/chamber floor, then there remains a slot or a groove at the invert of the gate. Debris, dirt etc. which may settle in this slot and may not allow the gate to close properly and this may give rise to heavy leakages while in operation. With a view to avoid this, in situations where the invert of the gate is to remain at the same level as that of the channel/floor, a flush bottom closing gate instead of conventional bottom closing gate should be provided.

Flush bottom closing shall involve a flexible rubber seal at the bottom of the gate, mounted either on the shutter or on the frame, ensuring that the sealing face remains flush with the floor. The cast iron bar fitted at the bottom of the frame is required to be embedded in the channel/chamber floor and for this a cut out/recess of ample dimensions is required to be provided beneath the waterway opening along the gate invert, while constructing the floor. The dimensions of this cut out shall be provided depending upon the feasibility to do so as per actual site conditions.

This cut out/recess is to be later on filled up with removable asphalt or loose concrete mixed with sand dust or vermiculate after putting the gate in position so that it is possible to break open this second stage grout for removal of the gate in future.

The rubber seal employed shall be made of EPDM or Neoprene rubber and the rubber seal retainer bar as well as the fasteners for fitting the rubber seal and the retainer bar are of stainless steel.

Gate Operating Head Stock/Lift Mechanism

- a) The operating head stocks shall be designed in such a manner as to permit the gate operation by a single person under the specified maximum operating head with an effort of less than 18kgs on the crank or hand wheel with a radius not exceeding 375mm. Vendor shall provide torque calculations in support of same.
- b) The headstock may be ungeared or geared type and the geared headstock may be either of single speed or of double speed, as might be necessary to make it convenient for one person to open or close the gate as fast as practicable. Two speed headstocks shall be supplied with gates requiring higher hoisting capacities. In this type of headstock the low speed is meant for crack opening the gate when the effort required to open the gate is maximum and the high speed is meant for further faster opening after the gate is crack opened.
- c) Geared headstock shall be supplied with easily removable crank handle or handwheel with a radius not exceeding 375mm.
- d) All the gears of geared headstock shall be kept completely encased in cast iron housing to protect

them from damage, dirt, dust, water etc. and other atmospheric effects and thus ensure their smooth operation. Grease nipples shall be provided at proper places for lubricating with grease.

- e) Headstock meant for mounting on operating platform shall be supplied with a pedestal/floor stand to provide a convenient operating height of approximately 900mm. The pedestal of the headstock shall be provided with a covered window opening to enable cleaning and greasing of stem threads.

Lifting Spindle/Stem

The sluice gates shall be supplied with rising type lifting spindles/stems. The stem shall be provided with acme/square threading, length of threaded portion being about 400mm more than the height of waterway opening. This much extra length is required to allow for a minor variation of approximately 100mm on either side of the specified height of operating platform.

The design of stem will be done as per the provision in IS: 13349.

Stem Block/Connecting Block/Thrust Nut

The rising type stem shall be connected to the door through a stem block/thrust nut housed in a ribbed pocket cast integral with the door. The bottom end of stem shall thread into the stem block and is locked in place by a set screw to prevent the stem from unscrewing. The stem block shall be cast Bronze or Gunmetal.

Safety Stop Nut

The stem shall be provided with a safety stop nut to prevent the chances of over closing of gate which may otherwise damage either the stem or the lifting platform. The stop nut shall be furnished with a set screw for setting it in a fixed position after the gate is installed. Upon installation the safety stop nut should be set in such a way that its bottom remains about 1mm to 2mm away from the top of headstock, in gate closed position.

In case of stainless steel stem, the stop nut shall also be of stainless steel material of the same grade.

Stem/Spindle Couplings

For ease in transportation and handling, maximum length of one piece stem shall be restricted within 5 meter length. Where the stem are required to be furnished in more than one piece, threaded stem couplings shall be furnished to interconnect different sections of the stem. The couplings shall have provision for pinning after inserting in the threaded end of the stem.

In case of stainless steel stem, the couplings shall also be of stainless steel material of the same grade.

Stem Guide Brackets

Longer stems shall be provided with sufficient number of stem guides to prevent buckling of stem. The stem guide bracket to be provided shall be adjustable center type - wherein a separate stem guide is bolted on to the wall bracket. The stem guide shall be adjustable in the slots on wall bracket in a direction perpendicular to the face of wall. Wall bracket should also offer minor adjustment in the direction parallel to the wall.

The stem guides shall have machine bored split journals to facilitate erection. The journal shall be lined with Brass/Gunmetal bush.

Pipe Hood for Stem

A pipe hood shall be provided on the top of headstock in case of rising spindle/stem gates to cover the spindle threads for protection against damage, dirt, dust, water etc. It shall be made of transparent fracture resistant polycarbonate material. The pipe hood shall have vent holes to prevent condensation.

Gate Opening Indicating Arrangement

Gate opening indicating arrangement shall be provided to indicate the position of the shutter. This shall comprise of scale mounted on the pipehood and an indicator nut mounted on the rising spindle to show the extent of the opening and closing. The minimum scale graduation shall be 25mm.

C. Materials of Construction

The materials of construction for various components shall be as under.

Gate Frame, Shutter, Thimble	: Plain Cast Iron IS: 210 FG 200
Headstock, Wedges, Stem Guides	: Plain Cast Iron IS: 210 FG 200
	Stem Guide shall be with LTB-2 Lining
Seating/Sealing Faces and Wedge Lining	: Stainless Steel ASTM A 240 Type 304
Rubber Seals (If Applicable)	: EPDM Rubber to ASTM D 2000
Rubber Seal Retainer Bar (If Applicable)	: Plain Cast Iron IS: 210 FG 200/Stainless Steel ASTM A 240 Type 304
Stem, Stem Guide Brackets, Coupling and Stop Nut	: Stainless Steel ASTM A 276 Type 304
Assembly Bolts, Nuts and Fasteners	: Stainless Steel ASTM A 276 Type 304
Yoke (If Applicable)	: Mild Steel to IS: 2062 Grade A, Epoxy Painted
Stem Block	: Leaded Tin bronze to IS: 318 Type LTB2
Lift Nut for Manual Ungearred	: Leaded Tin bronze to IS: 318 Type LTB2
Pipe Hood for Stem	: Transparent Fracture Resistant Polycarbonate Material
Operation	:
Lift Nut for Manual Geared/Actuator Operation	: As per Gear Box/Actuator Manufacturers' Standards

6.0 MANUAL BAR SCREEN

SCOPE:

The scope includes supply, installation and testing of removable manual coarse screen of 40 mm spacing along with all accessories and hardware.

The removable manually raked bar screen shall be made of SS 304 bars placed at 40 mm spacing and framed fabricated from angles, channels and sections made of SS 304 of suitable size all around and SS 304 flats of 10 mm thick and 50 mm depth, along with all accessories and hardware.

CONSTRUCTIONAL FEATURES:

Manually raked screens are to be installed in the inlet chamber for arresting floating or similar material from sewage entering into a pumping station.

The trash screen shall be removable type ,rectangular in shape and shall be capable of being lifted by means of mechanical lifting arrangement (CPB) and raised above the operating platform, as and when necessary.

The Screen shall be fabricated out of SS bars and Guiding channels shall be of M.S. (ISMC 100). Guide channel shall be provided by the contractor and same shall be welded with insert plates embedded to screen chamber RCC wall during the execution of civil works. It is responsibility of contractor to make & check its straightness in presence of client.

Screen shall be suitable to fit in RCC Screen channel having approximate width as indicated in BOQ and subject to slight variation as per design during execution. Manufacture of screen shall be carried out accordingly.

The trash screen shall move vertically up or down in guide channels which are securely fixed to the side walls of the inlet chamber welded on MS insert plates. Each screen shall have two lifting hooks, spaced sufficiently apart from the center at the top of the screen frame. The side of the screen shall have replaceable wear shoes of gunmetal on all the three side of frame section throughout its vertical height.

The frame work of screens shall be provided only on the downstream side of the screens.

7.0 MECHANICAL BAR SCREEN – STEP TYPE FINE BAR SCREEN

(A) STEP TYPE FINE BAR SCREEN / MECHANICAL RAKE BAR SCREEN

- Mechanically operated Step Screen completely made of Stainless Steel having 20 mm clear spacing between the bars shall be provided in inlet screen channel for screening out floating materials such as plastic pouches, bags, rags, floating debris, weeds, paper wastes and other floating materials from the raw sewage coming from the pumping station / gravity mains.
- The screen shall include discharge chute as required to discharge the screenings on the belt conveyor without employing any external mechanism / rake mechanism. The screen length shall be adequate to drop the screening directly over & about centre of the conveyor belt.
- The screen / bars shall be provided with top cover in SS-304 above TWL up to top of screen to arrest spreading / scattering of dried screening material due to wind.
- The screen shall be factory assembled & movement tested at plant before dispatch to site & shall only be installed at the site in factory assembled condition thereby avoiding chances of misalignments.

SCOPE:

Design, Supply, Installation, Testing & Commissioning of screening equipment consisting of following:

- (a) Mechanized step screen having 20 mm spacing between bars and suitable for installation at an inclination of 60 degrees in channel.
- (b) Ultrasonic type Differential Level sensing instrument or two nos. hydrostatic type level transmitters (one each at upstream and downstream side of screen with differential level indicator cum controller or calculation in PLC with potential free contact for auto operation of screen) connected to control panel through PLC/ Controller (shall be as per specific requirement if specified in process design criteria) for automatic operation of screen mechanism and allied accessories.
- (c) Local control panel installed near screen. It shall be possible to operate the screen manually as well as in auto modes viz. timer mode (with timer mode bypass facility) and PLC/controller mode. The panel shall be with double door and with canopy for protection from rain and suitable for outdoor application.
- (d) Belt conveyor to discharge the screened material of the screen to the waste bin.

SPECIFICATION

- **Material of construction:**

The fixed as well as movable bars, mechanism, support frame, fixings discharge chute shall be manufactured from stainless steel for long life in the aggressive sewage environment. No component of the screen assembly shall be made of carbon steel or any other material, which can get corroded in sewage environment.

- **Screen Construction**

- The step screen shall be a complete unit comprising of main frame with an integral mechanism containing movable bars located in between fixed bars without engagement of external mechanism / rake mechanism for pulling out the screened material ensuring minimum movement of the mechanism.
- The mechanism comprising of movable bars located between fixed bars shall gradually move the screened material upward in the form of a mat and deliver on the up to the discharge chute.
- The fixed as well as movable bars shall contain a series of steps to prevent the screenings from falling back into the main flow.
- The mechanism shall be mechanically operated by Electro-motor or hydraulic system and shall be suitable for automatic operation controlled by a level sensor.
- The screen shall operate automatically when the pre-set differential in level occurs between the upstream and downstream of the screen. The level difference between the upstream and downstream is sensed through ultrasonic level sensors and a 4-20mA signal is transmitted to control panel based on the level difference between the upstream and downstream of the screen and it

shall stop when the differential level decreases to a preset low level due to upward travel of screened material.

- The fine bar screen shall be capable of being tilted out of the sewage flow up to horizontal position for the purpose of cleaning & maintenance.
- The base of the screen shall be fitted with a specially profiled stainless steel plate to direct any grit that may be present towards the screen and taken out along with other screened material thus reducing the possibility of building up of grit in front of the screen.

- **Level Controller**

The level controller shall be Differential Type Ultrasonic Level Transmitter or Hydrostatic Type of approved make. Refer Instrumentation section for detailed specifications.

- **Electrical Motor**

The motor shall be TEFC type with IP 55 protection and shall be suitable for operation on $415V \pm 10\%$ and frequency of $50Hz \pm 5\%$. Motor shall be provided with canopy / cover.

- **Control Panel**

The Control Panel shall have IP-55 protection, painted with Epoxy paint and shall be comprising of

- Mushroom Head Emergency Stop
- Overload Relays for motor protection
- MCB's, HRC Fuses and Glass Fuses
- Circuitry to operate the screen with level sensors.
- Selector Switch to operate the screen on JOG mode
- Provision to run the screen with a timer in case of failure of level sensor. The timer shall be 0-24 hour settable range and it should be possible to bypass timer operation if required.
- External Canopy for protection from all 3 sides from rain

Belt Conveyor

A common belt conveyor shall be provided for collecting screening from fine bar screen will drop the screening in a trolley type container kept at one end of the conveyor for taking out the screening for disposal. The belt conveyor shall be 600 mm wide and suitable length to cover all the screen channels.

Each assembly of conveyor will consist of two pulleys with their shafts and bearings for driving the belt and idler pulleys for supporting the belt. The upper level idler pulleys will have three roll 20° roughing idlers. The bottom level idlers for belt return will be flat roll type.

At the end of belt drive an adjustable scrapper is provided on the screening hopper for diverting the screening through hopper to the container. The whole conveyor will be supported on steel structure over the screen channel.

The belt material will be 2 ply nylon with 3 mm neoprene covering on carrying side and 0.75 mm neoprene covering on pulley side. The speed of the belt will be about 20 m/min.

The power supply shall be by TEFC motor couple to the worm reduction gear box. Motor shall be provided with canopy / cover.

The gear box shall have a minimum service factor of two.

The belt conveyors shall be provided with guard covers in GI with adequate opening for screening to fall on belt to prevent the dispersal of screening in the plant from over the belt due to wind.

8.0 CHAIN PULLEY BLOCK (As Applicable)

GENERAL REQUIREMENT:

Chain pulley block shall be completed with hand chain, pulley block, hook, hand and load chains, brake and other accessories. The chain pulley block shall be designed as per IS: 3832.

The load chain shall be made of alloy steel as per IS: 3109. It shall be heat treated to give ductility and toughness so that it will stretch before breaking. It shall be of welded construction with a factor of safety not less than 4.

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 guarding to prevent sagging and fouling of 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 be as per BS 436 / IS: 4460.

Axles and shafts shall be made of carbon steel and shall be accurately machined and properly supported.

The lifting hooks shall be forged, heat treated alloy or carbon steel of rugged construction. They shall be of single hook type provided with a standard depress type safety latch. They shall swivel and operate on antifriction bearings with hardened races. Locks to prevent hooks from swivelling 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. It shall be of screw and friction disc type self-actuating load pressure brake. Brakes shall offer no resistance during hoisting.

All required test & material test certificate shall be provided.

9.0 E.O.T. CRANE:

The crane shall be electrically operated, box/standard "I" beam type single/double girder complete with all accessories including down shop conductor, crane rails and fixtures, starter panel, cable up to starter and shall conform to IS: 3177, IS: 807, IS: 3938 and other relevant approved standards. Crane having 10 MT or higher capacity shall be double girder type only and shall be provided as per the relevant IS and other applicable standards.

The crane bridge shall consist of single 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 required along the full span length of the bridge girder shall be provided for double girder crane and for single girder crane a center platform and two platforms at drive end shall be provided for ease of maintenance/access to crane drive. Steel shall be tested for quality conforming to IS: 2062, plates more than 20mm 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 grease nipples.

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 conforming to relevant standards.

The crane rails/square bars shall be of MS polish as per IS: 2062 or better grade of material. Mountings of the wheels shall be designed to facilitate easy removal for maintenance.

Walkways shall be of at least 500 mm clear inside width with 6mm 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 10,000 hours. Electro-magnetic or hydraulic thruster 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 15560 or relevant internationally approved standards and shall have a safety latch to prevent rope coming off the hook.

Hoist mechanism shall consist of motor, brake, gear box, rope drum and bottom block.

Rope drums shall be grooved and shall be made of seamless pipe as per ASTM 106 Gr. A or B, cast iron of minimum Grade 25 or cast steel, rolled steel of welded construction and in case of welded drum this should be stress relieved and conforming to IS: 3177/BS 466 or relevant internationally approved standards. Rope sheaves are to be made from CI running on drum with provision of adequate guards to prevent the rope from leaving the sheaves.

Hoist rope shall be extra flexible, improved plough galvanised/FMC plough steel rope with well lubricated hemp core and having six strands of 36 wires per strand with minimum ultimate tensile strength of 1.6/1.75 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.

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: 15560 or relevant internationally approved standards and shall have a safety latch to prevent rope coming off the hook.

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 or BS 721 or relevant internationally approved standards.

A SWL plate not less than 150mm in height showing year of manufacture and rated capacity of hoist in figures shall be placed on each side of the crane girder.

The maximum deflection under full load shall not exceed 1/900 of the span.

All accessory and auxiliary electrical equipment including drive motors, electrically operated brakes, controllers, braking 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, GI shrouded type. 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 indicating lamps.

`Start' and `Stop'

Long Travel - `Right' and `Left'

Cross Travel - `To' and `Fro'

Hook - `Hoist' and `Lower' and micro hoist and lower

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 over travel for each of the following:

For `UP' and `Down' motions of the hook

Long travel motion

Cross travel motion

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.

Drive motors shall be suitable for crane duty (S4) application and generally conforming to latest IS: 12615/IEC 600342-1 standards as applicable. Motor shall be designed for frequent reversal, braking, inching and acceleration. Pullout torque shall be 2.15 times the rated torque. Pendant control switch, controllers and resistors, controls, electrical protective devices, cables and conductors, earthing guards etc. shall be as per IS: 3938/IS: 3177. Limit switches shall be provided for over hoisting and over-lowering and of two extreme ends of trolley travel i.e. cross as well as long travels. Make of Crane Duty (S4) Motors for EOT Crane / electric hoist as per manufacturer standards shall be acceptable.

Drive for hoist drive (up and down motion) shall be provided with VFD. VFD shall be as per vendor selection to suit the application and reliable operation. For this application being intermittent operation, de-rating as specified in tender / electrical specifications, conformal coating, and other specific requirements like provision FA fuse, etc. not required.

Tests and Test Certificates

Overload tests at 125% of the rated load shall be carried out and test certificates shall be furnished for hook, wire rope, brake and complete crane.

Following accessories shall be provided with crane.

- a) Mechanical stoppers for long travel and cross travel shall be provided.
- b) Pendant push button station shall be located at maximum 1.0meter from operating floor elevation.
- c) Earthing terminals shall be provided.
- d) Limit switches for over hoist, over lower, over cross travel and over long travel shall be provided.
- e) Flexible trailing cable system shall be provided with sufficient number of loops for specified cross travel.
- f) The control panel shall be provided. Panel shall be with isolation breaker/switch to receive the power from electrical panel.
- g) MS ladder shall be provided by the contractor for maintenance.

FOLLOWING ACCESSORIES SHALL BE PROVIDED WITH E.O.T. CRANE:

Mechanical stoppers for long travel & cross travel shall be provided.

Pendant push button station shall be located at maximum 1.0 Mt. from operating floor elevation.

Earthing terminals shall be provided.

Limit switches for over hoist, over lower, over cross travel & over long travel shall be provided.

Flexible trailing cable system shall be provided with sufficient number of loops for specified cross travel.

The control panel shall be provided.

Isolation on switch to receive the power from Electrical Panel.

M.S. ladder shall be provided by the contractor for maintenance.

Painting

Refer painting requirement / specifications provided separately below.

(C) GENERAL REQUIREMENT FOR MECHANICAL ITEMS / EQUIPMENTS:

➤ PAINTING/COATING OF MECHANICAL ITEMS/EQUIPMENT

MS/CI/DI BODY OR PARTS OR STRUCTURE (GENERAL FOR PIPING AND PUMP/ BLOWER/ PROCESS OR SUH OTHER EQUIPMENT IF NOT PROVIDED AS SPECIFIC)

Painting shall be carried out with one coat of ~~red oxide~~/epoxy primer followed by two coats of epoxy paint after proper surface preparation as recommended by paint manufacturer/shot blasting prior to dispatch, to a total DFT of minimum 150 microns inclusive of priming (for equipment/gate/valves, etc. at manufacturer works before delivery).

Zinc rich epoxy primer and epoxy paint of approved quality shall be used for external and internal painting as applicable. The mix of zinc rich epoxy primer shall be prepared at work site not earlier than 15 minutes before applying the same on pipes and special surfaces. One coat of zinc rich epoxy primer of DFT 75 micron shall be applied along with two coats of epoxy paint DFT 40-45 micron and DFT 30-35 micron respectively. No thinner shall be added to ready mix paint without previous approval of the Employer's representative and the finishing coats on top of the primer coat shall only be applied after allowing the film to cure for at least 48 hours.

After application of zinc rich epoxy primer the surface should be cleaned by duster and inspected. If during inspection, any portion is found rusting the same shall be removed by emery paper and coated with zinc rich epoxy primer.

Mixed paint should be used within 3 to 4 hours of mixing or as recommended by manufacturer and fresh mixing shall be done for every new application. Every successive coat of paint shall be applied only after 48 hours of previous coat. Before applying the next coat, the surface should be properly cleaned by duster.

CED Coating i.e. Cathode electro deposition coating which is the latest technology for corrosion resistance with uniform coating is also permissible and preferable over conventional painting.

OPEN CHANNEL GATES/SLUICE GATES (THIMBLE MOUNTED GATES)

Following painting procedure shall be adopted for the gates (CI/DI/MS MOC).

Surface Preparation : Blast clean to near white metal finish using shot blasting.

Priming : One coat of red oxide primer.

Finish Painting : Black bituminous paint for gate assembly. Minimum DFT 200 microns inclusive of priming. Yoke and Headstock to be provided with ~~red oxide~~ / epoxy primer and epoxy grey or such suitable shade of paint having minimum DFT 150 microns inclusive of priming.

For Stainless steel gates, SS gate assembly shall be shot/grit blasted, pickled and passivated before delivery.

EOT / HOT CRANE

Painting shall be carried out as specified above for MS/CI/DI parts or structure before delivery. However, the final coat shall be golden yellow color with black zebra marking wherever applicable.

SS BODY OR PARTS OR STRUCTURE OR ENCLOSURE OR PIPING

Shall be shot/grit blasted, pickled and passivated before delivery / before erection at site (as applicable).

NOTE:

1. For equipment (including valves, gates, etc.) if paint surface is observed to be damaged/ deteriorated during storage or erection of such at site, an additional coat/touch up of paint shall be provided at site as directed by engineer-in-charge prior to commissioning/acceptance of site by client.
2. The paint shade as per manufacturers' standards' can be accepted.

➤ **DOCUMENTS SUBMISISON OF MECHANICAL ITEMS/EQUIPMENT**

In general, the minimum document submission for various equipment/items shall be as described below or additional as required for review to be submitted by manufacturers'/vendors' (duly stamped by manufacturers'/vendors') for review and approval during detailed engineering/execution and prior to manufacturing.

Manufacturing shall be carried out as per approved drawings and documents only and after complying comments as applicable.

PUMP AND PUMP-MOTOR SET (CENTRIFUGAL/POSITIVE DISPLACEMENT/ PROGRESSIVE CAVITY (SCREW)/RECIPROCATING (DOSING), ETC.)

1. Product technical data sheet.
2. Preliminary outline dimensional drawing (GA Drawing) showing the details of pump and motor, suction, discharge connections and foundation details.
3. Performance curves showing capacity v/s total head, efficiency, NPSH required and power requirements ranging from run out to pump shut off for minimum, maximum and rated impeller diameter of the offered pump.
4. ISO efficiency curve (as applicable).
5. Typical cross-sectional drawing showing internal features of pump, parts and their materials.
6. Torque – Speed curve of the pump (as applicable).
7. Quality Assurance Plan.

VALVES (SV/NRV/DPCV/BFV/KGV/BALL/AIR VALVE, ETC.), SLUICE GATES, OPEN CHANNEL GATES

1. Product technical data sheet (valve torque shall be provided for electric/pneumatic actuator operated valve)
2. General outline dimensional drawings.
3. Cross sectional drawing showing constructional details with part list with their quantity and MOC confirming to relevant standards.
4. QAP of the product.

Additional Documents for ELECTRIC ACTUATOR OPERATED VALVES

1. Actuator data sheet (shall include opening & closing time and actuator torque selection with required safety factor over valve torque).
2. GA and wiring drawing of electric actuator.
3. Valve torque calculations.
4. Product catalogue.

EXPANSION BELLOWS

1. Product technical data sheet.
2. GA Drawings.
3. QAP of the product.

PIPES (METALLIC: CI/DI/MS, ETC. and NON-METALLIC: HDPE/uPVC/RPVC/PP ETC.)

1. Bill of materials.
2. QAP of the product.

MATERIAL HANDLING EQUIPMENT Viz. EOT/HOT CRANE/CPB/HOT-MONORAIL

1. Product technical data sheet.

2. Preliminary outline dimensional drawings.
3. Requirement of Girders/ISMB including minimum required size with all calculations.
4. Wiring diagram of panel.
5. QAP of the product.

MECHANICAL & MANUAL FINE & COARSE SCREEN

1. Product technical data sheet.
2. GA drawing.
3. Hydraulic calculation for head drop across screen for design/peak flow @ 50% clogging.
4. GAD, wiring and schematic diagram with BOM for control panel or recommended schematic and wiring diagram (as applicable).
5. Recommended cable schedule (as applicable).
6. QAP of the product.

Note: The data sheet and GAD as specified for equipment/item shall also be considered to include coupled items like electrical drives/motor including its performance curves, electric actuators including its wiring diagram, pneumatic actuators etc. as applicable.

➤ INSPECTION AND TESTING REQUIREMENTS:

INSPECTION AND TESTING

Inspection of offered equipment/items at manufacturers' works' shall be done by the Client/PMC/TPI representatives as specified here in / as per approved inspection plan. Inspection shall be carried out as per relevant and applicable inspection and testing standards viz IS/BS/API etc. and as per approved quality assurance plans, technical data sheets, documents and drawings.

Inspection Criteria of Various Major Equipment/Items at Manufacturers' Works:

The Manufacturers'/OEM/Vendors' shall provide all instrument and equipment required to carry out applicable tests. The instruments shall be calibrated and certified by an approved independent testing authority preferably NABL accredited with valid calibration certificates as on date of inspection.

The inspection category and brief description of tests to be carried out for various equipment is as follows.

➤ **PUMP AND PUMP-MOTOR SET (CENTRIFUGAL/POSITIVE DISPLACEMENT/ PROGRESSIVE CAVITY (SCREW)/RECIPROCATING (DOSING), ETC.)**

HYDROSTATIC TEST

- A standard hydrostatic test shall be conducted on the pump casing with water at 1½ times the maximum discharge pressure on the head characteristic curve or 2 times the rated pressure whichever is higher.
- Unless otherwise stated in data sheet, the hydrostatic test on casing shall be conducted for minimum duration of 30 minutes.
- Manufacturer shall provide internal test certificates of hydrostatic test for review and acceptance by PMC and Client.

MECHANICAL BALANCING

- Major rotating components of the pumps like impellers, shaft, shaft sleeve etc. shall be individually statically as well as dynamically balanced preferably at rated speed.
- Vendor for PMC/Client's approval shall provide necessary test certificates.

MATERIAL TEST CERTIFICATES

- Material test certificates for the various pumps components shall be furnished for PMC/Client's review and approval as stated in the data sheet.

VISUAL INSPECTION

- Entire lot as per tender/BOQ shall be offered for visual inspection. The pumps shall not be painted before visual inspection and carrying out performance testing.

PERFORMANCE TESTING

Pump shall be tested for its full operating flow and head range.

Test shall be carried out for rated discharge and maximum discharge. Each pump shall be tested at its rated speed with preferably with **JOB** or shop motor of required rating and speed for its entire working range.

During pump testing, readings to the extent possible shall be taken to correspond to the net effective lift specified in the data sheet, and cover its full working range from its closed valve condition to run out condition i.e. when delivery valve is fully opened. Flow-Head, Flow-Power and Flow-Efficiency curves shall be drawn based on readings of tests carried out. The curves produced shall be used to determine the capacity of pump sets to meet guaranteed performance at site at rated speed.

PERFORMANCE WITNESS

1. CENTRIFUGAL PUMPS – ANY TYPE (HSCF/VT/SCF/HNC-VNC SEWAGE/ SEWEAGE SUBMERSIBLE/POLDER/MONO BLOCK/MONO SUBMERSIBLE ETC.)

Pump (Based On Drive Motor Rating)	Pump Performance Test to be Witnessed/Reviewed for each duty and type preferably with JOB MOTOR (Also see notes below)
Up to 30kW motors	Visual/Performance test witnessing not required. Vendor to submit internal test certificates for review, approval and dispatch clearance as per note given below prior to dispatch.
> 30kW up to 160 kW motors	50% quantity or minimum 1 No. whichever is higher per duty/type.
> 160kW	50% quantity or minimum 1 No. whichever is higher per duty/type.
Notes: (1) Manufacturer shall test all the pumps internally and shall provide their internal test records along with dynamic balancing, material test certificates for all major parts as per tender. Hydrostatic test certificate, dimensional check certificates etc. as per approved QAPs and data sheet, of each pump for review, record and dispatch clearance prior to dispatch of pumps. (2) Vendor shall provide certified parallel operation curve for pumps where more than two pumps are incorporated in BOQ along with individual pumps performance test witnessing. (3) HSCF/VT/HNC-VNC Pumps with drive motor ratings > 45kW to < 160 kW, ONE JOB motor of each type and rating, out of the project (tender) lot, shall be sent to the pump manufacturers' works for performance testing of pump-motor assembly set. In case of testing of pump(s) with job motor(s), witnessing of inspection test of motors @ motor manufacturers' works shall stand waived and if pump(s) are to be performance tested with shop motor(s), inspection tests of motors shall be witnessed by the Client/PMC/TPI @ manufacturers' works as specified in technical specifications of electrical works.	

➤ **VALVES (SV/NRV/DPCV/BFV/KGV/BALL/AIR VALVE)**

HYDROSTATIC TEST

- A standard hydrostatic test shall be conducted on the body and seat (with water) of valves at required test pressure depending on PN ratings/design pressure rating(s) of valves for minimum duration of 2 minutes or as specified in applicable testing standards.
- Manufacturer shall provide internal test certificates of hydrostatic test for review and acceptance by PMC and Client.

MATERIAL TEST CERTIFICATES

- Material test certificates for the various components of valves shall be furnished for PMC/Client's review and approval as stated in the data sheets.

VISUAL INSPECTION & VERIFICATION of DIMENSIONS

- Entire lot as per tender/BOQ shall be offered for visual inspection and verification check of dimensions. The valves shall not be painted before visual inspection and carrying out performance testing.

PERFORMANCE TESTING

- Valves shall be tested for operation as per applicable standards.
- Electric actuator operated valves shall be tested only on job electric actuator and shall verify operation time (Full open to full close in one cycle).

PERFORMANCE WITNESS

Size of Valves	Performance Test to be Witnessed/Reviewed for each size/
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	rating and type (Also see note below)
Up to 300mm diameter	10% quantity or minimum 1 number whichever is higher per size/ rating and type for hydro test and rest shall be review of internal documents.
> 300mm diameter up to 900mm diameter	10% quantity or minimum 1 number whichever is higher per size/ rating and type for hydro test and rest shall be review of internal documents..
> 900mm diameter	50% quantity to be witnessed.
Note: Manufacturer shall test all the valves internally and shall provide their internal test records for hydrostatic test along with material test certificates for all major parts as per tender, dimensional check certificates, actuator internal test records for valve etc. as per approved QAP and data sheets of valve type for review, record and dispatch clearance prior to dispatch of materials.	

➤ EXPANSION BELLOWS

HYDROSTATIC TEST

- A standard hydrostatic test shall be conducted on bellows at required test pressure depending on PN ratings/design pressure rating(s) of bellows for minimum duration of 15 minutes or as specified in applicable testing standards.
- Manufacturer shall provide internal test certificates of hydrostatic test for review and acceptance by PMC and Client.

MATERIAL TEST CERTIFICATES

- Material test certificates for the various components of bellows shall be furnished for PMC/Client's review and approval as stated in the data sheets.

VISUAL INSPECTION & VERIFICATION of DIMENSIONS

- Entire lot as per tender/BOQ shall be offered for visual inspection and verification check of dimensions. The bellows shall not be painted before visual inspection and carrying out performance testing.

PERFORMANCE TESTING

- Bellows shall be tested for axial expansion and compression test as per applicable standards.
- Dye penetration test (DPT) shall be carried out for weld joints on expansion bellows exceeding size of 1 meter (NB Dia.) selected randomly from entire project (tender) lot.

PERFORMANCE WITNESS

Size of Expansion Bellows	Performance Test to be Witnessed/Reviewed for each size/rating and type (Also see note below)
Up to 300mm diameter	10% quantity or minimum 1 number whichever is higher per size/ rating and type for hydro test and rest shall be review of internal documents.
> 300mm diameter up to 900mm diameter	10% quantity or minimum 1 number whichever is higher per size/ rating and type for hydro test and rest shall be review of internal documents.
> 900mm diameter	50% quantity to be witnessed.

Note: Manufacturer shall test all the expansion bellows internally and shall provide their internal test records for hydrostatic test along with material test certificates for all major parts as per tender, dimensional check certificates, actuator internal test records for valve etc. as per approved QAP and data sheets of expansion bellows for review, record and dispatch clearance prior to dispatch of materials.

➤ **PIPES (METALLIC: CI/DI/MS, ETC. and NON-METALLIC: HDPE/uPVC/RPVC/PP ETC.) AND CI/DI FITTINGS**

VISUAL INSPECTION & VERIFICATION of DIMENSIONS

- Entire lot as per tender/BOQ shall be offered for visual inspection and verification check of dimensions.
- Mass/Weight check and thickness check shall be carried out as per approved QAPs and applicable standards.

HYDROSTATIC TEST

- A standard hydrostatic test shall be conducted on pipes at random at required test pressure for minimum specified duration in applicable testing standards.
- All other tests shall be carried out as per applicable standards.

PERFORMANCE WITNESS

Size, Class and Type of Pipes and Fittings	Performance test to be Witnessed/Reviewed for each size/class and type of pipe and fittings (Also see notes below)
Up to 300mm diameter	Performance witnessing is not required.
> 300mm diameter and Up to 900mm diameter	10 % quantity or minimum 1 number whichever is higher per type size/class/length and type.
> 900mm diameter	25% quantity to be witnessed.
Notes: 1) Manufacturer shall test all the pipes & fittings internally and shall provide their internal test records for hydrostatic test along with material test certificates, mass/weigh check statement, dimensional check certificates etc. as per BOM and as per approved QAP for review, record and dispatch clearance prior to dispatch of materials. 2) For pipes above 300mm dia. and up to 900mm dia. size, if the total quantity required for entire pumping system/project is less than 100 meters, performance test is not to be witnessed. However, conditions mentioned at serial number 1) here in must be adhered to and complied with to the satisfaction of Engineer in charge/ PMC. 3) For pipes above 900mm dia. size, if the total quantity required for entire pumping system/project is less than 50meters, performance test is not to be witnessed. However conditions mentioned at serial number 1) here in must be adhered to and complied with to the satisfaction of Engineer in charge/ PMC. 4) For all fittings of all sizes if the total weight of total quantity required for entire pumping system/project is less than 5000kg, performance test is not to be witnessed. However, conditions mentioned at serial number 1) here in must be adhered to and complied with to the satisfaction of Engineer in charge/PMC.	

➤ **SLUICE GATE**

MATERIAL TEST CERTIFICATES

- Material tests certificates for all important components of gates such as thimble, frame, shutter, seat facings, spindle and rubber seals etc. to be furnished at the time of inspection.

VISUAL INSPECTION & VERIFICATION of DIMENSIONS

- Entire lot as per tender/BOQ shall be offered for visual inspection and verification check of important dimensions.

OTHER TESTS

Movement Test

- Movement test shall be conducted in horizontal/vertical assembled condition using stems and headstock. The gate should be operated once from full close to full open and back to full close condition with a maximum force of 135 Newton-meter on the crank or hand wheel.

Shop Leakage Test

- Shop leakage test by applying unseating hydraulic pressure will be conducted with gate mounted vertically on a test bench. A hydrostatic pressure equal to maximum seating/unseating head shall be applied to gate at centerline of gate opening from the back, i.e. unseating face of the gate in closed position, through pump. A suitable scaled calibrated pressure gauge put on the unseating face of the gate shall indicate reading equal to unseating pressure head. Water leakage through the gate under above condition shall be collected in a collection pan and measured.

The leakage so measured should not exceed the limit of 2.5, 3.5 and 4.5 LPM per meter sealing perimeter for class I, class II and class III sluice gates as stated in the IS: 13349 (1992).

No alternate testing arrangement will be permitted in place of above method. Gates can be applied with a coat of primer to prevent rusting due to water exposure during testing.

Hydrostatic Body Test

- After the leakage test, hydrostatic body test will be conducted by applying hydrostatic pressure equal to 1.5 times the maximum operating head on the gate for 5 minutes continuously. No permanent deformation in casting should be observed.

Torque Testing at Operating Head

- Torque test at operating head would be conducted at applicable head at manufacturer's shop for gates up to 2000mm x 2000mm size.

Seat Clearance Check

- With the gate in closed condition, 0.1 mm thick feeler gauge should not pass through between seat facings.

PMI Test

- Positive Material Identification (PMI) test to be conducted for sealing/seating faces, rubber seal retainer bar (if applicable) and stem/spindle during the inspection.
- Electric actuator operated valves shall be tested only on job electric actuator and shall verify operation time (Full open to full close in one cycle).

PERFORMANCE WITNESS

Size, Class and Type of Sluice Gate	Performance Test to be Witnessed/Reviewed for each size, type and class of Sluice Gate (Also see Note below)
Up to 1000mm dia./square (up to 1 m2 area)	Visual/Performance witnessing is not required. Vendor to submit test certificates for review/approval and dispatch clearance as per note given Below prior to dispatch.
> 1000 mm diameter/square (> 1 m2 area)	10% quantity or minimum 1 number whichever is higher per size/ class and type.

Note: Manufacturer shall test all the sluice gates internally and shall provide their internal test records for hydrostatic test along with material test certificates for all major parts as per tender, clearance check test, leakage test, movement test, dimensional check certificates, actuator internal test records for gates etc. as per approved QAP and data sheet of sluice gate for review, record and dispatch clearance prior to dispatch of material.

➤ **MATERIAL HANDLING EQUIPMENT Viz. EOT/HOT CRANE/CPB/HOT-MONORAIL**

MATERIAL TEST CERTIFICATES

- Material tests certificates for all important components of the equipment hook, wire rope, brakes etc. to be furnished at the time of inspection.

VISUAL INSPECTION & VERIFICATION of DIMENSIONS

- Entire lot as per tender/BOQ shall be offered for visual inspection and verification check of important dimensions.

OTHER TESTS

- All motorized material handling equipment shall be tested for overload tests at 125% of the rated load.
- All manual chain pulley blocks/HOT etc. shall be tested for overload tests at 150% of the rated load.
- Speed of lifting, long and cross travel as well as and deflection check shall be conducted as per governing standards.

PERFORMANCE WITNESS

Type & Capacity of Material Handling Equipment	Performance Test to be Witnessed/Reviewed for each type and capacity
((Electric/Manual) CPB/HOIST/HOT- Monorail / Chain Hoist– Any capacity	Visual/Performance witnessing is not required. Manufacturer shall test all the CPB/Hoist, HOT internally and shall provide their internal test records along with material test certificates for all major parts as per tender, dimensional check certificates etc. as per approved QAP and data sheet of CPB/Hoist, HOT for review, record and dispatch clearance prior to dispatch of materials.
EOT / HOT Crane	100 % EOT / HOT Crane shall be witnessed at manufacturer works for performance test as per approved documents / QAP.

➤ **MECHANICAL/MANUAL TYPE COARSE AND FINE SCREENS**

MATERIAL TEST CERTIFICATES

- Material tests certificates for all important components of the equipment to be furnished at the time of inspection.

VISUAL INSPECTION & VERIFICATION OF DIMENSIONS

- Entire lot as per tender/BOQ shall be offered for visual inspection and verification check of important dimensions.

PMI Test

- Positive Material Identification (PMI) test to be conducted for MOC during the inspection.

DPT

- Dye penetration test (DPT) shall be carried out for checking of soundness of weld joints on mechanical screens.

PERFORMANCE WITNESS

Type of Screen	Performance Test to be Witnessed/Reviewed for each type and size
Manual Screen – Any Type	Visual/Performance witnessing is not required. Manufacturer shall check all manual screens internally and shall provide their internal test records for dimensional check certificates along with material test certificates for all major parts as per tender and approved QAP and data sheet for review, record and dispatch clearance, prior to dispatch of materials.
Mechanical Screen – Any Type	10% quantity or minimum 1 No. whichever is higher per size of Mechanical screen shall be shall be witnessed at manufacturers' works for DPT, PMI and other required tests as per approved QAP and data sheet etc.

NOTES:

For all major equipment/items specified above, where factory inspections are exempted as clearly specified above, all tests as per relevant and applicable standards as well as approved QAPs, data sheets, documents and drawings must be carried out by the manufacturers'/vendors etc. and test certificates, MTCs etc. shall be submitted to the PMC/TPI prior to dispatch for getting dispatch clearance of the Client/PMC/TPI.

All other items not explicitly mentioned here but are in the scope of the tender (project) are exempted from performance tests @ manufacturers' works' to be witnessed by Client/PMC/TPI. However, all tests as per applicable governing standards should be carried out by the manufacturers and such test reports along with MTCs, dimensional verification certificates (if and as applicable) shall be submitted to the Client/PMC/TPI for review and acceptance for getting get dispatch clearance.

All expenditure pertaining to inspection including to and fro travel, local conveyance, lodging and boarding etc. shall be borne by the Contractor for minimum 2 representatives of Client/PMC/TPI Agency.

The Client or his authorized representative may visit the works during manufacture of various mechanical equipment/materials to assess the progress of work as well as to ascertain that only quality raw materials are used for the same. He shall be given full assistance to carry out stage inspection. Client's representative shall be given minimum two weeks advance notice for witnessing the final testing.

Field tests as per approved procedures/procedures available with Engineer-in-charge or his authorized representative shall be performed on the mechanical system/equipment before it is being put into service. All test equipment and instruments shall be arranged by the Vendor/Contractor. Test reports shall be approved by the Engineer-in-charge before acceptance of the equipment and complete plant.

(D) TESTING, ERECTION, AND COMMISSIONING

TESTING - GENERAL

Tests of the plant at the manufacturer's premises will be required in accordance with the conditions of contract. All inspection, examination and testing shall be carried out in accordance with appropriate standards.

Testing & inspection at manufacture works of all major items viz.: pumps, motors, valves, sluice gate, EOT crane. shall be conducted at manufacturer's work in presence of third-party inspection agency appointed by client/ or engineer-in-charge representatives of Client/PMC/TPI.

All the charges for third party inspection shall be included under the scope of contractor. All instruments used for such tests shall be calibrated and certified by an approved independent testing authority not more than 12 months prior the test in which they are used. The engineer's representative reserves the right to impound any instrument immediately after test for independent testing. A certificate shall be produced by the contractor prior to carrying out every test showing the readings obtained, calculations and full details of the calibration certificates referred to.

If the engineer's representative witnesses a test he shall be given a copy of the test results and certificates immediately. Whether he witnesses a test or not, copies of test certificate shall be sent to the engineer's representative. No item of the plant shall be forwarded to the site until its test certificate has been approved writing by the engineer's representative. Six copies of the test certificates shall be supplied in suitable folders with proper index.

Certificates shall be clearly identified by serial or reference number where possible to the material being certified and shall include information required by the relevant reference standard or specification clause.

INSPECTION AT MANUFACTURER'S PREMISES

The inspection of all equipment required to be supplied to complete the works shall be done as detailed in this specification. Only defect free and sound material meeting the technical requirements of this specification and in accordance with a high standard of engineering would be acceptable to the engineer's representative.

For meeting these requirements of inspection, testing (including testing for chemical analysis and physical properties) shall be carried out by the contractor and certificates submitted to the engineer's representative who will have the right to witness or inspect the above mentioned testing/inspection at any stage desired by him. Calibration certificates or test instruments shall be produced for the engineer's consent in advance of testing and if necessary instruments shall be recalibrated or substituted before the commencement of the test. 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.

If during or after testing, any item of the plant fails to achieve its intended duty or otherwise prove defective it shall be modified or altered as necessary, retested and re-inspected as required by the engineer.

At least 21 days notice shall be given to the engineer before the specified tests are carried out.

No material is to be delivered to site without the above described inspection having been carried out or officially waived in writing by the engineer's representative.

One pump of each rating shall be tested with shop motor at rated speed in the presence of client's

representative. Shop motor efficiency and rating shall be submitted to client for approval prior to inspection call.

TESTS AT MANUFACTURER'S PREMISES

WATER PUMPSET:

Pump testing and inspection shall confirm to the latest standard

(a) Hydrostatic testing

A standard hydrostatic test shall be conducted on all the pressure parts of the pumps at 1.5 times the shut-off head of the pump or twice the rated head whichever is higher. The hydrostatic test shall be conducted for a minimum duration of 30 minutes.

(b) Balancing Test

Impeller and pump rotating assembly shall be dynamically balanced.

(c) Performance Test

Each pump shall be tested for full operating range individually to BS : 5316 : Part 2. Test shall be carried out for performance at rated speed with minimum NPSH as available at site.

MOTORS

Motors shall be offered for routine and type tests in accordance with IS :996-1979 and IS : 325-1978 at the manufacturer's works. Test certificates shall be endorsed to the effect that the motors are properly balanced and free from vibration. In addition, a test shall be required to establish the maximum transient starting current.

PIPEWORK

Testing of pipes/fitting shall be carried out in accordance with relevant standard.

VALVES

- (a) All valves shall be hydrostatically tested close ended. Body, seat/door and back seat-test pressures shall be 15 bar, 10 bar and 6 respectively.
- (b) Valves shall be tested with associated actuators for general performance.

HOISTS

- (a) The hoist shall be completely assembled in the contractor's or sub-contractor's works and shall be subjected to the tests as specified in IS : 807/ IS : 3177. The contractor shall provide the test weights.
- (b) In addition a vertical deflection test shall be carried out with the 'Safe Working Load' suspended from the hook with the crab in the centre of the span. The ratio of deflection to span shall not exceed that specified in IS 807. Manufacturer's test certificates for mechanical items shall be furnished.

GATES

(a) Seat Clearance Check

With the gate fully closed, the clearance between seating faces when checked with thickness gauge, shall not exceed 0.1 mm.

(b) Movement Test

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 assembly is workable.

(c) Leakage Tests

With the gate in the closed position design pressure shall be applied for a period not lesser than 10 minutes to the unseating side of the sluice gate and the leakage shall not exceed the maximum leakage permissible as per AWWA C-501, for the head applied on the unseating side.

(d) Hydrostatic Tests

Finally a differential of one and half times the design pressure shall be applied to the unseating side of the gate. Under these tests no part shall show any deflection or deformation.

ERECTION - GENERAL

The contractor's staff shall include at least one competent erection engineer with proven suitable, previous experience on similar contract to supervise the erection of the works and sufficient skilled, semiskilled and unskilled labour to ensure completion of the works in time. The contractor shall not remove any representative, erector or skilled labour from the site without the prior approval of the engineer's representative.

One erection engineer who shall be deemed to be the contractor's representative shall be conversant with the erection and commissioning of the complete works. Should there be more than one erector, one shall be in charge and the contractor shall inform the engineer's representative in writing which erector is designated as his representative and is in charge. Erection engineer is to report to Project Manager.

The contractor's erection staff shall arrive on the site on date to be agreed by the engineer's representative before they proceed to the site, however, the contractor shall first satisfy himself, as necessary, that sufficient plant of his (or his sub-contractor's) supply has arrived on site so that there will be no delay on this account.

The contractor shall be responsible for setting up and erecting the plant to the line and levels of reference given by the engineer in writing, and for the correctness (subject as above mentioned) of the positions, levels dimensions and alignment of all parts of the works and for provision of all necessary instruments, appliances and labour in connection therewith. The checking of setting out of any line or level by the engineer or engineer's representative shall not in any way relieve the contractor of his responsibility for the correctness thereof.

Erection of plant shall be phased in such a manner so as 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 dimensions of structures where the various items of plant are to be installed and shall bring any deviations from the required positions, 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, at no additional cost to the Employer, make good, repair or replace the damage, promptly and

effectively as directed by the Engineer and to the Engineer's satisfaction..

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.

RECORD, 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 of shop inspection reports, shop testing reports, material test reports, based on which dispatch clearances are provided, 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's representative attesting conformity to specifications and is 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.

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:

- (a) Plant in the scope of the contractor has been erected, installed and grouted as per specifications.
- (b) Installation checks are completed and approved by the engineer.
- (c) The erected plant 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 bound to undergo commissioning checks/tests on completion.

Upon achieving the completion as described above, the contractor shall notify the engineer by a written notice intimating such mechanical completion of units and notify the engineer for inspection and acceptance of mechanical completion. The engineer/engineer's representative shall proceed with the inspection of such units within 14 days of such a notice.

Thereafter:

- (a) The engineer shall certify completion when there are no defaults in the works and the plant is acceptable or
- (b) The engineer shall inform the contractor list of deficiencies for rectification hereinafter referred as Punch List and the contractor shall complete the rectification work within a jointly agreed period before tests on or approval of the same before proceeding with the Tests on Completion or

- (c) 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 followed by Test on Completion when the contractor undertakes to complete such outstanding works within an agreed during Defects Liability Period.

Taking over shall be based on rectification of all deficiencies as advised by punch lists.

The erection period indicated by the contractor would be deemed to cover all the activities upto completion as stipulated in previous paragraphs, notice of completion by the contractor, inspection by the engineer for completion, and contractor rectification of all deficiencies as noticed by the deficiency/punch list, and acceptance by the engineer of such rectification, prior to Test on Completion.

Minor defects, which in the opinion of engineer which do not hamper operability and maintainability will not be taken in to account for deciding mechanical completion. Such defects shall be rectified concurrent to commissioning checks before Test on Completion. However, the engineer's decision in this regard is final.

The commissioning period as notified by the contractor shall be deemed to occur beyond the date of completion and shall include all period of pre-commissioning, trials and Test on Completion.

It is in the contractor's interest to offer the sections/units/systems, progressively under identified milestones within overall erection period, duly completed for inspection by the engineer's representative, obtain his 'punch' list, for rectification of any deficiencies pointed out by the engineer and to achieve mechanical completion before undertaking the Test on Completion within the specified erection period. The engineer also reserves a right to withhold the cost as estimated to be equivalent to the rectification of deficiencies pointed out to the contractor until such a time such deficiencies are rectified to the satisfaction of the engineer.

SETTING TO WORK

On completion of erection the contractor shall request the engineer's representative to carry out the installation inspection.

After the plant has been set to work the contractor shall continue to operate the plant for a period of one week.

INSTALLATION INSPECTION

In addition to the progressive supervision and inspection by the purchaser 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 by engineer, 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.

PUMPS, PIPING AND VALVES

- (a) The erected pipe work shall be subjected to a hydraulic test at 1.5 times the maximum pressure or twice the working pressure whichever is higher to test the soundness of the joints. Provision of the necessary pumps, gauges, blank flanges, tappings etc. for carrying out these tests shall be include in the contract.
- (b) Leakage tests shall be carried out on all erected pipe work, pumps and valves immediately after erection and where possible before being built in.

- (c) Operating tests shall be conducted on valves.
- (d) The pump set shall be tested for satisfactory operation. The vibration and noise level shall be checked to be within the specified limits.

PUMP MOTORS

Condition of winding insulation be tested and insulation values shall be restored to required level by suitable heating arrangements locally.

HOISTS

The hoist and lifting tackle shall be tested to 125 % of the safe working load. The contractor shall arrange the test load.

SLUICE GATE

- (a) Leakage test shall be performed by the contractor after installation of the sluice gates.
- (b) Under the design seating head and unseating head the leakage shall not exceed the limit specified in AWWA C501/IS : 13349, class 1 for shop testing.

INSTRUMENTATION

Performance of the instrumentation shall be checked as per the design requirements.

COMMISSIONING

SCOPE

At the time of commissioning, the engineer will appoint his representative as commissioning engineer. The contractor shall carry out commissioning tests in the presence of the commissioning engineer. Though the mechanical completion may have been checked and clarified by the site engineers, the commissioning engineer may verify any mechanical completion checks to satisfy himself that the plant is fit and sound, if such checks had not been witnessed by him. It will be the responsibility of the contractor to make all arrangements for carrying out these tests. The evaluation of test results and decision passed by the commissioning 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 at no extra cost.

MISCELLANEOUS

Completion checks and commissioning tests on items not covered under above, shall be carried out by the contractor as per the instructions of the engineer's representative.

HANDING OVER WORK

No item of Plant/Equipment will be certified for taking over by the Client's Engineer-in-charge unless it has successfully passed all the tests, requirements as mentioned in tender documents. Contractor has to handover phase wise work to Client and after completing all kinds of SITC work and upon fulfilling all checks/tests/reports as mentioned in tender the Handing Over will be taken by Client. Defect Liability Period will start from date from Completion and Handing-Over Entire work under this tender scope.

TAKING OVER

No item of plant will be certified for taking over by the purchaser unless it has successfully passed all the tests called for under the contract. If nevertheless the employer uses any part of the works, that part which is used shall be deemed to have been taken over at the date of such use.

Taking Over Certificate for plant shall not be issued unless the following documentation are duly compiled and submitted in final formats in duly bound volumes.

- (a) A compilation of all shop inspection results/reports of the plant/machinery with due attestation that the plants have been manufactured to specified standards (5 copies).
- (b) All erection/construction quality control checks in appropriate approved formats for all installation works with attestation that installation has been carried out as per acceptable/stipulated standards (6 copies).

**TECHNICAL DATA SHEET FOR MECHANICAL
EQUIPMENT'S**

(TO BE SUBMITTED DURING EXECUTION STAGE)

GENERAL NOTES / GUIDELINES FOR BIDDERS / VENDORS

1. The technical vendor data sheets for various electro-mechanical items shall be submitted by contractor during execution / respective equipment approval stage as per provided format as a minimum (and with additional details as required separately) for review and approval.
2. The design ambient temperature shall be considered as 5°C min. and 50°C max.
3. The specific gravity of various service fluids shall be considered as under:

Service Fluid	Sp. Gravity, g/cc
Clear / Potable Water, Tertiary Treated Sewage	1.00
Raw Water (river, Canal, etc.), Sec. Treated Sewage	1.01
Sewage	1.02
Sec. / Return Activated Sludge	1.03
Primary / Thickened / Digester Sludge	1.05
Any other	As per fluid properties and concentration

4. For painting, document submission and inspection & testing requirements bidder / vendor to refer the "GENERAL REQUIREMENT FOR MECHANICAL ITEMS / EQUIPMENT" section provided with specifications or other as specified elsewhere in tender.
5. The selection of motor operating characteristics and it's mounting to suit the equipment shall be responsibility of contractor / vendor.
6. The data sheet shall be submitted separately for each type / capacity of pump; for each size / type of valves & gates & it's type of operation; for each equipment, etc. as applicable.

DATA SHEET OF NON-CLOG SEWAGE SUBMERSIBLE PUMP-MOTOR SET		
Sr. No.	Particulars	Data To Fill by Contractor/ Vendor
1.0	Liquid Data	
1.1	Liquid Handled	Sewage
1.2	Specific Gravity	1.02
1.3	Temperature °C (Ambient)	
2.0	Pump Data	
2.1	Make	
2.2	Pump Type	Sewage Submersible CF pump with Dry Type Motor
2.3	Pump Model	
2.4	Quantity (Nos.)	
2.5	Type of Duty	Continuous
2.6	Design Capacity (m³/hr.)	
2.7	Head (m)	
2.8	Shut Off Head (m)	
2.9	Rated Speed of Pump (RPM)	
2.10	Pump Efficiency at Duty Point (%)	
2.11	Pump Input (Max. BKW) for Rated Impeller (kW)	
2.12	Recommended Drive Motor Rating (kW)	
2.13	Efficiency of Pump Set (%) @ Duty Point (Without Coating & Without Negative Tolerance)	
2.14	Full Load Motor Efficiency (%)	
2.15	Guaranteed Overall Efficiency of Pump-Motor Set @ Duty Point	
2.16	Full Load Speed of Motor (RPM)	
2.17	Minimum Submergence Required (m) (Measured from bottom to impeller for cavitation free operation of pumps (m) 1. for Solo Operation and 2. for Parallel Operation	
2.18	Maximum Permissible Size of Solids (mm)	
2.19	Guide Pipe, Size and Thickness/Schedule	
2.20	Length of Each Guide Pipe (m)	
2.21	Lifting Chain: Construction Details	
2.22	Lifting Chain: Length (m)	
2.23	Weight of Pump Motor Set (kg)	
2.24	GD² value of Pump-Motor Set	
3.0	Constructional Features	
3.1	Number of Stage	Single
3.2	Casing Type	Volute Type
3.3	Impeller Type (Enclosed/Semi Open)	Non-Clog Single Suction
3.4	Impeller Diameter (mm) Max./Rated/ Minimum	
3.5	Shaft/Drive Transmission	Direct Uni-Built (On Common Shaft)
3.6	Shaft Seal	Double Mechanical Seal
3.7	Mechanical Seals: Make, Type and Size Faces: Pump Side Motor Side	
3.8	Mounting Orientation	Vertical

Sr. No.	Particulars	Data To Fill by Contractor/ Vendor
3.9	Nozzle Orientation and Size (mm) Suction (Bottom/As per Application)	
	Discharge (Side/As per Application)	
3.10	Flange Drilling	As per IS: 1538, FF with off center bolt holes/IS: 6392/BS EN 1092 FF
3.11	Direction of Rotation	CW when viewed from Top
3.12	Type of Starter (DOL/Star-Delta/Soft/VFD)	
4.0	Motor Data	
4.1	Motor Rating (kW)	
4.2	Voltage/Phase/Frequency and % Variation	
4.3	Combined Voltage and Frequency Variation	
4.4	Design Ambient Temperature/Temperature Rise °C	
4.5	Insulation Class	
4.6	Duty	
4.7	Full Load Speed (RPM)	
4.8	Full Load Torque (FLT) (kgm)	
4.9	Starting Torque as Percentage of FLT (%)	
4.10	Full Load Current (FLC) (Amps.)	
4.11	Locked Rotor Current (Amps.)	
4.12	Starting Current as % of FLC	
4.13	Break Down Torque (POT) as % of FLT	
4.14	Starting Time at 80% V/100% V (Seconds) with Load Coupled	
4.15	No Load Starting Time	
4.16	Locked Rotor Withstand Time Hot/Cold (Seconds)	
4.17	Overload Capacity (%)	
4.18	Number of Permissible Cold/Hot Starts	
4.19	Starting Power Factor	
4.20	Motor Power Factor @ 50%, 75% and 100% Load	
4.21	Motor Efficiency @ 50%, 75% & 100% Load (%)	
4.22	Protection Class	
4.23	Provision of Thermistors	Yes
4.24	Winding and Moisture Protection Details	
4.25	Bearing Type/Number DE: NDE:	
4.26	Winding Insulation Class	
4.27	Motor Seal Cooling Details	
4.28	Winding Temperature Detector	
4.29	Seal Leakage (Moisture) Detector	
4.30	Cable Type	Dual PVC Sheathed, Round, Copper Conductor
4.31	Details of Power Cable: Run, Core & Size	
4.32	Details of Control Cable: Run, Core & Size	
4.33	Length of Pair of Cables offered with Pump Set (Power and Control) (m)	
5.0	Materials Of Construction	
5.1	Pump Casing (M)	
5.2	Casing Wear Ring (if provided)	

Sr. No.	Particulars	Data To Fill by Contractor/ Vendor
5.3	Suction Cover/Oil Chamber/Motor Casing	
5.4	Shaft (M)	
5.5	Shaft Sleeve (if required) (M)	
5.6	Impeller (M)	
5.7	Impeller Wear Rings (M)	
5.8	Impeller Nut (M)	
5.9	Mechanical Seal Faces: Pump Side Motor Side	
5.10	Stator Housing	
5.11	Stator	
5.12	Rotor	
5.13	Auto Coupling Unit (Pump Connector Unit)	
5.14	Guide Pipe	
5.15	Lifting Chain	
5.16	T Bracket	
5.17	Hardware – Bolts, Nuts, Anchor Fasteners etc.	
6.0	Accessories Required	
6.1	Auto Coupling Unit	Yes
6.2	Dual Guide Pipe with Support (SS)	Yes
6.3	Lifting Chain (SS)	Yes
6.4	Set of Foundation Bolts and Nuts	Yes
6.5	SS Suction Strainer with Details of Size and Area of Opening	Yes
6.6	PMU/Pump Monitoring-Safety Unit	Yes
6.7	Non-Standard/Special Tools	Yes
7.0	Drawings and Documents Submission	As per Specifications
7.1	Performance Curves (Capacity i.e. Flow Vs Head, Capacity Vs Efficiency and Capacity Vs Power)	
7.2	GA Drawing of Pump	
7.3	Cross Sectional Drawing of Pump	
7.4	Catalogue of Products	
7.5	QAP	
8.0	Painting	Refer General Requirement for Mechanical Items/Equipment Section /Tender Specifications
9.0	Testing	As Specified in Inspection-Testing

- Notes:** 1. Manufacturer/Supplier shall submit separate data sheet for each duty.
2. For components (marked-M) MTC (**of Laboratory accredited with NABL**) as per relevant standards shall be furnished.
3. Test certificates for hydrostatic test, static and dynamic balancing of impeller and rotating assembly are required for review and acceptance.
4. Bidder shall refer electrical specifications for motor requirement and shall offer accordingly.
5. Bidder shall have to submit completely filled data sheet in above format certified by approved pump manufacturer along with certified pump characteristic curves and offer pump model with guaranteed minimum acceptable pump and overall (pump and motor combined) acceptable efficiency.

DATA SHEET FOR SLUICE VALVE (MANUAL/GEAR BOX OPERATED)

Particulars	Data To Fill By Contractor/Vendor
Make	
Manufacturing and Testing Standards	IS: 14846
Size (mm)	
Quantity	
Pressure Rating	
Type (Non-Rising)	
Type of Operation: By Hand Wheel/Gear Box	
Ends (Flanged)	Flanged, FF as per IS: 1538 having off center bolt holes
Body/Bonnet	Bolted
Disc	
Maximum Valve Torque (Nm)	
Seat Body and Disc	Renewable
Type of Gear Box (For size ≥ 350 mm)	
Direction of Closing	CW Marked on Hand Wheel
Repacking/Back Seat Bush Arrangement	Required for size ≥ 300 mm
Channel and Shoe in Arrangement	Required for size ≥ 600 mm
Gear Box Arrangement	Required for size ≥ 350 mm
Maximum Valve Torque (Kgm)	
Gear Box Model and Rating (Kgm)	
Input Torque to Gear Box (Kgm)	
Gear Box Ratio/M. A.	
Number of Turns For Valve Close to Open	
Materials Of Construction	
Body, Bonnet (M)	
Wedge (M)	
Stem/Spindle (M)	
Stem Nut/Spindle Nut	
Body Seat Ring/Wedge Face Ring (M)	
Stuffing Box and Gland	
Back Seat Bush	
Bearings	
Stem Sealing	
Bonnet Gasket	
Channel and Shoe Lining	
Gland Packing	
Bolts, Studs and Nuts	
Hand Wheel/Cap	
Painting/Coating	Refer General Requirement for Mechanical Items/Equipment Section/Tender Specs.
Drawings and Document Submission	As per Specifications
GA Drawings of Valve and QAP	
Testing	As Specified in Inspection-Testing

Notes: 1. Manufacturer/Supplier shall submit separate data sheet for each size and rating.

2. For components (marked-M) MTC (of Laboratory accredited with NABL) as per relevant standards shall be furnished.

DATA SHEET FOR SLUICE VALVE (ELECTRIC ACTUATOR OPERATED)

Particulars	Data To Fill By Contractor/Vendor
Make	
Manufacturing and Testing Standards	
Size (mm)	
Quantity	
Pressure Rating	
Type (Rising)/Non-rising	
Type of Operation: Motorized Electric Actuator	
Ends - Flanged	Flanged, FF as per IS: 1538 having off center bolt holes
Body/Bonnet	Bolted
Disc	
Maximum Valve Torque (Nm) with Factor of safety (FOS)	
Stem Diameter (mm)	
Number of Turns	
Seat Body and Disc	Renewable
Direction of Closing	CW Marked on Hand Wheel
Materials Of Construction	
Body/Bonnet (M)	
Wedge (M)	
Stem/Spindle (M)	
Seat Rings (M)	
Back Seat Bush (M)	
Channel and Shoe Lining	
Stem Packing	
Bonnet Gasket	
Bolts, Studs and Nuts	
Hand Wheel	Required
Details of Electrical Actuator	
Actuator Make and Model	
Actuator Torque Capacity (Minimum and Maximum)	
Actuator Speed (RPM)	
Power Supply	
Valve Opening/Closing Time (seconds)	
Painting/Coating	Refer General Requirement for Mechanical Items/Equipment Section/Tender Specs.
Drawings and Document Submission	As per Specifications
GA and Cross Sectional Drawings of Valve	
QAP	
Actuator Details including Wiring Diagram	
Testing	As Specified in Inspection-Testing

Notes: 1. Manufacturer/Supplier shall submit separate data sheet for each size and rating.
2. For components (marked-M) MTC (**of Laboratory accredited with NABL**) as per relevant standards shall be furnished.
3. Bidder shall refer relevant specifications for electric actuator requirement and shall offer appropriate model accordingly.

DATA SHEET FOR SWING CHECK TYPE REFLUX (NON RETURN) VALVES

Particular	Data To Fill By Contractor/Vendor
Make	
Manufacturing and Testing Standards	IS: 5312
Size (mm)	
Quantity	
Pressure Rating	
Ends	Flanged, FF as per IS: 1538 part IV and VI having off center bolt holes/IS: 6392 Raised face
Materials Of Construction	
Body and Cover (M)	
Door and Hinge (M)	
Body and Disc/Clamping Rings (M)	
Disc Seal	
Hinge Pin (M)	
Bearing Bushes	
Gasket	
Bolts, Studs and Nuts	
Accessories Required	
By Pass	Required for size ≥ 300 mm
Drain Plug	Required for size ≥ 300 mm
Support Foot	Required for size ≥ 450 mm
By Pass Gate Valve (If Applicable)	
Painting/Coating	Refer General Requirement for Mechanical Items/Equipment Section/Tender Specs.
Drawings and Document Submission	As per Specifications
GA and Cross Sectional Drawings of Valve	
QAP	
Testing	As Specified in Inspection-Testing

Notes: 1. Manufacturer/Supplier shall submit separate data sheet for each size and rating.
2. For components (marked-M) MTC (of Laboratory accredited with NABL) as per relevant standards shall be furnished.

DATA SHEET FOR DUAL PLATE CHECK VALVE

Particulars	Data To Fill By Contractor/Vendor
Make	
Manufacturing Standards	API 594
Testing Standards	API 598
Size (mm)	
Quantity	
Pressure Rating	
Ends	Flanged, FF as per IS: 1538 having off center bolt holes
Materials Of Construction	
Body (M)	
Door (Disc/Closure Plate) (M)	
Door Face (Body/ Plate Seat) (M)	

Particulars	Data To Fill By Contractor/Vendor
Bearing Bush	
Hinge Pin and Stop pin (M)	
Springs (M)	
Body Seat Ring	
Bolts, Studs and Nuts	
Accessories Required	
Lifting Eye Bolts	Required for size $\geq$ 150 mm
Support Foot	Required for size $\geq$ 600 mm
By Pass Arrangement	Required for size $\geq$ 600 mm
Painting/Coating	Refer General Requirement for Mechanical Items/Equipment Section/Tender Specs.
Drawings and Document Submission	As per Specifications
GA Drawings of Valve	
QAP	
Testing	As Specified in Inspection-Testing

Notes: 1. Manufacturer/Supplier shall submit separate data sheet for each size and rating.
2. For components (marked-M) MTC (**of Laboratory accredited with NABL**) as per relevant standards shall be furnished.

DATA SHEET FOR BUTTERFLY VALVE

Particulars	Data To Fill By Contractor/Vendor
Make	
Manufacturing and Testing Standards	IS: 13095
Size (mm)	
Quantity	
Pressure Rating	
End Connection	Flanged, FF as per IS: 1538 Table IV and VI
Disc	Double Eccentric
Eccentricity - 1 (mm) and Eccentricity - 2 (mm)	
Type of Operation: (A) Manual: 1. Lever 2. Gear Box and (B) Electric Actuator Operated	
Maximum Valve Torque (Kgm)	
Type of Gear Box	Required for size $\geq$ 200 mm
Maximum Valve Torque (Kgm)	
Gear Box Model and Rating (Kgm)	
Input Torque to Gear Box (Kgm)	
Gear Box Ratio/M. A.	
Number of Turns For Valve Close to Open	
Materials Of Construction	
Body and Disc (M)	
Shaft (Long and Stub) and Shear Pin (M)	
Body Seat Ring (M)	
Disc Seal Ring (M)	
Bush (Long and Stub) Bearings	
End Cover and Gland Bush	
Bolts, Studs and Nuts	
Lever Assembly	
Accessories Required	
By Pass Arrangement	Required for size $\geq$ 600 mm
Support Foot	Required for size $\geq$ 900 mm
Hand Wheel	Required
Details of Electrical Actuator (If Applicable)	
Actuator Make and Model	
Actuator Torque Capacity (Min. and Max.)	
Actuator Speed (RPM)	
Power Supply	
Valve Opening/Closing Time (Seconds)	
Painting/Coating	Refer General Requirement for Mechanical Items/Equipment Section/Tender Specs.
Drawings and Document Submission	As per Specifications
GA Drawings of Valve	
QAP	
Actuator Details including Wiring Diagram	
Testing	As Specified in Inspection-Testing

Notes: 1. Manufacturer/Supplier shall submit separate data sheet for each size and rating.

2. For components (marked-M) MTC (**of Laboratory accredited with NABL**) as per relevant standards shall be furnished.

3. Bidder shall refer relevant specifications for electric actuator requirement and shall offer appropriate model accordingly.

DATA SHEET FOR KINETIC AIR RELEASE VALVE (With Isolating Sluice Valve)

Particulars	Data To Fill By Contractor/Vendor
Make	
Manufacturing and Testing Standards	AWWA C 512
Type	Double Acting, Triple Function, Tamper Proof, Bi-Stream
Size (mm)	As per SOQ
Quantity	Water / 1.0
Pressure Rating	PN : 1.0
End Connection	Double Acting, Triple Function, Tamper Proof, Bi-Stream
Materials Of Construction (For ARV As Applicable)	
Air Valve Body and Cover (M)	
Air Valve Float and Cage for Float (M)	
Valve Hood and Guide for Hood (M)	
Float (Low Pressure Orifice)	
Float (High Pressure Orifice)	
ARV Seat	
ARV Seal (Soft)	
Body Cover Gasket	
Linkages for ARV	
Float Stem	
Float Stem Guide Bush	
Float Cushion Seat	
Bolts, Studs and Nuts	
Isolation Sluice Valve	1) As per Standards/Specifications/Data Sheet given above of Required Size and MOC with Hand Wheel. 2) All required details to be given in combined data sheet and assembly drawing.
Painting/Coating	Refer General Requirement for Mechanical Items/Equipment Section/Tender Specs.
Drawings and Document Submission	As per Specifications
GA Assembly Drawings of Air Release Valve and Isolating Sluice Valve	
QAP	
Testing	As Specified in Inspection-Testing

Notes: 1. Manufacturer/Supplier shall submit separate data sheet for each size and rating.
 2. For components (marked-M) MTC (**of Laboratory accredited with NABL**) as per relevant standards shall be furnished.

DATA SHEET OF METALLIC EXPANSION BELLOWS

Particulars	Data To Fill By Contractor/Vendor
Make	
Manufacturing Standards (EJMA/ASME)	
Type	Corrugated Design Single Metallic
Size Range and Quantity	
Overall Length (mm)	
Pressure Rating	
Axial Expansion (mm)	Minimum 20 mm
Axial Compression (mm)	Minimum 10 mm
Fatigue Life Expectancy	Minimum 3000 Cycles
Overall Length of EB	
Mode of Installation (Horizontal)	
Ends Flanged, FF as per IS: 1538 having off center bolt holes	
Number of Convolutions	
Thickness of Weld End	
Thickness of Internal Sleeve	
Quantity and Position of Rods Minimum 2 Nos. up to 200 NB Minimum 3 Nos. from 250 to 450 NB Minimum 4 Nos. from 500 to 900 NB Minimum 6 Nos. above 1000 NB	
Materials of Construction	
Bellows (M)	
Internal Sleeves (M)	
Flanges (M)	
Lugs	
Rods	
Hardware	
Painting	Refer General Requirement for Mechanical Items/Equipment Section/Tender Specs.
Drawings and Document Submission	As per Specifications
GA Drawings of Bellows	
QAP	
Testing	As Specified in Inspection-Testing

Notes: 1. Manufacturer/Supplier shall submit separate data sheet for each size and rating.

2. For components (marked-M) MTC (of Laboratory accredited with NABL) as per relevant standards shall be furnished.

DATA SHEET FOR EOT / HOT CRANE

Particulars	Data to Fill By Contractor/Vendor
General	
Make	
Model	
Capacity in Metric Ton (MT)	
Location	Indoor
Quantity	
Crane	
Design and Construction Standards	
Class and Duty	
Type: Single/Double Girder	
Method of Operation	By Pendent Push Buttons @ Floor Level
Lift (meters)	As per Actual Requirement
Span (meters)	As per Actual Requirement
Bay Length (meters)	As per Actual Requirement
No. of Falls	
Operating Travel Speed (meter/minute) • Hoist • Cross • Longitudinal	
Creep Speed (meter/minute)	
Main Girder Details	
Type of Suspension	
Track (For Long and Cross Travel)	Straight
Long Track Rail Size	Minimum 40 mm Square Bar
Type of Gear Box For LT	
Brakes • Hoisting • CT • LT	
Brake Type	
Brake Size (mm)	
DSL	
Materials of Construction	
Main Girder	
End Carriage (M)	
Bridge (M)	
End Stopper (Required on Either Side of Bridge)	
Wheel Base	
Gears and Pinions (M)	
Wire Rope (M)	
Hook (M)	
Rope Drum and Sheaves (M)	
Rope Guide (m)	
Wheels (M)	
Shafts (M)	
Bearings	
Maintenance Platform/Access Walkway	
Electrical Details	

Power Supply	
Motor Standard	
Control Voltage	
Class of Insulation/Degree of Protection	
Ambient Temperature	50 °C
Type of Motor (Hoist Duty)	
Make	
Motor Ratings (kW) For • Hoisting (Vertical) • Cross Travel • Long Travel	
Method of Starting	
VFD for Hoist Motor • Make • Model • Type	
Total Connected Load (kw)	
Accessories Required	
Mechanical Stopper (For LT and CT)	
Pendant with Hanging Chain/Rope	
Limit Switches for • Over Hoisting • Over Lowering • Over Cross Travel • Over Long Travel	
Trailing Cable System	
Control Panel	
Isolation Switch for Electric Power	
Weight	
Weight of Hoist (kg)	
Weight of Bridge (kg)	
Painting	Refer General Requirement for Mechanical Items/Equipment Section/Tender Specs.
Drawings and Document Submission	As per Specifications
GA Drawings showing complete details of span, height, bay length, overhead and end clearance, hook approach, wheel base, overall width, power and control circuit diagram, control panel details, terminal diagram, push button station etc.	
BOM	
QAP	
Testing	As Specified in Inspection-Testing

Notes: 1. Manufacturer/supplier shall submit separate data sheet for each size.
2. For components (marked-M) MTC (**of Laboratory accredited with NABL**) as per relevant standards shall be furnished.
3. Contractor shall visit the site(s) and obtain accurate data for **span, lift, bay length** etc. suitable for proposed/existing pump house or location of installation as applicable and shall furnish all details accurately in data sheet.

DATA SHEET OF THIMBLE MOUNTED SLUICE GATE

Particulars		Data To Fill by Contractor/Vendor		
Make				
Manufacturing and Testing Standards		IS: 13349		
Class: I/II/III				
Pressure Rating (PN 1.0)				
Size (mm)				
Quantity				
Closure Type: Conventional/Flush Bottom				
Stem Type: Rising/Non-Rising				
Type of Operation: Manual Ungeared				
/Geared/Motorized Electric Actuator				
Operating Head (in meter):				
Seating Head				
Unseating Head				
Wedging Devices:				
Conventional: Side, Top and Bottom				
Flush Bottom: Side, Top and with Flush Bottom Arrangement.				
Maximum Torque (Nm) with Factor of safety (FOS)				
Spindle Length (CL-PL Distance in meter)				
Gate Opening & Closing Time				
Number of Turns (Revolutions) to Open & Close the Gate				
Cross Section & Depth of Wall Thimble (Minimum 300mm)				
Effort required to open/close the gate by a single person < 18kgs		Required		
Materials Of Construction				
Gate Frame				
Wall Thimble				
Gate Slide/Shutter/Door				
Wedging Devices				
Headstock				
Seating/Sealing Faces & Wedge Lining				
Stem, Stem Guide Brackets, Coupling & Stop Nut				
Yoke (If Applicable)				
Stem/Spindle Block				
Lift Nut: Manual Ungeared/Manual Geared/				
Electric Actuator Operation				
Rubber Seal (Applicable for FBC Gates)				
Assembly Bolts, Nuts and Fasteners				
Pipe Hood for Stem		Required Transparent Fracture Resistant Polycarbonate Material		
		Fracture Resistant Polycarbonate Material		
Details of Electrical Actuator				
Actuator Make and Model				
Actuator	Torque	Capacity	(Minimum	and
Maximum)				

Actuator Speed (RPM)	
Power Supply	
Gate Opening/Closing Time (Seconds)	
Painting/Coating	Refer General Requirement for Mechanical Items/Equipment Section/Tender Specifications
Drawings and Document Submission	As per Specifications
GA and Cross Sectional Drawings of Gate	
QAP	
Actuator Details including Wiring Diagram	
Testing	As Specified in Inspection-Testing

- Notes:**
1. Manufacturer/Supplier shall submit separate data sheet for each size and rating.
 2. Vendor to review the tender GAD for correctness of actual spindle length and closure type.
 3. Maximum length of one-piece stem shall be restricted within 5meter length for ease of transportation.
 4. Guide Brackets shall be adjustable center type.
 5. Vendor to submit torque calculation data along with other required documents.
 6. MTC of all major components/parts (of Laboratory accredited with NABL) as per relevant standards shall be furnished.
 7. Bidder shall refer relevant specifications for electric actuator requirement and shall offer appropriate model accordingly.

MECHANICAL FINE SCREEN

	Capacity of each screen channel	:	Flow as per BOQ
	Type of screen	:	One Step type (Mat) mechanical screen as working and one manual fine bar screen as standby
	Clear spacing for mechanical screen	:	Mechanical: 20 mm Manual: 40mm
	Angle of inclination	:	Mechanical: between 60 ° to 90 ° to Horizontal Manual: 45° to Horizontal
	Approach velocity at av. Flow	:	0.3 m/sec minimum
	Velocity through screen at av. Flow	:	0.6 m/sec maximum
	Retention Time	:	Minimum 7.5 Minutes
	Velocity through screen at peak flow	:	1.2 m/sec (max.)
	Head loss through screen in 50% clogged condition	:	300 mm (max.)
	Bar thickness for mech. Screen	:	Min. 2 mm thick SS-304 / 316 Flats (Step Type)
	Bar thickness for manual screen	:	Min. 6 mm thick x 50mm SS- 304 / 316 Flats
	Material of Construction	:	R.C.C. (M-30) with waterproof plaster
	Free board above TWL	:	500 mm
	Belt Conveyor	:	Min 1.0 m width to be provided (interlocked with mechanical screen)
	Screen Panel	:	Required, Outdoor type, double door with canopy, IP-65

	Operation of Screen	:	Manual, Timer mode (with timer bypass facility) as well as in auto mode through ultrasonic / hydrostatic type differential level transmitter to be provided at upstream and downstream of screen to start screen at high diff level and stop at low diff level. Diff. level shall be displayed at HMI and hi-hi diff. level shall be annunciated at HMI/SCADA.
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APPROVED VENDOR LIST FOR MECHANICAL EQUIPMENTS (as applicable)

ITEM	APPROVED MAKE
SUBMERSIBLE CENTRIFUGAL NON-CLOG PUMPS	KIRLOSKAR / LUBI / KSB / JASCO / AQUA
SLUICE VALVES, BUTTERFLY VALVE, DUAL PLATE CHECK VALVE, KINETIC AIR VALVE	IVC / KIRLOSKAR / R&D MULTIPLE / DURGA / IVI /UPADHAYA / HAWA VALVES LTD- “HAWA-BRAND ONLY”
ELECTRICAL VALVE ACTUATOR	ROTORK / AUMA /EMERSON
E.O.T. CRANE & ELECTRICAL HOIST / CP BLOCK	WH BRADY / SAFEX / INDEF / MORRIES / JAPS /ANKER
MANUAL / MECHANICAL SCREEN	JASH / JAPS / TRIVENI / SHIVPAD / APOLLO SCREEN / JOHNSON
BEARING	SKF / NBC / FAG / TATA
C.I. PIPE & FITTINGS	ORIENTAL CASTINGS / ELECTRO STEEL / BIC / KEJRIWAL / NJMW/ UPADHAYA
M.S. / G.I. PIPES	ARCELOR MITTAL (ESSAR) /TATA / JINDAL /SAIL / ZENITH / ASIAN / ANY REPUTED MFG.USING APPROVED MAKE OF M.S. OR G.I. PLATES & SHEETS
M.S / G.I PLATES &SHEETS	AS MS . GI PIPES
UPVC / CPVC PIPE	ASTRAL / ASHIRWAD / DUTRON / SUPREME / PRECISION AND EQUIVALENT.
EXPANSION BELLOWS	DHRUV / TECHNOFLEX / PRECISE ENGG. /PRECISION
DRAIN PUMP SET (SUB.& HORI. SELF PRIMINGNC PUMP UP TO 7.5 KW)	KSB / ABS / GRUNDFOS / KISHOR / AQUA / LUBI / JASCO / EBARA / MBH / M&P (WILO) /KIRLOSKAR
DI DF PIPES & FITTINGS	ELECTRO STEEL / KEJRIWAL / LANCO / KISWOK / JINDAL / ELECTROTHERM / CHANDRANCHAL / TRUFORM (DI PIPE FOR DI DF PIPE MANUFACTURING SHALL BE AS PER APPROVED MAKE OF DI PIPES ONLY)

(I) INFORMATION REGARDING TECHNICAL PARAMETERS BY THE TENDERER. (PUMP)

Sr. No.	Description	Tender Guaranteed Efficiency / Losses without negative tolerance			Guaranteed Efficiency / Losses without negative IS tolerance
1	Sewage Submersible Non-Clog Pump set (410 m ³ /hr @ 31 m head)	Pump Bowl Efficiency		(without energy improvement coating)	
2	Sewage Submersible Non-Clog Pump set (419 m ³ /hr @ 26 m head)	Pump Bowl Efficiency		(without energy improvement coating)	
3	Sewage Submersible Non-Clog Pump set (469 m ³ /hr @ 34 m head)	Pump Bowl Efficiency		(without energy improvement coating)	
4	Sewage Submersible Non-Clog Pump set (159 m ³ /hr @ 31 m head)	Pump Bowl Efficiency		(without energy improvement coating)	
Note: - 1) The information mentioned to be filled in above format. The above date to be confirmed on Manufacturer letter head to be enclosed with this schedule.					

(II) INFORMATION REGARDING TECHNICAL PARAMETERS BY THE TENDERER. (TRANSFORMER)

Sr. No.	Tender Guaranteed Requirement / Description	Confirm
1	Transformer shall be as per Energy Efficiency level-2 of IS: 1180 (Part-I):2021 latest edition & Tender Technical specification: Confirm the following: (i) Maximum Total losses at 100% load & at 50% load: As per Energy Efficiency level-2 of IS: 1180 (Part-I):2021 latest edition. (ii) Impedance: As per Energy Efficiency level-2 of IS: 1180 (Part-I):2021 latest edition.	

Signatures of the Tenderer with stamp

Company seal:

Name:

Date:

SECTION: 5.1

**TECHNICAL SPECIFICATIONS FOR
INSTRUMENTATION
WORK**

INTENT OF SPECIFICATIONS

This specification along with specific job requirements (if any) is intended to cover the design, engineering, supply, installation, testing and commissioning of entire instrumentation equipment and items and accessories including consumable against price quoted for instrumentation works as indicated here in and else where covered in the scope of this tender.

Compliance with this specification and / or review of any of the vendor documents shall not relieve the vendor of his responsibility towards his contractual obligation with regard to the completeness and satisfactory operation of the plant.

APPLICABLE NATIONAL/INTERNATIONAL STANDARDS

AGA American Gas Association, Gas Measurement Committee

ANSI/ASME American National Standards Institute/American Society of Mech. Engineers

B 1.20.1	Pipe Threads
B 16.5	Steel Pipe Flanges and Flanged Fittings
B 16.20	Ring Joint Gaskets and Grooves for Steel Pipe Flanges

ANSI/FCI American National Standards Institute/Fluid Controls Institute

70.2 Control Valve Seat Leakage Classification

API American Petroleum Institute

RP 520	Sizing, selection and installation of pressure relieving systems in refineries.
	Part-I - Sizing and selection
	Part-II - Installation
RP 521	Guide for pressure relieving and depressurising systems
RP 526	Flanged steel safety relief valves
RP 527	Seat tightness of pressure relief valves
MPMS	Manual of Petroleum measurement standards
RP 551	Process measurement instrumentation
	Part - I Process Control and Instrumentation
RP 552	Transmission Systems
S 2000	Venting atmospheric and low pressure storage tanks
S 670	Vibration, Axial-Position and Bearing Temperature Monitoring Systems

ASTM American Society for Tests and Materials

BS British Standards

BS-1042	Measurement of Fluid Flow in Closed Conduits
BS-5308 Part-II	Specification for PVC insulated cables
BS-7244	Breather Valves

DIN-43760 Temperature Vs. Resistance curves for RTDs

DIN-19234 Electrical Distance Sensors; DC interface for distance sensors and signal converter

DIN-50049 Document on Material Testing

IEC International Electrotechnical Commission

IEC 79	Electrical apparatus for Explosive Gas atmosphere
IEC 85	Thermal evaluation and classification for electrical insulation
IEC 332	Test on bunched wires or cables Part III Cat. A
IEC 529	Classification of degree of protection provided by enclosures
IEC 534-2	Industrial Process Control Valves - Flow capacity
IEC 584-2	Thermocouples - Tolerances
IEC 751	Industrial Platinum Resistance Thermometer Sensors
IEC 801	Electromagnetic compatibility for industrial process measurement and control equipment
IS	Indian Standard
IS-5	Colours for ready mixed paints
IS-319	Specification for free cutting brass bars, rods and sections
IS-1239	Mild Steel tubes, tubulars and other wrought steel fittings
IS-1271	Specification of Thermal Evaluation and Classification of Electrical Insulation
IS-1554 Part-I	PVC insulated (heavy duty) electrical cables – working Voltage upto and including 1100V
IS-2074	Ready mixed paints, air drying, red oxide - zinc chrome
IS-2147	Degree of protection provided by enclosures for low voltageswitch gear and control gear
IS-2148	Flame proof enclosures for electrical apparatus
IS-3624	Specification for Pressure and Vacuum gauges
IS-5831	PVC insulation and sheath of electric cables
IS-7358	Specification for Thermocouples
IS-8784	Thermocouple compensating cables
ISA	Instrument Society of America
S-5.2	Binary logic diagrams for process operations
S-7.3	Quality standard for instrument air
S-75.01	Flow equations for sizing control valves
ISO 5167	Measurement of fluid flow by means of orifice plates, nozzles and venture tubes inserted in circular cross-section conduits
NACE	National Association of Corrosion Engineers - MR-01-75
NEC	National Electric Code
NEMA	National Electrical Manufacturer's Association
ICS-6	Enclosures for industrial control and systems
NFPA	National Fire Protection Association
NFPA-496	Purged and pressurised enclosures for electrical equipment
OSHA	Occupational Safety and Health Authority

1. GENERAL:

The Contractor shall obtain all instruments from manufacturers of international standing.

The design and quality of all instruments shall be fully suited to the conditions which will be met in service. The design of electronic instruments shall be in compliance with the electromagnetic compatibility requirements as per IEC-801.

The instrumentation and control system shall be designed, manufactured and installed to ensure highest standard of operational reliability. Major instrumentation shall be electronic type. Panel mounted receiving instruments shall be electrically operated miniature flush mounting type unless otherwise specified. All instruments shall be installed in accordance with the recommendations or instructions of the instrument manufacturer for particular application.

All instruments shall be capable of carrying their full load currents without undue heating. They shall not be damaged by the passage of fault currents within the rating of the associated MCB or through the primaries of their corresponding instrument transformers. All instruments shall be back connected and the cases shall be earthed. Approved means shall be provided for zero adjustment of instruments without dismantling.

All voltage circuits to instruments shall be protected by MCB's in each unearthed phase of the circuit placed as close as practicable to the main connection.

Analogue signals shall be 4-20 mA according to BS 5862:Part I 1986 or its latest edition. They shall operate over two wires and be isolated from earth. 1-5V DC signals shall only be permitted within the main instrument enclosure.

The contractor shall furnish technical details / catalogues / drawings for the instruments and panels offered for monitoring and control of the entire plant to client/consultant for their approval prior to procurement of the same. Contractor shall offer inspection for the instruments/panel offered by him and in case of waiver of inspection by the client / consultant, necessary test certificates shall be submitted for approval of client / consultant before clearing the material for dispatch. Contractor shall submit their inspection plan to client/consultant for their approval for this purpose.

All instruments procured by the contractor as per the Engineer's approval, and those which perform similar duties shall be of uniform type and manufacture throughout the scheme (zone) in order to facilitate maintenance and the stocking of spare parts. Moving parts and contacts shall be adequately protected from the ingress of dust, and all instruments shall be protected by moisture and dust-proof cases including those mounted in panels. All equipment shall be suitable for its environment.

Panel mounted receiving instruments shall be of the electrically operated miniature flush mounting type unless otherwise stated.

Scales shall be clearly marked with black lettering and graduations on a white background. Instruments of the same type and range shall have identical scales.

Instrumentation System shall be designed as per good engineering practice.

POWER SUPPLY TO PACKAGE:

Power Supply shall be made available by the bidder at the following voltage levels, **unless otherwise specified.**

- For Instruments, Control Systems, Analysers : 230V AC $\pm$ 10%, 50 Hz $\pm$ 3 Hz
- Solenoid Valves, Relays, Lamps : 24V DC
- Input Interrogation Voltage : 24V DC
- Panel/Cabinets Lighting : 230V AC $\pm$ 10%

Client shall provide for a separate feeder in the Plant MCC of suitable current rating and at suitable locations to provide 230V AC $\pm$ 10%, 50 Hz $\pm$ 3Hz supply to Instrument Panel(s). Necessary cabling work shall be carried out by successful bidder for required power distribution.

24V DC required for Input Interrogation, relays and lamps etc., same shall be generated by the bidder using SMPS. Power shall be suitably conditioned by providing UPS / Isolation Transformer-Voltage Stabilizer-CVT to prevent damage to instruments against power fluctuation / disturbances.

Instrument power circuits shall be individually protected from fault with the help of MCBs of adequate rating with overload protection. MCBs shall be two pole type.

EARTHING :

Vendor shall provide separate earth bus bar connections for shield and panel electrical earthing.

Any special earthing requirements, if required, shall be provided by vendor during detailed engineering.

Necessary earth pits shall be provided for the same by the vendor.

ENCLOSURE :

All instruments enclosure mounted in the field shall be weatherproof to IP-65 / NEMA4 as a minimum.

For Hazardous Areas :

All electrical instruments except solenoid valves shall be intrinsically safe while solenoid valves shall be explosion proof. All such instruments shall be suitable for the applicable hazardous area classification. All intrinsically safe/explosion proof instruments shall be certified by any statutory body for use in specified hazardous area.

All electronic instruments like field transmitters shall be certified intrinsically safe.

All solenoid valves, field switches etc. shall be certified explosion proof to NEMA7. Contacts shall be gold plated rated for 30V, 1 Amp.

INTERLOCKS / LOOPS :

All plant interlocks shall be carried out using PLC / electromagnetic relays to be supplied by vendor for fail safe and reliable operation. Vendor to indicate all process interlock requirements on the P&IDs.

Loop integrity must be maintained for each loop. No component of any loop shall be shared by other loop.

The system shall be designed fail safe and shall meet the following requirements, as a minimum :-

- a) All initiating contacts shall be close under normal conditions and shall open under abnormal conditions.

- b) All relays and solenoid valves shall be energised under normal conditions and shall de-energise under abnormal conditions.

The system shall be designed using PLC / electromagnetic relays unless specified otherwise and shall be located locally or remotely as per the operational requirements. The system shall meet the following requirements as a minimum :

- a) The electromagnetic relays shall be low power continuously rated type and shall have LED for status indication.
- b) The relays shall be plug-in type and their plug-in bases shall have screwed terminals for interconnection. Lug type soldered connection shall not be acceptable.
- c) Each relay shall have minimum two numbers of 'NO' and two numbers of 'NC' contacts as a minimum. Out of these, one 'NO' and one 'NC' contacts shall not be used.

INTRINSIC SAFETY BARRIERS :

Intrinsic safe barriers shall be provided for all analog signals coming from hazardous area. The following points must be taken into consideration while selecting I.S. barriers :

- a.) Safety barriers must be based on entity concept.
- b.) Each instrument in the loop must be certified intrinsically safe by a statutory authority.
- c.) Each input/output in the loop shall have a separate I.S. barrier. No barrier shall be shared between two loops/inputs/outputs.
- d.) All safety barriers shall be isolating type, as far as possible.
- e.) All safety barriers shall be of MTL make or equivalent. The following barriers may be selected, unless otherwise necessary because of technical reasons :

Analog inputs: MTL 3041 or equi. (Repeater Power Supply for Transmitters)

Analog outputs: MTL 3042 or equivalent (4-20 mA Repeater)

Contact inputs: MTL 3011/2210B or equivalent

Contact outputs: MTL 2241/3021 or equivalent (Solenoid Valves)

2. CONTROL PANEL:

Control panels shall be prefabricated type, Sourced from Approved Vendors.

Control Panel shall be CNC machine prefabricated out of CRCA sheet steel of thickness not less than 1.5 mm, modular in construction, properly reinforced, powder coated and having rigid frame structure. Internal mounting plate including the gland plate shall be 3 mm thick. Anti vibration pad, Predrilled base channel ISMC – 100 or equivalent for all sides. The instrument panel shall have dimensions as per system requirement. However, the Control panel height shall not exceed 2100 mm.

The exterior corners and edges shall be rounded to give a smooth overall appearance with projections kept to a minimum.

Lifting lugs shall be provided for installation purposes and shall be replaced with corrosion resistant bolts after installation.

Control Panel shall be completely metal enclosed and shall be dust, moisture and vermin proof. Panel enclosures shall provide a degree of protection not less than IP 52 in accordance with IS: 13947 Part-I.

Control Panel shall be freestanding type. There shall be sufficient reinforcement to provide level surfaces, resistance to vibrations and rigidity during transportation and installation.

Metal sills in the form of metal channels properly drilled shall be furnished along with anchor bolts

and necessary hardware for mounting the Instrument panels. These shall be dispatched in advance so that they may be installed and leveled when concrete foundations are poured.

Cable entries to the panels shall be from the bottom with fire retardant spray compound sealing. Instrument panels shall be provided with louvers along with washable micron filters AIRIN – AIROUT fans will be provided.

No process fluid of any kind, except instrument air, shall enter the instrument cubicle. All cable entry shall be from the bottom of the panel. Also power supplies greater than 230 V shall not enter the LCP.

The internal layout of the panel/cabinets shall be designed considering proper approach for each item for maintenance. Following point must be taken into consideration while deciding the internal layout :

- a.) All wiring inside the panels shall be housed in covered non-flammable plastic raceways arranged to permit easy accessibility to various instruments for maintenance adjustment, repair and removal. No raceway shall be more than 70% full.
- b.) Separate wiring raceways shall be used for power supply wiring and low level signal wiring.
- c.) Distance between terminal strips and side of the panel parallel to the strips up to 50 terminals : Min. 50 mm.
- d.) Distance between terminal strip and top and bottom of cabinet : Min. 75 mm.
- e.) Distance between two adjacent terminal strips : Min. 100 mm.
- f.) Distance between cable gland plate and the bottom of strips : Min. 300 mm.
- g.) 20% spare terminals shall be provided as a minimum.

Overall height of Control Panel shall not exceed 2100 mm. Panel mounted instruments and controls shall be such mounted that they are accommodated between 800 mm and 1300 mm from floor level.

Control Panel shall be provided with fluorescent type lighting fixtures controlled from totally enclosed door operated switches for internal illumination of the panel cabinets.

Contractor shall provide with necessary cooling fans and cut-outs covered with appropriate filters for necessary air changes to limit temperature rise within panel to 5 deg C over ambient temperature.

Contractor shall consider necessary power conditioning unit (UPS) to prevent power fluctuation and surge to damage the instruments as well as other electronic components.

For cases where PLC is to be mounted, panel shall be designed suitably as per PLC manufacturer's recommendation. Necessary marshalling boxes may be considered if required as per design.

Mounting

All equipments on front of panel shall be mounted flush or semi-flush. In case of semi-flush mounting, only flange or bezel shall be visible from the front.

Equipment shall be mounted such that removal and replacement can be accomplished individually without interruption of service to adjacent equipment.

Equipment mounted inside the panel shall be so located that terminals and adjacent devices are readily accessible without the use of special tools. Terminal markings shall be clearly visible.

Earthing for Instruments

The panel shall be equipped with an earth bus securely fixed along the inside base of panel.

Minimum two numbers of Dedicated Earth Stations to be provided each for Instruments / Panel

Earthing and for Signal (Electronic) earthing. The earth station shall be of cu plate type electrode or maintenance free pipe in pipe technology having earth electrode of 50 mm dia. and length of 3000 mm.

All metallic cases of instruments and other panel mounted equipment shall be connected to the instrument earth bus.

Looping of earth connections which would result in loss of earth connection to other devices when the loop is broken shall not be permitted. However, looping of earth connections between equipment to create alternative paths to earth bus shall be provided.

A separate instrument earth bus will be created which will be floating and all the cable shields will be terminated onto this bus. This bus will be connected to an electronic earth pit as specified above.

Frame Earthing

All metal parts other than those forming part of an electrical circuit shall be connected to a copper earth bar run along the inside bottom of the panel. The minimum section of the earth bar shall be 25 mm x 3 mm. A 15 mm diameter hole is to be provided at each end of the bar. Connection of the earth bar to the station earth shall be carried out by Contractor.

Space Heater

Strip type space heaters of adequate capacity shall be provided inside control panels to prevent moisture condensation on the wiring and panel mounted equipment when the panel is not in operation. The heaters shall operate on 230 V AC. Heaters inside the panels shall not be mounted close to the wiring or any panel mounted equipment. The operation of heaters shall be controlled by thermostats.

Interior Lighting and Receptacles

Each panel shall be provided with either a LED lighting fixture rated for 5 watt, 230V, 1 phase, 50 Hz supply for the interior illumination of the panel during maintenance. The illumination lamp shall be operated by door switch or manual switch. Each panel section shall be provided with separate lighting.

Each panel shall be provided with 230V, 1 phase, 50 Hz, combined 5 amps and 15 amps, 3 pin receptacle with a switch and neon indication. The receptacle with switch shall be mounted inside the panel at a convenient location. If the panel has front and rear doors then maintenance socket shall be provided at both locations.

Labels

All the equipment mounted on the front facia of Instrument panel as well as equipment mounted inside the panels shall be provided with individual labels with equipment designation engraved. The labels shall be mounted directly below the respective equipment. Also the panel shall be provided at the top with a label engraved with panel designation.

Switches and Miniature Circuit Breakers (MCBs)

Each instrument panel shall be provided with necessary arrangement for receiving, distributing, isolating and protecting of DC and AC supplies for various controls, signaling, lighting and space heater circuits. The incoming and sub-circuits shall be separately provided with DP Miniature Circuit Breakers (MCBs). Potential circuits for relaying and metering also shall be protected by MCBs.

Intra-panel (i.e. Panel Internal) Wiring

Connections within a panel, between panel mounted devices and terminal blocks or between two panel mounted devices will be made by 600 volt grade, multi stranded copper flexible conductor insulated with FRLS Grade PVC and designed for a minimum conductor temperature of 70 degrees centigrade. The wires shall be shielded, where necessary.

Panels shall be supplied completely wired internally, with a colour coding scheme decided mutually between the Purchaser and the Contractor, to equipment and terminal blocks and ready for external cable connections at the terminal blocks.

Wires within the panel shall be continuous i.e. without splicing and shall comprise stranded copper conductors. Internal wiring or wiring between the two assemblies shall be commensurate with mechanical safety.

Wire termination shall be made with solderless crimping type of tinned copper lugs which firmly grip the conductor and insulation. Insulated sleeves shall be provided at all the wire terminations. Engraved core identification plastic ferrules, marked to correspond with panel wiring diagram shall be fitted at both ends of each wire. Ferrules shall fit tightly on the wires and shall not fall off when the wire is disconnected from terminal blocks. The ferrule system shall adopt single tube printed arrangement so that all the characters remain on one line always & hence easily readable

Terminal Blocks

Terminal blocks for power connection shall be 600V grade, 20 amps rated, one-piece moulded, complete with stud type terminals, washers, nuts and lock nuts and identification markings. Terminal block design shall include a white fibre marking strip with clear plastic, hinged terminal covers. Markings on the terminal strips shall correspond to wire numbers on the wiring diagrams. All control output terminals will be fused type .

All spare contacts and terminals of the panel mounted equipment and devices shall be wired to terminal blocks.

Panel internal wiring shall not be looped directly from instrument to instrument. The same shall be looped through the panel terminal block only.

If accidental short circuiting of certain wires is likely to result in malfunction of equipment, such as closing or tripping of a breaker, these wires shall not be terminated on adjacent terminal blocks.

Cable Supports

All external cables shall present a neat appearance and shall be suitably braced, placed in troughing clipped or laced to prevent effects of vibration.

Terminal / Identification

Every terminal plug shall be uniquely identified within the terminal cabinet by means of a terminal number. Appropriate labels shall be used to permit quick and unambiguous identification of each terminal and test plug.

Painting of System Cabinet/ Control Desk

All sheet steelwork shall be painted using seven tank process in accordance with the following procedure:

- i. The pre treatment shall be hot process with running water for rinsing.
- ii. Oil, grease, dirt and swarf shall be thoroughly removed by emulsion cleaning.
- iii. Rust and scale shall be removed by trickling with clean water followed by final rinsing with dilute dichromate solution.
- iv. The control panel shall be powder coated. Thickness of coating shall be around 60 microns. QA test certificate shall be furnished for thickness adhesion and hardening of powder coating.

ALARM ANNUNCIATOR :

- (i) Microprocessor based alarm annunciators shall be provided, **if specified**, for generating audio-visual alarms for each abnormal condition. Alarms shall be initiated by the opening and closing of volt-free contacts which shall remain unchanged throughout the periods in which the alarm conditions exist. 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. The sequence of alarm should be user selectable by dip switch.
- (ii) 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 future alarm condition occurs.
- (iii) Alarm circuitry shall be arranged so that spurious or transient alarm states persisting for less than 0.5 seconds do not initiate any action.
- (iv) Isolation facilities shall be provided for the hooter using an MCB
- (v) Alarm annunciator/indicator legends or labels shall be arranged with three lines of text as follows :

i.	top line	:	location
ii,	middle line	:	parameter
iii.	bottom line	:	status

e.g. RESERVOIR
 LEVEL
 HIGH

The annunciator will be split / integral architecture type and the facia will have Super Bright LEDs.

Alarm annunciator shall be provided on instrument control panel for annunciation of alarms in control room. A minimum of 20% spare windows with alarm modules shall be provided in alarm annunciator.

The technical particulars of alarm annunciator are as follows:

(a) Technical Particulars

- i. Type : Microprocessor based, split type / integral type with alarm windows mounted on the front door and electronic modules inside the panel
- ii. Mounting : Flush with panel
- iii. Construction : Modular
- iv. Inputs : Potential free, NO/NC contacts
- v. Size of windows : 60 mm X 26 mm
- vi. Operating sequences : First up (user selectable dip switch)
- vii. Bulbs per channel : 2 (Cluster LEDs)
- viii. Push Buttons : For Reset, Accept and Test

ix	Hooter	:	Required, electronic type
x	Power supply	:	24 V DC/240 V AC
xi.	Power supply status	:	Required indication
xii	Weather protection	:	IP-52 of IS 13947
xiii	No. of Windows	:	as per requirement + 20% spare windows

In case if hard wired annunciator is not specified in detailed specifications for instruments, then visual alarm shall be provided at HMI and audio alarm through panel mounted hooter along with rest push button shall be provided for all the required alarms as per specifications / approved P&ID / process requirement.

Annunciator, in general, shall be solid state type with plug-in modules, in a cabinet with backlighted engraved windows and integral power supply.

Alarm logic module shall be single channel type. In case multi-input alarm module are selected, only one channel shall be used.

Intrinsically safe annunciator circuit, when used, shall have power supply unit in a safe area.

Annunciator alarm sequence shall be Automatic Reset Type / Automatic Reset First Out with First Out flashing and Reset Push Button as a minimum.

The design of alarm annunciator system shall be such that transient alarms of less than 330 milliseconds duration shall be automatically rejected.

ANALOGUE SIGNAL MULTIPLIERS:

They'll provide loop power with option to select measurement with power and without. The multiplier will provide 2 outputs of 4-20mA one for the panel mounted indicator and other for PLC i/p. There will be total galvanic isolation between field I/O's and also between the 2 outputs.

RECEIVING INDICATORS/CONTROLLERS :

All indicators/controllers shall be electronic (microprocessor based) programmable indicator and shall be mounted on the control panel located in the control room.

Notes :

Indicating instruments shall indicate various process parameters as per following measuring units, in general :

Flow	M ³ /Hr or MLD or LPS	as per process requirement
Level	m	Meters
Pressure	Mt. head of water or Kg/Cm ²	as pr process req.
Temperature	C	Degree Celsius
Concentration	ppm or mg/l	Parts per million or Milligram per litre.
Current	A	Amperes
Voltage	V	Volts
Power	W	Watts
Electrical Energy	Whr	Watt-hours
Frequency	Hz	Hertz
Speed	r.p.m.	Revolutions per minute.

Multiplying factors for flow scales shall be specified on manufacturer's name plate.

FIELD MOUNTED INSTRUMENTS

Field mounted instruments shall, where possible, be hermetically sealed. If this is not possible, they shall be of weatherproof construction with heavy cases. Transmitters and similar equipment shall be further enclosed in purpose made weatherproof, glass reinforced fire-retardant polyester resin cabinets.

Particular regard shall be paid to the ease of access to all instruments. Serial number/calibration plates shall be visible when the instrument is in its cabinet.

Locally mounted indicating instruments shall be mounted in viewable positions.

Field mounted instruments shall be complete with all mounting brackets, pillars, fittings and fixings to complete the installation.

FIELD TRANSMITTERS:

Smart transmitters when used shall be used in analog mode only. Smart transmitters when specified shall have accuracy of 0.1% of span, as a minimum.

DP Type Flow Transmitter if used for congealing, corrosive and highly viscous services shall have Diaphragm Seal element with Capillary.

Transmitter shall be capable of delivering rated current into external load of at least 600 ohms when powered with 24V DC nominal voltage.

PUSHBUTTONS AND SWITCHES

Pushbuttons for operational circuits shall be provided with a shroud, guard or other suitable means to prevent inadvertent operation. They shall be in accordance with the high standard generally required by the specification as a whole and by the equipment with which they are associated.

Illuminated pushbuttons where used shall be of a design that allows easy replacement of the lamps from the front of the panel.

If legends are engraved on the pushbuttons they shall be clear and concise and shall be approved by the Engineer – In charge before manufacture.

Control switches shall be in accordance with the high standard generally required by the specification as a whole and by the equipment with which they are associated.

INSTRUMENT CONNECTIONS:

Electrical cable entry shall be ½" NPT(F). Suitable cable gland shall be used.

End connections shall meet the following unless, otherwise specified:

Threaded end connection shall be NPT as per ANSI / ASME B.1.20.1

Flanged end connection shall be as per ANSI / ASME B16.5

3. INSTRUMENTS: (As Applicable)

Instruments as per following details and specifications shall be provided by vendor as a minimum. Quantities mentioned, if any, are indicative only and contractor shall provide all necessary instruments described in this section or as required for proper operation of the plant as described else where in this tender or found necessary during detailed engineering in addition to below mentioned instruments and their locations. Bidder choosing to supply instrument with communication port suitable for process / diagnostic data transfer with PLC/HMI need not consider analog signal and alarm contacts inputs to PLC.

All instruments, gauges and control equipment shall be strictly procured as per the list of approved vendors enclosed herewith as part of the tender documents.

a) PRESSURE GAUGES:

All pumps, compressors and air blowers shall have PG at their discharge lines. Pressure Gauges for process fluids containing sludge/solids and corrosive chemicals shall be of diaphragm type.

PG dial face shall be marked with pressure element material. Ranges shall be so specified that the gauge normally operates in the middle third of the scale and shall confirm to IS-3624 standard dials, wherever possible.

Diaphragm seals, filled type or mechanical type shall be furnished where plugging of the element may occur or where suitable material is not available in highly corrosive services. When chemical seals are required, they shall be of clean out type with flushing connection.

Pressure Gauge Dial Size shall be of minimum 150mm and of white with black engraving, shall be provided with blow out disc, toughened/safety glass window, bayonet type bezel ring, case material of SS304, Bourdon Element / Socket of SS316, movement parts of SS, weather proof to IP-65, offering accuracy of $\pm 1\%$ of FSD. Micro-zero adjustment at the pointer, bottom process connection shall be 1/2" NPT, over-range protection of 130% of FSD.

In case of Diaphragm type Pressure Gauge, Diaphragm / Lower Chamber Wetted Parts shall be of SS316, Upper Chamber of SS304 / SS316, with silicon oil sealing fluid, 2" ANSI B16.5 flanged process connection

Following accessories shall be supplied as a standard with all pressure gauges:

Isolation Valve : Required, Gate / Ball Valve, SS 316
Manifold Valve : Required, SS 316, 3 Way 2 Valve type

b) PRESSURE TRANSMITTER (DISPLAY TYPE AT COMMON HEADER AND BLIND TYPE AT EACH PUMP DELIVERY LINE OR AS PER BOQ)

a.	GENERAL		
1	Location of Measurement		Gauge Pressure at each Pump discharge line and Common header as per SOQ
2	Service		Sewage Water
3	Function		Transmit & Indicate
4	Type		Smart

5	Mounting		Yoke
6	Zero elevation & suppression		Provided
7	Operating Temperature		0 to 50 °C
8	Installation		Indoor / Outdoor
b.	Measuring Unit		
1	Service		Sewage Water
2	Element Type		Diaphragm
3	Element Material		SS316L
4	Body Material	MOC	Cast Alu. or equi. as per mfr. Std.
5	Over range Protection		130% of maximum static pressure
6	Process Connection		1/2" NPTF through adaptor
7	Connection Location		Bottom
8	Calibration Certificate		Required
c.	Transmitter		
1	Type		Microprocessor based, User Programmable, 2-Wire, Smart
2	Measurement (Calibration) Range		Suitable for Gauge Pressure measurement as per SOQ:
3	Accuracy		± 0.1% of Span
4	Output		4-20 mA DC , Two Wire, with HART protocol
	- Load Resistance		600 Ohms max.
5	Tx. Power Supply		24V DC
6	Cable Entry		1/2" NPT F
7	Local Indicator / Display		Digital Display for common header and Blind type at each pump discharge
8	Scale Graduation / Measuring Units		Engg. Units
9	Protection:		
a	Elec. Area Classification		Safe
b	Intrinsically Safe		N.A.
c	Enclosure	Type & Protection Class	IP-66/68
		MOC	Cast Alu. or equi. as per mfr. Std. suitable for withstanding harsh environment
		Paint	Chemical Resistant / Epoxy Coating
		Requirement for Hazardous Area	N.A.
10	Mounting		2" Pipe Mounting / Field Enclosure Mounting
d.	Options / Accessories:		
1	Mounting Accessories		Required, 2" Pipe Mounting
2	Tag Plate		Required, SS 304
3	Cable Glands		Required, IP-65/66 as a min., Ni-Plated Brass / Polyamide
4	Plugs for addl. cable entries		Close up Plugs shall be provided for all unused cable entries, Ni-Plated Brass / Polyamide

5	Isolation Valve		Required, ½” Ball Valve
6	3-Way Manifold (2 Valve)		Required (With SS-316 Tubing/fitting as required)
e.	Quantity of Instruments:		As per SOQ

Pressure readings shall be continuously displayed locally as well as in remote at PLC / HMI control room. Low & High alarms shall be annunciated at HMI.

c) ULTRASONIC TYPE LEVEL TRANSMITTER:

Ultrasonic transmitter shall be provided to measure liquid level of sump. The purpose is to monitor Sump levels and for start/stop of pumps of WDS in auto mode through suitable logic to be decided during detailed engineering. The Level transmitter also provide at ESR to measure the level of ESR. The specification shall be as under:

a.	GENERAL		
1	Location of Measurement		To measure liquid level at WDS
2	Service		Sewage Water
3	Function		To measure & indicate Level / Transmit
4	Operating Temperature		0 to 50 °C
5	Operating Pressure		Atm.
6	Installation		Outdoor
b.	LEVEL TRANSMITTER / SENSOR		
1	Measuring Principle		Ultrasonic Non-Contact type Level Measurement, Time of Flight method
2	Type		Microprocessor based, User Programmable, 4-Wire type, Remote Transmitter
3	Measurement Range		As per SOQ
	- Blanking Distance	Max.	0-3-0.4m max.
	- Sensor Meas. Range Selection		Sensor Range shall be Actual Meas. Range + Unit Free Board + Blanking Distance. Sensor shall be mounted above the top of sump by at least the blanking distance i.e. entire unit depth shall be measurable.
4	Temperature Compensation		Built-in, Automatic
5	Output Signal	Level	4 -20 mADC analog HART
6	Accuracy		± 0.5 % of measuring range
7	Resolution		± 3mm or suitable as per mfr. Std.
8	Protection:		
a	Elec. Area Classification		Safe
b	Enclosure	Type & Protection	Weather Proof to IP-66/68 minimum for transmitter

		Class	
		MOC	Aluminium / PBT or equi. as per mfr. std.
		Paint	Chemical Resistant / Epoxy Coating
c	Sensor	MOC	PVDF or equi. as per mfr. std.
		Prot. Class	IP-68
9	Cable Length - Sensor	Remote Transmitter	As per SOQ
10	Process Connection (Mounting)		1.5" / 2" NPT threaded or 3" or 4" Flanged or as per mfr. Std.
11	Programmer		Built-in or Hand held type
12	Instrument Power Supply		100 to 240 VAC $\pm$ 10%, 50 Hz $\pm$ 5% or 24V DC as per mfr. Std.
13	Cable / Conduit Entry		1/2" NPT or M20 or equi. as per mfr. Std.
14	Local Indicator / Display	Level, in mm or m	LCD Display
15	Scale Graduation / Measuring Units		Engg. Units
c.	Options / Accessories:		
1	Tag Plate		Required, SS 304
2	Cable Glands	Protection	Required, IP-65/66 as a min.
		MOC	Ni plated Brass or Polyamide (IP-67/68 only)
3	Plugs for addl. cable entries		Close up Plugs shall be provided for all unused cable entries, SS316 / Polyamide / Equi.
4	Cabinet for Transmitter	To prevent from direct sun & rain	Required. Lockable with transparent protection cover
d.	Quantity of Instruments:		As per SOQ

Level readings shall be continuously displayed locally as well as in remote at PLC /HMI at control room. Low-Low & High-High level alarms shall be annunciated at HMI.

2.0 PRESSURE GAUGES:

All pumps, compressors and air blowers shall have PG at their discharge lines. Pressure Gauges for process fluids containing sludge/solids and corrosive chemicals shall be of diaphragm type.

PG dial face shall be marked with pressure element material. Ranges shall be so specified that the gauge normally operates in the middle third of the scale and shall confirm to IS-3624 standard dials, wherever possible.

Diaphragm seals, filled type or mechanical type shall be furnished where plugging of the element may occur or where suitable material is not available in highly corrosive services. When chemical seals are required, they shall be of clean out type with flushing connection.

Pressure Gauge Dial Size shall be of minimum 150mm and of white with black engraving, shall be provided with blow out disc, toughened/safety glass window, bayonet type bezel ring, case material of

SS304, Bourdon Element / Socket of SS316, movement parts of SS, weather proof to IP-65,

offering accuracy of +1% of FSD.

Micro-zero adjustment at the pointer, bottom process connection shall be 1/2" NPT, over-range protection of 130% of FSD.

In case of Diaphragm type Pressure Gauge, Diaphragm / Lower Chamber Wetted Parts shall be of SS316, Upper Chamber of SS304 / SS316, with silicon oil sealing fluid, 2" ANSI B16.5 flanged process connection

Following accessories shall be supplied as a standard with all pressure gauges:

Isolation Valve : Required, Gate / Ball Valve, SS 316

Manifold Valve : Required, SS 316, 3 Way 2 Valve type

d) FLOAT TYPE LEVEL SWITCHES:

a.	GENERAL	
1	Type	Float Type
2	Operating Temperature	Ambient / 45°C
3	Max. Pressure	Atm. + Liq Depth, Max. 1 Bar
4	Specific Gravity	1.0 to 1.1
b.	Float	
1	MOC of Float	Polypropylene
2	Construction	Circular / Tubular / Bioconical
3	No. of Float	1
4	Protection	Min IP-68
5	Switch Type	Micro Switch, SPDT
6	Contact Rating	8A @ 230V AC (1 NO + 1 NC)
7	Cable	Inbuilt cable from Float upto Terminal Box
8	Cable Material	Suitable for Fluid application
9	Cable Length	As per SOQ
10	Process Connection	Flanged 4" NB
11	Counter Weight (Ballast)/	Required to ensure stable vertical position of the Float
	Support pipe for Clamping cable	
12	Adj. Stopper	As Applicable
13	Float Installation Hardware Material	SS 316
14	Stopper / Ballast MOC	Rubber
c.	Junction Box	
1	Mounting	On Top of tank & sump, Flanged
2	Junction Box - MOC	Cast Alu.
	Prot. Class	IP-55
3	Connection Size	1/2" NPT / 3/4" ET or to suit cable dia.
4	Electrical Area Classification	Safe
5	Process Connection	Through Flange
d.	Accessories	
1	Cable gland	Required
2	Mounting accessories	Required
e	Locations / Service	As per SOQ for Dry Run Protection of Pump (relay based logic to stop pump in any mode, auto or manual, of operation with necessary alarms.
d.	Quantity of Instruments:	As Per SOQ

e) RECEIVING INDICATORS MOUNTED AT ICP/LCP: (As Applicable)

All indicators/controllers shall be electronic (microprocessor based) type programmable indicator and shall be mounted on the control panel located in the control room. Multiplying factors, shall be specified on manufacturer's nameplate, if applicable. Specifications, as applicable are as follows:

Process Indicator:

16.23 Type	:	Microprocessor based, programmable
Input	:	4-20 mA
Display	:	4 ½ Digit, 7 Segment LED display
Display Units	:	% or Engg. Units, user programmable at site
Alarm Setpoint	:	Two nos., pot. free relay contact rated at 5A @230V AC resistive load, adj. over entire range
Transmitter Supply	:	Required, 24V DC @30mA
Retransmission Output	:	Required, 4-20 mA in 600 ohm load
Accuracy	:	± 0.25% of FSD
Terminals	:	suitable for up to 2.5 sq.mm. wires
Mounting	:	panel flush mounting
Power	:	110/230 V AC, 50 Hz

Flow Indicator cum totaliser shall also have following in addition to above:

16.24 Totalising Counts/Hr	:	User Programmable at site
Totaliser Display	:	6/8 Digit Digital Display with Battery Backup to retain totalized data in the event of power failure for a minimum period of 24 hours.

ELECTRO MAGNETIC FLOW MEASURING SYSTEM (MAINS OPERATED)

Generally, the flow meter shall be as follows:

Flow metering System

Each flow metering system shall consist of the primary transducer (Sealed to IP-68), earthing electrode / rings, the necessary signal converter and power supply unit and all cabling between the primary transducer and signal converter and power supply unit. Flowmeter in general shall be sized considering maximum design line velocity as specified in this tender specifications (2.5m/sec for pumped flow)

Each of the signal converts / power supply units shall be supplied for remote mounting, unless otherwise specified.

The signal converts / power supply units shall be provided with a 4-20 mA output signal, linear with flow and suitable for retransmission to remote instrumentation. The above units shall operate from a 230 VAC / 24V DC supply. The supply voltage may vary by $\pm 15\%$ and frequency between 47 and 52 Hz.

The contractor shall provide sufficient suitable cable to allow for the primary transducers to be situated up to **30** meters from their signal converters, unless a longer length is specified.

The Contractor shall provide full details of the cable; he proposes to use.

The general specifications for electromagnetic flow meter shall be as under:

Service		Sewage Water Application
Function		To measure & indicate Instantaneous Flow and Totalised Flow / Transmit (Flow)
Fluid Conductivity		> 20 $\mu\text{S/cm}$
Installation		Indoor or Outdoor, Below or Above Ground as per piping / site conditions
Operating Temperature		0 to 50 °C
Accuracy		$\pm 0.5\%$ of Flow Rate / Meas. Value or better
Flow Sensor / Tube / Element		
Type of Sensor		Full Bore type
Flange Materials		CS/MS with anti-corrosive epoxy paint or better as per mfr. Std.
Tube Material		SS304 or SS 316
Liner Material		Hard Rubber / PU
Body Material / Coil Housing		MS / CS or better with anti-corrosive epoxy paint
Electrode Material		SS316L or Ha-C
Power Supply		From Transmitter
Grounding	Type / Material	Earthing Electrode / Set of earth rings SS316
Protection Class		IP-68
Cable Entry (for separated / remote version) & Glands		Shall be as per mfr. Std. and suitable to maintain the specified protection class at site

Cable Length	Sensor to Transmitter	Min. 10 m, dual shielded cable
Painting, where applicable	CS / other	Chemical Resistant, Epoxy Painted
TRANSMITTER		
Function		Transmit and Indicate
Type		Remote (Non-Integral) type, Microprocessor based, User Programmable, 2-Wire or 4-Wire type as per mfr. Std.
Flow / Velocity Measurement Range	Max. Flow Velocity	Flowmeter shall be capable to measure flow with velocity up to max. 5 m/sec.
	Minimum Flow Velocity	up to 0.3 m/sec. (shall measure flow without loss of accuracy up to 0.5 m/sec and below that, accuracy shall be as per mfr. Std.)
Accuracy	Flow Vel. ≥ 0.5 m/s	$\pm 0.5\%$ of Flow Rate / Measured Value or better
	Flow Vel. < 0.5 m/s	as per mfr. Std. for flow velocity up to 0.3 m/s
Analogue Output Signal	For Flow	Isolated, 4 -20 mA DC with HART / Modbus RS-485
Pulsed O/P		Required For Totalized flow
Instrument Power Supply		100 to 240 VAC $\pm 10\%$, 50 Hz $\pm 5\%$ or 24V DC as per mfr. Std.
Cable / Conduit Entry		1/2" NPT.
Local Indicator / Display	Inst. & Total Flow	Backlit LCD Display (Inst. Flow and 8/9 digit internal totalized flow)
Enclosure	Type & Protection Class	Weather Proof to IP-66 as a minimum or better
	MOC	Cast Alu. or equi. as per mfr. Std. suitable for withstanding harsh environment with chemical resistant / epoxy coating
	Type	Wall mounting / Pipe mounting
Vibration Conditions		Conformity with IEC 60068-2-6 or equi., shall be able to endure vibration, when in service, without any degradation in performance
Pipe not Full Detection / Empty Pipe Detection		Required
Cabinet for Transmitter	To prevent from direct sun & rain	Required. Lockable MSEP Housing with front transparent door cover for viewing
Size & Qty.		As per SOQ

Flow (Instantaneous and Totalized) readings shall be continuously displayed locally as well as panel mounted flow indicator cum totalizer.

The Flow meters shall be calibrated according to the ISO-8316. Standard. Performance Type Testing Certification (ISO 9104) strictly not acceptable. The suppliers shall also have a testing facility in India or abroad so that methodology and procedures can be verified. The testing facility shall be duly accredited in accordance with ISO 17025 standards in India.

Test bed shall be accredited by national /international certifying authority (FCRI / NABL or such) as per ISO 8316 (Calibration by Volumetric Method) or ISO 4185 (Measurement of fluid flow in

closed conduits - weighing method).

Minimum 10% or one no. (Whichever is higher) of flow meters of each size shall be wet calibrated at accredited facility / test bed as mentioned above either at manufacture works or at FCRI facility in India. Flow meters shall be tested for accuracy, calibration & sealed in presence of the Client Engineers / TPI / PMC at manufacturer's works / Calibration Facility. All electro-magnetic flow meters shall be provided with manufacturer's calibration certificates.

h) FLOAT & BOARD TYPE LEVEL GAUGES: (As Applicable)

Sump shall be provided with local level indication gauge as specified. Gauges shall be mounted in a manner that it is easily visible to the operator with gauge preferably facing towards the pump house control / operator room and preferably visible to the operator from these rooms and the nearby access road.

Meas. Range	:	As per Sump Height
Float Size / MOC	:	300 mm dia. / SS316
Float Wire Size / MOC	:	1.5-1.6 mm / SS316
Guide Wire Size / MOC:	:	3 mm / SS316
Bottom Anchor Bar	:	SS316
Guide Pipe	:	G.I., Class B
90° Sheave Elbow	:	Cast aluminum
Roller Pulley	:	2 nos.
Top Anchor	:	Cast aluminum
Tension Spring	:	Cd Plated Steel
Pipe Support & U Bolts :	:	MS (Epoxy coated)
Scale	:	MS (epoxy painted), 125 mm wide, White background, Minor marking at every 50 mm in Black, Major marking at every 1000 mm in Red.
Pointer	:	MS (Cd Plated), painted in red

4. PROGRAMMABLE LOGIC CONTROLLERS

Codes and Standards

PLC shall comply with International standards such as NEMA, IEC, ANSI, ISA, IEEE, DIN and VDE
DESIGN AND CONSTRUCTION REQUIREMENTS

PLC H/W & S/W shall be from the same family and should be sourced from approved Vendors only. Programmable logic controller (PLC) shall be microprocessor based with 32 bit or suitable processor and be fully programmable and capable of performing control relay logic, including timing, counting, sequencing, and interlocking.

The PLC shall be high performance processors suitable for real time process application. High inherent reliability, self checking, error-recovery and trouble-shooting features shall be some of the features of PLC.

The PLC shall have a modular / modular chassis design which allows for ease of future expansion. The processor module shall be easily removed from the I/O chassis for service or repair. The I/O chassis shall have slots for installing I/O cards, communications, or other special function modules. All I/O cards and

modules shall be capable of being installed in any open slot in the chassis or DIN rail mounted. Module and channel level diagnostics should be standard feature.

The PLC shall have a suitable power supply and can be easily serviced or replaceable. The system shall be capable of being powered on 120VAC / 230VAC / 24V DC as per mfr. Std..

The PLC shall be rated to operate from 0 to 55 ± 5 degC Degrees C, with a humidity rating of 10 to 95% $\pm$ 5% (non-condensing). All module circuit boards shall be encased and protected such that, when properly installed, they are not exposed to accidental contact by personnel or other objects.

The PLC shall be of high quality and reliability with replacement processors, power supplies, chassis, I/O and specialty modules that are readily available on an urgent or emergency basis. **All PLC / HMI products shall be fully supported and available for purchase for up to ten (10) years from the date of the original system purchase and shall be upgraded or maintained as required till completion period of O & M contract, at no extra cost and accordingly any software or hardware getting obsolete shall be upgraded or replaced by contractor at no extra cost with prevailing latest version during O & M period.**

Basic Processor Functions

Real-time control of output points for turning on and off digital devices such as motor starters and solenoids.

Read the status of real world digital inputs from limit switches, float switches, and other field devices.

Real-time control of analog process control variables.

Read the status of real world analog set points and feedback values.

Perform timing, counting, sequencing, and interlocking functions for pump/equipment control.

Process local alarm handling functions

Math and Advanced Functions

Four function math in floating point or signed integer format Convert to/from BCD

Data comparison and manipulation

Scaling from integer data into engineering units such as flow, level and pressure

Full PID Instructions for control of process control variables such as flow, level and pressure.

ASCII instruction set for interfacing to ASCII devices

Compute Instruction which executes a mathematical expression and can be used for totalizing functions

Trigonometric and Exponential math functions

Real-Time Calendar Clock for time stamping alarms and events.

Automatic restart of the system on resumption of power shall be provided.

The processor shall have solid state RAM memory to store the application program, process data, and alarm status. This memory shall have both capacitor and battery backup in the event that input power to the processor is lost. It shall also have the capability of EEPROM backup which automatically reloads the memory on a power cycle. The processor shall have the ability to automatically control the process on a power cycle, provided there are no major or unrecoverable processor faults.

Processor RAM memory shall be adequate and selected with at least 25-30% spare capacity for application program storage over the actual requirement, and also should be expandable for future expansions. Bidder shall demonstrate the spare capacity at the time of commissioning and after completion of entire logic development for the plant controls and monitoring as per the logic write-up to be furnished by client / consultant to the successful bidder after award of work.

Sufficient program memory and data memory space shall be provided. System initialization and application software shall be stored in EEPROM or EPROM with necessary hardware. Running data shall be stored in a RAM with internal battery back-up

All process parameters and electrical parameters as specified in the tender shall be monitored at HMI and necessary controls actions shall be initiated.

The PLC & SCADA System shall be provided either by PLC OEM or Authorized System integrator of PLC OEM only. In case of system integrator, required valid certificate from OEM shall be provided in this regards along with drawing / document submission.

Specific Requirements for PLC:

Parameter	:	Specification
(a) Expandability in future	:	30% of installed capacity
(b) Weather Protection	:	IP-20 for PLC hardware and shall be IP-52 of IS 13947 when mounted in ICP
(c) Power Supply	:	230V AC / 24V DC
(d) Interrogation Voltage	:	24V DC
(e) CPU, communication module and power supply module	:	Required, high performance 32 bit or suitable CPU Module having modular configuration suitable for real time process application. CPU shall be of same family if provided at different locations.
(f) Scan time	:	0.7 Milliseconds or better for 1K instructions
(g) Key Switch for Processor	:	Shall be as per mfr. Std.
(h) Three way to configure channel	:	(1) Via BOOT P or DHCP (2) Manually by software
(i) Mounting	:	Inside the main instrument/local instrument control panel
(j) Inputs and Outputs	:	As required for process operation with an intention to maximise the automatic operation of equipment/plant and ease of operation and maintenance of the plant. Bidder shall submit the proposed I/O list along with their technical bid. However, the proposed I/O list shall not be limiting and bidder shall provide for I/O for the explained purpose.
(k) System Loading	:	Max. 60% under worst loading conditions
(l) Power supply to sensor / transmitters	:	Required
(m) Type of input	:	NO/NC – Contacts field selectable from programmer
(n) Outputs	:	Relay outputs for driving MCC starter coils, driving motorized valves etc.
(o) Spare I/O (Wired)	:	Min. 2 nos. or 20% of each type of I/O, whichever is higher, at each panel/location, wired to terminal block
(p) Interposing Relays	:	Shall be provided for all (Actual + Spare) the Digital Output (DO) including spare DO & for Digital Input wherever required
(q) Interface (Hardware and Software) to HMI	:	Required (plug and play) ready to use type Remote data transmission facility (GSM/GPRS)
(r) Printers for alarm, status, report generation	:	NA
(s) HMI	:	10” color touch screen HMI
(t) Type of Protocol on communication port	:	The data communication shall be based on GSM/GPRS with required communication port and modem suitable for GPRS data communication on 4G network and SIM card at SPS site for Remote data transmission (GSM/GPRS) to Concern TSPS/STP of Client.
(v) Tests	:	Functional test (simulated) for complete system Test for monitoring function Factory acceptance test (to be witnessed by Purchaser / purchaser’s representative Simulation test for all logic / loops (to be witnessed by Purchaser’s / purchaser’s representative) Vendor to submit all Test

Parameter : Specification
Certificates for purchaser / consultant's review.

Input / Output Modules

- (a) Standard DIN Rail / rack mounted I/O modules with plug-in cards shall be provided. Field wiring shall be terminated in screwed terminal blocks and interconnected to the processor I/O system with preferably pre-fabricated cables and plug in card type connectors.
- (b) Min. 2 nos. or 20% of each type of I/O, whichever is higher, extra I/O's of installed capacity for each type shall be provided as spares and shall be wired to the terminal block of the control panel. Provision shall be made for future expansion of extra I/O modules of the installed capacity.
- (c) Discrete Input Cards: Solid-state input circuits rated for 10-30VDC operation. Cards must be available in 8 or 16 or 32 point configurations and shall source current to the field device. Each input point shall have a status LED which indicates the ON or CLOSED condition for that field sensor or switch. Cards must have removable terminal strips so that module can be easily replaced without disturbing the field wiring online while system is running.
- (d) Discrete Output Cards: Solid-state output circuits rated for 24VDC operation. Cards must be available in 8 or 16 or 32 point configurations and shall be able to operate a control relay. Each output point shall have a status LED which indicates the ON condition of the output. Cards must have removable terminal strips so that module can be easily replaced without disturbing the field wiring. The control Relay-contact shall be rated for 5A @240VAC or 5A @125VDC. The control relay shall have a LED indication to show the status of the control relay.
- (e) Analog Input Cards: Analog inputs shall capable of reading in 0 to 20mA or 4 to 20mA signal. The A/D converter shall provide a minimum 12 bit resolution over the full range from module minimum to module maximum.
- (f) Analog Output Cards: Analog Outputs shall be capable of outputting 0 to 20mA or 4 to 20mA signals. The A/D converter shall provide a minimum 12 bit resolution over the full range from module minimum to module maximum.

Communications

- (a) **The remote data communication shall be based on GPRS with required communication port and modem suitable for GPRS data communication on 4G or higher network of selected service provider for remote data transmission to Existing central SCADA of client for remote monitoring & controlling of SPS functioning from client control room.**
- (b) RS 232/ RS 485/ Ethernet or other such required port/s for the program upload / download, on-line editing, peer-to-peer messaging, data acquisition and man machine interface.

One Modbus Converter port for connecting devices over network for data acquisition from Energy analyzers/soft starters /temp. scanners etc. Bidder to include connectivity of all energy analyzers of alogn with required cabling in the scope of work.

General specifications for HMI shall be as under:

1	HMI shall be with 10" Wide Size TFT Color LCD Touch Screen Display with 800 x 400 dots resolution as a minimum
2	HMI shall have LED Backlight
3	HMI shall have FRAM/ROM of 10MB and SRAM of 128KB as a minimum
4	HMI shall have 1 nos. 485 Port and 1 no. RS-232 port as a minimum. Ethernet port shall be available as an option
5	HMI shall be with 1 no USB Port to permit insertion of pen drive for Data Backup and 1 no. Mini USB port (for programming/printing, as required) as a min.
6	HMI shall have Built in RTC with Lithium Primary Battery

7	HMI shall be suitable to operate for ambient temperature of 50 deg C and 95% RH
8	HMI shall be provided with Built in Software for Viewing HMI Screen on LAN (with Ethernet Port)
9	HMI shall be provided with 32 GB Removable Pen Drive for Recording Historical Data & Streaming

Specifications for GPRS Modem shall be as under:

1	Modem shall support SIM900 Quad Band GSM/GPRS engine suitable to transfer data over GPRS for any 4G or latest network
2	Modem shall have Built In RS232 Serial Interface Port/ Ethernet /Suitable port/SIM
3	Modem shall have Built In Network Status LED
4	Modem shall have Built In Sim Card Holder
5	Modem shall have configurable Baud Rate
6	Modem shall operate with Input Voltage of 24VDC
7	Modem must have auto reset facility when network resume

Contractor shall provide minimum of 3 sets of as-built control panel wiring drawings, PLC logic write-up, I/O Schedule/assignment, ladder diagram and other relevant documents in hard copy format and 3 sets in soft copy form on CDs. Soft copy format shall be in editable form to enable incorporating any changes in future. 3 sets of application program as back- up shall also be provided in soft form on CDs. All application programs shall be without password protection and as per final approved scheme ready to install and use by client and same shall be demonstrated by bidder prior to acceptance of system at site.

Bidder to note that the operation philosophy / logic specified anywhere in tender specifications is indicative only and same shall be submitted by successful bidder as per requirement and to ensure smooth and trouble free operation with minimum manual intervention during detailed engineering for review and approval and shall carry out all software development as per approved philosophy only.

5. Uninterruptible power Supply

UPS of suitable capacity as per following specifications for minimum 60 minutes back-up shall be supplied for entire load of instrument control panel including PLC and essential / critical instrument supply for necessary shut-down in case of power failure.

- (a) The UPS shall be floor mounted, self contained and metal clad and shall be suitable for supplying a non linear load.
- (b) It shall be possible to open the enclosure front door when the unit is in use without exposing any live contact touch.
- (c) The UPS shall be on-line type incorporating a six-pulse rectifier and pulse width modulation inverter technology with microprocessor control. It shall incorporate a static bypass switch that shall operate in event of UPS failure, overload or manual initiation in order to transfer the output supply to mains without disturbance to the output supply.
- (d) The UPS shall incorporate a DC under voltage trip circuit to Electro-mechanically trip the UPS output in order to protect the batteries.

The noise level of the unit shall not exceed 50 dB(A) at 1 m from the UPS cabinet.

- (a) The output of the inverter shall be a sine wave having less than 3% THD for linear loads and less than 5% for 50% non linear loads. It shall be suitable for load power factors 0.8 lag to 0.9 lead.
- (b) The unit shall have a dynamic response such that 100 % step load causes an output voltage transient of less than $\pm 4\%$ with a recovery of less than 4ms. The load crest factor shall not

- be less than 3:1.
- (c) Indicators shall be provided for the following
 - i. UPS status
 - ii. PS alarm conditions
 - (d) The UPS shall provide volt free contact outputs for the following purpose:
 - i. Warning, (viz., low battery voltage)
 - (e) The UPS shall have an overloaded capacity of 110-125 % for 30 seconds and shall be protected in the event of a short circuit of the output.
 - (f) The batteries shall be housed, within a separate matching battery cubicle suitable for location adjacent to the UPS. The batteries shall be of the rechargeable, sealed maintenance free lead acid type. The battery supply to the UPS shall be via a fused load break switch disconnecter circuit breaker. The battery recharge time to 90% of full charge shall be approximately ten times the discharge time at full load or as per manufacturer standard..
 - (g) Terminals shall be shrouded to prevent accidental contact

The Uninterruptible Power Supply (UPS) System with SMF Lead Acid battery shall conform to the minimum following specifications:

Section	Specification
i. Input	
Input Voltage	230 V, $\pm 5\%$
Frequency	50 Hz $\pm 5\%$
Nominal DC input (Battery)	Bidder to design and submit calculations
ii. Output	
Output	230 V AC, applicable KVA with 25% margin as per Load Calculation
Regulation mode	$\pm 1\%$
Load power factor	0.8 to unity
Duty	Continuous
Ripple on DC	$< 2\%$
iii. General	
Principle of operation	Shall be solid state, pulse width Modulation (PWM)
Cable entry	Bottom
Cooling method	Forced air
Type of Battery	Sealed Maintenance free
Alarms	Potential free contact for Power Healthy, Fault and Batt. Low shall be provided

6. INSTALLATION MATERIALS:

Vendor shall supply all erection hardware required for the installation of complete instrumentation forming part of this tender.

This includes items like cables, cable glands, junction boxes, instrument valves and manifolds, mounting accessories, impulse piping / tubing, pipe/tube fittings, pneumatic signal tubes, air line pipes and fittings, filter regulator, insulation material, cable duct and trays, conduits, identification tags, structural material required for instrument supports and trays etc.

A) CABLES:

Vendor is fully responsible for the sizing of all cables in their scope of supply considering factors like maximum distance between Panel Room and the Unit. Specifications for cables for analog signals, digital signals and instrument power cables shall be as follows:

Cables For Analog Signals:

Cables shall be of 660V/1100V grade, single or multi-pair cables, annealed, tinned, high conductivity 1.5 sq.mm stranded copper conductor, PVC insulated two cores twisted into pair, laid up collectively, individual pair shielded and overall shielded with aluminium mylar tape, ATC drain wire running continuously in contact with aluminium side of the tape, PVC inner sheath, armoured with galvanised steel wire overall sheathed with PVC, conforming to IS:1554 & IEC:189 Part II shall be used for analog signals. Sequential marking of the length of the cable in meters shall be provided on the outer sheath at every one meter. For multipair cable, Pair identification as per BS 5308 Part-II marking pair no. for each pair shall be provided at maximum 50mm between two consecutive numbers.

Cables For Digital Signals:

Cables of 660V/1100V grade, multi-core cables, multi-stranded high conductivity annealed 1.5 sq.mm stranded, tinned copper conductor, PVC insulated, overall shielded with aluminium mylar tape, PVC inner sheath, armoured with galvanised steel wire overall sheathed with PVC, conforming to IS:1554 & IEC:189 Part II shall be used for digital signals. Sequential marking of the length of the cable in meters shall be provided on the outer sheath at every one meter. The embossing/engraving shall be legible and indelible. Control cables having 6 cores and above shall be identified with prominent and indelible Arabic numerals on the outer surface of the insulation. Colour of the numbers shall contrast with the colour of insulation with a spacing of maximum 50mm between two consecutive numbers. Color coding for cables upto 5 cores shall be as per IS.

Cables For Instrument Power Supply:

Cables of 660V/1100V grade, multi-core cables, multi-stranded high conductivity annealed 2.5 sq.mm, stranded, tinned copper conductor, PVC insulated, PVC inner sheath, armoured with galvanised steel wire overall sheathed with PVC, conforming to IS:1554 & IEC:189 Part I & II shall be used for instrument power supply. Sequential marking of the length of the cable in meters shall be provided on the outer sheath at every one meter.

Laying of Cables:

Cables shall be laid on trays, in trenches, conduits, ducts as necessary. Instrument cables shall not be buried in ground as far as possible. Cable joints in instruments signal and power supply cables shall not be permitted. In case if some of the instrument cables are to be buried in the ground, it shall be as per standard/good engineering practice and shall be subject to client's/consultant's approval.

The contractor shall also supply necessary materials such as junction boxes, glands, lugs etc. required for termination of cables. Each cable shall be terminated to individual panel/terminals box. Cable glands shall be of Nickel Plated Brass and of Double Compression Weather proof type.

A distance of minimum 300 mm shall be maintained between the cables carrying low voltage AC & DC signals and a distance of minimum 600 mm shall be maintained between cables carrying HT & LT cables.

Identification of each cable shall be by proper ferrules at each junction as per cable schedule to be prepared by contractor. All cables shall be identified close to their termination point by cable numbers as per cable interconnection schedule. Identification tags shall be securely fastened to the cables at both ends.

B) CABLE GLANDS:

Cable glands shall be nickel-plated brass and shall be of double compression type suitable for armored cables.

Flame proof gland wherever required shall be with Ex(d) certification.

C) INSTRUMENT VALVES (MINIATURE TYPE) AND MANIFOLDS:

Body rating shall be as per piping class or better. Valve body and Trim material shall be SS316 as a minimum. Packing material in general shall be PTFE. Valves and Manifolds shall be of forged type only.

D) PIPE AND TUBE FITTINGS:

Tube fitting shall be flareless compression type and of three piece construction of Swagelok / Parker Hannifin make.

Ferrule shall be of SS in general.

Socket Weld type forged pipe fitting of suitable material and rating shall be supplied for pipe fittings. The minimum rating shall be 3000 lbs. Weld neck fittings shall be used where socket weld is not allowed by piping class.

For air service instrument brass fittings suitable for use on copper tubes conforming to ASTM B 68 / B 68M shall be used. It shall be manufactured from Bar Stock or equivalent and shall be nickel plated.

E) PERFORATED CABLE TRAYS:

All branch cables/tubes, cables on various civil units/structures shall run on cable trays only.

Cable trays shall be made out of galvanized mild steel sheets of 2 mm thickness with required accessories. All material shall be hot dip galvanized (as per IS 2629). The width shall be so selected that 40-50% space is available for future use.

Suitable cable clamps shall be supplied for binding cables / tubes at every 500mm

F) JUNCTION BOX:

Junction Box material shall be Cast Aluminium (LM-6) only and shall be weather proof to IP-65. Flame proof junction boxes shall be supplied with Ex(d) certification in addition.

The boxes shall have terminals suitable for a minimum of 4 mm² cable termination mounted on rails. 20% spare terminals shall be supplied in junction boxes.

Each junction box shall have 10% or minimum 2nos., whichever is higher, spare entries of each size. Spare entries shall be provided with plugs.

7. INSPECTION: (As Applicable)

Inspection of offered equipment/items at manufacturers' works' shall be done by the Client/PMC/TPI as specified here in as per relevant inspection and testing standards and as per approved, quality assurance plans, technical data sheets, documents and drawings.

Inspection Criteria of Various Major Equipment/Items at Manufacturers' Works:

Major instrumentation system electrical equipment/items as specified below, shall be tested and inspected at vendor manufacturers' works as narrated, prior to dispatch to ensure compliance with the specifications, requirements and applicable codes and standards and approved quality assurance and testing plans by the Client/PMC/TPI.

➤ **PLC-SCADA Panel**

100% quantity of PLC-SCADA based Control panels, tests (FAT) shall be witnessed @ Manufacturers' works by the Client/PMC/TPI.

➤ **Electro-Magnetic Flow Meters**

Flow Meters $\leq$ 500 mm dia. NB: Wet calibration tests carried out internally and test certificates shall be submitted for review and acceptance by the Client/PMC/TPI.

Flow Meters > 500 mm dia. NB to $\leq$ 900 mm Dia. NB: Wet calibration tests of **5% quantity or one number (whichever is higher)** of each class type and size shall be witnessed @ Manufacturers' works by the Client/PMC/TPI.

Flow Meters > 900 mm dia. NB: Wet calibration tests of **10% quantity or one number (whichever is higher)** of each class, type and size shall be witnessed @ Manufacturers' works by the Client/PMC/TPI.

Wet calibration (3 point calibration, 3 separate point) test shall be conducted as per governing standards approved Quality Assurance Plan (QAP) by Client/PMC/TPI as applicable shall be as specified below.

All electro-magnetic flow meters shall be provided with manufacturers' calibration certificates.

Manufacturer shall test all the meters internally and shall provide their internal test records for hydrostatic test along with material test certificates, Dimensional check certificates etc. and as per approved QAP for review, record and dispatch clearance prior to dispatch of materials.

The flow calibration and testing should be as per ISO 8316 (Calibration by Volumetric Method) or ISO 4185 (Measurement of fluid flow in closed conduits - Weighing Method) and shall be calibrated for minimum 3 Point Calibration (3 Separate point). Performance Type Testing Certification (ISO 9104) is strictly not acceptable. The manufacturer shall also have a flow calibration and testing facility in India or abroad so that methodology and procedures can be verified and each meter shall be tested and wet calibrated before shipment by the manufacturer. The flow calibration and testing facility shall be duly accredited in accordance with ISO 17025 standards.

The manufacturer's flow calibration and testing facility if in India shall be preferably accredited by National Accreditation Board for Testing & Calibration Laboratories (NABL). If the manufacturer is outside India then their flow calibration and testing facility should be accredited by a reputed International authority.

Further, if manufacturer test bed in India is not accredited to NABL or for flow meters imported from outside India then,

- The flow meter shall be calibrated/witnessed for wet calibration at the facility of FCRI, Palakkad, Kerala or other FCRI facility in India.
OR ALTERNATIVELY,
- The flow meter shall be calibrated/witnessed for wet calibration at any NABL accredited laboratory / facility in India (laboratory to meet above mentioned requirements for conducting wet calibration test)
OR ALTERNATIVELY,
- For flow meters imported from outside India, contractor shall arrange to inspect/ witness for wet calibration by a reputed third party inspection agency (SGS/ Bureau Veritas/TUV) as per approved inspection plan at manufacturer works at no extra cost. The test/performance certificates and relevant supporting documents shall be submitted to Client/PMC/TPI for review and approval. The meter(s) shall be dispatched only after obtaining dispatch clearance

from Client. Additionally if desired by Client a simultaneous inspection/witness for wet calibration shall be offered virtually to Client/Client representative.

➤ **Cables**

For all types of control and signal cables, if the quantity of each type of cable where length of cable is ≥ 1000 meters, tests shall be witnessed @ Manufacturers' works by the Client/PMC/TPI.

All other items shall be cleared for dispatch based on review of material test certificates / manufacturers' test reports' by the Client/PMC/TPI.

All expenditure pertaining to inspection including to and fro travel, local conveyance, lodging and boarding etc. shall be borne by the Contractor for minimum 2 representatives of Client/PMC/TPI Agency.

Field tests as per approved procedures/procedures available with Engineer-in-charge or his authorized representative shall be performed on the Instrumentation system/equipment before it is being put into service. All required test equipment shall be arranged by the Vendor/Contractor. Test reports shall be approved by the Engineer-in-charge before acceptance of the equipment and complete plant.

8. VENDOR DATA REQUIREMENT (INSTRUMENTATION)

Sr. No.	Description	With Bid	Info. / Review	As-Built
1	Piping & Instrument Diagram		*	*
2	Instrument index		*	*
3	Vendor List for Instruments & accessories		*	
4	Sizing Calculations		*	
5	Utility requirements		*	
6	Instrument Specifications and data sheets		*	*
7	Detailed loop drawings		*	*
8	Panel front arrangement		*	*
9	Wiring diagram for panels		*	*
10	Cable Schedule		*	*
11	Instrument Installation drawings		*	*
12	Bill of Material for installation items		*	*
13	Inspection and Test procedures		*	
14	Test Certificates and certific. from statutory bodies		*	*
15	Complete catalogues with part list for all vendor supplied instruments, controls etc.		*	
16	Installation, Operation and maintenance manuals			*

NOTE :- This list indicates the minimum drawing and document list. However vendor shall also furnish any other drawing or document required to be furnished during the course of job execution.

9. APPROVED VENDORS LIST FOR INSTRUMENTATION SYSTEM

SR. NO.	ITEMS	APPROVED MAKE
1.	ULTRASONIC LEVEL TRANSMITTER, PRESSURE TRANSMITTER	ABB/E+H/ KROHNE-MARSHALL/ SIEMENS/ EMERSON / VEGA
2.	ELECTROMAGNETIC FLOW METER	ABB/E+H/ KROHNE-MARSHALL/ SIEMENS
3.	INSTRUMENT CABLES (POWER, SIGNAL, CONTROL)	ASSOCIATED CABLES/ DELTON / HAVELLS / RPG CABLES / POLYCAB /RR CABEL / D-LINK / LAPP
4.	FLOAT TYPE LEVEL SWITCH	PUNE TECHTROL / SBEM / D-LINK/ NETGEAR/ LEVCON NIVO / TOSHBRO
5.	CABLE TRAY	GLOBE / M.M. ENGINEERING / TUSHARTECH /SILVERLINE POWER / SHREE KRISHNA ENGINNERING / EQUI. REPUTED.
6.	FLOAT & BOARD TYPE LEVEL GAUGE	TOSHNIWAL / NIVO / TOSHBRO / CONTROLS / PUNE TECHTROL
7.	PRESSURE GAUGE	WIKA / H-GURU/ WAREE/ GLUCK/ FORBES MARSHALL
8.	PLC, SCADA, HMI	ABB /ROCKWELL / SCHNEIDER / SIEMENS / HONEYWEL L/ L & T
9.	PANEL WIRES	FINOLEX, HAVELL'S, R R KABEL, LAPP CABLE, L&T, POLYCAB

The contractor shall distinctly understand that it will not be their prerogative to insist on a particular brand from the list, final selection will be done with the approval of Engineer in charge.

SPECIFICATIONS FOR ELECTRICAL WORKS

SECTION: 5.2

A GENERAL REQUIREMENTS

General Requirements

All equipment and materials shall be designed, manufactured and tested in accordance with the latest applicable Indian and International Standards except where modified and/or supplemented by this specification. Only in absence of Indian standards, International standards shall be followed.

The equipment shall meet the requirements of Indian Electricity Rules, CEA Notification, CPWD guidelines as amended up to date and relevant IS Codes of Practice. In addition, other rules and regulations as applicable to the work shall be followed. In case of any discrepancy, the more restrictive rule shall be binding.

Completeness of Supply

It is not the intent to specify completely herein all details of the equipment. Nevertheless, the equipment shall be complete and operative in all aspects and shall conform to highest standard of engineering, design and workmanship. The following shall be considered in the scope of work as a minimum.

Any material or accessory which may not have been specifically mentioned but which is necessary or usual for satisfactory and trouble free operation and maintenance of the equipment shall be furnished without any extra charge.

SITC of Electrical Equipment with all necessary erection accessories and materials, all steel members (angle, channel, plate, steel sheet etc.) for installation of electrical equipment, GI pipes, GI/PVC conduits, bends, clamps, nut, bolts, hot dipped GI/FRP ladder type cable trays, tray installation materials and accessories, cable supporting structures, flexible metallic hoses, sealing materials for openings/conduits, single/double compression cable glands, cable lugs, cable tags, cable fasteners, insulating tapes, ferrules, RCC slabs/checker plates, GI/RCC pipes for protection of cables at road crossings and other places, cable markers, cable jointing and termination kits and materials, earthing strips of different sizes, junction boxes, pull boxes, epoxy paints and all consumable materials for complete laying and termination of cables, earthing system and erection of electrical equipment etc.

Obtaining license/certificates/clearances etc. from appropriate Govt. statutory authority/body for installation and energizing the complete electrical system and necessary liasoning work for the same (Necessary statutory fees only shall be paid by client).

The quantity/number of items, weight and length of cables/earthing strips etc. mentioned in tender documents are tentatively taken, however the payment will be given as per items installed, works done and actual length of cable/earthing strips etc. actually used and installed.

Submission of all engineering documents, drawings, data sheets, earthing system, layout etc. for review and approval. All manuals, catalogues, characteristic curves etc. for various electrical equipment/components shall be submitted.

Contractor shall verify the quantity of cable or such material required as per site condition against quantity specified in BOQ/SOQ and for procurement and place order as per actual site requirement.

All Drawings/Datasheets/Technical Catalogues/Documents for various electrical works/items shall be submitted by bidder as under.

Number of copies for Submission for various Drawings/Documents shall be as under.

- a) **In four sets by successful bidder in hard copy for review and approval including revisions, if any. The approved drawings for execution purpose shall be retained in Two Sets by Client, One Set by Client's Consultant and One Set shall be returned to Contractor. The contractor must ensure that copy of approved drawings are kept readily available at site.**

- b) **In four sets by successful bidder in hard copy and two sets in soft copy (on two separate CD) of as-built drawings.**
- c) **In three sets by successful bidder in hard copy and two sets in soft copy (on two separate CD) of Operation and Maintenance (O and M) manual including manufacturers' O and M and preventive maintenance schedule, recommended spares list etc.**

All above final documents and drawings incorporating modifications, if any, done during erection/ commissioning shall be furnished.

SITE/AMBIENT CONDITIONS

All electrical equipment and installation shall be for the tropical climatic conditions and be suitable continuous operation under the site conditions as described below.

Maximum Ambient Temperature :	47 °C
Minimum Ambient Temperature :	5 °C
Design Ambient temperature :	50 °C (Unless otherwise specified for Specific Components/equipment in the Tender)
Relative Humidity :	95 %
Climate :	Tropical, Dusty, Corrosive

If not specifically mentioned, an altitude not exceeding 1000m above mean sea level shall be taken into consideration for design purpose.

Where the equipment is installed outside and exposed to direct sun, these shall be suitable for operation at higher ambient temperature and rigorous weather conditions under which they are required to operate.

CODES AND STANDARDS

The electrical equipment and complete installation offered shall comply with the relevant Indian Standards/Codes of Practices, this specification, statutory regulations and sound engineering practices.

The complete system shall conform to the latest revisions of the following.

- The Indian Electricity Act & Rules 2003
- The Indian Electricity (Supply) Act, 1948
- Regulations laid down by local statutory authorities and CEA, CPWD, Electrical Inspectorate.
- The requirement of GETCO/Power Utility Companies ie Discoms viz UGVCL, PGVCL etc.
- Fire advisory Committee Insurance Act / Fire Insurance Regulations
- Indian Petroleum rules and any other regulations laid down by the Chief Controller of Explosives
- The factory act and any other regulations laid down by factory inspectorate.

Wherever Indian Standards do not exist, the relevant IEC, British or German (VDE)/IEEE/NEMA standards shall apply. Any other Standard which is considered equivalent to or superior than applicable Indian Standards may also be acceptable. The bidder however, shall have to substantiate equivalence or superiority.

- Applicable standards govern the materials and workmanship in the manufacture of all equipments/ items of Electrical Equipment.

Codes	Description
IS: 731, BS 137, IEC 383	Pin and Disc Insulator
IS: 2544, IS: 5350, BS 3297, IEC 168	Porcelain post insulators for systems with nominal voltage greater than 1000V

IS 5621	Hollow insulators for use in electrical equipment
IS: 398 (Part-I & II) 1996	ACSR conductor
IS: 9920, Part 1 to 4 (2002)	Specification for High Voltage Switches for rated voltage above 1 kV and less than 52 kV (First Revision)
IS: 9921	Alternating current dis-connectors (isolators) and earthing switches for voltages above 1000 V
IS: 9385 (1983)	Governing spec. for GOAB switch
IS: 3070	Lighting arresters for alternating current systems
IS: 15086	Surge arresters
IS: 8828	Electrical Accessories -Circuit Breakers for Over Current Protection for Household and Similar Installations
IEC 60529	Enclosure degree of protection IP-5X
IS: 3231	Electrical relays for power system protection
IS: 4047, IEC-408	Air Break Switches
IS: 2208, IEC 259-1	Fuses
IS: 1248	Direct acting indicating analogue electrical measuring instruments and their accessories
IS: 2419	Dimensions for panel mounted indicating and recording electrical instruments
IS: 2705	Current transformers
IS: 3156	Voltage transformers
IS: 2026, IEC 60076	Power transformers
IS: 11171	Specification for Dry Type Power Transformers
IS: 335	New insulating oils
IS: 1180 Part-1 (2014)	Outdoor Type Oil Immersed Distribution Transformers up to and including 2500 kVA, 33 kV Specification
IS: 8468	On-load tap changers
IS: 2099	Bushings for alternating voltages above 1000 Volts
IS: 6600	Guide for loading of oil immersed transformers
IS: 4237	Switchgear General Requirements
IEC 60947	Low voltage switchgear and control gear
IS: 375	Panel Wiring
IS: 3427	AC Metal Enclosed Switchgear and Control gear for Rated Voltages Above 1 kV and Up to and Including 52 kV
IS: 2516	Moulded Case Circuit Breakers
IS: 3842	Application guide for electrical relays for ac systems
IS: 13925	Shunt capacitors for ac power systems having a rated voltage above 1000 V
IEC 60831(1 and 2)	Shunt capacitor of the self- healing type for AC systems having rated voltage up-to and including 1000V
IEC 61921	Power capacitors -Low-voltage power factor correction banks
IS: 16636	Automatic Power Factor Correction (APFC Panels for voltage Rating up-to and including 1000V
IS: 2959, IEC 158-1	Contactors

IS: 1822, IEC 292	Starters
EN 50081-1, 50082-2 and 60204-1	Microprocessor Soft Starter
IEC 61800 and/or IEEE 519 1992	Harmonics Control & Reactive Compensation Of Static Power Converters
IEC 721-3-3, Class 3C1	Maximum Corrosion Level of the Cooling Air
IEC 721-3-3 Class 3C2	Maximum Corrosion Level of the Chemical Gases
UL 508C	Solid state thermal protection of AC Drive
IS: 722	Specification for AC Electricity Meters
IS: 12615 (2018)	Energy efficient induction motors-three phase squirrel cage
IS: 15999 (Part 1)	Rotating electrical machines: Part 1 Rating and performance
IS: 15999 (part 2)	Rotating electrical machines: Part 2 Method of tests, standard methods for determining losses and efficiency from tests (excluding machines for traction vehicles)
IS: 12065	Permissible limits of noise level for rotating electrical machines
IS: 2253	Designation types of construction and mounting arrangement of rotating electrical machines
IS: 8789	Values of performance characteristics for three phase induction motors
IS: 9283	Motors for submersible pump sets
IS: 9334	Electric motor operated actuators
IS: 8130	Conductors for insulated electric cables and flexible cords
IEC 228	Conductors of Insulated Cables
IEC 230	Impulse tests on cables and their accessories
IEC 502	Extruded solid dielectric-insulated power cables for rated voltage from 1 kV up to 30 kV
IEC 540	Test methods for insulations and sheaths of electric cables and chords
IEC 229	Test on cable over sheaths which have special protective functions and are applied by extrusion
IEC 287	Calculations of continuous current rating of cables (100% load factor)
IEC 60751	Industrial platinum resistance thermometers and platinum temperature sensors
IEC 61537	Cable management - Cable tray systems and cable ladder systems
IS 1554 part1	PVC insulated (heavy duty) LT electric cables up to 1.1 kV
IS: 7098 Part I	XLPE Insulated LT Electric cables (heavy duty) up to 1.1 kV
IS: 7098(Part II	XLPE insulated PVC sheathed cable for voltage from 3.3 kV up to 33 kV
IS: 5831 (1984)	PVC insulation & sheath of electrical cables
IS: 694	PVC Insulated cables for working voltage up to and including 1100 V
IS: 1255	Code of practice for installation and maintenance of power cables up to and including 33kV rating
IS: 3975	Mild steel wires, formed wires and tapes for armouring of cables
IEC 885-2 (1987) (Part II)	Electrical test methods for electric cables partial discharge test
IS: 10810	Methods of test for cables
IEC 811	Common test methods for insulating and sheathing materials of electric cables

IEC 230	Impulse test on cables & other accessories
IEC 859	Cable termination for gas insulated switchgear
IS: 3961	Recommended current ratings for cables
IS: 3043	Code of practice for earthing
IS: 2629	Recommended Practice for Hot-Dip Galvanizing of Iron and Steel
IS: 2633	Methods for testing uniformity of coating of zinc coated articles
IS: 1897	Copper strip for electrical purposes – Specification
IEC/IS: 62305	Code of practice for protection of buildings and allied structures against lightning
IS: 732	Code of practice for electrical wiring installations
IS: 1646	Code of practice for fire safety of buildings (General) Electrical installation
IS: 2509	Rigid non-metallic conduits for electrical wiring
IS: 6946	Flexible (Pliable) non-metallic conduits for electrical installation
IS: 9537	Conduits for electrical installations
IS: 3854	Switches for domestic purpose
IS: 3415	Fittings for rigid non-metallic conduit
IS: 3837	Accessories for rigid steel conduits for electrical wiring
IS: 14927	Cable trunking and ducting systems for electrical installation
IS: 4648	Guide for electrical layout in residential building Indian electricity act and rule
IS: 1293	3 pin plugs and sockets
IS: 4795	Holders for Indicator Lamps for Electronic and Telecommunication Equipment
IS: 3646	Code of practice for interior illumination
IS: 1913	1969 General and Safety requirements for Electric lighting fittings
IS: 1239, IS: 2713	GI Lighting Poles
IS: 1944	Code of practice for lighting of public thoroughfare
IS: 374	Electric ceiling type fans and regulators
IS: 1293	Plugs and socket-outlets of rated voltage up to and including 250 volts and rated current up to 16 amperes – Specification
IS: 6665	Code of practice for industrial lighting
IS: 8224	Electric lighting fittings for division 2 areas
IS: 9583	Emergency lighting units
IS: 9974	High pressure sodium vapour lamps
IEC 62305	Protection against lightning Part 4: Electrical and electronic systems within structures
IS: 1271	Thermal evaluation and classification of electrical insulation
IS: 1544	Cotton calico
IS: 1868	Anodic Coatings on Aluminium and its Alloys – Specification

IS: 2190	Selection, Installation and Maintenance of First-aid Fire Extinguishers - code of practice
IS: 2546	Specification for galvanized mild steel fire bucket
IS: 5572	Classification of hazardous areas (other than mines) having flammable gases and vapours for electrical installation
IS: 9677	Guide for limits of temperature-rise of the windings of electrical equipment when tested by different methods
IS: 9678	Methods of measuring temperature rise of electrical equipment
IS: 10118	Code of practice for selection, installation and maintenance of switchgear and control gear
IS: 15652	Insulating mats for electrical purposes – Specification
IS: 5424	Rubber mat
IS: 4770	Rubber Gloves -Electrical Purposes – Specification
IS: 2551	Danger notice plates
ISO 3046	Diesel Engine
IS: 4722, BS 2613	Alternator
IS: 16101	General lighting LED and LED modules
IS: 16102 (Part 1)	Self ballasted LED lamps for general lighting service-Safety Requirement
IS: 16102 (Part 2)	Self ballasted LED lamps for general lighting service-Performance Requirement
IS: 16103 (Part 1)	LED modules for General lighting-Safety Requirement
IS: 16103 (Part 2)	LED modules for General lighting-Performance Requirement
IS: 16107 (Part 10)	Luminaries Performance-General Requirement
IS: 16108	Photo biological safety of lamps and lamp systems

DESIGN BASIS

The Electrical equipment system shall be in accordance with project specifications and shall ensure continuity/reliability of supply, flexibility of operation and safety.

The Basic Design Data to be considered as follows.

Incoming Supply Conditions	11kV $\pm$ 10%
Frequency	50 Hz $\pm$ 5%
Voltage and Frequency Combined Variation	$\pm$ 10%
Fault Level at 11kV	500/350 MVA symmetrical (1 second) or higher as per Statutory requirement
System Grounding	Solidly Earthed
Fault Level at 415V (Design)	50kA Symmetrical (1 second)
Control Circuit Voltage	230V AC via Constant Voltage Transformer for LV Panels and 110V DC for HV Panel via Power Pack
HV Cabling	3C XLPE, 11 kV (E), Extruded Inner Sheath
LV Cabling	Copper/Alluminium Stranded Conductor XLPE/PVC insulated, Extruded Inner Sheath
Earthing	Earth Pit: Cu Plate/GI Pipe electrode (Maintenance free Chemical Type) as per IS: 3043/Specifications/ Drawings
Induction Motor	Energy Efficient Design of IE3 Class as per IS:12615 (2018)

	amended up to date
Soft Starter	DOL starting, Soft Starter De-rated current for 50 °C operating conditions $\geq$ Minimum 110% of rated motor current as per IS: 12615/BOQ, with in-built or external bypass contactor, with in-line contactor and semi-conductor (fast acting) fuse protection, required protection parameters etc. as per SLD/SOQ /Specifications
Variable Frequency Drive (VFD)	VFD De-rated current for 50 °C operating conditions $\geq$ Minimum 110% of rated motor current as per IS: 12615/SOQ with in-line contactor and semi-conductor (fast acting) fuse protection, required protection parameters etc. as per SLD/ SOQ/Specifications

Power is expected through single circuit 11kV overhead line from the local power supply company to be terminated in proposed new plant's Two/Four pole Structure with DO type HV isolator, fuses and lightening arrestors or at Power Supply Company breaker cum metering panel as applicable. Power is then transmitted through cables buried underground and terminated to the indoor 11kV switch gear board located in substation and then transmitted to respective transformers, located in substation.

The proposed transformers are connected by LV cables/Bus duct (as per SOQ) to the main 415V over Motor Control Centre (PMCC/PCC/MCC LV panels). Fuse less design shall be used in PMCC/APFC/ MCC as per CPWD Guidelines/Specifications.

This LV panel shall in turn feed downstream APFC/MCC/LDB/PDBs etc. for feeding various loads.

Motors shall be started and stopped by push buttons at Local Control Stations located near respective motors as per specifications/SLD/SOQ. Starters shall be housed in MCCs with STOP/START (where ever LCS is not applicable)/RESET Push Button.

In outdoor areas cables shall be mostly buried directly underground with mechanical protection wherever applicable. In indoor areas, cables shall be laid in trenches through Hot Dip Galvanized Iron (GI) Strip/ FRP cable trays as per BOQ/SOQ.

Earthing system design and installation shall be generally as per IS: 3043. Earthing system shall be carried out by pipe-in-pipe technology and maintenance free UL listed chemical earthing system as per SOQ/BOQ by hot dip galvanized GI strips, Cu strips, maintenance free UL listed Cu bonded earthing electrodes, GI pipes, earth enhancement materials ie back filling compounds for chemical earthing etc. as per actual requirement of the entire Plant. All equipment shall have two separate and distinct earth points. Earth resistance shall not exceed one ohm at any point.

Notwithstanding anything mentioned in this tender specifications and Schedule of Quantities (SOQ)/Bill of Quantities (BOQ), contractor shall be responsible to provide all equipment and material to complete the electrical installation in all respects at no extra cost. Bidder is responsible to study the technical specifications/SOQ in entirety and understand the requirements prior to bid submission and shall bid/quote accordingly.

GENERAL INSTRUCTIONS

UNIT RATE

The unit rate of all the item of works as per SOQ shall include the following job as a minimum.

- Delivery of the Equipment at site.
- Unloading at site store/proposed area.
- Storage and security of supplied materials and equipment till installation at site and handing over to client.
- Power and Control cabling work between equipment.
- Assembling various item as per requirement.
- Checking of operation and wiring before commissioning.
- Testing and commissioning of equipment.
- Supply of necessary spares required for commissioning.

DRAWINGS/DOCUMENTS

Successful bidder shall submit documents, **Technical data sheets in the formats given in the tender**, all manuals, catalogues, characteristic curves etc. for various electrical equipment/components for review and approval.

Detailed documents to be prepared in line with recommended specifications/details and submitted to client in a timely manner to allow for review and approval.

The bidder shall furnish following required drawings/**documents** for each item for review and approval as a minimum.

- a) List of Drives/Loads with Quantity/Ratings/Specifications along with power load statement.
- b) Transformer, DG Set and Capacitor Sizing Calculations.
- c) SLD and control diagram of complete electrical system.
- d) GA drawing, SLD, Sectional drawings, BOM, Wiring/Schematic Drawings etc. as applicable for complete electrical system (HV and LV Panels, LVDB, Lighting Panels, PDBs etc.)
- e) Overall Cable Layout and Unit Wise Cable Tray layout.
- f) Earthing Layout with Earthing Calculations.
- g) Internal Lighting Layout with Calculations.
- h) External Lighting Layout.
- i) Cable Schedule with voltage drop calculation/sizing calculations.
- j) Interconnection Schedule.
- k) GA Drawings for all equipment including sectional drawing wherever necessary and specifying recommended installation, weight, clearances requirements etc.
- l) Filled in Data Sheets.
- m) Schedule of quantities along with brief specifications.
- n) Design/sizing calculations for equipment as applicable.
- o) O and M manual for all equipment.

VENDOR DATA REQUIREMENT

Following minimum documents shall be submitted by contractor along with the bid/offer for review and approval during detailed engineering, as indicated.

VENDOR DATA REQUIREMENT FOR ELECTRICAL WORKS				
Sr. No.	Description	With Bid/ Offer	For Review/ Approval	As Built
1	Technical Details for Major Equipment		*	*
2	List of Recommended Spares		*	*
3	Data Sheet/GA drawing/BOM/SLD/Wiring and Schematic Diagram for Power and Control Circuit/Data sheet of Relay for 11 kV HV VCB Panel/Transformers/Motor/Bus Duct/DP Structure as applicable		*	*
4	GA Drawings with sectional view, door open view, top and bottom view, Rear view, Mounting plate details etc./BOM/SLD/ Wiring and Schematic Diagram for Power and Control circuit for LV Panel/Starter/ APFC Panel/Bus Duct		*	*
5	Technical Data Sheet/ Catalogue of ACB, MFM, Soft Starter, VFD, APFC Relay, Detuned Reactor		*	
6	GA Drawing/BOM/Technical Details for LCS/Indoor and Outdoor Light Fixtures /LDB/Switch Board/Safety Equipment		*	*
7	Data Sheet and BOM for Cable Tray		*	*
8	Cable Schedule/Data Sheet/Make and Type for HV/LV Power and Control Cables.		*	*
9	Earthing (Grounding) System Calculation and Details		*	*
10	Lightening Protection System for Buildings and Structures (If and as Applicable)			
11	RCC Foundation Details for various Electric Equipment.		*	*
12	Inspection Schedule and QAPs for Major Equipment		*	
13	Test Certificates		*	*
14	O and M Manual (If and As Applicable)		*	*

(B) DETAILS TECHNICAL SPECIFICATIONS

16.26

11 KV SWITCHYARD (TWO/FOUR POLE STRUCTURE)

Two pole structures shall be erected in switchyard to receive 11 kV power supply from power supply company (DISCOM) with following minimum equipment.

- a) 11 kV MS pole structure with ISMB, ISMC, hardware etc. including grouting of MS poles in RCC grout blocks/foundation works.
- b) Vertical 150 mm dia. GI pipe for cable support.
- c) Chain links fencing with gate.

The minimum Factor of Safety for supports shall be as per CEA (Measures relating to Safety and Electricity Supply), Regulations as and when these are notified by the authority. The supports shall be suitable for the wind loads as per relevant IS.

Following equipment/accessories shall be required for each 11 kV two pole structure as minimum and other as per drawings/statutory requirements at site shall be provided. All required sub assemblies and accessories shall be suitable for environmental and atmospheric conditions as well as pollution levels of the location(s) where such switchyards are to be built. For locations where pollution levels are high or for critical locations anti-fog type insulators are to be used invariably.

Sr. No.	Particulars	Quantity
1	11 kV Porcelain glazed disc insulator with hardware/polymer composite insulators.	3 Nos.
2	11 kV, 10 kA single pole gapless lightning arrestor (LA) with all required fitting accessories/hardware. LA shall be with surge counter and monitor.	3 Nos.
3	11 kV, 9 kV LA clamp with nut bolt.	3 Set
4	11 kV, 10 kV LA jumper wire.	3 Nos.
5	11 kV, 400 A, 3 pole gang operated air break (GOAB) heavy duty switch with gang operated mechanism & earth switch and all required fitting accessories/hardware. Insulators shall be as per expected environmental and pollution conditions.	3 Nos.
6	11 kV, DO fuse assemblies with 400A fuse element with fuse barrel, fiber barrel insulated operating rod and all required fitting accessories/hardware.	3 Nos.
7	11 kV, 10 kA insulator for 11 kV GOAB switch, DO fuse etc. porcelain glazed disc insulator with hardware/polymer composite insulators.	15 Nos.
8	Fiber operating insulated rod with mechanism and handle suitable for 11 kV GOAB switch.	1 Set
9	ACSR (Mink/Dog/Panther) conductor with required clamps, connectors and hardware etc.	30 RMT or as actual
10	25mm X 6mm thick Copper earth strips in two parallel runs in required quantity i.e. from LA to earthing chambers.	As required
11	Required concrete foundation (grout blocks) etc.	Lot
12	Two/Four pole structure is to be painted with two coats of red oxide followed by two final coats of Alluminium paint as per IS, specifications and drawings.	Lot

Note: For ratings other than 11 kV, equipment kV rating shall be changed to suit requirements as per system kV rating and all clearances, safety requirement, accessories etc. shall be as per IS/CPWD/CEA guidelines.

All members shall be fabricated to suit the mounting/fixing of GOD, LA, DOF, Disc/Pin/Post insulators, cable end termination kit/box etc. All members, nut-bolts, washer etc. used shall be hot dip galvanized. All metallic supports shall be permanently and effectively earthed.

Earthing terminals shall be provided by welding 12mm size bolt/cleat of 50mm x 6mm size MS flat shall be fixed to each joist with a hole of 15mm dia. Fixing or joining of members shall be done by nuts and bolts. Suitable MS flat supports and cleats shall be fixed to ISMB poles for supporting/ fixing the earthing protection strip in the manner approved by the Client.

Vitreous enamelled caution boards or any other statutory requirements shall be provided in accordance with CEA (Measures relating to Safety and Electricity Supply).

Protective guards shall be used where overhead line crosses or is in proximity to any telecommunication line, or any other overhead lines, and in populated localities. Every guard wire shall be connected to earth wherever its electrical continuity is broken.

DP structure/accessories shall meet all statutory requirement laid down in I. E. Act/CEA regulations.

Structure

Pole structure shall be of rolled steel of minimum ISMB 150mm X 75mm size and minimum 9 meters in length with 400mm X 400mm X 6mm thick base plate welded at bottom end of the poles of structure.

Mild steel cross members of minimum ISMC 100mm X 50mm size channels of required length and numbers shall be provided with cross bracing angles ISA of 50mm X 50mm X 6mm size of required length. Clamps, cleats etc. shall be fabricated from minimum 50mm X 6mm size MS flats as per actual requirement. All bolts, nuts, washers etc. shall be of minimum 15mm dia.

Welding at site should be avoided as far as possible. In case, welding becomes necessary, the joint shall be covered with cold galvanizing paint.

All MS parts shall be painted with two coats of red oxide followed by two coats of Aluminium paint. All MS part shall be hot dip galvanized as per IS: 2629. Alternatively All cross members and clamps shall be hot dip galvanised after fabrication.

11 kV GOAB Switch

The GOAB switch shall be triple pole construction suitable for vertical/horizontal mounting. Each pole shall consist galvanized steel base, insulators, Copper alloy male and female contacts, arcing horns of adequate section to break magnetizing current of transformer, MS square coupling rod of adequate length for rocking operation, required length of GI pipe for operation from ground level and operating handle, for smooth operation. Jumper shall be EC grade braided Copper of appropriate size to complete the current path from moving post to fix post.

Disconnecter and earthing switches, including their operating mechanism shall be designed such that they cannot come out of their open and closed positions by gravity, wind pressure, vibrations, reasonable shocks or accidental touching of the connecting rods of their operating mechanism.

Isolators shall be provided with provision of locking in open and closed positions. The switch shall be single throw-single break or single throw-double break.

The insulators shall be post type, high quality brown porcelain, highly glazed/polymer insulator and shall be of appropriate voltage rating, suitable for atmospheric conditions specified. Grading rings may be provided to obtain uniform voltage stress distribution, where required.

All poles of the switch shall be gang operated by a common operating mechanism such that all poles close or open simultaneously. The operating mechanism shall be positive type and shall be provided with two earthing terminals. Operating handle shall also be provided with an "equalizing braid" earth connection to prevent unequal potential between structure and rod during faults.

11 kV Drop Out Fuse

The DO fuse assembly set shall be single pole construction suitable for 11 kV supply and suitable for vertical mounting. Each pole shall consist galvanized steel base, insulators, Copper alloy DO top and bottom contacts and fuse carrier top and bottom contacts, epoxy extruded fiber fuse carrier. The assembly shall be mounted on pole structure, complete with fuse elements of required ampere rating. The fuse link shall consist of iron channel base, stack insulator per phase, fuse carrier Bakelite tube, non-ferrous metal parts and spring loaded phosphor-bronze contacts. The insulator shall comply with impulse voltage test in accordance with relevant IS.

Technical Requirement for GOAB Switch and DO Fuse Set

Rated Voltage	12 kV
Rated Current for DO Fuse Set	250/400 Amp

Rated Current for GOAB Switch	400 Amp
Impulse Withstand Voltage to Earth	60 kV
Impulse Withstand Voltage Across the Terminals	75 kV
Power Frequency Withstand Voltage to Earth	28 kV
Power Frequency Withstand Voltage Across the Terminals	32 kV
Rated Short Time Current for 1 Second	10 kA

Lightning Arrestor

Lightning arrestor shall be for 11 kV rating furnished complete with insulating base and anchoring hardware for mounting on steel structure. The arrestors shall be metal oxide gapless type comprising of a stack of zinc oxide valve elements as per IS: 3070.

The arrestors shall be single phase, single pole suitable for outdoor installation under atmospheric conditions as specified elsewhere.

The arrestor shall have adequate thermal discharge capacity for severe switching surges, long duration surges and multiple strokes. Insulators shall be wet process porcelain, brown glazed and free from imperfection. All metal parts and hardware shall be hot dip galvanized.

Independent Copper earthing shall be provided for LA.

Technical Requirement for Lightning Arrestor

Rated Voltage	9 kV
Rated Current	400 Amp
Creepage Distance	Total: 300mm & Protected: 140mm
Type	Station Class
(1) 1 Minute Power Frequency Withstand Test Voltage	28 kV
(2) Impulse Withstand Test Voltage	75 kV
Minimum prospective for 0.2 Second Symmetrical Fault Current	21.86 kA
(1) Top Connection Arrangement (2) Bottom Connection Arrangement	(1) ACSR Conductor (2) Hot dip galvanized strip/ galvanized stranded steel wire
Nominal Discharge Current	10 kA

Conductor

Aluminium conductor steel reinforced (ACSR) or equivalent all aluminium alloy conductors (AAAC), all aluminium conductor (AAC) as per site environmental and pollution conditions shall be used. ACSR shall be hard drawn from 99.5% pure electrolytic aluminium rods with 60% IACS conductivity. The vendor shall specify the conductivity. The aluminium shall have resistivity of $0.028264 \Omega \text{ mm}^2/\text{m}$ at 20 °C temperature. Thermal conductivity shall be 0.563 calories/cm/°C and density shall be 2.703 gram/cm³ shall be as per typical drawing and as per IS: 398.

The size of conductor shall depend upon the voltage regulation, factor of safety, power to be transmitted, length of line, line voltage and mechanical strength desired.

Suitable insulating paint shall be applied on bare conductors in coastal areas to prevent corrosion.

Stay Arrangement

To prevent tilting of a pole from its normal position due to abnormal wind pressure and deviation of alignment, the pole shall be kept in position by stays.

Galvanized iron stay wires and stay rods of adequate size shall be used. The individual wire used to form “stranded stay-wire” shall have minimum tensile strength complying with relevant IS. For double pole structure, for stays along the line, two in each direction or as required depending on the angle of deviation shall be provided.

When two or more stays are provided on the same pole, each stay shall be grouted entirely separate from the other.

The angle between the pole and stay wire shall be about 45 degree and in no case it shall be less the 30 degree.

Stays shall be anchored either by providing base plates, iron angle or rail.

Stay wires shall be connected to the pole with a Porcelain Guy Strain Insulator. The standard guy strain insulators shall be as per relevant IS. The porcelain insulator shall be inserted in the stay wire at a height of minimum 3 meter vertically above the ground level. The strain insulators shall be free from defects, thoroughly vitrified and smoothly glazed.

Wooden insulators shall not be used for stay/guy wire.

11 kV HV SWITCHGEAR (VCB) PANEL

Design Criteria

The switchgear system shall be capable of continuous operation at specified rating under the design conditions specified here in.

The switchgears will be located indoor/outdoor area as per requirement.

The de-rating of complete panel including bus bar section shall be done at **50 0C ambient design temperature** if it is designed at lower ambient temperature. The maximum temperature in any part of the equipment at specified rating shall not exceed 85 0C.

Applicable standards for HV panels shall be, IEC 62271/100-200, IEEE 1584, IEC 60947, IEC 60439, IS: 13118-191.

Specific Requirements

The switchgear shall be metal-clad, extensible on both sides, floor mounted, draw-out type with fuse-less design and suitable for Local/Remote operation (Both control and monitoring). Enclosure shall conform to the degree of protection IP 4X and IP 5X for metering section.

The minimum thickness of sheet steel used shall be 2mm CRCA steel/Al Zn and gland plate of 3mm thick.

The switch gear assembly shall comprise continuous, dead-front, line-up of free standing, vertical cubicles. Each cubicle shall have front hinged door with latches and removable back cover. All covers and doors shall be provided with recessed neoprene gaskets. All doors shall have pad locking arrangement. The swing of the door shall be more than 90 degree.

The design shall be such that failure of one equipment shall not affect the adjacent units.

Each cubicle shall be separated from adjacent one, by grounded sheet steel barrier and bus sealing arrangement.

All relays, meters, switches and lamps shall be flush mounted on the respective cubicle door or on control cabinet built on the front of the cubicle.

Each breaker shall be provided with 6 way, 3 position, spring return to neutral, angular movement, Trip-Neutral-Close (TNC) switch with lockable pistol grip type handle.

Each breaker shall be provided with 4 way, 2 position, angular movement with lever type handle Local-Remote selector switch.

Each switchgear cubicle shall be provided with thermostat controlled space heater and 3 pin 15 Amp plug point and light point operated at 230V 50 Hz AC.

Bus connections from bus compartment to breaker compartment, breaker compartment to cable compartment, and bus compartment to adjacent panels shall be through sealed resin cast bushing assembly.

Each breaker cubicle shall be provided with 'service' and 'test' position limit switches having at least 4 NO and 4 NC contacts. The swing of the door shall be more than 90 degree.

Bus and Bus Taps

Bus bars shall be of uniform cross section throughout the entire length of panel and suitable for carrying rated current continuously and short circuit current for specified duration without overheating.

The main bus bar and connections shall be of high conductivity Copper. **Copper bus bars shall be sized for maximum 1.4 A/mm² current density.**

All bus bars, jumper connection shall be fully insulated for working voltage with adequate phase /ground clearances and shall be sleeved with R,Y,B colour coded PVC heat shrinkable sleeves. Bus bars, links, live parts etc. shall have non-flammable epoxy cast-resin shrouds. All jointing hardware shall have nylon caps.

No paper/cotton based insulation shall be used anywhere in the panel.

Safety shutter, phase barrier, bus bar seal-off bushing plate, support insulators etc. shall be of non- flammable high tracking fibre glass/epoxy insulation system.

All buses and connections shall be supported and braced to withstand dynamic electro-magnetic stresses due to maximum short circuit current and also to take care of any thermal expansion.

Circuit Breaker

Circuit breaker shall be triple pole, single throw, vacuum type, electrically operated (on/off), electrical draw out

(EDO) type.

Circuit breaker shall have Service, Test and Disconnected (Isolated) positions with positive indication for each position.

Circuit breakers of identical rating shall be physically and electrically interchangeable.

Circuit breaker shall have manual spring charge as well as motor wound charging facility with mechanical and electrical anti-pumping features and shunt trip. Motor wound mechanism spring charging shall take place automatically after each breaker's closing operation. The motor shall be suitable for operation with voltage variation from 85% to 110% of rated voltage.

Mechanical safety interlock shall be provided to prevent following.

- a) Circuit breaker from being raked in or out of the service position when the breaker is closed.
- b) Raking in the circuit breaker unless the control plug is fully engaged.
- c) Closing and opening of the breaker in an intermediate position between 'Service' and 'Test' and between 'Test' and 'Disconnected' position.

Automatic safety shutters shall be provided to fully cover the female primary contacts when the breaker is withdrawn from service position.

The manual trip device shall be located on the front door and indicators with shrouds will be visible from front door even when breaker is closed.

Each breaker shall be provided with following.

- a) Auxiliary switch with 6 NO + 6 NC contacts, mounted on the draw-out portion of the switchgear.
- b) Position/cell switch with minimum 3 NO + 1 NC contacts, one each for Test and Service position.
- c) Auxiliary switch, with 4 NO + 4 NC contacts, mounted on the stationary portion of the switchgear and operated mechanically by a sliding lever from the breaker in Service position.
- d) Trip push button, mechanical ON-OFF indication, operation counter and mechanism charge/discharge indicator.

Limit/auxiliary switches shall be convertible type i.e. facility for changing NO contact to NC and vice-versa. Switch contact shall be rated 10 A AC and 2A DC at operating voltage.

Each breaker shall be provided with suitable encased rollers.

The trip coils shall be operated satisfactorily at voltage between 70% and 110% of rated control supply voltage.

Each circuit breaker cubicle shall be provided with earthing facility. Earthing facilities shall be fully interlocked to prevent faulty operation e.g. earthing of live parts.

One set of earthing truck for cable earthing and bus earthing shall be supplied along with panel. For each breaker feeder following DI and DO shall be considered.

DI

Breaker ON Breaker Trip

Breaker Test Position Breaker Service Position DC Fail

Local/Remote Selection

Vibration Sensor Feedback: 6 Nos. (if applicable for motor feeder)

DO

Breaker On

Breaker OFF

RTD Input

Winding and Bearing Temperature: 8 Nos (if applicable for motor feeder)

Protection and Measurement Protective Scheme Requirement

Main protective relay shall be microprocessor based, current and voltage based/monitoring numerical relays with combined protections and with communication facility as listed in the table given below. Relay shall have minimum

5 logic input and output each, with fault (Minimum 10) and event record (Minimum 100). Front USB port for local downloading of fault, event records.

Auxiliary relays, timers switches etc. required to make the scheme complete shall be considered as part of the scope of work.

All CT-PT wires shall be brought to test terminal blocks before connecting to circuits.

The circuits of various protections shall be connected to master trip relays through auxiliary relays (flag indicated).

Auxiliary relays shall be provided for each transformer fault. Connection of the relay shall be through links to facilitate maintenance.

For control supply distribution, panel to panel, separate set of terminal blocks shall be provided. All items/accessories required for above in each panel and in incoming panels shall be provided by the supplier.

All relays shall be self/hand-reset type with digital/flag indication. NO/NC contacts for relays shall be as per requirement of approved protection, annunciation and interlock schemes. Wherever required, Vendor/Supplier shall provide auxiliary relays for contact multiplication.

Annunciation facia shall be mounted on the panel and details shall be finalized during drawing approval stage.

Emergency stay-put type off push button/mechanism are to be considered. DC supply fails alarm and indication is to be considered.

Draw-out type line PTs, shall be provided on all incomers with suitable 110V AC secondary two winding transformer for metering and protection separately of minimum burden 100/200 VA or higher as required.

Incomer of HV breaker shall be with following as a minimum.

Sr. No.	Relay	Indication and Monitoring	Digital Type Meter
1	PT Fuse Failure Relay	Phase Indication (R, Y ,B)	PF Meter & Ammeter and ASS
2	Numerical Relay with RS 485 Communication with Combined Protection with Configurable Digital Input and Digital Output (Minimum 5 each), Fault Record (Minimum 10) and Event Record (Minimum 100), for the following.	Breaker ON, OFF, Trip	Voltmeter and VSS
2.1	IDMT and Instantaneous 3 O/C + 1 E/F (50, 51, 50N, 51N)	DC Supply ON, AC Supply ON	MFM with Communication Port Equivalent to Schneider (Conzerv) EM 6400NG with RS 485 (Cl. 0.5s)
2.2	Under Voltage and Over Voltage with Time Delay (27/59)	Spring Charge	
2.3	Trip Circuit Supervision (95)	Test and Service Position	
2.4	Circuit Breaker Protection/Failure (50 BF)	Trip Circuit Healthy	
2.5	Anti-Pumping Relay	Minimum 12 Window Annunciation Panel	
3	Master Trip Relay (High Speed Trip Relay) with Hand Reset Contact (2 NO and 2 NC contact)		

Outgoing (Transformer) HV breaker shall be with following as a minimum.

Sr. No.	Relay	Indication and Monitoring	Digital Type Meter
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1	Numerical Relay with RS 485 Communication with Combined Protection with Configurable Digital Input and Digital Output (Minimum 5 each), Fault Record (Minimum 10) and Event Record (Minimum 100), for the following.	Breaker ON, OFF, Trip	PF Meter & Ammeter and ASS
1.1	IDMT and Instantaneous 3 O/C + 1 E/F (50, 51, 50N, 51N), Thermal Overload (49)	DC Supply ON	MFM with Communication Port Equivalent to Schneider (Conzerv) EM 6400NG with RS 485 (Cl. 0.5s)
1.2	Trip Circuit Supervision (95)	Spring Charge	
1.3	Circuit Breaker Protection/Failure (50BF)	Test and Service Position	
1.4	Anti-Pumping	Trip Circuit Healthy	
2	Auxiliary Relay for WTI, OTI, Bucholz Alarm Indication and Trip	12 Window Annunciation Panel or Higher as Required.	
3	Master Trip Relay (High Speed Trip Relay) with Hand Reset Contact (2 NO and 2 NC Contact)		
4	Restricted Earth Fault (REF) and Differential Earth Fault Protection Relay for Transformer Rating 2000 kVA and Above		

CBCT shall be provided for Sensitive Earth Fault (SEF) for transformer feeder.

Outgoing (Motor Feeder) HV Breaker shall be with following as a minimum.

Sr. No.	Relay	Indication and Monitoring	Meter
1	Numerical Relay with RS 485 communication with Combined Protection with Configurable Digital Input and Digital Output (Minimum 5 each), Fault Record (Minimum 10) and Event Record (Minimum 100), for the following.	Breaker ON, OFF, Trip	PF Meter & Ammeter and ASS
1.1	IDMT and Instantaneous 3 O/C + 1 E/F (50, 51, 50N, 51N), Thermal Overload (49), Negative Phase Sequence Overcurrent (46), Locked Rotor during Start-up (51S), Under Current/Loss of Load (37), Start/Stalled Protection/Motor Re-Acceleration (48/51 LR), Number of Starts Limitation (66), RTD Temperature Monitoring (38/49T)	DC Supply ON,	MFM with Communication Port Equivalent to Schneider (Conzerv) EM 6400NG with RS 485 (Cl. 0.5s)
1.2	Trip Circuit Supervision (95)	Spring Charge	
1.3	Circuit Breaker Protection/Failure (50BF)	Test and Service Position,	
1.4	Anti-Pumping Relay	Trip Circuit Healthy	

2	Master Trip Relay (High Speed Trip Relay) with Hand Reset Contact (2 NO and 2 NC Contact)	Minimum 12 Window Annunciation Panel or Higher as Required.	
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CBCT shall be provided for SEF for outgoing feeder for cable protection.

Numerical protection relay for motor feeder shall be MiCOM 220 with RS 485 of Schneider or Equivalent of any approved make.

Relays and Meters

MFM shall be microprocessor based numerical and communicable type with RS 485 port. Communication link shall be provided between MFM and numerical relays for further communication to PLC/SCADA.

All instantaneous current protection relays shall be of 3 pole type.

Relays shall be rated for operation on 110V DC secondary voltage and 1A secondary current. Number and rating of relay contacts shall suit the job requirements.

All relays shall furnish, install and coordinate to suit the protection and interlock requirement of VCB panel.

Relay shall be low burden, provided with RS 485 computer communication port for monitoring and operation from Remote location/PLC with suitable Software.

Current Transformer

Current transformers shall be cast resin type and shall be as per IS: 2705 (Part 1 to 4).

CTs shall have shorting link on secondary side to facilitate insertion of meters on secondary side without opening CT circuits.

Accuracy class of the current transformers shall be as under.

- a) Class PS for differential and restricted earth fault relaying.
- b) Class 5P10 for other relaying.
- c) Class 0.5 for MFM.
- d) ISF < 5 for metering.

The CTs shall be capable for safely withstanding the short circuit stresses corresponding to the fault level as indicated and shall be able to meet short-time requirement specified.

All CT secondary shall be earthed through separate switch link on terminal block. CT terminals and their polarities shall be clearly marked.

Voltage Transformer

Voltage transformer shall be provided in separate cubicle.

PTs, connection, insulation levels shall be similar to rating of associated breaker.

VA burden shall be selected based on requirement for meters, closing, tripping and indicating circuit.

Voltage transformer shall be cast-resin, draw-out type, dual core (for secondary) for metering and protection separately and shall have an accuracy class 0.5 and 3P for metering and protection respectively. Voltage transformer mounted on breaker carriage is not acceptable.

The PTs shall be of shell type single phase construction with HRC fuses at both ends and plug-in connection on primary side.

High voltage windings of voltage transformer shall be protected by current limiting fuses. The voltage transformer and fuses shall be completely disconnected and visibly grounded in fully draw- out position.

Control MCB of suitable rating shall be provided on the secondary side to prevent overload. The PTs shall be capable of operating continuously at 110% of the rated voltage without any damage. When star-star connection is required in non-effective or under grounded system, the PTs shall be suitable for continuous operation with a persistent phase to ground fault.

Indication and Monitoring Instruments

Control cabinet, mounted on top of breaker cabinet, provided with suitable anti-vibration facilities and one number heavy duty spring return type TRIP-NORMAL-CLOSE control switch with pistol grip lockable handle.

Indicating lights to be provided in front of compartments as a minimum.

Green : Breaker Open

Red : Breaker Closed
 Amber : Auto Trip
 White : Trip Circuit Healthy
 Yellow : Breaker Test Position
 Blue : Breaker Service Position
 DC supply ON : White

Indicating lamps shall be 20 mm dia LED type with series resistance. Lamp and lens shall be replaceable from the front.

All indicating instruments shall conform to IS: 1248 (1983) and IS: 2419 (1979) and shall be capable of withstanding system fault current taking into account CT saturation, back connected and located in the upper part of the panel.

Meters

Indicating instruments shall be minimum 96 sq.mm. dial flush mounted digital type with accuracy class 0.5 minimum.

Digital type Multi Function Meter shall be three line display of accuracy class 0.5s for incomer and outgoing and suitable for measuring and digitally displaying following parameters. kVA, kW, kWh, kVAh, kVAr, kVArh, A, V, PF, frequency, Harmonic, MD measurement and control (MD control only in incomer feeder). Minimum 2 nos. digital output shall be available.

Each meter will be provided with at least two output signals of 4-20 mA and communication port (RS 485) for all above parameters for monitoring and operation from Remote location/PLC with suitable Software.

Meter selector switches shall maintain firm contact, stay put type with knob handle. Ammeter selector switches shall be four-position type having make before break contacts to prevent open circuit of CT secondary. Digital Power factor meter shall be provided separately for Incoming and Outgoing Feeder.

Annunciation

It shall be static type suitable to work on AC supply as specified. Hooter and bell for trip and alarm indication respectively.

Test, accept and reset facilities (with push button) shall be provided on each panel.

Suitable audio-visual indication shall be provided on DC failure. Audio alarm with reset facility shall be provided.

Visual indication shall be given panel wise.

Spare annunciation points shall be wired up to terminal blocks. 20% spare facia shall be provided. Sequence shall be as follows.

	VISUAL	AUDIO
On Occurring of Fault	Flashing	On
On Accepting	Steady On	Off
On Reset (Fault Cleared)	Off	Off
On Reset (Fault Persists)	Steady On	Off

Warning and emergency points shall be as per the list approved during detailed engineering stage. One common point shall be provided to indicate operation of annunciation system of the complete panel (in case of any trouble in the panel in tie feeder, bus coupler, incomer etc.). Remote and annunciation facia window details shall be finalized during detailed engineering.

A common audible alarm for each switchgear line up shall be provided to alert the Operator that circuit breaker has tripped. Means shall be provided for silencing the audible alarm whilst leaving it free to sound when any other alarm is initiated but the associated alarm indications shall continue until cancelled.

Secondary Wiring

Switchgear panel shall be fully wired at the factory to ensure proper functioning of control, protection, transfer and interlocking schemes.

Control MCB of suitable rating shall be provided to permit individual circuit isolation from bus/ wires without disturbing other circuits. All spare contacts of relays, switches and other devices shall be wired up to terminal blocks. Wiring shall be done with flexible, 650V grade; FRLS PVC insulated wires with stranded Copper conductors of 1.5 mm² for control current circuits and voltage circuits. All power wiring like space heater supply etc. shall be carried out with min. 2.5 mm² PVC insulated Copper conductor wire.

Each wire shall be identified at both ends with dependent and cross addressing permanent markers bearing wire numbers. Trip circuit shall have red colour ferrule.

Wire termination shall be made with crimping type ring connectors with insulating sleeves. Wires shall not be spliced between terminals.

The wires shall run preferably through PVC channel with cover adequately supported along its run to prevent sagging due to flexibility or vibration. The control and power wires shall be routed through separate channels. Inter panel wiring PVC channel shall be furnished for wiring between switchgear cubicles. All wiring required for interlocking between the cubicles of any switchgear shall be furnished and installed. Wherever wires are passing through cutouts or openings, they shall be protected by providing suitable grommet or gasket around the openings. Inter panel wiring at shipping sections shall be through terminal blocks placed suitably at intersection points. The colour of wire shall be taken as follows.

AC System	:	Black	
DC System	:	Grey	
Earthing System	:	Green	
CT and PT Wiring System	:	Red, Yellow, Blue Color Code	

Terminal Blocks

Terminal blocks shall be 660V grade box clamp type with 10 mm² marking strips.

Terminal for PT secondary lead shall be disconnecting link type. Power wiring circuits and PT secondary wiring circuits shall be terminated by bolt type terminal blocks and rest by screw type terminal blocks.

Not more than two wires shall be connected to any terminal. Spare terminals equal in number to 20% active terminals shall be furnished. Multi connection terminal strip to be used if required.

Wiring shall be so arranged that an external cable can be connected to consecutive terminals. Terminal blocks for external/space heater wiring shall be separate from inter panel wiring. All control wire shall be terminated with ring type insulated lug only.

The terminal block shall be grouped according to circuit functions and individual terminals in each block shall be serially numbered in accordance with the drawings. Such numbering shall be legible, permanent and indelible.

Communication port of meters and relays of individual breaker panel shall be looped together and brought out at External Terminal Connector/Block using instrument signal cable 1 pair, annealed Tinned Copper conductor flexible cable.

All spare contacts of Breaker, CT, Relay, Annunciator etc. shall be wired upto external TB.

Cable Termination

Switchgear panel shall be designed for cable entry from the bottom. Sufficient space shall be provided for ease of termination and connection with suitable size gland plates with knock out plates for specified HV cable connection. The design of cable box shall be such that any type of jointing methods such as heat shrinkable/push on type/cold shrinkable type termination can be adopted.

Ground Bus

A ground bus shall be minimum 40mm x 6mm Tinned Copper or higher as per requirement, shall extend the full length of the switchgear panel in all compartments including cable compartments etc.

Each stationary unit shall be connected directly to the ground bus. The frame of each circuit breaker and draw-out PT unit shall be grounded through heavy multiple contacts.

CT and PT secondary neutrals shall be earthed through removable links so that earth of one circuit may be removed without disturbing other.

All hinged doors shall be grounded using silver plated and braided copper flexible of adequate size.

Name Plates

Name plate shall be provided as per standard.

Space Heaters and Plug Sockets

Each cubicle shall be provided with thermostat-controlled space heaters and 5/15A, 6 pin plug socket, panel illumination lamp. Cubicle heater, plug/socket circuits shall have individual MCBs.

230V AC supply for HV panel shall be taken from LV panel in the plant/pumping station.

Auxiliary Power and Control Supply

- a) Control voltage shall be for
 - Closing, Tripping Coil : 110V DC
 - Indication Circuit : 110V AC
 - Spring charging motor, panel space heater, 3 pin socket and panel illumination : 230V AC
- b) Bus wires of adequate (minimum 4 sq. mm. Copper) capacity shall be provided to distribute the incoming supplies to different cubicles.
- c) DP MCB shall be provided at switchgear for the incoming supplies 230V AC supply and 110V DC supply (as applicable).
- d) Battery backup/power pack unit (1 No.) shall be provided for switchgear panel for 110V AC/110V DC for closing and trip circuit suitable for minimum two successive open and close operations after failure of power. Power pack connected on 110V AC PT supply OR 110V DC, shall be minimum 100 Ah capacity or higher as required.
- e) Battery and Battery Charger and DCDB shall be provided if specified in the scope of work/SOQ.

Tropical Protection

- All equipment, accessories and wiring shall have fungus protection involving special treatment of insulation and metal against fungus, insects and corrosion.

Screens of stainless steel shall be furnished on all ventilating louvers to prevent entrance of insects.

Painting

The HV panel shall be treated with seven tank process with cleaning of scale, grease, rust and foreign adhering matters and chemical de-rusting, sand blasting, degreasing, pickling in acid bath and phosphating as per IS: 6005 and primed.

After cleaning, the surfaces shall be given 2 coats of epoxy primer.

After seven tank process and primer coating, panel shall be powder coated with **RAL 7035** for inside and outside of the entire panel.

Inspection and Tests

The switchgear panel shall be completely assembled, wired, adjusted, inspected and tested at the factory/works as per relevant applicable standards.

Routine Tests

The tests shall include but not necessarily limited to the following for switchgear panel.

- a) Operation under simulated service condition to ensure accuracy of wiring, correctness of control scheme and proper functioning of the equipment.
- b) All wiring and current carrying part shall be given appropriate High Voltage test.
- c) Primary current and voltage shall be applied to all instrument transformers.
- d) Routine test shall be carried out on all equipment such as circuit breakers, instrument transformers, meters etc.
- e) Power frequency withstand insulation HV test for main circuits, auxiliary and control circuit as per relevant IS.
- f) Milli-volt drop test across main contacts of each phase of VCB and close and open time test for VCB shall also be a part of Routine Test.

Test Witness

Panel builder/integrator/manufacture shall perform all the tests as per IS/IEC Standards and specifications on all the panels (100% quantity of the project/tender lot) @ factory/works' in presence of Client/PMC/TPI.

Test Certificate

- a) Certified reports of all tests carried out at factory/works shall be furnished in four (4) copies for approval of the Client.
- b) The panel shall be dispatched from factory/works only after receipt of Client's written approval.

The test reports shall furnish complete identification of panel such as serial number, rating, equipment designation as per drawings/documents etc. and date of tests carried out.

DISTRIBUTION TRANSFORMER

Scope

The scope covers the detailed requirements regarding supply, installation, testing, commissioning of transformers required for the indoor/outdoor installation in substation, meeting the requirements specified in the data sheet.

Associated civil works i.e. RCC pedestal/platform and fire wall as required for installation of transformers are also included in the scope.

Standards and Compliances

The transformer shall comply with IS: 2026 (Part I to V) and IS: 1180 Part I (2021) (latest editions) and shall be suitable for service under voltage and frequency fluctuation conditions as permissible under Indian Electricity Act. Transformers shall meet the requirements of governing standards and loading requirements in accordance with IS: 6600.

General Construction

Transformers shall be capable of operating continuously and without adverse effects of overheating under all specified conditions of operation including variation in system of $\pm 10\%$ voltage and $\pm 3\%$ frequency or $\pm 10\%$ combined voltage and frequency unless otherwise specified.

Transformer shall be indoor or outdoor type as specified. Unless otherwise specified the transformer in addition shall have thermal and dynamic ability to withstand external short circuit as per clause 9 of IS: 2026 Part I (1977).

Transformer shall be designed for frequent direct on line starting of motors having an equivalent rating in kVA up to CMR of the transformer and shall be capable of withstanding the forces arising from the starting currents of these motors.

Transformer shall be supplied with first filling of oil and 10% extra oil in non returnable drums conforming to IS: 335. The BDV of oil shall confirm to IS/IEE standards at the time of delivery at site and also at the time of commissioning.

Transformer rated **2000 kVA and above** shall be considered with OLTC and RTCC, if specified otherwise in tender/SOQ.

For transformer rated 2000 kVA and above, neutral CTs for stand by Earth Fault and REF protection shall be provided along with differential protection. Neutral CTs shall be provided before bifurcation of neutral.

Creepage distance of 31 kV/mm is to be considered.

All hard ware shall be hot dipped GI.

The Maximum Total Losses and % Impedance for transformer ratings up to and including 2500 kVA shall be as per **Energy Efficiency Level 1** as clearly specified in Table 3 (For and Up to 200 kVA Ratings) and Table 6 (From 250 kVA to 2500 kVA Ratings) of IS: 1180 Part I (2021).

For transformer ratings above 2500 kVA the maximum permissible losses and % impedance shall be as per CBIP Manual/Publication (Latest Version) and are indicated under as reference.

Transformer Rating	Maximum Permissible Load Losses with IS Tolerance	Maximum Permissible No Load Losses with IS Tolerance	% Impedance Voltage with IS Tolerance
3150 kVA	20 kW	2.9 kW	6.25%

4000 kVA	27 kW	3.2 kW	7.15%
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Taps and Tap Change Gear/Device

Tap changing device to be provided for voltage variation on HV side and shall be either off circuit type or on load type as specified in SOQ/tender.

Off Circuit Tap Change Gear (Off Load Tap Changer)

Off circuit type tap changer shall be externally hand operated with necessary indication for tap position and pad locking arrangement at all tapping positions.

It shall be, designed for bi-directional operation; self-positioning type and shall have total seven (7) number of tap positions and voltage variation ranging from +5% to -10% in steps of 2.5%.

The tap changers shall be off circuit type mechanical, rugged and arranged to provide for convenient operation and maintenance without necessity of un-tanking.

The position indicators shall be positive and there shall not be any ambiguity resulting into incomplete tap change with respect to the mechanical tap position indication.

The operating handle of tap changer shall be brought out of the tank at the side at an accessible height from ground level. Tap changer operating switch mounted on the top of the transformer tank will not be acceptable.

Provision of padlocking the tap changers without interfering with visual tap position indicator shall be provided. The tap changing handle shall have locking arrangement of suitable size.

On Load Tap Change Gear (OLTC)

OLTC shall be with +5% to -15% taps in steps of 1.25% on HV winding of transformer. It shall have following technical features.

OLTC gear shall be designed to complete successfully tap changes for current equal to 120% of current at minimum tap position of the transformer. Also, OLTC over loading capability shall be compatible with that of transformer specified in IS/IEC specifications "Guide for loading of oil immersed transformers". Devices shall be incorporated to prevent tap change when the through current is in excess of the safe current that the tap changer can handle. OLTC gear shall withstand through fault currents without injury.

When a tap change has been commenced it shall be completed independently of the operation of the control relays and switches. Necessary safeguard shall be provided to allow for failure of auxiliary power supply or any other contingency which may result in the tap changer movement not being completed once it is commenced.

Oil in compartments which contain making and breaking contacts of OLTC shall not mix with oil in other compartments of the OLTC or with transformer oil. Gases released from these compartments shall be conveyed by pipe to separate oil conservator or to segregated compartment within the main transformer conservator. An oil surge relay shall be installed in above pipe. The conservator shall be provided with prismatic oil level gauge.

Oil, in compartments of OLTC which do not contain the make and break contacts, shall be maintained under conservator head by valved pipe connections. Any gas leaving these compartments shall pass through the oil surge relay before entering the conservator.

Oil filled compartments shall be provided with filling plug, drain valve with plug, air release vent, oil sampling device, inspection window with view glass.

OLTC driving mechanism and its associated control equipment shall be mounted in outdoor, weather proof cabinet conforming to degree of enclosure i. e. protection IP 55. The finish shall match with that of the transformer on which

it is mounted. The cabinet shall include following.

- Driving motor (415V, 3 Phase, 50Hz, AC squirrel cage),
- Mechanically and electrically interlocked motor starting contactors with thermal overload relay, isolating switch and MCCBs,
- Duplicate sources of power supply with automatic changeover from the running source to the standby source and vice versa will be provided in transformer marshalling box and one number outgoing feeder extending to OLTC driving motor cabinet, with appropriate provision for receiving the same,
- Control switch: Raise/Off/Lower (spring return to normal type) or independent push buttons,
- Emergency “OFF” push button (maintained type),
- Remote/Local selector switch (maintained contact type),
- Mechanical tap position indicator,
- Limit switches to prevent motor over-travel in either direction or final mechanical stops,
- Appropriate scheme/device to permit only one tap change at a time on manual operation,
- Emergency manual operating device (hand crank or hand wheel),
- A five digit operation counter,
- Space heaters with thermostat and MCB,
- Control transformers with MPCB/MCBs on primary and secondary sides for each supply,
- Interior lighting fixture with lamp, door switch/ON-OFF switch and MCB,
- Gasketed and hinged door with locking arrangement,
- Terminal blocks, internal wiring, earthing terminals and cable glands for power and control cables,
- Necessary relays, contactors, current transformers etc. and
- Transducers or any other appropriate device for remote tap position indication.

Control Requirements for OLTC

The following electrical control features shall be provided.

- Positive completion of load current transfer, once a tap change has been initiated, without stopping on any intermediate position, even in case of failure of external power supply.
- Only one tap change from each taps change command even if the command is maintained.
- Cut off of electrical control when manual operation is resorted to.
- Cut off of a counter impulse for a reverse tap change until the mechanism comes to rest and resets the circuits for a fresh operation.
- Cut off of electrical control when it tends to operate the tap beyond its extreme position.

Remote Control Equipment

OLTC remote control equipment shall be housed in an indoor sheet steel cubicle to be located in a remote-control room. It shall conform to degree of enclosure protection IP 42 or better and shall comprise the following.

- Control switches: Raise/Off /Lower (spring return to normal type) or independent push buttons,
- If automatic operation is specified, auto/manual selector switch (maintained contact type) and other items as listed,
- If parallel operation is specified, master/independent/follower selector switch (maintained contact type) with, out of step annunciation,
- Tap position indicator,
- Facia type alarm annunciators with “accept”, “lamp test” facilities and hooter/buzzer for alarms as listed,
- Necessary auxiliary relays,
- Lamp indications for: Tap change in progress, Lower limit reached & Upper limit reached,
- Transformer cooler control apparatus (if applicable),
- Cable glands for power and control cables,
- 240 V rated panel space heater with thermostat,
- CFL type interior lighting fixture with lamp and door switch,
- MCBs,

- Terminal blocks,
- Internal wiring,
- Earthing terminal,
- Hook up for the remote operation of tap lower and raise operation and contact and
- signal for tap position indication to Client's DCS shall be incorporated in the panel.

Automatic Control of OLTC

Automatic voltage regulator (AVR) for auto control of OLTC shall include following.

- Voltage setting device,
- Voltage sensing and voltage regulating devices,
- Line drop compensator with adjustable R and X elements,
- Timer 5-25 seconds for delaying the operation of the tap changer in the first step for every tap change operation,
- Adjustable dead band for voltage variation and
- Additional features as required when parallel operation with other transformers is specified.

Alarms

The following alarms shall be provided.

- AC supply failure,
- Drive motor auto tripped,
- Other protective purpose considered essential by the Contractor,
- Out of step operation when paralleled transformers supposed to operate on the same tap are operating at different taps,
- Tap change delayed,
- AVR failure (if AVR is specified),
- For the all specified above a "OLTC trouble" group alarm to be provided in DCS which is located in control room and
- Others, as specified.

Annunciation

Microprocessor based annunciation, minimum 6 window or higher as required shall be provided for following fascia.

- AC supply fail
- out of step relay operated
- tap changer motor trip
- tap change incomplete
- spare
- spare

Tests

1) Routine Tests

Routine tests as per IS: 8468 shall be performed on all OLTCs and motor drive mechanisms. Over and above, pressure and vacuum tests shall be conducted as per IEC: 60214.

2) Type Tests

Type tests as per IS: 8468 shall be carried out on OLTC and motor drive mechanism when called for. The Bidder shall indicate in his price schedule extra price, if any, for carrying out these tests. If type tests are not called for, type test reports for tests conducted on a similar or higher rating OLTC and motor drive mechanism shall be submitted for Client's approval.

Additional Requirements

Tap position indicators and OLTC control switch shall be supplied loose if Client decides to mount the same in the power transformer control panel.

The finish and dimensions of the panel shall be as specified so as to match with the other panels in remote control room.

Fittings and Accessories

All transformers shall be supplied/fitted with following accessories as per relevant IS.

- Inspection cover,
- Buchholz relay with alarm and trip contacts (**for transformer ratings of 250 kVA and above**),
- Marshalling box of IP 55 class of protection,
- Sampling valve with plug or cover plate,
- Magnetic oil level gauge and Plain oil level indicator with minimum mark,
- Conservator and conservator drain valve,
- Bi-directional rollers,
- Oil temperature indicator with alarm and trip contacts,
- Bottom drain and filter valve with plug or cover plate,
- Double diaphragm explosion vent,
- Silica gel breather,
- Air release plug/device,
- Separate neutral bushing,
- Top oil filter valve,
- Jacking pads,
- Lifting lugs,
- Two earthing terminals,
- Thermometer pocket for OTI,
- Winding temperature indicator with alarm and trip contacts,
- Pressure relief valve (**for transformer ratings of 200 kVA and above**),
- Rating and diagram plate,
- Neutral CTs (NCT) for REF and Back-up E/F protection, differential protection (**for transformer ratings of 2000 kVA and above**),
- OLTC and RTCC panel (**for transformer ratings of 2000 kVA and above** if specified elsewhere in tender/SOQ),
- Oil surge relay (**only for transformers with OLTC**) and
- Any other required as per IS: 1180/IS: 2026

Accommodation for Auxiliary Apparatus

Where specified, Neutral CTs to be provided for the protection such as, restricted earth fault, back up earth fault and differential protection.

Rating Plates and terminal Plates

The followings plates shall be fixed to Transformer in a visible position.

- a) Rating Plate and Terminal marking plate shall be provided as per IS: 2026 Part:1/IS: 1180 Part:1 (2021).

Gas and Oil Actuated (Buchholz) Relay

Buchholz Relay shall be provided with isolation valve on both the sides for transformers of capacity 250 kVA and

above.

The design of the relay mounting arrangements, the associated pipe work shall be such that mal-operation of the relays shall not take place under normal service. The pipe work shall be so arranged that all gas arising from the transformer shall pass through the gas and oil actuated relay.

The oil circuit through the relay shall not form a delivery path in parallel with any circulating oil pipe, nor shall it be tied into or connected through the pressure relief vent, Sharp bends in the pipe work shall be avoided.

All wiring connections, terminal boards, fuses and links etc. connected with gas actuated relays shall be suitable for tropical atmosphere. Any wiring liable to be in contact with oil shall have oil resistant insulation and the bared ends of stranded wire shall be sealed together to prevent seepage of oil entering connection boxes used for cables or wiring.

Cable Box/Bus Duct Box

Cable box shall not be mounted on the tank covers. It shall be feasible to remove the tank covers for inspection during maintenance etc. without recourse to breaking the joints or disturbing the cables already terminated. Necessary removable links in oil approachable through inspection cover in tank cover etc. after lowering oil shall be provided for test purpose. HV cable box shall be considered with disconnecting chamber.

Cable box entry shall be suitable for the size and number of run of cables. Gland plate shall be provided with required number/size of knockouts for cable terminations.

In case of bus duct, bus duct box of suitable type shall be provided.

In case of ACSR conductor connection on HV side, vertical bushing of suitable type and size shall be provided.

Parallel Operation

Transformers shall be suitable for parallel operation when explicitly mentioned in SOQ. For parallel operation of transformers, the transformers shall have identical percentage impedance, transformer (X/R) ratio, voltage ratio, vector group, phase sequence, polarity, phase angle etc. as minimum.

Tests

1) Tests at Works

All routine (Impedance voltage and load loss, no load loss and excitation current, applied voltage, induced voltage, resistance measurement, ratio tests, polarity and phase relation, insulation resistance leakage etc. tests) and other tests prescribed by IS: 1180 Part: 1 (2021) shall be carried out at the manufacturers' works' before dispatch of the transformers without any additional cost to the Client.

For all transformers **rated below 500 kVA**, all routine tests as narrated above shall be carried out by the manufacturers' works' before dispatch of the transformers. Certified copies of test certificates shall be furnished to the Client/PMC/TPI for review and approval.

For all transformers **rated 500 kVA and above**, all routine tests as narrated above shall be carried out in the presence of Client/PMC/TPI.

In addition to the prescribed routine tests, heat run/temperature rise test shall be invariably done on one transformer of each design for ratings of 2000 kVA and above.

For transformers with ratings lower than 2000 kVA, temperature rise test certificate of identically rated transformer carried out as type test shall be submitted for review and acceptance.

In case, heat run/temperature rise test is to be carried out on transformers below 2000 kVA ratings, it shall be clearly

specified in SOQ of the tender.

A copy of the impulse test certificate done on the same type/design of the transformer shall be furnished in accordance with IS for purpose of record. If no impulse test was done in an earlier unit of the same design and capacity, one transformer will be subjected to impulse test in consultation with the Client/PMC/TPI at Vendor/Contractor's cost.

Copies of the certificates for pressure test, bushings test and type test for short circuit shall be supplied to the Client/PMC/TPI for review.

Further if specified explicitly in SOQ/tender, one transformer of each type, design and rating approved from the project (tender) lot shall be selected randomly and sent to **ERDA** for determination/varification of losses. Costs incurred for such a test shall be paid separately as per SOQ. If values of losses so determined by ERDA, do not match with allowable maximum losses of particular rating, as specified in IS: 1180, such transformer shall be outrightly rejected and the Contractor shall replace the transformer without any additional cost to the Client.

2) Tests at Site

In addition to tests at manufacturers' premises, all relevant pre commissioning checks and tests conforming to IS code of practice No. 10028 (Part II and III) shall be done before energization.

The following tests are to be particularly done before cable joints or connecting up the bus bar trunking.

- a) Insulation test between HV to earth and HV to MV with 5000 volts Megger.
- b) Insulation test between MV to earth with 500 volts Megger.
- c) Di-electrical strength Test on oil.
- d) Buchholz relay operation by simulation test when fitted.

All test result is to be recorded and reports should be submitted to the department.

Installation and Commissioning

Fire protection system for transformers shall be provided as per CEA (measures relating to safety and electric Supply) Regulations/IE Act/Electrical Inspector. Separation walls or fire barrier wall shall be provided between the transformers as per the requirement. An oil soak pit/common burnt oil pit of adequate capacity with necessary valves/suitable pumping facility to keep the pit empty shall be provided as per applicable Standards/IE ACT/Regulations/Notification.

The transformer shall be installed in accordance with IS: 10028 (Part II and III) code of practice for installation and maintenance of transformer. Necessary support channels shall be grouted in the flooring.

The transformer shall be moved to its location and shall be correctly positioned. Transformer wheels shall be either locked or provided with wheel stoppers.

Transformer oil supplied in drums shall be topped up into the transformer after duly testing/filtering up to the correct level required.

Drying out of transformer winding will be necessary when the dielectric strength of the oil is lower than the minimum value as per IS: 10028 or the transformer has not been energized within 12 months of leaving the works or where the radiator assembly is done at site.

The transformer shall be dried out/filtration done by one of the methods specified in IS: 10028. Drying out with centrifugal or vacuum type filters will, however, be preferred. The contractor shall carry out the process of drying without interruption and shall maintain a log sheet indicating time, oil temperature and insulation resistance. BDV test shall be carried out and records to be maintained.

SWITCHYARD AND TRANSFORMER YARD WITH FENCING AND GATE

Fencing around the outdoor transformer substation/11 kV switchyard.

The fencing shall be at a distance of not less than 1.5 meter on all sides of the substation (pole structure and transformer plinths, as applicable) to ensure free movement all round.

Fencing shall be with GI chain links with proper MS angle supports. The posts shall be 75mm x 75mm x 6mm angle/channel of 3meter long. The post shall be 2.4 meter above finish ground level (FGL) and 0.6 meter below FGL, fixed in 1:4:8 cement concrete foundation of size 250mm x 250mm.

GI heavy duty chain link fencing panel of size 2meter width and 2meter height made from 50mm x 50mm angle frame and covering with GI wire chain mesh 75mm, 8 SWG. Cross support of GI flat of minimum 50mm x 6mm shall be provided diagonally in the frame. Frame shall be fixed to the post with heavy duty GI bolts.

A gate of minimum 3metre (2meter x 1.5meter) with GI heavy angle frame as above and with chain link fencing as per above details shall be provided with necessary access (road/pathway) for easy mobility of each transformers/vehicular movement and for ease of O and M of switchyard/transformer yard.

Minimum 2 hinges shall be provided on each side of the gate.

Two coats of Aluminium paint over a coat of Aluminium primer shall be applied on fencing post, fencing panel and gate. Final one coat of paint shall be applied after completion of work at site at the time of handing over.

Fencing and gates shall be installed as per site condition and actual requirement.

Fencing shall be earthed properly covering all rows on all sides. Fencing shall be connected to earthing grid through suitable size hot dip galvanized earth strip as specified else where.

Caution notice should be fixed one on the 2/4 pole structure and at suitable location near transformers and another on the gate.

The sub station shall be uniformly levelled after proper ramming. Brick soling of thickness 75mm including consolidating by proper ramming, providing 100mm thick layer of 1:3:6 cement concrete and then spreading 40 mm aggregate stone jelly of thickness 100mm.

The above shall be done for transformer yard and also 1 meter all around the fencing.

Transformer details like name of the manufacturer, rating, year of manufacture, date of charging etc. shall be painted on the fire wall at suitable location for clear visibility.

LV PANELS: PCC/PMCC/MCC/APFC/LVDB/OTHER SWITCH BOARDS

Panel shall conform to Indian Electricity Act and rules CEA Notification/Guidelines, CPWD guidelines 2019 as amended up to date and shall be as a minimum.

The LV switchboard panels shall be floor mounting, free standing, compartmentalized, extensible, Modular type suitable for indoor installation. The panel shall be totally enclosed and dust, damp & vermin proof. Enclosure shall have IP 52 or better degree of protection for indoor unit and IP 55 or better degree of protection for outdoor unit as a minimum. Outdoor unit shall be double door and additionally provided with canopy or weather shed for protection.

Panel construction shall be complying to Form 3b type as per IS/IEC 61439 (i.e. separation of bus bars, all functional units and of terminals and external conductors etc. shall be as per Form 3b type as per IS/IEC 61439). Only metallic sheet shall be used for compartment separations/partitions. Hylam/PVC sheets shall not be allowed.

LV panels/switch boards sheet steel shall be CRCA minimum 2 mm for load bearing members, mounting plate,

partition, doors/covers, canopy. Gland plate shall be CRCA sheet minimum 3 mm thick. All the doors and others openings shall be provided with neoprene rubber gaskets or of durable material gaskets.

All hardware shall be corrosion resistant. Star washers shall be used for effective continuity.

Suitable lifting arrangement with L angle welded at top for PMCC/MCC/APFC etc. shall be provided on each panel or on each shipping section for ease of lifting of switchboard.

A base channel of 100 mm x 50 mm x 5 mm thick shall be provided at the bottom of the panel on all four sides of each shipping section.

Overall height of panel shall not exceed 2300 mm (For VFD/Soft starter panel height up to maximum 2500 mm can be accepted) including minimum 100 mm ISMC base frame. However, in case of panel mounted on floor without cable trench shall be mounted at least 500 mm above the floor level to provide adequate bending radius for in and out cables. Folding type stand of minimum height 500 mm with folding CRCA cover/sheet of 1.6 mm thick all around the stand shall be provided. **Operational height of starters and control switch gear shall not exceed 1800/1900 mm above FFL (irrespective of overall height of panel) for ease of operation.**

Shipping section length shall be maximum 2500 mm. Each shipping section shall have full side sheets of 2 mm thick on both the sides. Vertical partition of incomer/bus coupler/outgoing feeders etc. shall be of full depth of the panel. Detachable gland plate shall be provided at the top on both the ends of the shipping sections for connecting/joining of bus bars.

Minimum dimension of incomer, bus coupler, starter, MCCB cubical compartment shall be as per the Table. Height of main horizontal bus bar chamber shall be minimum 300mm up to 630A rating and 350 mm or higher for 800 A and above. Vertical bus bar shall be minimum 300mm or higher as per kA level and temperature rise required. Minimum width of cable alley shall be 350mm or higher as per number of cables.

All type of meters shall be digital type. Ampere meter and voltmeter shall be single phase and separate selector switches shall be provided. Meter with inbuilt selector switches is not acceptable.

Control MCB shall be provided for control wiring circuit. Panel shall be of fuse less design.

CT on Y phase with digital ammeter to be considered from 7.5 kW to less than 15 kW motor feeders. 3 Nos. CTs with digital ammeter and ammeter selector switch to be considered for motors rated 15 kW and above and less than 30 kW. Digital multi function meters are to be provided for motors of 30 kW and above.

RS 485 of all meters/MFMs shall be looped together inside the panel and brought out in the cable alley.

LV panel shall be of fixed type, single/double front. LV panel shall be single tier for incomers and bus coupler feeders rated 500A and above. Panels with VFD and soft starter feeders rated 22 kW and above shall be in single tier only while the same shall be in single tier or two tier for less than 22 kW VFD/soft starter feeders.

Outgoing ACB feeder of 1000 A and above ratings shall be in single tier only.

Vacant space on incomer and bus coupler panel shall not be used for mounting the starter, switch gear modules, MCB feeder. Fixed capacitor/reactor may be housed below bus coupler with steel sheet separation/barrier.

VFD starter panel shall be stand alone panel in case of VFD for motors rating > 150 kW with minimum height of panel – 1800 mm. This provision does not apply in case of VFD panels to drive equipment like

turbo blowers etc.

All auxiliary devices for control, metering, protection, indication and measurement such as push buttons, control and selector switches, indicating lamps, ammeters, voltmeters, kWh meters and protective relays shall be mounted on the front side of respective compartment, for easy operation without opening the door. Metering cubicle shall be separate/independent of ACB/MCCB incomer feeders.

Circuit breakers of required capability/suitability to interrupt applicable capacitive current shall be specifically verified/supported by manufacturers' recommendations.

The switch board components, bus bars etc. shall be designed to withstand the maximum designed short circuit level for minimum 1 second.

MCCB shall be TPN/4P, microprocessor-based release/thermal magnetic release as specified elsewhere. All MCCBs shall be suitable for $I_{cs} = 100\% I_{cu}$. The rated service short circuit breaking capacity (I_{cs}) of MCCBs shall be more than or equal to the specified fault level. MCCB shall be supplied with extended rotary handle, terminal spreader, auxiliary C/O + trip contact as applicable.

Rating of MCCB/MPCB, contactors, relay etc. of motor feeders as recommended by equipment manufacturers' and shall comply with Type 2 Coordination as per IS: 60947.

Panel shall have main horizontal and riser bus bars, air insulated with coloured heat shrinkable PVC sleeves, housed in a separate compartment, segregated from all other compartments, with sheet steel barriers, sufficient louvers with wire mesh for air circulation.

The LV panels shall be provided with a continuous earth bus having sufficient cross section to carry the specified fault current for specified duration without exceeding the safe temperature throughout its entire length.

All control wiring except CT secondary wiring shall be carried out with minimum 1.0 mm² FRLS PVC copper flexible wires (Grey). CT secondary wiring shall be carried out with 2.5 mm² FRLS PVC copper flexible wires (Color coded).

Adequately rated anti condensation heater with porcelain connectors shall be provided in each breaker panel and in cable alley to maintain inside temperature 5 °C above outside ambient temperature. It shall be supplied from 240V AC auxiliary bus for space heater. The space heater shall be provided with a thermostat having variable setting of 30-70 °C and manually operated switch fuse and link for phase and neutral respectively.

All starters shall be provided with Auto-Off-Manual and Local-Remote selector switches (where start PB provided at panel end) to monitor and operate MCC or LCS, ICP/PLC.

All ACBs, MFM, VFD, Soft Starters where provided shall have inbuilt RS 485 port to communicate with PLC/SCADA for monitoring and control. RS 485 terminal shall be wired upto external TB with shielded wire.

240V AC control supply shall be fed from 415/230V AC constant voltage/control voltage transformer (with $\pm 2.5\%$ and $\pm 5.0\%$ tapings on both primary and secondary sides) one number on each bus of minimum 1.5 kVA rating (for less than 630 Amps connected load), and higher kVA rating depending on total connected working load. Suitable control logic through contactors shall be provided such that control supply is available to all feeders based on incomer 1 and incomer 2 status. Only one control transformer shall be ON at a time. **Separate control transformer 415/230V of suitable VA rating shall be provided for incomers. DP MCB of suitable rating shall be provided on both incoming as well as outgoing side of control transformer.** All CTs, PTs and constant voltage/control

transformer shall be cast resin type with terminals. CT shorting link type control terminal shall be provided. Only Ring type lugs shall be used for CT termination.

2 Nos. auxiliary contactors to be considered for PLC interface.

All capacitors generally shall be at 440V or 525V if provided with detuned reactor or as specified in BOQ. Capacitors shall be heavy duty type with discharge resistors and with dielectric losses $\leq 0.2\text{w/kVAR}$.

Following communication RS 485 Modbus, DI, AI and DO, AO to be considered for various type of feeder for PLC/SCADA interface.

	INCOMER (ACB/MCCB)	SOFT/VFD/SD STARTER (MPR)	MOV
Communication	Inbuilt Modbus RS 485 for control and monitoring metering, energy and protection parameters (Applicable only for ACB)	Modbus RS 485 monitoring and control (SS and VFD) & MPR Only monitoring & Trip. In VFD: PF, energy saving also to be monitored.	-
Digital Input (DI)	Breaker ON/OFF	Motor Run	Valve Open
	Breaker Trip	Motor Trip	Valve Close
	Auto/Manual	Auto/Manual	Local/Remote
		Local/Remote	Trip/Fault
Digital Output (DO)	Breaker ON/OFF (latched type)	Start/Stop (latched type)	Valve Open
			Valve Close
Analog Input (AI)		Speed Feedback (Only for VFD)	Valve Position Feedback
Analog Output (AO)		Speed Reference (Only for VFD)	Valve Position Reference (Only for VFD)

In addition to above MFM and Temperature scanner with RS 485 Communication MODBUS shall be taken for interfacing with PLC/SCADA for monitoring and for controlling further as required.

Bus Bar

Bus bars shall be of high conductivity, electrolytic Aluminium (E91E) suitable for carrying the rated and short time current without overheating supported on insulators made of non hygroscopic, non flammable material to ensure free thermal expansion with tracking index equal to or more than that defined in IS.

Aluminium bus bars shall be sized for maximum 0.8 A/mm^2 current density only.

Whenever incoming supply is through bus duct, incoming bus bar of incomer shall be extended till the top end of panel and phase positioning/orientation of bus bars shall be suitable for transformer LV terminal arrangement to avoid additional phase cross over chamber.

Bus bars for risers shall be rated to carry minimum 80% or higher of the rated current of all feeders connected to the risers as per the design of the system/loading.

The current rating of neutral shall be minimum half that of phase bus bars. For LDB neutral rating shall be equal to that of phase bus bar.

Both horizontal and vertical TP and N, bus bars, bus joints and supports shall be capable of withstanding dynamic and thermal stresses of the specified short circuit currents for 1 second.

Only high tensile steel bolts, nuts and washers duly zinc passivated or cadmium shall be used for all bus bars joints and supports.

The hot spot temperature of bus bars including joints at design temperature shall not exceed 85 °C for normal operating conditions.

All bus bars shall be insulated with heat shrunk PVC sleeves of 1100V grade.

The bus bars shall be arranged such that minimum clearance between the bus bar for 50kA fault current shall be maintained as below.

- Between phases : 27mm minimum
- Between Phase and Neutral : 25mm minimum
- Between phase and Earth : 25mm minimum

To fulfill the requirement of 65kA for 1 second, necessary clearance as per relevant IS shall be maintained.

Auxiliary Supply Bus Bars

Auxiliary bus bar of **Tinned Copper EC grade** of suitable size shall run throughout the length of main busbar/vertical bus bar alley and supply shall be tapped to individual feeder directly from the bus and shall not be looped between the feeders. Control MCB shall be provided for individual feeder. Auxiliary bus shall be provided for following applications. Exact size/capacity of bus bar shall depend on various controls, metering and auxiliary power distribution requirement.

- Panel space heater supply and motor space heater supply,
- Control supply for breaker tripping, closing and indication circuits,
- Control supply for breaker spring charging motors, motor starter control and indication circuits and
- AC potential supply for MFM, meters, starter and voltage operated relays etc.

• Power and Control Wiring and Terminal Blocks

All wiring shall be done with FRLS PVC copper flexible wires with IS marks. The insulation grade for these wires shall be 660V grade. The control wiring shall be enclosed in plastic channels/Race way and neatly bunched together.

Control circuit wiring shall be FRLS PVC copper flexible wire of minimum 1.0 mm² size and CT circuit wiring shall be minimum 2.5 mm² size. CT wiring shall be R Y B colour coded and terminals shall be CT shorting link type only. Power wiring inside the starter module/MCCB/MCB shall be rated for full current rating of feeder MCCB/MCB.

All feeder modules shall be provided with neutral link. Suitable size and rating terminal blocks shall be provided for all outgoing feeders in the cable alley for connecting power and control cables. Cable shall never be connected directly to MCCB/MCB terminals.

Flexible wire shall be used only up to and including 100 A MCB/MCCB. For above 100 A MCCBs bus bar shall be used. Minimum size of FRLS Copper wire shall be up to and including 16A: 2.5 mm²; 20A: 4 mm²; 32A: 6 mm²; 40A: 10 mm²; 50A: 16 mm²; 63A: 25 mm². and 100A: 35 mm².

Each wire shall be identified at both ends by PVC ferrules. Inter panel wiring shall be done through rubber grommets. A minimum of 2 numbers or 20%, whichever is higher, spare terminals shall be provided on

each terminal block.

Marking on the terminal strips shall correspond to wire numbers on the wiring diagrams. All spare contacts and terminal of panel mounted equipment and devices shall be wired to terminal blocks.

Earthing

The minimum earth bus size shall be minimum **65mm x10mm (hot dip galvanised strip) or 40mm x 10mm (Aluminium) or** higher to suit the fault level/kA requirement.

All doors and movable parts shall be earthed using minimum 1.5 mm² FRLS Copper flexible wires (Green colour) to the fixed frame of the switch board. Provision shall be made to connect the earthing bus bar to the plant earthing grid at two ends. All non-current carrying metallic parts of the mounted equipment shall be earthed. Minimum 4 numbers, 10 mm dia. hole shall be provided on the earth bus for termination of earth strip/wire.

Name Plate

Name plates shall be provided as per standards.

LV panel shall be with details like name of Client (on first row/top row), Project name (second row), name of Contractor (third row) and Panel builder/manufacture (in fourth row) all with equal of descending order letters size on top of front side of panel.

LV panel shall be with name plate (on front side of door of incomer) having minimum details like (1) Power supply voltage, (2) Control supply voltage, (3) Frequency, (4) Panel fault level, (5) Panel protection class and (6) Panel manufacturing IS standards considered etc. details.

16.27 Painting

The LV panel shall be treated with seven tank/nine tank process with degreasing, water rinsing, De-rusting, water rinsing, phosphating, water rinsing, passivation.

After seven tank process the external paint shall be powder coated with Siemens grey RAL 7035 for inside and outside of LV panel.

Mounting plate shall be painted Glossy white.

Thickness of paint shall be between 100 Micron to 120 Micron.

Switchgear Modules

16.28 Air Circuit Breakers

Circuit breakers shall be air break, electrical draw out type for feeders 630A and above. All ACB shall be with microprocessor based release with overload, short circuit and inbuilt earth fault protection. Only for APFC incomer thermal magnetic type can be accepted.

The ACB shall be minimum 50kA (1 Second) or higher as per fault rating, $I_{cs} = 100\%I_{cu} = I_{cw}$. All ACBs shall comply and tested as per IS: 13947/IEC 60947-1 and IEC 60947-2 standards.

ACB for all incoming, Bus coupler should be Four Pole Type. PCC outgoing feeders shall be Four Pole/Three Pole + Solid Neutral (TPN) Type.

ACB for incoming and bus coupler shall be identical and interchangeable.

ACB models shall be: **Schneider: Master pact NW, Siemens: 3WL, L & T: U power, ABB: E-Max; or Equivalent** model from Approved Vendor list. Data sheet with parameter comparison shall be submitted for approval.

ACB shall be with **inbuilt Communication Module** RS 485 for MODBUS for communication with SCADA/PLC for both control and monitoring.

Electrical and mechanical interlocking shall be provided between ACB incomers and bus coupler with required key locks, under voltage coil etc. as per the system requirement. Only ACB auxiliary built-in contact shall be used for interlocking i.e. auxiliary contactor/plug-in relay shall not be used.

ACB Trip Release LSIG (Micro Processor based) should have minimum as following.

- Overload with time delay
- S/C with time delay and instantaneous trip setting
- Earth fault with time delay
- Under/over voltage for incomer
- LSIG fault record display (Only For Incomer and Bus coupler)
- Metering and Energy display (Only For Incomer and Bus coupler)
- Ammeter display (For Outgoing feeders)

16.29 ACB shall be fitted with following.

- Auxiliary built-in contacts having not less than 4 NO + 4NC contacts
- Built in resin cast current transformer
- Shunt and under voltage tripping device
- The ACB shall be suitable for locking the breaker in various positions. Interlocks shall be provided to: Prevent the breaker from being isolated unless it is in the 'OFF' Position; Prevent the breaker from being racked in to the service position unless it is in the 'OFF' position; Prevent the breaker from being accidentally pulled completely 'OFF' the guide rail.
- Safety shutters of an insulation material shall be provided to prevent access to all live contacts, when the breaker is in the inspection position or completely withdrawn.

16.30

16.31 Moulded Case Circuit Breakers (MCCB)

All MCCBs shall be comply and tested as per IS: 2516/IEC 60947-1 and IEC 60947-2 standards.

Incomer MCCBs shall be 4 P, 50kA or higher (and $I_{cs} = 100\% I_{cu}$) with micro-processor based release with in built O/C, S/C and E/F protection.

Outgoing MCCB TPN for power feeders up to and including 200 A shall be with thermal magnetic release with adjustable O/L and Adjustable/Fixed S/C protection. Outgoing MCCBs from 250 A and above shall be with microprocessor based release with in built Adjustable O/C, Adjustable S/C and Adjustable E/F protection.

All MCCBs shall be 50 kA or higher, $I_{cs} = 100\% I_{cu}$ and with extended rotary handle and terminal spreader. Auxiliary change over contact 1 No + 1 NC and trip contact shall be provided as per the requirement.

MCCB of Soft Starter/VFD feeder shall be TPN with microprocessor release with overload/short circuit and inbuilt earth fault release.

MCCB as part of DOL/Start Delta motor starter module shall be current limiting type, TPN, (rating and protection type as indicated above) and type tested for Type 2 Coordination as per IS: 13947/ IS/IEC: 60947.

MCCB models shall be: **Schneider: NSX/CVS** (for ≥ 250 A) and **CVS** (for ≤ 200 A) or **Siemens: 3VL** or **L & T: D Sine** or **ABB: T-Max**; or **Equivalent model** from approved vendor list.

Electrical interlocking shall be provided between MCCB incomers and bus coupler with required under voltage coil, auxiliary contactors as per the system requirement.

Switches/Fuses

The switches or fuse switches shall be load break, heavy duty/motor duty, air break type provided with quick make/break manual operating mechanism. The operating handle shall be mounted on the door of the compartment having the switch. Fuses shall be non-deteriorating HRC cartridge link type.

Rating of heavy duty switches or motor duty starter modules shall meet the requirement of AC23 duty as per IS: 13947.

Contactors

The contactors shall be air break type, equipped with three main contacts and minimum (2 NO + 2 NC) auxiliary contacts. All contactors shall be 3 Pole, AC3 duty except for lighting feeder where in the contactor shall be 4 P and AC1 duty. External bypass contactor used for soft starter shall be AC1 or AC3 as recommended by soft starter manufacturer.

Unless otherwise specified, the coil of the contactor shall be suitable for operation on 240V, 1 Phase AC supply and shall work satisfactorily between 65 to 110% of the rated value.

Contactor used for capacitor feeder shall be capacitor duty contactor with inbuilt leading contact with wiper function for limiting/damping the capacitor inrush current with NO NC Auxiliary contact.

Bimetal Relay

All bimetal overload relays shall be with in-built single phasing prevention and with Manual/Auto reset type (selectable) with at least 1 NO and 1 NC contact with reset type push buttons in the front, mounted on door such that it shall be possible to reset the O/L relay without opening the compartment door.

16.32

Motor Protection Relay (MPR)

Motor Protection Relay (MPR) shall be provided for 30kW and above and only for star delta starters. MPR is not required for VFD/Soft starter motor feeders.

Motor protection relay (MPR) shall be numerical type with over load, short circuit, earth fault, under current, unbalance, phase loss/reversal, stall, locked rotor, no load running.

Single phasing prevention with adjustable under/over voltage protection shall be provided separately if the same is not inbuilt feature in MPR.

MPR shall be Numerical with adjustable parameter with inbuilt MODBUS over RS 485 interface if specified in SOQ/elsewhere in the tender. MPR shall be DIN rail mountable base module and LCD display module shall be panel door mountable. ZCT/CBCT shall be provided for earth fault/ leakage protection (range 0.1A to 2A). It shall have programmable 2 DI and 2 DO.

MPR shall display 3 phase current, unbalance 9% as minimum and earth current monitoring.

MPR shall store fault records/Start- Stop records/motor run hours/maximum starting current etc.

For motors 30kW and above external CT (3 nos) 5A, Resin cast of suitable VA shall be used.

Make: **C & S mPRO 200 with ZCT or equivalent model** of other approved makes. Data sheet with parameters comparison shall be submitted for approval.

Motor Starter

DOL starter to be considered for rating less than 7.5kW rating. Star-delta starter is to be considered from 7.5kW rating and upto less than 75kW rating. Soft starter to be considered for 75kW and above ratings.

VFD shall be provided for any rating if specifically asked for/as per the requirement/application.

Soft starter shall be provided for lower ratings also if specifically asked for/as per the requirement.

MCCB rating upto 800A as incomer for Soft starter and VFD starter is acceptable.

MPCB with overload protection, short circuit protection and single phasing/phase loss protection, AC3 duty contactor for DOL feeders and Start Delta feeders up to and including 15kW.

All MPCB shall be with rotary switch.

MCCB (with adjustable overload, adjustable short circuit, earth fault) microprocessor release or thermal magnetic release (with adjustable overload, adjustable/fixed short circuit) as per MCCB rating, AC3 duty contactor, numerical motor protection relay as applicable, A/M switch, L/R switch, indicating lamps, push button etc. shall be provided. Provision for door mounting PMU shall be provided in the starter cubicle of submersible pump motor. Wiring shall be done up to terminal connector for PMU input from field.

Minimum 8 channel or higher, temperature scanner shall be provided in starter feeder for 90kW and above rated motor feeders wherever motor is supplied with RTD and BTM.

Temperature scanner/Thermister and PMU (as applicable) shall be interlocked with starter feeder with control/tripping circuit of starter feeder. Temperature scanner shall be door mounted. Soft starter/VFD shall be with input terminal for RTD (PT 100) and Thermistor for motor temperature (winding and bearing) monitoring/protection.

Temperature Scanner

Temperature scanner of required channels with minimum 2 spare channels shall be provided to detect high winding, and bearing temperature in order to generate tripping signals. The input signals to temperature scanner shall be derived from the motor. Industrial type PT 100 resistance temperature detectors shall be provided in the motor windings and bearings.

16.32.1

1	Service and type	Motor winding and bearing temperature measurements – microprocessor based
2	Range	0 to 200 °C
3	Alarm Contacts	Adjustable 4 Nos. (high temperature and very high temperature) for motor winding and bearing
4	Type of Relay contacts	One Single Pole Double Throw per set point (Relay)
5	Input Signal	From RTDs for each Motor winding and bearing winding
6	No. of channels	6 Nos. for Winding + 2 nos. Bearing + 2 Spare
7	Accuracy	± 1 °C
8	Communication	RS 485 for Instrumentation panel interface if specified to be provided in SOQ/elsewhere in the tender.

Instrument Transformers (CTs/PTs)

Current transformer and potential transformer shall generally conform to IS: 2705, IS/IEC: 60044-122 and any special requirement with reference to numerical relay shall be taken care of by contractor. All CTs shall be resin cast type and secondary 5 A. APFC feedback CTs, MFM CTs, MPR CTs shall be of Class 0.5 and 10 VA. CTs (80A and above) of digital ammeter, APFC panel metering shall be Cl. 1 and 5 VA. CTs less than 80A shall be Cl 1.0 and 2.5 VA.

The current transformers in breaker feeders shall be capable of withstanding the applicable peak momentary short circuit and the symmetrical short circuit current for 1 second.

16.33 Indicating/Measuring Instruments

The meters shall be digital type and generally of square pattern type of 96mm x 96mm suitable for flush mounting. Instrument shall generally conform to IS: 1248 and shall have accuracy class of 1.0 or better.

Digital meters shall have 3 line, 3 ½ digit, LCD display as a minimum.

All auxiliary equipment such as shunt transducers, CTs, PTs etc. as required shall be included in the supply of

panel/switch board.

The current coil of ammeters and potential coils of voltmeters shall continuously withstand 120% of rated current and voltage, respectively, without the loss of accuracy.

Digital ammeter and voltmeter shall be with separate selector switches instead of meters with inbuilt selector switches. Ammeters and voltmeters with built in selector switches are not acceptable.

Digital type multi function meter shall be with 3 line display, accuracy class: 0.5 suitable for measuring and displaying the following parameters: A, V, F, PF, kW, kWH, kVA, KVAR, KVARh, Md (for PCC/PMCC incomer feeder MFM only), Harmonic and with inbuilt RS 485 communication port. (**Schneider**: EM 6400NG; **L & T**: MFM 4420; **Secure**: Elite 443; equivalent model of other approved make). Data sheet with parameter comparison shall be submitted for approval.

MFM shall be provided for all incomers (PCC/PMCC), all motor starter feeder rated 30kW and above and all outgoing power feeders of PCC/PMCC rated 100A and above. For motor starters and outgoing power feeders provided with MFM, separate ammeter/voltmeter/PF meter is not required.

Push Buttons

Push buttons shall have rated operational current of not less than 4A (AC 11).

Push buttons for START, OPEN, CLOSE, LEFT, RIGHT, FORWARD, REVERSE etc. shall be flush type with spring aided self reset contacts.

Push buttons for STOP/EMERGENCY STOP shall be mushroom headed type with stay put contacts and shall be coloured red. The operation of the button shall be press to lock and twist to release.

The stop PB for each outgoing feeder/starter at MCC and for field LCS shall be EMERGENCY STOP push button.

Push buttons shall be in compliance with IEC 60947-5-5.

Illuminated PB is not accepted.

Push Button

Colour of push buttons shall be as follows.

Stop/Open/Emergency	:	Red
Start/Close	:	Green
Reset/Test	:	Yellow/White

Indicating Lamps

Colour shade for the indicating lamps shall be as below LED type.

ON indicating lamp	:	Red
OFF indicating lamp	:	Green
TRIP indicating lamp	:	Amber
PHASE indicating lamp	:	Red, Yellow and Blue
TRIP circuit healthy lamp	:	Milky

Fixed Compensation

Fixed capacitor banks for transformer compensation (for no load as well as leakage reactance) shall be provided. MCCB 50kA or higher as per specifications along with ammeter, CT 3 nos, capacitor duty contactors, ON delay timer, heavy duty multiple capacitor units (in smaller kVAr ratings viz 10,5,2,1) totaling to 5% value of transformer rating. Capacitor shall not be mounted below incomer feeder. Capacitor, if provided below bus coupler, capacitor housing/compartment shall be fully separated with steel sheet. Proper ventilation shall be provided.

7% detuned reactor with thermostat, 440V shall be provided in series with 525V capacitor or as per SOQ, if working VFD load is more than 50% of total load or if specified in SOQ. kVAr rating of capacitor shall be suitable for reactor

rating.

For Capacitor banks of ratings > 50 kVAr for transformer fixed compensation, separate enclosure shall be provided. Fixed capacitor banks meant for transformer compensation for ratings > 50 kVAr shall not be permitted to house in main LV PMCC/PCC panels. Only 4P MCCB power feeder shall be provided in PCC/PMCC panel for the same.

Danger Notice Plates

The danger notice plate shall be affixed in permanent manner on operating side of the panels. The danger notice plate shall indicate danger notice both in Hindi and English and local language with a sign of skull and bones as per IS: 2551.

Shop Drawings

Prior to fabrication of the panels the panel builder/vendor/contractor shall submit documents consisting of technical data sheet (duly filled), GA drawings, GA drawings with front door open with mounting plate details and equipment, sectional elevation, single line diagram, power/wiring drawing, bill of material etc. including design calculations indicating type, size, short circuiting rating of all the electrical components used, bus bar size and calculation, power/control wiring size, panels dimensions, colour, mounting details etc. in 5 sets for PMC/TPI's approval.

The contractor shall submit manufacturers' technical catalogues of major items like ACB, Soft Starter, VFD, MPR of offered makes/models for approval along with above documents.

Soft Starter/VFD selection indicating rated full load current, de-rated current for design ambient temperature, full load current of motor, 110% rated full load current of motor as per IS: 12615 shall be given by SS/VFD OEM. De-rated current of SS/VFD shall be equal to higher than 110% full load current of motor as per IS: 12615/SOQ. Power drawing and control drawing of SS/VFD shall be got vetted from SS/VFD OEM before submission of drawings.

Test Certificates

Testing of panels shall be carried out at factory as specified in Indian Standards in the presence of Client/PMC/TPI. The test results shall be recorded on a prescribed form. All type test certificates and routine test certificate for the test carried out at factory and bought out material and at site shall be submitted in duplicate to the consultant for approval.

Cubicle/Feeder Size Criteria For LV Panels

ACB Minimum cubicle compartment size considering minimum height of 1800 mm.

ACB Rating	Width of Compartment (I/C or O/G) (mm)	Width of Compartment (Bus Coupler) (mm)	Depth (mm)	Remark
630 A – 1250 A 4P	800	900	1000	Cable entry
1600 A 4P	900	1000	1000	Cable entry
2000 A - 2500 A 4P	900	1000	1200	Bus duct entry
3200 A – 4000 A 4P	1100	1200	1300	Bus duct entry

NOTE: Dimension mentioned above is minimum. Height of ACB feeder shall be 1800 mm excluding main Bus bar chamber. Above 1000A ACB outgoing feeders shall be in single tier. Up to and including 1000A ACB outgoing breaker feeder shall be in single/double tier.

MCCB Minimum cubicle compartment size.

MCCB Rating	Width of Compartment (mm)	Height (mm)	Remark
Up to 100A	350	300	Copper flexible shall be used
125A – 200A	400	350(3P)/400(4P)	Bus bar/strip
Above 200A to 400A	500	450	Bus bar/strip
Above 400A to 550A	600	500	Bus bar/strip
Above 550A	600	600	Bus bar/strip

NOTE: Dimension mentioned above is Minimum. Depth of panel as per required depending on cable size/ site condition and for ease of maintenance.

VFD and SOFT Starter Minimum cubicle compartment size considering minimum height of 1800mm.

Motor Rating	Minimum Width of Compartment (For VFD and for Soft Starter with External Bypass Contactor)	Minimum Width of Compartment (For Soft Starter with Built in Bypass Contactor)	Depth of Compartment
Less than 75 kW	700	700	800
75 kW to ≤ 132 kW	800	750	900
Above $132 \leq 250$ kW	900	800	900
Above 250 kW	1000	900	1000

NOTE: Dimension mentioned above is minimum. S/S and VFD feeder for 22 kW and above shall be in single tier only.

TECHNICAL DATA SHEET FOR LOW/MEDIUM VOLTAGE PANEL BOARD

Sr. No.	PARTICULAR	DETAILS
1.0	SITE CONDITIONS	
1.1	Type/Make	Indoor/As per Tender BOQ
1.2	Mounting	Floor/Stand mounted as per BOQ/Site Conditions
1.3	Design Ambient Temperature	50 °C
1.4	Atmosphere	Corrosive, Humid and Dusty
2.0	CONSTRUCTION	
2.1	Housing	2.0 mm thick CRCA sheet for Body, Partition, Cover/Door
2.2	Protection Class	IP 52 (Indoor)
2.4	Base Channel	100mm x 50mm x 5mm Channel
2.5	Shipping Section Length	2500mm (Maximum)
2.6	Side Sheets for Shipping Section	Full side sheet on both side of shipping section

3.0	OPERATING CONDITIONS	
3.1	Voltage	415V $\pm$ 10%
3.2	Number of Phase	3
3.3	System	3 Phase, 4 Wire
3.4	Frequency	50 $\pm$ 5% Hz
3.5	Fault Current	50 kA as per SLD
3.6	Neutral Grounding	Solid
4.0	CONTROL SYSTEM	
4.1	Voltage	
	For Indication	240V AC
	For Metering	240V AC
	For Protection	240V AC
4.2	Control Supply Through Control Transformer/ Constant Voltage Transformer	240V AC for PMCC
4.3	Wiring	Control Wiring: 1.0 mm ² FRLS PVC Cu Flexible Wire (Grey); CT Wiring: 2.5 mm ² FRLS, Color Coded: Door Earthing: 1.5 mm ² FRLS (Green)
5.0	BUS BAR	
5.1	Phase Bus Bar Material	EC Grade Aluminium
5.2	Neutral Bus Bar Material	Same as Phase Bus Bar
5.3	Earth Bus Bar Material	65 x 10 mm (Hot Dip Galvanised Strip) or 40mm x 10mm (EC grade Al)
5.4	Current Density	1 sq. mm = 0.8 A. Size of bus bar based on design temperature, kA level and current density
5.5	Hard Ware	High Tensile Steel Bolts, Nuts and Washers duly Zinc/Cd Passivated shall be used for all bus bars joints and supports
6.0	PLC Based System	As per SLD/SOQ
7.0	ACB	
7.1	Type, Rating, Number of Poles	EDO, 50kA Rating and Pole as per SLD
7.2	Protection	LSIG with Display and Fault Record Display Control and Monitoring from Remote Location
7.3	Display of Metering	Basic (A,V,F) and Energy for I/C and Only Current Display of Outgoing
7.4	Communication port	Inbuilt RS 485 (on MODBUS/Ethernet)

7.5	Model	Schneider Master pact NW or Siemens 3WL or L & T U power or ABB E-Max; or Equivalent model from Approved Vendor List
8.0	MCCB (Ics= 100% Icu)	
8.1	Incomer and Bus Coupler MCCB	Microprocessor based Release with Adjustable O/L, Adjustable S/C, Inbuilt Adjustable E/F, 50kA, 4 Pole
8.2	Outgoing MCCB	
8.2.1	For Rating Above 200 A	Microprocessor based Release with Adjustable O/L, Adjustable S/C, Inbuilt Adjustable E/F, 50kA, 3/4 Pole as Specified in SLD
8.2.2	For Rating Up to and including 200 A	Thermal Magnetic based Release with Adjustable O/L, Adjustable/Fixed S/C, 50kA, 3/4 Pole
8.2.3	For SS/VFD Starter Feeder MCCB	Microprocessor based Release with Adjustable O/L, Adjustable S/C, Inbuilt Adjustable E/F, 50kA, 4 Pole
8.2.4	Accessories	Extended Rotary Handle, Terminal Spreader, Auxiliary Change Over Contact + Trip Contact to be provided
9.0	Electronic Motor Protection Relay	
9.1	Type	Electronic MPR with LCD display (3 Phase Current), Record Storage, DI/DO Interface etc. as per Detailed Specifications
9.2	Protection/Interface	Confirm the Following
		1) Over Current 2) Short Circuit 3) Earth Fault 4) Current Unbalance 5) Phase Loss/Reversal 6) Under Current (Dry Run) 7) Stall (Bearing Broken) 8) Locked Rotor 9) Ground/Earth Fault/Leakage (ZCT) 10) Single Phasing with Under voltage and Over Voltage 11) Over temperature (with PTC Thermister) 12) 3 Programmable DI and 2 Programmable DO 13) Fault Record, Start/Stop, Run Hrs. Maximum Starting Current Record
10.0	PAINTING	
10.1	7 Tank Processed Sheet	Required
10.2	Colour and Shade and Thickness: Panel Exterior and Interior	RAL 7035 100 Micron – 120 micron
10.3	Mounting Plate	Glossy White

11.0	Current Transformer	
11.1	Type	Resin Cast
11.2	Class of Accuracy	Cl 0.5 for MFM, APFC Load Sensing, Summation, MPR Cl: 1 for Ammeter
11.3	Burden (VA)	As per Specifications
12.0	Hardware	For Bus Bar Joints High Tensile With Zinc Passivation/Cd Plated
13.0	Space Heater	230V AC with Thermostat
14.0	Pocket for Drawings at Door	Yes
15.0	Instrumentation Compartment	Separate Compartment for Energy Meter, Hour Meter, Level Controller etc. with Necessary Internal Wiring
16.0	Panel Internal Lighting	1 ft Long LED Panel Light 9W or Higher with Auto NO Contact/Switch with Panel Door and control MCB for VFD/SS/Starter Feeder/Incomer/Cable Alley

Note: Other specifications not mentioned in datasheet shall be considered as per tender specifications/SLD.

AUTOMATIC POWER FACTOR CONTROL PANEL (APFC PANEL)

APFC panel shall be floor mounting, free standing, compartmentalized, extensible, modular type suitable for indoor installation.

The panel shall be IP 52 for metering and switchgear module and shall be IP 42 for reactor/capacitor section. Full partition shall be provided between switchgear components and capacitor section. Each feeder module shall be fully compartmentalised. Capacitor/reactor shall be mounted in separate vertical section/cubicle adjacent to switchgear cubicle instead of mounting at the rear end/backside of switchgear module as per availability of space.

The control equipment including capacitors shall be mounted in panel made of 2mm CRCA sheet. Panel shall be fully compartmentalised, extensible and with main bus bars in horizontal bus bar alley.

Capacitor feeder rating shall not exceed 100 kVAr rating.

Ammeter, ammeter selector switch and CT shall be provided in 50 kVAr and above rated feeders to measure capacitor current.

APFC panel control logic shall be such that when DG is ON, APFC panel shall be OFF and shall become automatically ON when the Grid power/utility power is restored.

The fixed capacitor bank will be provided on each incomer, as applicable, on upstream side of incomer breaker. Adequate arrangement of interlocking between APFC panel and transformer fixed compensation power capacitor bank for no load power factor improvement must be made in such a way that during load condition i.e. when associated incomer breaker is ON and downstream load is working (load/current is being sensed above certain threshold), the fixed compensation capacitor bank shall be switched off. Similarly, when incomer breaker is OFF or the downstream load are OFF (load/current is zero/below certain threshold), the fixed capacitor banks shall be ON i.e. in functional/working mode. The objective of this interlocking arrangement is to compensate for p.f. during no load condition and it shall also be ensured that power factor does not go into leading side when pumping system is not running / plant under no load condition. For this purpose the fixed capacitor bank shall be adjusted / fine tuned at site to decide the required kVAR to be kept ON out of total and same will be reviewed and set from time to time periodically.

APFC panel shall be operated on AUTO and MANUAL mode. Individual capacitor feeder shall be possible to be operated on AUTO/MANUAL mode even when A/M switch in incomer feeder is on AUTO Mode.

All capacitors shall be heavy duty MPP/Heavy duty Gas filled with discharge resistor and as per the technical data sheet provided here in. However in case of only smaller capacity ie < 5 kVAr, APP type capacitors are also acceptable.

Heavy duty exhaust fan 6"/8" (shall be continuous duty, metal housing with metal impeller) with canopy shall be provided at the top. Louvers with wire mesh (up to maximum 1mm opening) shall be provided at the bottom end of capacitor section. Minimum 1 number of fan shall be provided per meter length of panel or part thereof or more numbers as required.

Minimum distance between two capacitors and from all sides of panel enclosure (including terminal) shall be 25mm.

Earthing terminal of capacitor shall be connected to earth bus bar.

Automatic Control Panel and Fixed Capacitor Panel (for Transformer Compensation) shall comprise following.

MCCB for protection of each capacitor bank (MCCB should be suitable for capacitor switching and kA rating shall be as per main panel kA rating). For smaller ratings of capacitors ie < 10 kVAr only D curve MCBs of appropriate ampere ratings are acceptable.

Incomer MCCB shall be TPN, microprocessor based/thermal magnetic (adjustable O/L and Adjustable S/C) as per LV panel specifications.

APFC relay shall be microprocessor based with inbuilt RS 485 for sensing and correcting the power factor of the system with required number of steps to achieve the specified power factor. Minimum steps of power factor relay shall be 10 or as per SOQ. Minimum operating current/sensing current shall be 10 mA/10% of load. Minimum 2 numbers additional spare relay contact shall be available for future use.

Two numbers vacant feeders with mounting plate and cutouts shall be provided for future use.

A/M switch with Auto/Manual indicating lamps shall be provided in addition to R Y B indicating lamps.

Each outgoing capacitor feeder shall be provided with suitably rated MCCB, capacitor duty contactor with inrush damping resistor, A/M switch, 'ON' and 'OFF' push with ON, TRIP, AUTO indication lamp, ON delay timer (only for Manual mode of individual feeder), 440V capacitor unit with discharge resistor.

Control circuit of individual feeder shall have control MCB for protection and indicating lamp shall be only through auxiliary contact.

All outgoing MCCB feeders shall be 50kA, $I_{cs} = 100\% I_{cu}$, with trip indication/fault signal contact, with extended rotary operating handle, any other components required for satisfactory and safe operation shall be provided.

Capacitor shall be compact in size and hermetically sealed. In built fuses and surge suppressors shall be provided for protection of each capacitor element.

Capacitor banks shall comprise identical delta connected three phase units. Capacitor banks shall be non-flammable, non-toxic, non-PCB, dry technology, inert gas (N₂)/PU resin impregnated, MPP heavy duty type/Gas filled.

Only one wire shall be connected to each contactor terminal i.e. whenever more than one capacitor is controlled from contactor suitable size bus bar strip shall be provided and power shall be tapped. Else separate contactors shall be used for each capacitor unit.

If load is VFD driven and working VFD driven load is more than 50% of total load, or if required or specified in SOQ, APFC panel shall be with detuned reactors. 7% detuned reactor, 440V, Al. wound with thermostat shall be provided in series with capacitor unit. Capacitor voltage shall be 525V or as specified in SOQ and kVAr rating suitable for reactor kVAr rating. Filter rating (Reactor + Capacitor) shall be rating of APFC panel.

Except for the specific requirements of APFC panel specified here in, rest all specifications shall be as per LV panel/switchboard specifications specified herein.

Capacitor rating generally shall be at 525V if provided with detuned reactor or as specified in SOQ and APFC Panel shall conform to IS: 16636 (2017).

Three Phase Filter Reactor

Anti resonance three phase filter reactor, Aluminium wound, 440V detuned reactors (5.67% or 7%) as required are to be used in series with shunt capacitors to prevent harmonic resonance and harmonic overloading of capacitors, transformers, whenever power electronic equipment (Drives, UPS etc.) producing nonlinear currents are used. Detuned systems shall be such that the self resonant frequency is below the lowest line harmonic.

Features of Reactors

- High linearity, low losses and noise level
- High over loading capability
- Inbuilt temperature micro switch

Micro switch potential free contact shall be used in control circuit of respective capacitor feeder to trip the contactor in case of high temperature.

Reactor shall be kept in independent cubicle and adequate ventilation shall be provided.

Power Factor Correction Thyristor Switch Module

Thyristor switching instead of contactor switching shall be used when load variation is rapid. Semi conductor fuses shall be used for protection of Thyristor switches in addition to MCC, BHRC fuses shall not be used. Discharge reactors shall be used for fast discharge for fast reconnection of capacitor.

Technical Features

- Suitable for real time power factor correction
- Switching time less than 5 milli seconds
- PIV: 2200
- Permanent self controlling of voltage parameter, capacitor current, temperature of the thyristor switch
- Suitable for manual operation also
- Automatic switch off in case of over current and over temperature
- Display of: Operation, Faults, Activation.

APFC Controller with RS 485

Microprocessor based intelligent control, menu driven, single/3 CT sensing, 5A CT selectable with RS 485 communication port and features as below.

- Display: LCD illumination, large and multi functional characters.
- Parameters: Voltage, monitoring of individual capacitor currents, Real time PF, Power kW, kVA, kVAR, Temperature, Energy KWh, KVAh, KVARh
- Steps: 4, 6, 8, 12,16 as required
- Mounting: Panel mounting (size: 144mm x 144mm)
- Current input: 1 A or 5 A selectable
- Operating temperature: 0 to 60 °C
- Supply voltage: 230V AC
- Target PF: 0.8 inductive - 0.8 capacitive.
- Minimum operating current: 10 / 50 mA
- Sensing: Single/3 CT, 3 CT sensing for unbalanced load.
- Dual target power factor setting: for utility and DG mode operation.
- Facility of including “Fixed capacitor bank” for purpose of transformer compensation. This can be set such that the controller doesn’t ‘see’ this capacitor.
- Potential free contacts/alarm output: Insufficient compensation, over compensation, under current, over current, over temperature, harmonics exceeded.
- Suitable for Thyristor switching if Thyristors are used instead of contactor.

Minimum rating of MCCB, Cable/flexible wire size for capacitor feeder shall be as below.

Cable Size Selection Chart (Minimum)

Sr. No.	Capacitor Rating (KVAR)	MCCB Rating (Amps)	FRLS Copper Cable/Wire size (mm ²)
1	Up to and ≤ 5	16 (MCB Acceptable)	2.5
2	10	32	4
3	12.5	32	6
4	15	63	6
5	20	63	10
6	25	63	16
7	30	100	25
8	40	125	35 mm ² /Bus bar from bus to MCCB
9	50/60	160	50 mm ² /Bus bar from bus to MCCB

10	75	200	70 mm ² /Bus bar from bus to MCCB
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CAPACITOR DATA SHEET

Sr. No.	PARAMETER	Unit	
	Capacitor Type		Heavy duty MPP/Heavy duty Gas Filled
1	Conformance to Standards		IS: 13340/IEC 60831
2	Rated Voltage	V	440/525 as required/Applicable
3	Inrush Current	A	Up to 200 Ir
4	Maximum Permissible Current/ Over Current	A (Imax)	1.5 Ir
5	Maximum permissible Voltage/ Over Voltage	V (Vmax)	1.1 Vr
6	Temperature Class	°C	60
7	Losses (per phase)	W/kVAr	Dielectric: less than 0.2 Total : less than 0.5
8	Capacitance Tolerance		-5% / + 10%
9	Dielectric		Poly Propylene
10	Impregnation		Non-PCB PU Resin/Inert Gas Nitrogen
11	Number of Switching Operation		5000 as per IEC 60832
11	Useful Life	Hours	125000 Minimum
12	Maximum THD in Voltage		3%
13	Maximum THD in Current		15%

Note: Rest all construction features and other requirements shall be as per specifications of LV Panel.

Test and Test Reports

All tests shall be conducted in accordance with the latest edition of IS: 2834 and as applicable for controls.

Type test certificates for similar capacitor units shall be furnished for review and acceptance.

Drawings to be submitted for the approval of the Client/PMC/TPI

- GAD with elevation, side view, sectional view and foundation details.
- Complete schematic and wiring diagrams.
- Detailed BOM and GTP.
- Manufacturers' technical data sheet of capacitors and APFC relay.

SOFT STARTER (FORMING PART OF LV PANEL) OR STAND ALONE SOFT STARTER PANEL

Scope

This specification covers the requirement for design, manufacture, installation, testing and commissioning of step-less reduced voltage/solid state torque controlled soft starter for motors in MCC panel to provide linear ramp starting and stopping of AC induction motors.

Constructional and Performance Features (Microprocessor Soft Starter)

The PCB power structure shall consist of six SCR's mounted on a heat sink for ratings up to suitable rating of motor. PCB shall be self tuning to accept control power input as per design.

Soft starter shall have current transformer/sensor in all the three phases for current monitoring.

All phases should be controlled during start/stop.

Soft starter shall consist of built-in RS 485 MODBUS RTU for monitoring and control through PLC/ SCADA.

Soft starter should be built for continuous operation without need of by pass for any reason.

Soft starter shall have features which allows the soft starter to operate with only 2 controlled phases in case of short circuit of 1 set of thyristor avoiding unplanned stop and possibility to keep running motor until the softstarter is repaired.

Control terminals shall be easily accessible and located on the front bottom of the device.

Sizing/Selection Criteria for Soft Starters

Soft starter de-rating factor for selection of soft starter shall be based on design ambient temperature (50°C), altitude (up to 1000 m above MSL as standard or higher as per site requirement) etc. declared by OEM as % de-rating in their published catalogue available in the PUBLIC DOMAIN only. Rating/model selection based on design software/certificate issued by OEM will not be acceptable/considered for selection.

Further the soft starter shall meet following conditions to be confirmed by soft starter manufacturer/ OEM.

Start Current (cold start)	:	400% of I_n (rated current of motor) for 20 seconds (Class 20 Tripping Class)
Starting Frequency	:	Up to 10 number of starts per hour

Following shall be considered while sizing the soft starter and its enclosure.

Soft starter shall be de-rated as per manufacturers' recommendation for 50°C operating conditions based on site/operating condition and such de-rated current of soft starter shall be minimum 110% of full load current of motor as per IS: 12615 (latest edition) or as per SOQ.

Soft starter shall be rated for DOL starting and shall have **In-built/External Bypass** contactor of AC1 or AC3 rating as recommended by soft starter OEM.

Soft starter shall be provided with breaker (MCCB/ACB) along with fast acting semi conductor fuse protection, with fuse base and with series contactor of required rating as recommended by OEM.

Soft starter signal to be interlocked with PLC and in manual mode timer based interlock to be provided to ensure that signal to turn on soft starter is fed only if contactor close signal is received to switch off supply to contactor through PLC when soft starter is not ON.

Contractor/Vendor shall furnish the heat dissipation load data and shall provide the cooling arrangement accordingly to ensure that the temperature rise within enclosure does not exceed 5°C over the maximum ambient temperature of 50°C .

Minimum two cooling fans shall be provided or higher number as required. Cooling fan shall be continuous duty,

metal housing with metal impeller, minimum 6" size (minimum 8" for 160kW and above). The enclosure cooling fans and temperature sensing device (RTD/Thermistors) with tripping arrangement shall be provided and shall also be interlocked with soft starter operation i.e. in case of cooling fan failure or excess temperature (55 °C or as set), the soft starter shall be tripped/shall not turn ON.

Vents for air suction into panel shall be provided with louvers with filter (front washable and replaceable). However for 160kW rating and above vents shall be Louvers with wire mesh (up to maximum 1mm opening) and in this case enclosure shall be generally with IP 42 protection class.

Soft starter shall be provided with conformal coating according to IEC 60721-3-3 to withstand harsh environment.

Auxiliary contact of incoming breaker and contactor shall be used in series to provide "Soft Starter Ready" interlock signal for PLC/remote operation

Detachable display/key pad with digital parameter adjustment, preferred with cable suitable for door mounting. The control key pad and display shall have the option for remote mounting. For safety reasons the controller should have green lights for running and red for start/stop.

Enclosure/panel shall be generally as per IP 52 protection.

Control Module Design Features

User Adjustments

The acceleration start ramp and stop ramp timers shall have minimum individual adjustments from 1 to 60 seconds. The initial torque setting shall be adjustable from 0 to 200% of motor torque.

The end torque setting shall be adjustable from 50 to 200% of motor torque.
Current limit setting shall be adjustable from 150% to 500% of the motor's full load current.

Pump Control (Standard Feature)

The standard feature pump control shall be implemented to provide closed loop control of motor to match the specific torque requirements of centrifugal pumps for both starting and stopping.

Pump stop shall be initiated without the need for a dedicated pump stop input. A coast-to-rest stop shall still be possible with stop input.

Controller's Features and Modes

- a) **Starting modes** required for controller includes linear torque control for Start, Pump Control Current Limit Start (Voltage Ramp Start, Voltage Ramp with Current Limit Start, Full Voltage DPL Start, Soft Start with Selectable Torque Boost etc.), Bypass Control and Bypass Contactor mode with all the protection parameter working.
- b) **Stopping modes** required for controller includes linear torque control for Stop, Pump Control (DOL/Coast to stop), Bypass Control, DC/Dynamic brake for fast stop of motor with high moment of inertia etc.

Protection and Diagnostics

Protections of Controller shall meet applicable standards.

Protective Features

Motor Thermal Overload—selectable for starting class 10A, 15A, 25A under load protection (to avoid dry run), Soft Start thermal overload, PTC input, Phase imbalance, Phase reversal, Over voltage, Under voltage, Locked Rotor, Excessive Starts per hour for application, Phase loss input/output etc.

Electronic thermal memory shall be provided for enhanced motor protection.

All Protections should be available in bypass mode also.

When fault conditions are detected, the controller shall inhibit starting or shut down SCR pulse firing.

Soft starter shall preferably be with input terminal for RTD (PT 100) and Thermistor for Motor Temperature (winding and Bearing) monitoring/control/protection.

Fault Indications

Controller shall indicate latest fault indications/occurrence for: Line failure, Phase imbalance, Over temperature: motor, Over temperature: Soft Starter, Shorted Thyristor, Open Thyristor, Locked Rotor, Motor output loss, Overload and Under load – Shaft Torque, Over voltage, Under voltage, Excessive Starts and Phase reversal etc.

Viewing Functions

Motor Current, Three Phase Voltage, Shaft Power in kW/HP (selectable), Motor thermal capacity, Motor Energy consumption (kWh), Power factor, Run time in hours etc.

Soft starter model shall be: Schneider: ATS-48, ATS-480; ABB: PSTX; Danfoss: MCD600 or equivalent model of **Siemens** or **Rockwell** or additional vendor from approved vendor list.

Notes:

1. For soft starter standalone panel, rest all construction features and other requirements shall be as per the specifications of LV panel.
2. The soft starter features specified are in general and any manufacturer specific deviations in certain features can be reviewed and accepted based on merit/application requirement.

INDUCTION MOTOR (LOW VOLTAGE)

Scope

This specification covers the design, manufacture, inspection, testing at works, supply, delivery to site, installation, testing at a site and commissioning of TEFC, squirrel cage, solid shaft induction motors with all accessories for driving various pumps/equipment working on three phase LV AC supply required for the complete operation of the plant as per the scope of this work.

All motors shall be as per these specifications unless for any other more stringent requirements mentioned elsewhere.

Codes and Standards

The design, material, construction, manufacture, inspection, testing and performance of induction motors shall comply with all currently applicable status, regulations and safety codes in the locality where the equipment will be installed. The equipment shall also confirm to the IS: 12615 (2018)/IEC 60034 amended up to date.

General Design and Constructional Requirements

Motors shall be continuous maximum rated as per IS: 12615 (2018) and IS: 4722 (latest edition) and preferably be designed for low starting current and smooth acceleration except for cases where the driven equipment characteristic demand otherwise. Motors shall be of 4/6/8 pole design as required and provided with terminal box large enough to accommodate armoured PVC/XLPE insulated Aluminium conductor cable of required/specified size/ratings. Motors

shall be of energy efficiency class IE3 as per IS: 12615 (2018) except submersible motors which shall be IE2 as per IS.

All motors shall be foot/flange mounted or as per pump/driven equipment coupling requirements and squirrel cage induction type and shall be capable of developing at least minimum 10% more power than demanded by the Pump/Submersible Pump or driven equipment over its duty point of operation.

The minimum power rating for motors to drive pump/submersible pump/driven equipment should be selected as per table below based on CPHEEO manual to meet the power demanded over its duty point of operation.

Required BkW of Pump/Submersible Pump/Driven Equipment	Minimum multiplying factor to arrive at motor rating
Below 7.5 kW	1.3
7.5 kW and above but below 15 kW	1.2
15 kW and above but below 75 kW	1.15
75 kW and above	1.10

Operating Conditions

1) Frequency and Voltage Variation

All LV motors shall be TEFC squirrel cage motor and the motor shall be suitable for the following.

Design Temperature	:	50 °C
Supply Voltage	:	415 Volts, 3 Phase, 50 Hz AC supply
Voltage Variation	:	± 10%
Frequency Variation	:	± 5%
Combined Variation of Voltage and Frequency	:	± 10%

2) Starting

- Unless otherwise specified, motors shall be designed for direct-on-line starting.
- Motors shall be designed for re-acceleration under full load after momentary loss of voltage with the residual voltage being 100% and is in phase opposition to the applied voltage.
- Minimum locked rotor thermal withstand time at rated voltage shall be 10 seconds under cold conditions and 8 seconds under hot conditions. The starting time of motor shall be less than the hot thermal withstand time to permit application of conventional bimetal relays or thermal release against locked rotor and overload conditions.
- The motors shall be suitable for starting under specified load conditions with 75% of rated voltage at the motor terminals.

3) Direction of Rotation

Motors shall be suitable for either direction of rotation. In case unidirectional fan is provided for motors, direction of rotation for which the motor is designed shall be permanently indicated by means of an arrow. When a motor is provided with bi-directional fans, a double headed arrow should be provided.

Normally clockwise rotation is desired as observed from driving (coupling) end. Ample space shall be provided in terminal box for interchanging any two external leads for obtaining reverse phase sequence.

Perormance

Motors shall be rated for continuous duty S1 unless otherwise specified. For hoist/crane it shall be S4 duty.

All performance characteristics shall be as per IS: 12615 (2018) or latest revision and the torque and other specific requirement shall be selected by the concerned equipment vendor to suit the application.

Construction Details

Motor Casing and Type of Enclosure

Motors for use in safe area shall be of industrial type meeting the specified ambient conditions, starting and operating requirements. Motors for use in hazardous areas shall have type of protection Ex-d or other as per area classification and to meet requirement of applicable Indian Standards.

The motor enclosure including terminal boxes and bearing housing shall have IP 55 degree of protection.

Motor casing shall be provided with a suitable drain for removal of condensed moisture for motors operating in safe area.

All vertical motors shall be provided with suitable canopies covering the motors fully.

Motors designed to handle external thrust from the driven equipment shall be supplied with a thrust bearing at the NDE.

Motors shall have standard frame sizes for various output ratings as per relevant IS.

Motors installed in outdoor areas shall be provided with FRP type canopies/covers of 2mm thick.

All external surfaces of the motor and its canopy shall be given coat of epoxy-based paint shade 632 as per IS.

Insulation and bracing

Unless otherwise specified, motors shall be provided with class F insulation with the permissible temperature rise above the specified ambient temperature shall be limited to that of class class B. **VFD operated motor shall be with Class H insulation ONLY with temperature rise limited to Class F.**

The winding shall be tropicalized. The windings shall preferably be vacuum impregnated. Alternately the windings shall be suitably varnished, baked and treated with epoxy gel for operating satisfactorily in humid and corrosive atmosphere.

Windings shall be adequately braced to prevent any relative movement during operation.

Overhung of winding shall be double coated with epoxy gel.

However, motors operating with Variable Frequency Drive shall have winding and other features as follows.

- Winding shall be double insulated, vacuum impregnated.
- Winding shall have class H insulation with temperature rise limited to Class F.
- Motors shall have adequate and suitable cooling arrangement and frame size shall be suitably selected for effective heat dissipation unless otherwise specified in SOQ.
- Motors shall be suitable to continuously operate within 30% to 100% speed range variation.

Phase Connections and Terminal Box

The windings shall be connected in Delta. The ends of the windings shall be brought out into a terminal box.

All motors shall be with six terminals and suitable links to connect them in star or in delta. Motors rated up to and including 2.2kW which may be accepted with three terminals.

The terminal box shall be located on the RHS as viewed from driving (coupling) end (for motors above 3.7kW).

The terminal box shall be rotatable in steps of 90 degree to allow cable entry from any direction.

Adequately sized earth terminal shall be provided in the motor terminal box. Terminal box shall be provided at the side of the motor.

Bearing and Lubrication

Motors shall have grease lubricated ball or roller bearings with minimum L 10 rating life of 5 years (40,000 hours) at rated operating condition.

Bearings shall be capable of grease injection from outside without removal of covers with motors in running condition.

Necessary seal to prevent entry of dust/moisture and loss of grease shall be provided. Grease nipples shall be

provided with appropriately located relief devices which ensure passage of grease through the bearings. VFD operated motor shall be considered with insulated bearings for motor rating 90kW and above (not applicable for package product like turbo blower etc.).

Cooling System

All motors shall be self-ventilated, fan cooled. VFD operated motors shall be VFD duty and shall be fully compliant to VFD drive conditions.

Rotor

The motor shall be squirrel cage type, dynamically balanced to provide a low vibration level and long service life of the bearings.

Shaft Extension

Motors shall be provided with a single shaft extension with key-way and full key. Motor shaft shall be sized to withstand 10 times the rated design torque.

Lifting Hook

All motors weighing more than 30kg shall be provided with lifting hook of adequate capacity.

Earth Terminals

Two earth terminals of adequate size, located preferably on diametrically opposite sides shall be provided for each motor. Necessary nuts and spring washers shall be provided for earth connection.

Accessories

- Anti-condensation heaters of 240V, single phase, shall be provided for motors rated 30kW and above. Heaters shall remain ON when the motor is not in service and as such shall not cause damage to the windings. Heaters shall be metal encased with a low surface temperature.
- RTD/BTD: 2 number per phase RTD and 2 numbers BTD for bearings both drive and non-driven ends shall be provided for motors rated 90kW and above, suitably terminated in auxiliary terminal box. Separate terminal box shall be considered for space heater and RTD/BTD.
- Name plates shall be provided on each motor as per IEC/IS.
- Noise level and motor vibrations shall be within the limits as laid down in IS.
- **Special application motor for higher pump RPM than motor:** For special applications like high pressure RO pumps etc. where in the pump RPM selected are more than motor RPM, such motors shall be driven by VFD only to achieve higher motor RPM as per pump RPM and the de-rated motor torque at such higher RPM shall be more than pump torque requirement with minimum 10% safety margin or higher as recommended by pump manufacturer/vendor. The motor for such application shall be de-rated and offered with required higher frame size/rating as recommended by motor manufacturer/vendor and shall be suitable for VFD duty requirements specified.

Notes:

The motor and make of motor as per manufacturers' standards shall be acceptable for following

- The TEFC squirrel cage induction type drive (motor) for imported equipment coming as part of equipment from foreign country. However same shall be generally meeting IE3 efficiency class requirements.
- DC motors (e.g. Turbo Blowers etc.)
- Motor for special applications viz. Braking applications like mechanical screens, EOT Crane Hoist/Electric Hoist, Electric Actuators, SBR Decanter etc.

16.35 Motor Testing

Testing of motors shall comply with the requirements of IS: 4029/IS: 15999.

Motor shall be subjected to all routine tests as per IS: 12615 (2018)/IS: 15999 applicable standard with latest amendments, shall be carried on the motors in OEM factory, in witness of Client/PMC/TPI agency.

All type tests certificates shall be furnished during factory test. Generated values of efficiency and power factors at full load, $\frac{1}{2}$ load and $\frac{3}{4}$ load shall be furnished by the Bidder.

Testing and inspection plan, methodology and applicability for various ratings of motors is specified in details in the Inspection & Testing Chapter provided in this specifications.

Drawings

The contractor shall submit the following documents of motors obtained from motor manufacturer /vendor for review and approval.

- GAD and Preliminary outline dimensional drawings showing details of motor, terminal box etc.
- Typical cross sectional drawing showing constructional details with complete bill of materials and relevant standards.
- QAP, Performance Curves, Marking and labeling plate details.
- Data Sheets/Guaranteed Technical Parameters.

HV and LV CABLES WITH LAYING DETAILS

All power and control cables for use on low/medium/high voltage shall be heavy duty type, multi strand Aluminum/Copper conductor, PVC/XLPE insulated, extruded inner sheathed, armoured and overall PVC sheathed as described below.

The medium voltage power and control cables have following minimum overall cross sectional areas.

- | | | | |
|----|-----------------|---|--|
| a. | Power Cables | : | 6 sq mm and above (Aluminium)/Up to 4.0 sq mm (Copper) |
| b. | Control Cables | : | Up to 2.5 sq mm (Copper) |
| c. | Lighting Cables | : | Up to 2.5 sq mm (Copper)/6 sq mm and above Aluminium |

Cables shall be sized based on maximum continuous load current and permissible voltage drop. The derating due to ambient air temperature, ground temperature, grouping and proximity of cables with each other etc. as per applicable standards have been taken into account.

Below ground cables in paved areas shall be in concrete lined trenches with pre-cast concrete covers having proper slope and suitable drainage arrangement to avoid water collection. In unpaved areas cables shall be in lined trenches or directly buried in the ground.

In hazardous areas and transformer bays, trenches shall be completely filled up with sand.

Concrete lined cable trenches shall be sealed against ingress of liquids or gases wherever the trenches are in hazardous area or enter into control room or substation area.

Cable trenches shall be sized depending upon the number and voltage grade of cables to be lined. Where underground cables cross roadways, pipe sleepers at grade etc., they shall be protected by being drawn through PVC sleeves/ducts or suitable RCC Pipes/DWC to provide permanent crossing. Pipes laid shall be sealed at both ends for mechanical protection.

High voltage, medium voltage power, control and signal cables shall be separated from one another/each other by

adequate spacing or running through independent pipes, trenches or cable trays as applicable. Cable trays, racks and trenches shall be sized to allow for laying 20% cables in future. Cable installation shall provide minimum cable bending radii as recommended by cable manufacturers’.

Cable route markers shall be installed at every 30meter interval all along the routes of directly buried cable trench and also at locations where the direction of cable trench changes.

All power and control cables shall be of continuous length without intermediate joints. Where joints are unavoidable, these shall be provided with the permission of Engineer-in-charge. All cables shall carry tag numbers for easy identification. In case of control cables all cores shall be identified at both sides by their terminal numbers using PVC ferrules as per interconnection diagrams.

Sequential marking of the length of the cable in meters shall be provided on the outer sheath at every meter. The embossing/engraving shall be legible and indelible.

Control cables having 6 cores and above shall be identified with prominent and indelible Arabic numerals on the outer surface of the insulation. Colour of the numbers shall contrast with the colour of insulation with a spacing of maximum 50mm between two consecutive numbers. Colour coding for cables up to 5 cores shall be as per IS.

A HV XLPE CABLES

Scope

The scope shall cover supplying, laying, testing and commissioning of 3 core cables of circular stranded Aluminium conductors, XLPE extruded dielectric, copper tape screened, armoured, extruded semi conducting compound inner-sheathed and PVC overall sheathed confirming to IS: 7098 Part 2 with latest amendments.

The cables shall be armoured with galvanized steel strip/wire armour.

Cables shall be capable of operating at sustained conductor temperature of 90 °C and suitable for maximum conductor short circuits temperature of 250 °C.

Operating Conditions

Electric system

- System Voltage : 11 kV
- Frequency : 50 Hz

Environment

- Ground Temperature : 35 °C
- Ambient Air Temperature : 50 °C
- Atmospheric Conditions : Humid and Dusty

Construction

11 kV grade stranded compact circular Aluminium conductor, conductor screen with extruded semi conducting compound, cross linked polyethylene (XLPE) insulated, insulation screening with extruded semi conducting compound in combination with copper tape, GI flat/round wire armoured, PVC outer sheathed HV cable as per IS: 7098 Part 2 with latest amendment.

Cable Marking

Embossing on outer sheath shall be as follows.

The PVC outer sheath shall be legibly embossed/printed with the legend “ELECTRIC CABLE 11000 VOLT”, cable size, IS number, identification of manufacturer and year of manufacture, sequential length marking etc. shall be supplied in non returnable drums as per IS: 10418 standard. Cable identification details as above shall be written on drums also as per IS.

Testing

Manufacturer shall carry out routine tests and acceptance tests in accordance with the relevant IS/IEC standards. Routine/acceptance tests reports shall be furnished before dispatch of cables/supply of cables at site. The copies of Type test results shall be submitted along with each drum length.

B LV Power and Control Cables

The scope shall cover supply, laying, testing and commissioning of low and medium voltage XLPE cables.

All cables shall carry tag numbers for easy identification. In case of control cables all cores shall be identified at both sides by their terminal numbers using PVC ferrules as per interconnection diagrams.

XLPE Insulated Power/Control Cables (Medium Voltage)

1.1 kV grade stranded Aluminium/Copper conductor, XLPE insulated, extruded inner sheath, GI strip/ wire armoured (Aluminium armoured for single core cable) LV XLPE cable as per IS: 7098 Part 1 with latest amendment.

RTD/BTD/Signal Cables

Contractor/Vendor is responsible for sizing of all cables considering factors like maximum distance between panel/control room and the units/motors.

Specifications for cables for RTD/BTD/Analog signals shall be as follows.

Cables shall be of 660V/1100V grade, single/multi-pair/triad/core cables as per requirement. Triad/multi core signal cables shall be annealed, tinned, high conductivity 0.5/1.0/1.5 sq mm stranded Copper conductor, polyester tapped PVC insulated number of cores twisted into pair, laid up collectively, individual pair/triad shielded and overall shielded with aluminum mylar tape, armoured with galvanized steel wire/strip, overall sheathed with PVC conforming to IS: 1554 and IEC 189 Part II.

16.36

Splicing and Termination

Branch circuit wiring shall be spliced only in switch boxes, panel switch socket outlet boxes light fixtures outlets and circular junction boxes. They shall be made only with approved polycarbonate type connectors. No joints shall be allowed within the conduit pipes, cable entry pipes or ducts for cable laying and wire pulling.

Testing

Cables shall be tested in accordance with IS: 7098.

Finished Cable Tests at Manufacturers' Works

The finished cables shall be tested at manufacturers' works. Following routine tests for each and every length of cable and copy of test results shall be furnished for each length of cable along with supply. If specified, the cables shall be tested in presence of Client/PMC/TPI.

1. Voltage Test

Each core of cable shall be tested at room temperature at 3 kV AC RMS for duration of 5 minutes.

2. Conductor Resistance Test

The DC resistance of each conductor shall be measured at room temperature and the results shall be corrected to 20 °C to check the compliance with the values specified in IS: 8130 (1976).

Testing and inspection plan, methodology and applicability for various types, sizes and ampere ratings of cables is specified in details in the Inspection & Testing Chapter provided in this

specifications.

Cable Test before and after laying of cables at site.

1. Insulation resistance test between phases, phase to neutral and phase to earth.
2. Continuity test of all the phases, neutral and earth continuity conductor.
3. Sheathing continuity test.
4. Earth resistance test of all the phases and neutral.

Sealing and Drumming

Cable shall be supplied in non returnable drums as per IS: 10418 standard. Cable identification details like voltage, size, name etc. shall be written on drums also as per IS.

C Cable Accessories

All accessories like cable glands, lugs and terminal markings etc. shall be used conforming to relevant standards/as specified.

The end termination for HV cables shall be heat shrinkable type.

For 1100V grade cables, Ni-Plated Brass Double Compression type glands weather protection of IP 65 as minimum.

Crimping type lugs of Copper/Aluminium (as applicable) of required sizes shall be used.

D Cable Laying

HV power, MV power and control cables shall be separated from one another/each other by adequate spacing or by running through independent pipes, trenches or cable trays. Cable laying and termination shall be such that chances of cable getting damaged are eliminated.

LV cable shall be laid in cable tunnel or tray racks or buried underground with appropriate protection. Black shall indicate the neutral, while red, yellow and blue for three different phases. All LV cables when laid on the cable racks shall be properly dressed and clamped as required without criss crossing and unnecessary overlapping. Cables shall be properly dressed and clamped.

Laying of HV and LV underground cables

Minimum depth of cable trench shall be 750mm for LV cables and 900mm for HV cables from finished ground level (FFL/FGL). Before placing of cables in the excavated trench, bottom shall be cleared from all rocks, stones and sharp objects. The cables shall be protected by filling bottom of the trench with a layer of sand. This sand layer shall be leveled prior to laying of cables over it. Such laid cables shall be covered with 150mm of sand on top of the largest diameter cable and sand shall be lightly compacted. A flat protective cover of 75mm thick second class red bricks shall then be laid properly in alignment followed by backfilling of the remaining portion of trench with soil, duly rammed and leveled.

While routing, necessary barriers and spacing shall be maintained for cables of different voltages in case they are laid side by side (in adjacency).

Telephone/Telecommunication cables shall cross the power cables only at about right angles and these two shall not run in close proximity.

LV cables shall be bent in radius not less than 12 times their individual overall diameters, while HV cable shall have bends not less than 15 times their individual overall diameters.

Cable routing between cable trench and equipment/motors shall preferably be taken through GI/DWC pipe sleeves of adequate size. Pipe sleeves shall be laid at angle of maximum 45 degree to the trench wall. Bending radii of pipes shall not be less than 8 times their individual overall diameters.

It shall be ensured that both ends of the pipe sleeves are sealed with approved WP sealing compound after cabling. In places where it is not possible, cables shall be laid on smaller branch trays.

All cable shall be identified close to their termination point by cable tag numbers as per cable schedule. Cable tags shall be punched on aluminium straps (2mm thick, 20mm wide of sufficient length) securely fastened to the cable and wrapped around it.

Routes of these cables shall be arrived at on the basis of relevant drawings and with due consultation with the Engineer-in-charge.

16.37 E Drawings and Schedules

Size of cables shall be given in single line power diagrams. Cable schedule shall be prepared on the basis of relevant drawings. All cables and wires shall be adequately sized to carry continuously the normal currents expected on the relative circuits. All trenches for electrical cables shall be separate from water or sewage pipe line trenches.

16.38 F Splicing and Termination

Straight through joints shall be avoided. In case, these are absolutely necessary they shall be made at convenient locations suitably protected as approved and sanctioned by the Engineer-in-charge but in no case within the conduit pipes or ducts.

Branch circuit wiring shall be spliced only in switch boxes, panel switch socket outlet boxes light fixtures outlets and circular junction boxes. They shall be made only with approved porcelain connectors.

CABLE ACCESSORIES AND MISCELLANEOUS ITEMS

This defines specifications and requirements mainly for miscellaneous items and accessories, which are generally supplied by the erection contractor/agency.

All materials, accessories and consumables to be supplied by the contractor shall be selected from the list of specified makes and shall conform to the specifications given here under.

The accessories shall be manufactured in accordance with prevailing latest IS specifications wherever they exist or with the BS or NEC specifications, if no such IS standards are available. In the absence of any specification, the materials shall be as approved by the Client/PMC/TPI.

All similar materials and removable parts shall be uniform and interchangeable with one another. Makes of bought out items selected by the contractor must be from the approved vendor list of tender.

Cable Trays

These shall be channel type, fabricated from structural steel, hot dip galvanised complete with all accessories such as bends, tees and reducers.

MS/Aluminium flat clamps with GI/Chrome plated bolts, nuts/screws to be used for clamping cables.

Sizes of these trays shall be as specified in bill of quantities/drawings approved by Client/PMC/TPI.

Size 150mm and above shall be ladder type and below 150 mm shall be perforated type. Collar size of the ladder type cable tray shall be 100 mm and 50 mm for perforated type.

Alternatively **FRP cable trays** manufactured as per applicable/relevant standards of required thickness and sizes are also acceptable with prior approval by the Client/PMC/TPI

Cable Glands

Cable glands shall be heavy duty double compression type of Ni-Plated brass. These shall be suitable for armoured/unarmoured cables, which are being used.

Cable Connectors

Cable connectors, lugs/sockets, shall be of Copper/Aluminium alloy, suitably tinned, solder less, crimping type.

These shall be suitable for the cable being connected and type of function (such as power, control or connection to instruments etc.).

Cable Indicators

All cables shall be identified by cable tag of 2mm thick, 15mm wide of enough length of Aluminium straps securely fastened to the cable. PVC identification number, ferrules shall be used for each wire.

Conduits for Cables

For laying of cables under floor, medium duty GI/UPVC/DWC/RCC pipes shall be used.

Pipe shall be laid at an angle of maximum 45 degree to trench wall. Both ends of pipe shall be sealed with approved water proof sealing compound after cabling work.

Size of pipe shall depend upon the overall outer diameter of cable to be drawn through pipe.

To determine the size of pipe, minimum 40% area of selected pipe shall be free after drawing of cable.

LOCAL PUSH BUTTON STATION

Each motor shall be provided with a local control station in the vicinity (area) of the motor.

Construction Features

Push button and related control switches shall be as per IS: 6875.

The local push button station/local control station (LCS) shall have Polycarbonate/FRP/die cast Aluminium enclosure or as specified in BOQ of IP 65 with gland plate with knock out holes suitable for outdoor application.

All control stations shall be suitable for 10A continuous current rating 240V AC as well as 110 V/220 V DC control supply.

All push buttons shall be fitted with 2 NO + 2 NC rated to carry and break 6A at 415V (10A at 240V AC).

The open/close/start push buttons shall be of the momentary contact push to actuate type and shall be green in colour.

The stop push buttons shall be stay put type with mushroom knob and lockable in pressed position and shall be red in colour.

All ammeters shall be of moving iron type having an accuracy class of 1.0 and suitable for 1A CT secondary. The size of ammeter shall be 72mm x 72mm or minimum 65mm dia. The ammeter front glass shall be toughened/transparent Acrylic.

20% spare or minimum 2 number spare terminals shall be considered.

Type of Push Button Stations

Type of LCS	Application	Features Required
Type A	Motor without VFD	Start and Stop PB
Type B	Motor with VFD	Start, Stop, Speed Increment and Speed Decrement. Ammeter if specified in BOQ/Scope of work for motor rated above 30kW
Type C	Motor above 30kW	Start, Stop PB, Ammeter if specified in BOQ/Scope of work
Type D	MOV	Open, Close and Stop PB
Type E	Reversible Motor	Forward, Reverse and Stop PB

INTERNAL AND EXTERNAL ILLUMINATION

General

The illumination system shall consist of lighting poles, lighting distribution boards, lighting panels/power panels complete with FSU/ELCB/MCB, fixtures, cables, junction boxes, terminal blocks, cable glands, 3 pin 5 A/15 A convenience socket outlets, conduits and accessories and supporting and anchoring materials, lighting fixtures with LED lamps/tubes, sodium vapour lamps, wires etc. All materials, fittings and appliances use in electrical installation shall conform to the relevant IS specifications, required area classification and environmental conditions and shall be anticorrosive painted/FRP enclosures.

The wiring for lighting circuits shall be done by wires run in PVC conduits for indoor areas. For outdoor lighting, wiring shall be done by armoured cables.

- Illumination Level**

The following minimum levels of illumination (average lux level) shall be provided in the respective areas.

Sr. No.	Area/Building	Illumination Level
1	Pump House/Centrifuge or Press Area/Sheds/Blower Room	150 Lux
2	Control Room/Laboratory	300 Lux
3	Office	200 Lux
4	Switchgear/MCC Rooms	200 Lux
5	Sub Station (Switchyard)	50 Lux
6	Toilet Block/Wash Room etc.	100 Lux
7	Roads/Walkways	10 Lux

8	Yard/Outdoor Area	10 Lux
9	General Process/Outdoor Equipment Area	100 Lux

The lighting fixtures offered shall comply with the following requirements.

- a) Luminaries shall have high efficiency Lumen Output/Watts.
- b) Enclosures shall preferably be FRP/Cast Aluminium with corrosion resistance paints.
- c) All indoor and outdoor lighting fixtures shall be power saving long life LED type only.

All lighting fixtures shall be supplied complete with control gear and lamps. Special fixtures, wherever required to meet operational requirements, aesthetics etc. shall also be provided by the Bidder. Make of lighting fixture shall be embossed on each lighting fixture.

Lighting wiring between LDB/SB and lighting fixtures shall be done by PVC insulated, Copper wire (phase, neutral and earth) for non plant buildings which shall be through surface run/ concealed conduit. All lighting cables shall be 3C x 2.5sq mm, 660/1100V grade, Copper conductor, PVC insulated, armoured type.

Conduit wiring shall be done in 25mm dia. minimum 16 gauge black enameled steel structure conduit or PVC concealed conduit with 1100V grade PVC insulated copper wire of minimum size 1.5/2.5 sqmm for fixtures/5A receptacles and 4sq mm for power sockets. Not more than 7 wires shall be accommodated in each conduit. All lighting fittings/convenience outlets shall be earthed through the third wire/separate core in conduit/cable.

On walkway, platforms and other outdoor areas, lighting fixtures shall be nearer to landing of stairs or ladders, gauges, flow meters, panel boards or other equipment requiring good illumination.

In outdoor equipment area at ground level, lighting fixtures shall be mounted preferably 4 meter above floor level. Where this is impractical, the minimum height of any lighting fixture shall not be less than 2.5meter. Socket outlets in process plant areas shall be approximately 1200mm above floor level and 300mm above floor level in office area.

Lighting/power panels shall be mounted such that the top of the panel ie 1800mm above finished grade. Control gears of lighting fixtures with separate control gear shall be mounted at suitable height from ground/platform for easy access/maintenance.

All lighting circuits and convenience receptacles shall be fed from lighting/power panels. Main/Lighting Distribution Board (MDB/LDB) shall be dust and vermin proof and shall be provided with SFUs (HRC)/MCCB as incomer and outgoing feeders where fault level is more than 9kA.

Main and Branch Distribution Boards

Each main DB should be provided with 4 pole isolator as incomer and DP ELCB+MCB as outgoing circuit in each phase and all sub DBs should be with Isolator + ELCB as in comer and MCB as outgoing to control and for protection of lighting circuits.

All DBs should be double door type. Hinged door to cover the operations knobs shall be provided. MCBs shall not be loaded beyond 80% of rated capacity. Minimum of 20% MCB in each panel shall be kept as spare. Power and lighting panel shall be of 16 gauge sheet steel construction and shall be suitable for surface or flush mounting.

All outdoor lighting shall be automatically controlled by means of synchronous timers with manual override control. Normally about 8-10 fixtures shall be wired in each circuit. Lighting feeders requiring

automatic control shall be provided with contactors of suitable rating.

Sufficient number of three pin type 5A/15A receptacles as per IS: 1293 shall be provided. Flush mounting type receptacle shall be used where concealed wiring has been adopted and surface type shall be used for other areas. For exhaust fans and wall mounted air circulators, socket and switch enclosure shall be separate whereas for rest receptacle and controlling on/off switch shall be mounted in the same enclosure.

In building such as sub station, DG shed, workshop, maintenance shop etc. industrial type metal clad socket outlets and plugs shall be provided. The sockets shall be supplied complete with plugs.

Adequate number of ceiling fans of 1200mm sweep (with double ball bearing and regulator) shall be provided in offices and rooms allocated to operating and maintenance personnel etc. In places where ceiling fans are provided, lighting fixtures shall be suspended below fan level with the help of conduits/chains to avoid shadows on the floor.

Minimum 2 number or sufficient exhaust fans as required during detailed engineering/ recommended by equipment manufacturer shall be provided at battery room, laboratory room, sub station/switchgear-MCC room, DG room, all pump houses, filter house etc.

The exhaust fans shall be provided with louvers/net to prevent insects. For pump house below ground level, suitable GI ducts for exhaust shall be provided as decided during detailed engineering and instructed by Engineer-in-charge.

Lux levels shall be maintained at various locations as indicated above and shall be backed up by calculations from manufacturer.

Switch Box

Switch Box shall be made of metal on all sides, except on the front.

In the case of cast boxes, wall thickness shall be at least 3mm and in case of welded mild steel sheet boxes the wall thickness shall not be less than 18 gauge for boxes, up to a size of 20cm x 30cm and above this MS boxes having minimum sheet thickness of 1.6mm shall be used. Switch boxes shall be galvanized after fabrication. Except where otherwise stated 3mm thick phenolic laminated sheets like summica shall be fixed on the front with brass screws. Clear depth of the box shall not be less than 60mm and this shall be increased suitably to accommodate mounting of fan regulators in flush pattern. All fittings shall be flush pattern. It shall be provided with adequate number of knock outs on all sides for ease of wiring either with conduits or without conduits.

Modular type switch boxes are also acceptable.

Wiring/Conduit System

Surface Conduit Wiring System

PVC conduit pipes of approved minimum 1.6mm wall thickness shall be used. The minimum PVC conduit diameter shall not be less than 25mm. Maximum number of wires permissible in a conduit shall be seven/nine for wire size of 2.5sq mm/1.5sq mm respectively.

In long distance straight run of conduit, inspection type junction box at reasonable intervals shall be provided.

Fixing of Conduit

Conduit pipes shall be fixed by heavy duty GI pressure saddle with screws in an approved manner at an interval of more more than one metre but on either side of the couplers bends, or similar fittings, saddles shall be fixed at a distance of 30cm from the centre of such fittings. The saddle should not be less than 20 gauge for conduits.

Where conduit pipes are to be laid along the trusses, steel joints etc. the same shall be secured by means of ordinary clips or girder lips as required by the Engineer-in-charge. Where it is not possible to drill holes in the truss members, suitable clamps with bolts and nuts shall be used. The width and the thickness of the ordinary clips or girders clips and clamps shall not be less than as stated below.

Recessed Conduit Wiring System

Recessed PVC conduit wiring system shall comply with all the requirements of surface conduit wiring system specified in clauses above and in addition to the requirements specified in the following clauses.

The chase in the wall shall be neatly made and of ample dimensions to permit the conduit to be fixed in the manner desired. In the case of buildings under construction, fixed work, special care shall be taken to fix the conduit and accessories in position along within the building work, to avoid damage to the finished wall etc.

All outlets such as switches, wall sockets etc. shall be flush type.

The outlet box shall be same as above and shall be mounted flush with the wall. The metal box shall be efficiently earthed with conduit by an approved means of each attachment.

To facilitate drawings of wire in the conduit. GI mesh wire of 10 SWG shall be provided while laying of recessed conduit.

Lighting Poles

Steel Tubular Swaged Type

Street light poles shall be steel tubular swaged type made from GI pipe conforming to IS: 1239 medium class and made as per IS: 2713.

Street light pole, steel tubular swaged type, 9/7.5/6 meter long (6/4.5/3.0m x 1.5m x 1.5m) 139.7mm, 114.3mm, 88.9mm dia. respectively and 4.85mm, 3.65mm, 3.25mm thick respectively, with MS base plate.

Steel Octagonal Type

Steel octagonal pole with base plate made from CR sheet steel. The pole should be made as per IS and shall be coated with hot dip galvanizing as per IS: 2629/4759 with required base plate and suitable to sustain local wind speed.

Lighting poles shall be of octagonal poles made from sheet steel conforming to BSEN 10025. Internal and external surface of octagonal pole shall be hot dip galvanized to minimum 65 micron DFT. Octagonal poles shall be provided with base plate and provision for fixing foundation bolts. Base plate shall be as per IS: 2062. All poles are tapered octagonal and shall be in single section.

The street light poles shall have minimum 6meter height, Top dia. – 70mm, Bottom dia. – 130mm and 3mm thickness sheet with bracket for mounting the light fittings and all required accessories. Base plate of minimum dimension 200mm x 200mm x 12mm.

The Flood light poles shall have minimum 9meter height, Top dia. – 70mm, Bottom dia. – 155mm and 3mm thickness sheet with bracket for mounting the light fittings and all required accessories. Base plate of minimum dimension 260mm x 260mm x 16mm.

All poles shall be supplied along with pipe cap, single/double arm of 1m/0.5m height and over hung 1m/1.5m long GI pipe having dia. to suit the socket of 250/150/70W etc. 240V, HPSV/LED/MH/HPMV lighting fixture as applicable and with following.

1. PVC junction boxes on pole with 8 way connector and 1 no. 4A SP MCB.
2. Street light pole shall be as per approved drawings.
3. Internal pole wiring with 3 core 1.5/2.5sq mm flexible stranded copper conductor, FRLS insulated wire from junction box to up to Street light/Flood light/fixture as required.

Balancing of Circuits

The balancing of circuits in three phase installations shall be arranged before hand to the satisfaction of Engineer in charge.

Drawings

All wiring diagrams shall indicate clearly in plan, the main switch board, the distribution fuse board, the run of various mains and sub mains and the position of all points with their classification.

Rating of Lamp, Fans, Socket Outlet Points and Exhaust Fans

Lamps installed in pump house and other means shall be LED Type only.

Table fans and ceiling fans shall be rated at 60watts. Exhaust fans shall be rated according to their capacity.

5A socket outlet points and 15A socket outlet points shall be rated at 100watts and 1000watts respectively, unless the actual values of load are known or specified.

Capacity of Circuits

Lights and fans may be wired on a common circuits, such circuit shall not have more than a total of ten points of light, fan and socket outlet or a load or 800watts whichever is less.

Power circuits on buildings shall be designed with a maximum of two outlets per circuit, based on the loading.

Where, not specified the load shall be taken as 1kW per outlet. Wherever the load to be fed is more than 1kW it shall be controlled by an isolator switch or miniature circuit breaker.

Indoor and Outdoor Light Fixtures/Lightings (LED LIGHTING)

LED fixtures shall be generally having following.

- LED luminous Efficacy lumens/watt: 100% minimum
- Efficiency of Electronics System : 80% - 85% minimum
- LED Lamp/Light Efficiency : 85% - 90% minimum
- Total Harmonic Distortion : For Outdoor Fittings: $\leq 20\%$
For Indoor Fittings: $\leq 20\%$
- Power Factor : ≥ 0.85
- Colour Rendering Index (CRI) : ≥ 70
- Colour Temperature/Apparent : $\geq 5700\text{K}$ (Cool day light)
- Radiation : No Ultra-Violet (UV) or Infra-Red (IR) No RF to interfere with radio equipment
- LED Life : Long Life, generally 50,000 Hrs.
- RoHS compliant, Eco Friendly green technology, Mercury free.
- Outdoor LED fixtures must be fully enclosed with minimum IP Rating of IP 66/65 (Weatherproof). LED optical system must be gasketed (enclosed) to minimize light dirt depreciation.
- Electrical safety for outdoor LED Lights shall be of Class I.
- Luminaries must be clearly marked with manufacturer name, model number, electrical rating and agency approval (If applicable - CSA, UL etc.).

Industrial Luminaire

Indoor LED wall mounting Industrial Luminaire shall be LED type minimum 10watt to 48watt.

Each fitting shall be required LM 79 and LM 80 Certificates.

Tube light shall be 20watt or higher wattage with integral/non integral driver, surge 4kV, IP 20, 4 feet with LEDs of wattage 0.2watt to 0.5watt assembled on single MCPCB with housing used as a heat sink shall be made of thick sheet steel conforming to IS: 513/CRCA polyester powder coated and high UV and corrosion resistance with diffuser and/or Polycarbonate optics with company mark/name.

120 to 300V, Power Factor more than 0.9, THD $< 20\%$

CCT 4000 K to 6500K, Uniformity Ratio > 0.7 ,

Luminaire Efficacy > 85 lumens/watt ,

LED Driver Efficiency $> 85\%$

Fixtures shall be with earthing arrangement facility suitable for ceiling or pendant mounting suitable for 19 mm conduit with stove enameled reflector gray outside and white inside which can be installed without aid of any tools, complete in all respects and ready for use.

Emergency Light

Emergency light unit working on 230V AC supply shall be self containing LED type of minimum with 20watts 600mm long type 'SWITCH ON MAIN FAILURE. It shall be electronic automatic type which incorporates a unit trickle charge circuit, which shall prevent over charging or battery The battery shall be maintenance free. The unit shall provide 4 hours illumination following power failure. The units shall generally conform to IS: 9583.

Gate Lights

The gate lights shall be post top lantern LED type, weather proof and shall be suitable for use with one number 40watt LED and aesthetics appearance shall be as approved by Client/PMC/TPI.

Post Top Lantern LED fitting comprises of Copper dust finish cast aluminum spigot and spun aluminum canopy fixed with opal polycarbonate, pipe arrangement for vertical mounting, open construction driver and accessories wired upto terminal block.

The post top lantern shall be suitable for use with one number 40watt LED.

GI pipes of suitable dia. shall be provided at gate concrete pillar as conduit for wiring and fixing post top lantern luminaire.

Outdoor Yard/Road Lighting

Outdoor Luminaire

The luminaire shall be LED type with minimum 40watt to 240watt LED complete with all accessories and each street light/flood light industrial luminaire shall be IP 65 and Surge 4kV and shall be required LM 79 and LM 80 certificates.

LED outdoor street light/flood light/well glass industrial luminaire shall be with high power white LEDs wattage of 1watt and above assembled on single MCPCB, efficiency more than 130 lm/w and corrosion free high pressure die cast aluminum housing with smooth finish powder coated and heat sink extruded aluminium with diffuser and Polycarbonate optics/lenses with company mark/name engraved or embossed.

120 to 300V,

Power Factor more than 0.95,

THD < 20%,

CCT 5000 K to 5700 K,

Uniformity Ratio > 0.45,

Luminaire Efficacy > 85 lumens/watt,

LED Driver Efficiency > 85 %.

The required parameters of LED fixtures have been enumerated above.

EARTHING SYSTEM

Earthing system design and installation shall generally be as per IS: 3043. All metallic non current carrying parts of electrical apparatus, current and potential transformer secondaries, columns, vessels, towers, stacks, storage tanks etc. shall be earthed at least by two distinct separate earth conductors from the earth plate connected to main earthing

loop.

The main grid conductor shall be hot dip galvanized MS flat. The amount of galvanizing shall be minimum 610 gm per sqm. The main earth loop shall be laid at a depth of 500mm below grade level.

Earthing conductor shall be laid around the battery limit of the plant. Horizontal conductors shall be laid in both longitudinal and transverse direction to facilitate earthing of various equipment in most economical and reliable manner.

Cable trays in process areas shall be earthed with the help of risers emerging from main earthing conductors laid below/adjacent to structures carrying cable trays. Trays shall be earthed at an interval of approximately 30meter and in any case shall be connected to the earthing grid at minimum two points.

Joints and tappings in the main loop shall be made in such a way that reliable and good electrical connections are permanently ensured. All joints below grade shall be welded and suitably protected by giving two coats of bitumen and covered with hessian tape.

Adequate number of minimum 65mm dia. or higher size as per IS: 3043, 3meter long GI pipe earth electrodes with earth pit shall be provided. All earth electrodes shall preferably be driven to a sufficient depth to reach permanently moist soil.

Multiple earth connection shall be taken from suitably located earth plates connected to earth loop. All hardware used for earthing installation shall be hot dip galvanized or zinc passivated. Spring washers shall be used for all earthing connections of equipment. Unless otherwise specified, earthing connections to individual equipment shall be done in accordance with standard equipment earthing schedule.

Lightening protection shall be provided for equipment, structures and buildings as per IS/IEC 62305. Self conducting structures may not be provided with aerial rod and down conductors but shall be connected to the earthing grid at minimum two points of the base. An independent earthing network shall be provided for lightening protection and this shall be bonded with the main earthing network minimum at two points at the buried electrodes.

The resistance value of an earthing system to the general mass of earth for the electrical system and equipment shall be as follows.

- a) For the electrical system and equipment a value that ensure the operation of the protective device in the electrical circuit but not in excess of 5ohms. However, for generating stations and sub stations this value shall not be more than 1ohm.
- b) For lightening protection, the value of 5ohms as earth resistance shall be desirable, but in no case it shall be more than 10ohms.

Connection

The earth system connection shall generally cover the following.

Equipment earthing for personnel safety

System neutral earthing

Static and lightning protection

System neutral

Current and potential transformer secondary neutral

Metallic non current carrying parts of all electrical apparatus such as transformers, switchboards, bus ducts, motors, neutral earthing resistors, capacitors, UPS, battery charger panels, welding receptacles, power sockets, lighting/power panels, control stations, lighting fixtures etc.

Steel structures/columns etc.

Cable trays and racks, lighting mast and poles

Storage tanks, vessels, and all other process equipment

Fence and Gate for electrical apparatus (e.g. transformer, yard etc.)

Cable shields and armour

Shield wire

All main earthing shall be used for earthing of equipment to protect against static electricity.

All LV, medium and high voltage (HV) equipment (above 250V) shall be earthed by two separate and distinct connections with earth.

Plant instrument system clean earthing, UPS system clean/safety earth shall be separate from the electrical earthing system.

All earthing connections for equipment earthing shall preferably from the earth plate mounted above ground wherever provided. Equipment foundation bolts shall not be used for earthing.

Earth connections shall be made through compression type cable lugs/by welded lugs.

All hardware used for earthing installation shall be hot dip galvanized or zinc passivated. Spring washers shall be used for all earthing connections and all connections adequately locked against loosening.

Lighting fixtures and receptacles shall be earthed through the extra core provided in the lighting circuit/cable for this purpose.

The reinforcements of sub station building and sub-station floor shall be connected to main earth grid.

The earth electrodes shall be situated at a distance not less than 3meter from the building fencing structure and equipment foundations. The surrounding the electrodes, soil shall be treated up with salt, coke and charcoal. The distance between two electrodes shall not be less than twice the depth of electrode.

Minimum requirement of earth pits as per IE rules are as under.

- Two numbers independent for transformer body.
- Two numbers independent for transformer neutral.
- Two numbers independent for two/four pole structure.
- One number for lightning arrestors.
- Two numbers for LV panel at sub station and at pump house.

The main earth electrodes after being driven into the ground shall be protected at the top by constructing concrete or block masonry chamber or pre-cast chambers of size 300mm x 300mm x height 300mm with CI cover. The resistance of any point in the earth continuity system of the installation to the main earth electrode shall preferably not exceed 1ohm. The remaining space in the bore hole shall be filled with bentonite. The bentonite will hold the earth rod in position. The neutral conductor shall be insulated throughout and shall not be connected at any point to the consumers earthing system.

It shall not be allowed to use the armour of the incoming feeders cable to the sub-distribution board as the only earthing system.

Sheathed lugs of ample capacities and size shall be used for all underground conductors for sizes above 3 mm² whenever they are to be fitted on equipment of flat copper conductor.

The lugs shall be fitted on equipment body to be grounded or flat copper only after the portion on which it is to be fixed is scrubbed, cleaned or paint or any oily substance on a subsequently tinned.

No strands shall be allowed to be cut in case of stranded ground round conductors. GI embedded conduits shall be made electrically continuous by means of good continuity fixing and also rounding copper wires and approved copper clamps.

Earthing of Lighting Poles

All external poles are to be looped together with continuous 8 SWG GI earth wire clamped a dollies provided on every fuse box of poles and looped onwards to the other pole. Every fifth pole shall be connected to earth through an earth electrode.

Recommended Size of Earthing Conductors

Below mentioned are the recommended minimum sizes of earth conductors. However, Earthing strips/conductors, if required of higher size as per Ground Fault Calculations, should be laid as per SOQ or as per site requirement.

Type of Equipment	Earth Conductor (See Note)
Motors upto 3.7kW	8 SWG solid GI wire
Motors from 5.5kW to 30kW and welding receptacles	10mm dia GI wire rope
Motors above 37 kW	16mm dia GI wire rope OR 40mm x 5mm GI strip
Building columns, fencing	40mm x 5mm GI strip
Storage Tanks (Vertical/Horizontal)/Vessels	40mm x 5mm GI strip

Small equipment and instrument	8 SWG GI solid wire
Lighting, Power and Instrument Panels	10mm dia GI wire rope
Main Earth Bus/LV and HV Switchgear Interconnections	75mm x 8mm GI strip
Power Transformer/HV Sub stations	50mm x 6mm Cu for Neutral 75mm x 8mm GI strip for rest
Push Button Stations (LCS)	8 SWG GI solid wire
Street Light Poles	8 SWG GI solid wire
Lighting Transformer	16mm dia. GI rope
Pipe Rack	40mm x 5mm GI strip
Bonding of pipe	25sq mm insulated flexible Cu cable

Notes:

- 1) Earth connection to individual equipment from nearest earth plate/grid may also be done alternately using aluminium/copper conductor PVC insulated core of size not less than half the cross section of the respective power cable to equipment (motor, panel etc.). Connections shall be made using crimp type lugs.
- 2) Number of runs of Cu/GI earthing strips shall be as per ground fault calculations.
- 3) The size of strip mentioned may be changed as per availability meeting the minimum area requirement of specified size of strip/conductor.

Maintenance Free Safe (Chemical Type) Earthing System

Chemical type earthing electrode shall be used for equipment body earthing. It shall be made with steel core and a copper exterior to provide increased conductivity and corrosion resistance. The electrodes shall be minimum 3meter length, 17mm diameter with 99.9% pure electrolyte copper coating of minimum 250 microns and ANSI/UL 467 approved. Adherence of copper to steel rod is achieved through a pioneered bright acid copper plating process using 14 stations using proper current densities, temperature and brightener additives to achieve copper plating with finer grain structure and a smoother, harder and more uniform surface. It shall have minimum tensile strength of 80,000 PSI and straightness tolerance 0.01" per linear foot and shall meet the requirement of ANSI/UL 467, CSA and ANSI/ NEMA. UL logo and control number where applicable shall be stamped on each rod for easy inspection after installation. The rod shall be tested according to IEC 62561-2 and comply to the requirements of IEC 60364-5-54. The rods also should withstand short circuit currents. All fasteners used should conform to the requirements of the above standards.

Back filling compound used shall have resistivity less than 20ohm-cm in its set form. Earth resistance shall be remained same over a wide temperature variation of -60 °C to + 60 °C. It shall be suitable to absorb and retain moisture for long time and shall reduce soil resistivity, Dissipate fault current very fast, Eliminate needs of salt and chemical around electrode and maintain compatibility of soil and rod contact. Earth enhancing compound (Soil conductivity improver) used should be tested according to IEC 62561 – 7 from an NABL accredited laboratory. Exothermic welding material used shall be tested as per IEEE 837

Construction Procedure of Chemical Type Earth Pit

A hole of 100 to 125mm dia. shall be augured/dug to a depth of about more than 3meters or as per instruction of Engineer-in-charge.

Earth electrode of minimum 3meter length shall be placed into this hole.

It will be penetrated into the soil by gently driving on the top of the rod. Here natural soil is assumed to be

available at the bottom of the electrode so that min 150mm of the electrode shall be inserted in the natural soil.

Earth Enhancing material (minimum 20 kg) shall be filled in to the augured/dug hole in slurry form and allowed to set. After the material gets set, the diameter of the composite structure (earth electrode + Earth Enhancing material) shall be of minimum 100mm dia. covering entire length of the hole.

Remaining portion of the hole is filled with backfill soil which is taken out during auguring/ digging.

Construction of masonry earth chamber and cast iron cover with earth resistance result with date or as per instruction of Engineer-in-charge.

For interconnection to the main earthing grid, 40mm X 5mm thick copper clamp shall be provided.

A) PIPE-IN-PIPE Technology Safe earthing

Two pipes of coaxial diameters joined together for enhancing the service life and performance of the overall earthing system.

The cavity in between the electrodes shall be filled with crystalline conductive compounds for current dissipation and anti corrosive properties.

The electrode cross section shall be circular for the uniform distribution of fault current all around from electrode to earth.

Inner pipe of length 3meter shall be hot dip galvanized/zinc coated with minimum galvanizing thickness 80 - 100 micron or Copper plated (minimum 250mm) as per Drawing/SOQ. Minimum size of pipe as per Drawing/BOQ.

Outer pipe of length 3meter shall be hot dip galvanized/zinc coated (minimum 150 micron) or Copper plated (minimum 250mm) as per Drawing/SOQ. Minimum Size of pipe as per Drawing/SOQ.

A hole of 200mm - 225mm dia. shall be augured/dug to a depth of about more than 3meters or as per instruction of Engineer-in-charge.

Earth enhancing compound of minimum 50kg shall be filled. **Earth enhancing compound shall be filled till top of Earthing Pipe electrode.**

B) Plate Type Earthing Stations

The earthing station shall be as per drawing/IS: 3043. The equipment neutral earthing shall be with Copper plate earthing station.

The plate electrode shall be 600mm x 600mm x 3.15mm Copper plate for neutral earthing.

The earthing conductors shall be of Copper strip in plate type earthing.

GI pipe with funnel of good quality shall be used for watering the earthing electrodes/stations.

The brick masonry or pre case CC chamber with cover/chequered plate shall be provided for housing the above referred funnel and pipe.

Earthing Unit Measurement

Earthing station/pit complete with excavation, electrode, watering pipe, soil treatment, masonry chamber with cast iron cover etc. as per tender specifications/drawings shall be treated as one unit.

Different sizes of strips/wires per unit length covering/including cost of interconnection the earthing station to earthing grid, and to respective equipment with fixing accessories like earthing clamps, saddle, labour etc. shall be traded as unit length.

The earth system connection shall generally cover the following.

1. Equipment earthing for personnel safety
2. Transformer, DG and System neutral earthing

3. Static and lightning protection
4. Current and potential transformer secondary neutral
5. Metallic non current carrying parts of all electrical apparatus such as transformers, switchboards, bus ducts, motors, neutral earthing resistors, capacitors, UPS, battery charger panels, welding receptacles, power sockets, lighting/power panels, control stations, lighting fixtures ceiling fan and exhaust fan, street light, flood light pole circuit/cable.
6. Fence and Gate for electrical apparatus (e.g. transformer, yard etc.)
7. Cable shields armour and shield wire.

The scope of work shall also cover supply, laying, installation, connecting, testing and commissioning of following.

Plate (600mm x 600mm x 3.15mm Copper plate) type/Pipe type (Chemical type) earthing station with Copper bonded earth electrode/Copper plate of size as per tender/IS.

Earthing Copper strips from Plate earthing station and hot dipped GI strip for pipe earth to equipotential bar/earth grid.

Earthing GI/Copper strips/wires from earth grid/equipotential bar to power panels, DBs, motors, indoor/outdoor lighting systems etc.

Bonding of non current carrying parts and metallic parts of the electrical installation.

Quantity of pits mentioned are minimum or higher as per soil resistivity. Measurement of soil resistivity to be carried out by contractor at no extra cost.

All the earthing material and installation and construction of earth pit, chamber etc. shall be as per IS: 3043 and tender.

Galvanising thickness shall be 86 micron and 610 g/m² as a minimum.

SAFETY EQUIPMENT

The contractor shall provide safety equipment and accessories for HV panels, DG panels, LV control panels etc. as per statutory requirement.

Generally following shall be provided as a minimum (forming part of scope of this work).

- Supply and spreading synthetic rubber mat, 1meter wide, 2mm thick, conforming to IS: 15652 Class A for 1.1kV LV voltage in front of LV PMCC/MCC/LVDB/APFC etc.
- Supply and spreading 1meter wide 2.5mm thick synthetic insulating mat as per IS: 15652 Class B suitable for operation of 11kV equipment in front of all HV panels for their entire length. The insulating mat should have ISI mark on every one meter.
- Pairs of electrically tested 22kV rubber gloves. These are to be kept in a suitable wooden box.
- A shock treatment instruction chart in English and local language duly framed as detailed in IS: 1355. Details of the nearest medical facility available with phone number shall also be kept.
- First aid box containing first aid kit for treatment of electrical burns in the main switch room.
- ABC powder type 'Ceasefire' portable type Fire Extinguishers as per IS: 13849 of minimum 4.5 Kg capacity with necessary clamps for erection on wall for individual substation, HV and LV panel/control rooms as required and as per fire safety guidelines and norms.

- Danger/Caution notices in English shall be fixed permanently on the equipment, LV, HV panel room, switch yard etc to comply the requirement of IE rules.
- Safety posters for vigilance against electrical accidents as detailed in IS: 1255.
- Fire buckets with MS angle stand and with 4 number round bottom fire buckets marked fire shall be provided in the LV panel room, HV sub station and at transformer yard. Stand shall be with canopy. Stand shall be grouted in RCC.
- 3meter and 6meter long folding Aluminium ladders for safe maintenance of lighting system etc.
- SLD and earthing layout of suitable size duly framed/laminated shall be fixed on the wall near the entrance.

INSPECTION and TESTING

Inspection of offered equipment/items at manufacturers' works' shall be done by the Client/PMC/TPI as specified here in as per relevant inspection and testing standards and as per approved, quality assurance plans, technical data sheets, SLD, documents and drawings.

Inspection Criteria of Various Major Equipment/Items at Manufacturers' Works:

Major electrical equipment/items as specified below, shall be tested and inspected at vendor manufacturers' works as narrated, prior to dispatch to ensure compliance with the specifications, requirements and applicable codes and standards and approved quality assurance and testing plans by the Client/PMC/TPI.

○ **HV Panels/RMU**

100% quantity of HV breaker panels and RMU, tests shall be witnessed @ Manufacturers' works by the Client/PMC/TPI.

100% quantity of **HV FCMA/HFSR/VFD starter panels**, tests shall be witnessed @ Manufacturers' works by the Client/PMC/TPI.

○ **LV Panels**

100% quantity of LV panels for **Amperes Ratings ≥ 630 Amps**, tests shall be witnessed @ Manufacturers' works by the Client/PMC/TPI.

○ **VFD Stand Alone and MCC Panels with VFD**

100% quantity of VFD stand alone panels and all LV panels with VFD starters irrespective of **Amperes Ratings**, tests shall be witnessed @ Manufacturers' works by the Client/PMC/TPI.

○ **APFC Panels**

100% quantity of APFC panels for **KVAr Ratings ≥ 100 KVAr**, tests shall be witnessed @ Manufacturers' works by the Client/PMC/TPI.

○ **Transformers**

100% quantity of transformers for **kVA Ratings ≥ 500 KVAr**, routine tests shall be witnessed @ Manufacturers' works by the Client/PMC/TPI.

○ **DG Sets**

1 No. of each for **kVA Ratings ≥ 500 kVA**, tests shall be witnessed @ Manufacturers' works by the Client/PMC/TPI.

○ **HV Cable**

For all types, ratings and sizes of HV cables, if the quantity of each size, type and where length of cable is $\geq$ **250 meters**, tests shall be witnessed @ Manufacturers' works by the Client/PMC/TPI.

- **LV Cables**

For all types, ratings and sizes of LV cables, if the quantity of each type and size $\leq$ **120 sq. mm** and where length of cable is $\geq$ **1000 meters**, tests shall be witnessed @ Manufacturers' works by the Client/PMC/TPI.

Similarly For all types, ratings and sizes of LV cables, if the quantity of each type and sizes $>$ **120 sq. mm** and where length of cable is $\geq$ **500 meters**, tests shall be witnessed @ Manufacturers' works by the Client/PMC/TPI.

- **HV Motors**

100% quantity of motors of each type and rating of entire lot, routine tests shall be witnessed @ Manufacturers' works by the Client/PMC/TPI. Type test of one motor of each type and rating out of entire lot, shall also be witnessed @ Manufacturers' works by the Client/PMC/TPI.

- **LV Motors**

Motors $\leq$ 45 kW: Routine tests carried out internally and type test certificate of identically rated motor $\leq$ **45 kW** shall be submitted for review and acceptance by the Client/PMC/TPI.

Motors $>$ 45 kW to $<$ 160 kW: For motor ratings $>$ **45 kW**, **one motor** of each type and rating out of the lot shall be sent to pump manufacturer for performance testing of pump-motor assembly set, while all other motors in the lot shall be subjected to internal routine tests. Routine test certificates and type test certificate of identically rated motor shall be submitted for review and acceptance @ the time of pump-motor assembly performance test.

OR

Out of all motors rated $>$ **45 kW to $<$ 160 kW**, **25% quantity of motors of each type and rating or one number (whichever is higher)** out of entire lot, routine tests shall be witnessed @ Manufacturers' works by the Client/PMC/TPI and routine tests of all other motors carried out internally and type test certificate of identically rated motor shall be submitted for review and acceptance.

Motors $\geq$ 160 kW: For motors rating $\geq$ **160 kW**, **25% quantity of motors of each type and rating or one number (whichever is higher)** out of entire lot, routine tests shall be witnessed @ Manufacturers' works by the Client/PMC/TPI. **Type test of one motor of each rating** out of entire lot, shall also be witnessed @ Manufacturers' works by the Client/PMC/TPI. Routine tests of all other motors carried out internally shall be submitted for review and acceptance.

- For all major equipment/items specified above, where factory inspections are exempted as clearly specified above, all tests as per relevant and applicable standards as well as approved QAPs, data sheets, SLD, documents and drawings must be carried out by the manufacturers'/vendors/panel builders etc. and test certificates, As built drawings and BOM, MTCs etc. shall be submitted to the PMC/TPI prior to dispatch for getting dispatch clearance of the Client/PMC/TPI.
- All other items shall be cleared for dispatch based on review of material test certificates/ manufacturers' test reports' by the Client/PMC/TPI.

All expenditure pertaining to inspection including to and fro travel, local conveyance, lodging and boarding etc. shall be borne by the Contractor for minimum 2 representatives of Client/PMC/TPI Agency.

The Client or his authorized representative may visit the works during manufacture of various electrical equipment/materials to assess the progress of work as well as to ascertain that only quality raw materials are used for the same. He shall be given full assistance to carry out stage inspection. Client's representative shall be given minimum two weeks advance notice for witnessing the final testing.

Field tests as per approved procedures/procedures available with Engineer-in-charge or his authorized representative shall be performed on the electrical system/equipment before it is being put into service. All test equipment shall be arranged by the Vendor/Contractor. Test reports shall be approved by the Engineer-in-charge before acceptance of the equipment and complete plant.

ELECTRICAL INSTALLATION

This specification covers the technical requirements for equipment, materials and installation methods, testing and commissioning of electrical system.

The contractor shall possess a valid electrical contractor's license for the state in which site is located and shall ensure its validity during the duration of the contract.

The contractor shall employ adequate skilled and unskilled labour to complete all work according to programme of work. Skilled workers shall possess the minimum qualifications stipulated by statutory or competent authorities.

The contractor shall employ adequate numbers of supervisor to control the labour force and to carry out the work as per schedule. Supervisory staff shall also possess the minimum qualifications stipulated by statutory and competent authorities.

Various types of equipment shall be installed in accordance with approved drawings and/or manufacturers' instructions and good engineering practices. Particular attention shall be paid to lubrication of moving parts and bearings, alignment, tightness of all connections (mechanical and electrical) and wiring.

The transformers and DG sets shall be moved to its location and shall be correctly positioned on their bases.

All parts of the transformers, which are supplied loose, such as conservator, radiator banks, buchholz relays, dial thermometers, bushings, etc. shall be fitted onto the transformers.

Transformer oil if supplied in drums shall be filled into the transformer after duly testing/filtering, up to the correct level required. The transformer may have to be dried out and oil filtered.

The contractor shall place the switchgear correctly on the base of foundation prepared for the same. If the switchgear consists of a switchboard with number of panels bolted together, he will place all the sections of the switchboard correctly, align them and bolt the sections together to form one continuous switchboard. The switchgear shall then be secured to the foundation by means of nuts and bolts or foundation bolts grouted in the base. The contractor shall also make inter section bus/wiring connections.

In case of wall/structure mounted equipment, boards, the contractor shall fabricate and install the structural steel frame work suitable for mounting the various equipment boards. The contractor may have to prepare drawing showing the proposed general arrangement, of the structural frame which shall be subject to the approval of the Engineer-in-charge. The fabrication and installation of the framework shall be recommended only after the approval of drawings. Various items of the equipment, board shall be mounted in accordance with the approved drawings.

Motor shall generally be installed by others, along with the driven equipment. The contractor may, however, be asked to install motors in specific instances.

Cable routes and mode of installation shall generally be as shown in the construction drawings.

Identification tags indicating cable designation, shall be affixed to each cable at ends and at an interval not exceeding 15 meters or at the location where cables change direction or elevation. Signboards with necessary indication/arrow mark with necessary structure/foundation shall be also be installed, of adequate size as approved by Engineer-in-charge, for the entire cabling system buried underground.

HV XLPE/PVC armoured cables shall be terminated or jointed by means of cold setting epoxy based cast resin jointing system or heat shrinkable or push on type cold setting kit.

All cable glands should be of nickel plated brass, double compression type. All Alu/Cu cables shall be terminated through crimping type Alu/Cu lugs respectively.

All electrical equipment viz. transformers, switchgear, motor control centers, motors, control stations, switches, lighting, fittings and other electrical apparatus shall be connected to the main earth loop by means of two separate and distinct external earth conductors. The material, type and size of earth conductors will be as shown in the drawings or as specified.

Electrical installation in hazardous areas if applicable as defined in IS: 5571 shall be carried out with utmost care and special precautions shall be taken to ensure operational safety.

All personnel, especially supervisory staff, working on such installations shall be fully conversant with the applicable National Standards and Code of Practice and shall have previous experience of such work.

The contractor shall take all reasonable safety precautions during construction and testing of the works. Particular attention shall be paid to the following:

- a) To prevent any conductor or apparatus becoming accidentally or inadvertently charged.
- b) Prior to electrical installation (or part thereof) being connected to the main supply, the Contractor shall ensure that uncommissioned or incomplete circuits cannot be inadvertently energized and completed circuit cannot be used without the Engineer's consent.
- c) No hot work is carried out without work-permit issued by the Engineer in FLP zones (if stipulated by process application).

The tests specified below/elsewhere as part of this tender document shall be carried out on the electrical equipment and installation before commissioning the same. The tests shall be performed by or under the direct supervision of a competent person, qualified to carry out the tests. All tests shall be carried out in the presence of the authorized representative of the Employer/Owner and/or the Engineer, unless this stipulation is waived in writing.

PAINTING

All surfaces of equipment/structural steel shall be sand blasted, degreased and pickled in acid as required to provide a smooth & clean surface, free of rust/scale/grease.

After cleaning the surface shall be given one coat of high quality red oxide or yellow chromate and baking in the oven (for equipment only).

All surfaces shall be then finished with 2 (two) coats of finished epoxy based paint of shade 631 of IS: 5 or with a paint shade of Client's choice unless otherwise specified.

DETAILS OF TESTS

I POWER and DISTRIBUTION TRANSFORMERS

- i) Check HV and LV cable terminations, ground connections, fittings and accessories, oil level and oil leaks at various joints. Check breather, thermometers and buchholz relay for proper functioning and operation. Check junction box, marshalling box etc. for correct wiring.

- ii) Oil Test

Crackle test and dielectric test as per Clause 7.11 of IS: 10028. The oil shall withstand at least 40kV with a gap of 4mm.

- iii) Insulation Resistance Test

This may be carried out on new transformer without drying out the transformer, provided the transformer has not been idle or stored for a long period. Otherwise, this test shall be carried out during drying out of transformers. Insulating resistance test shall be carried out between primary & secondary to ground as well as between primary and secondary. Windings not under test shall be grounded during the test.

A megger rated 1000V or higher shall be used for the test.

iv) Polarity and Phasing Out Test

Check external connection of the transformer in accordance with diagram of connection and phase sequence (anti-clockwise)

• **II HV AND MV SWITCH GEAR**

- i) Check proper mechanical operation of circuit breakers including alignment of trolleys in case of draw out type circuits breakers, smooth operation of all mechanical parts, lubrication, mechanical interlocks etc.
- ii) Check contact alignment and wipe, proper sequence of closing and opening of main and arcing contacts.
- iii) Check electrical relays, instruments and controls for correct wiring.
- iv) Insulating test on bus bars – phase to phase and phase to ground. This test will be carried out with circuit breakers in service position, but contacts remaining open.
- v) Insulation test on relays & control wiring including current and potential transformers and wiring of CT and PT secondaries.
- vi) Insulation test on circuit breakers in withdrawn position – phase to phase and phase to ground with contacts closed.
- vii) Adjust correct settings of relays and/or direct acting trips - as specified.
- viii) Operation test

Energise only control circuits and carry out closing and tripping operations (where AC supply derived from main supply is used for operation, the switch–gear bus may be energised). Check operations of electrical interlocks. Check tripping of circuit breakers by manual operations of protective relays contacts. Check operations of mechanical closing and tripping devices. Check lockout conditions for closing of circuit breakers by simulating the required conditions. Check control, indications, sequence interlocks and alarms.

- ix) Polarity and connections of instrument transformers – Check for correctness of CT and PT connections provided. Check electrical continuity of secondary with ELV tester.
- x) Check operation of instruments, meters, relays and tripping of circuit breakers by primary/ secondary injections as specified.
- xi) Check continuity of power circuits and earth continuity of all non current metallic parts with a low voltage (6 volts or less) continuity tester.

III MOTOR CONTROL CENTRES, SWITCHGEARS

- i) Check equipment, internal wiring, smooth mechanical operation, interlocks etc.
- ii) Check continuity of power circuits and earth continuity of all non current carrying metallic parts with a low voltage continuity tester.

- iii) Insulation test for power and control circuits between phases, between phases and neutral and between phase/neutral and ground.
- iv) Check operation by energizing control circuits (without energizing power circuits) for correct functioning. Simulate external controls and interlocks for the same. Note chatter or humming of contactor and rectify, in necessary.
- v) Check fuse ratings and adjust relay setting (overhead, single phasing preventers etc) in accordance with load ratings.
- vi) Polarity and connections of instrument transformers – Check for correctness of CT and PT connections provided. Check electrical continuity of secondary circuits with ELV tester.

IV Motors and Rotating Equipment

- i) Check equipment for free movement of rotor, and play, lubrication and for any other visual checks.
- ii) Insulation test of motors – between winding and ground. Use 500V megger for MV motors and 1000V megger for HV motors.
- iii) Check electrical continuity with ELV tester.
- iv) No load running of motor noting down no load current and voltages in all three phases.

V Cables

- i) Insulation Test between each phase and neutral and between each phase/neutral and ground.
- ii) DC high voltage test on HV cables in accordance with the relevant Indian Standards and Code of Practice. This test shall be carried out on cables installed in final positions, and all joints and terminations have been made. The cables, however, may not be connected to the equipment, so that the equipment may not be subject to the test voltage.
- iii) In case of lighting wiring, insulating test shall be carried out on lighting feeders with branch circuits open. Branch circuits shall be tested separately with lamp holders, plug receptacles and lighting fittings in position, but without lamps. In case of lighting circuits with lamp ballasts and glow starters, insulation resistance may be measured between phase and ground only.
- iv) In case of directly buried cables, insulation resistance of cables shall be measured before and after the back fillings.
- v) Test all receptacles for correct phase sequence.

VI Earthing System

- i) Measure earth resistance of each electrode separately. If a number of earth electrodes are interconnected with one another, combined earth resistance shall also be measured. The earth resistance of each electrode and/or a group of electrodes shall not exceed the values specified.
- ii) Carry out line earth loop impedance test. The loop comprises the line conductor from the point of fault, back to the supply transformer, the path through transformer winding, the earthed neutral point of the transformer and path for that point to the point of fault through the earthing system.
- iii) Continuity test for earth continuity conductors with ELV tester.

STATUTORY APPROVAL

The Contractor shall be totally responsible for obtaining statutory approval from the electrical inspector or any other statutory authority for the entire installation including DG Set carried out by him unless otherwise specified and agreed. Necessary test reports shall be submitted by him to electrical inspector. This will be an integral part of the contract and shall not be paid for separately. **The contractor shall liaison with local electric supply company for getting power supply and only necessary fees, if any, payable to supply company shall be borne by the Owner.**

ACCEPTANCE OF INSTALLATION

On completion of the work the Engineer-in-charge, together with the Contractor, will carry out an inspection of the Installation. The Engineer-in-charge will issue a completed copy of the Client's Acceptance of Electrical Installation to the Contractor as confirmation that the works have been accepted, subject to any matters noted on the form being attended to.

PRICE BREAKDOWN

- 1.1 Whenever requested by the Engineer-in-charge, the contractor shall furnish detailed price breakdown for supply and installation of each of the items of electrical works including for each type/size of applicable cable/light fitting/earth pit/earth stations.
- 1.2 This breakdown prices are required for the purpose of justification for progress payment and also for working out addition and deletion, if any, in the scope of work at a later date.

**TECHNICAL DATA SHEET FOR
ELECTRICAL EQUIPMENT**

**(TO BE SUBMITTED DURING
EXECUTION STAGE)**

DOCUMENT: TECHNICAL DATA SHEET FOR H. T. VCB (If Applicable)

Sr. No.	Particular	Details	Confirm/ DATA to be submitted at the time of Drg. approval
1.0	General :		
1.1	Make	As per Approved vendor list	
1.2	Model & Type no.	Pl. furnish	
1.3	Design Ambient temperature	50°C	
1.4	Atmosphere	Corrosive, Humid, Dusty	
1.5	Location	Indoor / Outdoor	
1.6	Degree of Protection	As per tender	
2.0	Electrical Data :		
2.1	Type of breaker	Vacuum Circuit Breaker	
2.2	Service	Continuous	
2.3	Voltage	11 kV $\pm$ 10%	
2.4	System earthing	Solidly earthed	
2.5	Frequency	50 Hz. + 5% to - 5 %	
2.6	No. of phase	3	
2.7	System fault level	350/500 MVA or higher as per Statutory requirements	
2.8	Rated short time current	18.37/26.3 kA (1 sec.) or higher as per Statutory requirements	
2.9	Max. system voltage	12 kV	
2.10	Auxiliary supply : (Power Pack required)	110V D.C derived from Power Pack connected on 110V AC P.T. supply. Power Pack required for Incoming as well as Outgoing feeders.	
2.11	Making capacity	46 KA (peak)	
2.12	Busbar material & current rating	Copper & 400 / 630A as per BOQ.	
2.13	Cable entry	Bottom	
2.14	Cable termination space required for:	For 3C x 300 sq.mm, XLPE armoured cable	
2.15	Breaker particulars :		
	(a) Operating duty	Pl. .furnish/ show catalogue / IS	
	(b) Operating mechanism	Motor charged spring / manual trip & close	
	(c) Spring charging motor	230 V AC, 200 W	
	(d) Trip / Closing coil	110 V DC, 180 W	
	(e) Anti pumping feature/relay	Required.	
	(f) Latching requirement	Trip free	
	(g) Emergency trip push button	Required.	
	(h) Space heater and cubicle lamp	Required.	
2.16	Constructional requirements		

Sr. No.	Particular	Details	Confirm/ DATA to be submitted at the time of Drg. approval
	(a) Thickness of sheet steel for frame, enclosure, doors, covers and partitions	CRCA sheet - 2 mm, hinge type door with neoprene rubber gasket	
	(b) Colour	Epoxy powder coating RAL 7035	
	(c) Earth bus size	40 x 6 mm. tinned Copper	
	(d) Foundation frame	ISMC-100, Suitable for three breakers or as per BOQ, with necessary bed plate and foundations bolt.	
	(e) Over all dimension	Provide dimensions	
	(f) Over load of equipment	Provide as per tender	
	(g) Minimum clear space required (i) front side as well as (ii) rear side	Provide dimensions	
2.17	Annunciation Provided	To be Provided as per tender	
2.18	Relays	As per Specifications	
	(a) Relay no. & detail	Shall be as per tender	
	(b) Type of relay	Shall be as per tender	
	(c) Make of relay	Shall be as per tender	
	(d) Model no of relay	Provide details	
2.19	Current Transformer		
	(a) Type of CT	Cast Resin	
	(b) Accuracy class	Provide details as per tender	
	(c) VA burden	Provide details as per tender	
	(d) CT ratio	Provide details as per tender	
2.20	Potential Transformer		
	(a) Type of PT	Cast Resin	
	(b) Accuracy class	Provide details as per tender	
	(c) VA burden	Provide details as per tender	
	(d) PT ratio	Provide details as per tender	
2.21	Panel Accessories		
a)	Toggle switch for space heater and socket	230 V A.C , 6 A	
b)	(b) Socket	6 pin 5/15 A with DP MCB	
c)	(c) MCB for spring charging motor circuit	6 A , DP MCB	
d)	(d) MCB for ON / OFF	Double pole, 16 A, 110 V D.C for D.C ckt. Double pole, 16 A, 230 V A.C for A.C ckt.	
e)	Local / Remote selector switch	4 ways, 2 positions, lockable in any position, angular movement, stay put, lever type handle.	
f)	Trip – Neutral – Close (TNC) Switch.	6 ways, 3 position, spring return to neutral, angular movement, lockable pistol grip type handle.	

Sr. No.	Particular	Details	Confirm/ DATA to be submitted at the time of Drg. approval
g)	Space Heater	230 VA.C , 100 W (LT supply from LT Panel)	
h)	Limit switch for test and service position.	Required	

DOCUMENT: TECHNICAL DATA SHEET FOR TRANSFORMER

SR. NO.	PARTICULAR	DETAILS	Confirm/ DATA to be submitted at the time of Drg. approval
1.0	GENERAL FEATURES		
1.1	Make	As per Tender	
1.2	Rating in kVA	As per SOQ	
1.3	Installation	Outdoor	
1.4	Service	Continuous	
1.5	Climate	Corrosive	
1.6	Type of cooling	ONAN (Oil natural Air Natural)	
1.7	Ambient temperature	Max. 50° C Avg. 35° C	
1.8	Allowable temperature rise	As per IS:1180(Part-1)	
1.9	Painting	Epoxy, shade no. Siemens Grey RAL-7035	
1.10	Oil type	Mineral oil	
1.11	Position	Plinth mounted	
2.0	ELECTRICAL DATA :		
2.1	Earthing : L.V. side	Solid	
2.2	No. of windings	Two	
2.3	Phase	3	
2.4	Frequency	50 Hz.	
2.5	Voltage ratio	11 / 0.433 kV	
2.6	Phase connection	Delta – Star	
2.7	Vector group	Dyn – 11	
2.8	Winding insulation class	"A"	
2.9	Terminations suitable for:	11 kV(E), 3CX340 Sqmm Al. XLPE Cable,as per SLD / BOQ	
a)	H.V. side		
b)	L.V. side		
3.0	TAP CHANGER :		
3.1	Tapping	H.V.	

SR. NO.	PARTICULAR	DETAILS	Confirm/ DATA to be submitted at the time of Drg. approval
3.2	Tap changer	Off Circuit(<2000KVA) OLTC(2000kVA & Above) OR as specified in BOQ	
3.3	Tapping range	as per IS-1180 (Part 1):2021	
3.4	No. of steps	as per IS-1180 (Part 1):2021	
4.0	Limit for transformer operation under over load condition as per IS	Pl. furnish	
5.0	ACCESSORIES AS UNDER :	Required	
— — — — — — — — — — — — —	Inspection cover. Buchholz relay with alarm & trip contacts (for 400 KVA & Above) Marshallingbox suitable for IP-55 class of protection. Sampling valve with plug or cover plate. Magnetic oil level gauge & Plain oil level indicator with mini. Mark. Conservator & conservator drain valve Bidirectional rollers. Oil temp. indicator with alarm & trip contacts Bottom drain & Filter valve with plug or cover plate. Double diaphragm Explosion vent Silica-gel breather		
— — — — — — — — — — — — — —	Air release plug / device. Separate neutral bushing Top oil filter valve Jacking pads Lifting Lugs Two Earthing terminals. Thermometer pocket for O.T.I. Winding temp. indicator with alarm & trip contacts Pressure relief valve (for rating 2500KVA& above) Rating and diagram plate Neutral CTs for REF and Back-up E/F protection(For Transformer rated 2500KVA and above)		

SR. NO.	PARTICULAR	DETAILS	Confirm/ DATA to be submitted at the time of Drg. approval
— — — — —	OLTC & RTCC panel (For Transformer rated 2000KVA&above if specified in SLD/BOQ) Oil surge Relay (For Transformer rated 2000KVA& above if specified in SLD/BOQ) Any other required as per IS:1180 / IS:2026		
6.0	PERFORMANCE DATA :	Pl. furnish	
6.1. a)	Guaranteed Maximum Total losses without Positive tolerance (no-load + load losses at 75° C) at 100% of rated load.	IS:1180(Part-1):2021 / as per specifications	
b)	Guaranteed Maximum Total losses without Positive tolerance (no-load + load losses at 75° C) at 50% of rated load.	IS:1180(Part-1):2021/ as per specifications	
c)	Impedance (Percent) on principal tap	IS:1180(Part-1):2021 / as per specifications	
6.2 a) b)	Rated current No load current at 100% voltage No load current at 112.5% voltage	As per IS-1180(Part 1):2021 2% of Full load Current 5% of Full load Current	
6.3	Rated efficiency at 0.8 P.F.	As per IS-1180 (Part1):2021	
a) b) c)	At full load At 100% load At 50% load	Pl. furnish.	
6.4 a) b) c)	Rated regulation At 0.9 P.F. lag At 0.8 P.F. lag At unity P.F.	Pl. furnish	
6.5	Load at which max. efficiency occurs	Pl. furnish	
6.6	Maximum efficiency	Pl. furnish	
6.7	Permissible flux density & Over fluxing	As per IS-1180 (Part 1):2021 Pl. furnish	
6.8	Current density	Pl. furnish	
7.0	MECHANICAL DATA :	Pl. furnish	
7.1	Total Quantity of oil.	Pl. furnish	
7.1a	Extra Oil	10% Extra oil in Non returnable drum	
7.1b	All Hardware	Hot Dip GI	
7.2 a) b) c) d)	Total Trans. Weight (with oil) Trans. Weight without oil Copper weight core weight	Pl. furnish Pl. furnish Pl. furnish Pl. furnish	

SR. NO.	PARTICULAR	DETAILS	Confirm/ DATA to be submitted at the time of Drg. approval
7.3	Dimensions of transformer including All all accessories: (L x W x H in mm)	Pl. furnish	
7.4	Recommended Dimensions of Plinth for Transformer (L x W x H in mm)	Pl. furnish	

ANNEXURE 1: TECHNICAL DATA SHEET FOR MEDIUM VOLTAGE PANEL BOARD

SR. NO.	PARTICULAR	DETAILS	Confirm/ data to be submitted at the time of Drg. approval
1.0	SITE CONDITION		
1.1	Type/Make	Indoor / As per tender	
1.2	Mounting	Floor	
1.3	Design Ambient Temperature	50° C	
1.4	Atmosphere	Corrosive, Humid and Dusty	
2.0	CONSTRUCTION		
2.1	Housing	2.0 mm thick CRCA sheet for Body, Partition, Cover/door	
2.2	Protection Class	IP-5X	
2.4	Base channel	100 x50 x5 mm Channel	
2.5	Shipping section length	2500mm (Max)	
2.6	Side sheets for shipping section	Full side sheet on both side of shipping section	
3.0	OPERATIVECONDITION		
3.1	Voltage	415V±10%	
3.2	No. of phase	3	
3.3	System	3phase,4wire	
3.4	Frequency	50Hz,+5%/-5%	
3.5	Fault Current	50kAas per SLD	
3.6	Neutral Grounding	Solid	
4.0	CONTROLSYSTEM		
4.1	Voltage		
	For Indication	230VA.C.	
	For Metering	230VA.C.	

	For Protection	230VA.C.	
4.2	Control Supply Through Constant Voltage Transformer	230VA.C. for PMCC & APFC only	
4.3	Wiring	Control wiring : 1.5mm ² FRLS PVC Cu flexible Wire (Grey); CT wiring 2.5 mm ² Color coded	
5.0	BUSBAR		
5.1	Phase Bus bar Material	EC grade Aluminium	
5.2	Neutral Bus bar Material	Same as Phase Bus bar.	
5.3	Earth Bus bar Material	65 x 10mm(Hot Dip Galvanised Strip) OR 40 x 10mm (EC grade AL)	
5.4	Current density (minimum)	1 sq.mm = 0.8 A minimum. Size of busbar based on Design temperature, KA level and minimum Current density	
5.5	Hard ware	High Tensile Steel Bolts, Nuts and Washers duly Zinc/ Cd Passivated shall be used for all bus bars joints and supports.	
6.0	PLC Based System	As per SLD / BOQ.	
7.0	ACB		
7.1	Type, Rating, No of poles	EDO, 50 KA, Rating & pole as per SLD	
7.2	Protection	LSIG with Display& fault record display	
7.3	Display of Metering	Basic (A,V,F) &Energy for I/C & Only current display of Outgoing.	
7.4	Communication port	Inbuilt RS 485 (on MODBUS/ Ethernet/ -)	
7.5	Model	Schneider Master pact NW or Siemens 3WL or L&T U power or ABB E-Max; or Equivalent model from Vendor Approved list	
8.0	MCCB (Ics= 100% Icu)		
8.1	INCOMER & Bus-coupler MCCB	Microprocessor based release with O/L, S/C, inbuilt E/F, 50 KA, 4 pole	
8.2	Outgoing MCCB		

8.21	For rating above 200A	Microprocessor based release with O/L, S/C, inbuilt E/F, 50 KA, 3/4 pole as specified in SLD	
8.22	For rating upto& including 200A	Thermal Magnetic based release with Adjustable O/L, Adjustable S/C, 50 KA, 3/4 pole	
8.23	For SS/ VFD starter feeder MCCB	Microprocessor based release with O/L, S/C, inbuilt E/F, 50 KA, 3/4 pole as specified in SLD	
8.24	Accessories	Extended Rotary Handle, Terminal spreader, Auxiliary change over contact + Trip Contact : To be provided	
9.0	Electronic Motor Protection Relay (with RS-485port)		
9.1	Type	Electronic MPR with LCD display (3 phase current), Record storage, DI/DO interface etc. as per detailed specification give above with RS 485	
9.2	Protection/ interface	Confirm the following	
		1)overcurrent 2)short circuit 3)Earth Fault 4)Current unbalance 5)phase loss/ reversal 6)under current (dry run) 7)stall (bearing broken) 8) locked rotor 9)Ground/Earth fault /leakage (ZCT) 10)Single Phasing with Under voltage and Over Voltage 11)Over temperature (With PTC Thermister) 12) 3Programmable DI & 2 Programmable DO 13)Fault record, Start/Stop , Run Hrs. Max Starting current record.	
10.0	PAINTING		
10.1	Sheet should be 7 tank processed, 2 coats of primer, Oven Baked at310°C with powder coating.	Required	
10.2	Colour & Shade & thickness: Panel Exterior & Interior	RAL 7035 Thickness: Minimum 100 Micron	

10.3	Mounting plate	Glossy white	
11.0	Current Transformer		
11.1	Type	Resin Cast	
11.2	Class of Accuracy	Cl : 0.5 for MFM, APFC load sensing, Summation, MPR Cl: 1 for Ammeter	
11.3	Burden (VA)	As per specification	
12.0	Control Wiring	FRLS PVC Copper Flexible 1.5 sq. mm : control wiring 2.5 sq.mm: CT wiring	
13.0	Hardware	YES. For bus bar joints High Tensile With Zink passivation/Cd plated	
14.0	Space Heater	230VA.C.witht Thermostat	
15.0	Pocket For Drawings at door	YES.	
16.0	Instrumentation compartment	Separate compartment for energy meter, Hour meter, level controller, etc. with necessary internal wiring	
17.0	Panel Internal Lighting	LED light 3W with Auto NO contact/switch with Panel door for VFD/SS/Starter feeder. 3 W LED Panel light ½ ft long , with Control MCB for Internal Lighting for Incomer/ cable alley	
18.0	Danger Notice Plate	With Sign of Skull and Bones as IS – 2551	
19.0	Technical Name Plate	Power Supply voltage, Panel fault level, Panel protection class etc.	
20.0	LT Panel Name Plate	Name of Client (on first row/top row), Project name (second row), Name of Contractor (third row) and Panel manufacturer (in fourth row)	

Note: Other specifications not mentioned in datasheet shall be considered as per tender specification/ SLD.

DOCUMENT: TECHNICAL DATA SHEET FOR INDUCTION MOTOR

SR. NO.	PARTICULAR	DESCRIPTION	Confirm/ data to be submitted at the time of Drg. approval
1.0	Make	Pl. Furnish	
2.0	Application	Pl. furnish as per applicable	
3.0	Type of motor	Squirrel cage induction	
4.0	Efficiency class	IE3 as per IS: 12615: 2018	
5.0	Ambient Temperature	50°C	
6.0	Degree of protection	IP 55	
7.0	Pump shaft BkW in KW	Pl. Furnish	
8.0	Motor Ratings in KW	Please Furnish Detail	
9.0	No. of units/Qty.-nos	As per BOQ / Tender	
10.0	Supply neutral	Solidly earthed	
11.0	Rated voltage	415 V	
12.0	No. of Phase & frequency	3 Phase & 50 Hz.	
13.0	Full load Amp.-A	Pl. Furnish	
14.0	Supply condition	± 10% voltage variation ± 5% frequency variation ± 10% combined variation	
15.0	Synchronous Speed	As per BOQ / Tender	
15.0	Duty condition as per IS 12615 or equivalent	S1 suitable for continuous operations	
16.0	Method of starting	DOL / Star delta / Soft Starter / VFD etc. as applicable	
17.0	Guaranteed Motor Efficiency @ full load @3/4 load @ ½ load	Motor shall be IE3 (as per BOQ) as per IS:12615-2018. Pl. furnish	
18.0	Power Factor @ full load @3/4 load @ ½ load	As per IE3 as per IS:12615-2018. Pl. furnish.	
19.0	Starting torque % of full load torque	Sufficient starting torque to start the maximum full load of driven equipment. Pl. furnish.	
20.0	Pull out torque % of full load torque	Sufficient to bring the motor to normal speed in minimum time. Pl. furnish.	
20.1	Starting time at specified minimum starting voltage Sec.	Pl. furnish (As per Tender)	
20.2	Permissible running time at full load at minimum	Pl. furnish (As per Tender)	

SR. NO.	PARTICULAR	DESCRIPTION	Confirm/ data to be submitted at the time of Drg. approval
	allowable voltage Min.		
21.0	Locked rotor current withstand time (safe stall time) at 110% rated voltage	Pl. furnish (As per Tender)	
22.0	At rated temp. (Hot)	Pl. furnish (As per Tender)	
23.0	When cold	Pl. furnish (As per Tender)	
24.0	Class of insulation & temp. rise by thermometer	Pl. furnish (As per Tender)	
25.0	Design temperature	50° C	
26.0	Location	As per Tender	
27.0	Hazardous area division	As per Tender	
28.0	Atmosphere	As per Tender	
29.0	a) Type of Cooling b) Type of enclosure c) Degree of protection	Pl. furnish. Pl. furnish. For Motor & TB: Min. IP 55:	
30.0	Terminal box	As per Mfg. Standard	
31.0	Earthing Terminals	Required as per IS. Min. 2 no.	
32.0	External cable details.	As per the SLD / Tender	
33.0	Shaft – Hollow / Solid	Pl. furnish (As per Tender)	
34.0	Type of Couplings	Pl. furnish (as per Tender)	
35.0	Type of bearings	Pl. furnish (As per Tender)	
36.0	Colour shade of paint	Epoxy Grey shade 632 as per IS:5	
37.0	Space heater for motors	Confirm as per SLD / SOQ / Tender	
38.0	RTD/ BTD	For 90KW and above motors (6 nos: for winding temperature, 2 nos for bearing & 2 nos. spare)	
39.0	Winding connections	6 Terminals	
40.0	Marking & Labelling	Marking on Rating plate as per 10 of IS 15999 (Part 1)	
41.0	Standard to be followed	IS 12615 -2018, 15999, 8225, 4889, 4772, 4029, 4691 and other relevant Indian Standard or equivalent Standards.	

Note: 1) Manufacturer / supplier shall submit separate data sheet for each duty/ rating alongwith rating determination calculations as per tender specifications.

2) Other specifications not mentioned in datasheet, shall be considered as per tender specification / relevant governing IS / Other norms and statutory Requirements.

APPROVED VENDOR LIST – ELECTRICAL EQUIPMENT / COMPONENT

ITEM DESCRIPTION	APPROVED MAKE
COMPACT SUBSTATIONS	ABB / CGL / SCHNEIDER / SIEMENS/C&S
DISTRIBUTION TRANSFORMERS	CGL / KIRLOSKAR / RAYCHEM RPG LTD. / SCHNEIDER / VOLTAMP / POWERLITE ELECTRICALS
TRANSFORMER LIGHTING- DRY TYPE (CAST RESIN)	ABB / AUTOMATIC ELECTRIC LTD. / CGL / INDCOIL / KOTSONS / VOLTAMP
SWITCHBOARD & SWITCHGEAR MV- II /33KV- INDOOR/ OUTDOOR TYPE (VCB/SF6)	ABB / AREVA / BHEL / CGL / GEC / JYOTI / L & T / SCHNEIDER / SIEMENS/HIGH VOLT (ABB)
PROTECTIVE RELAYS (NUMERICAL TYPE)	ABB / ALSTOM / CGL / GE / L & T / SCHNEIDER / SIEMENS/ C&S
PROTECTIVE/AUX. RELAYS (ELECTROMECHANICAL TYPE)	AS ABOVE
ELECTRONIC CIRCUIT RELAY	ALLEN BRADLEY / OEN / OMRON / PLA
CONTROL AND RELAY PANEL	ABB / ALSTOM / EASUN REYROLLE / L & T / SCHNEIDER / SIEMENS
INSTRUMENT TRANSFORMERS (CT /PT)	AEP / ASHMOR / AUTOMATIC ELECTRIC / CGL / CONTROL & SWGR / ECS / GILBERT AND MAXWELL / INDCOIL / JYOTI / KAPPA / PRAGATI / PRECISE / SILKAANS/NEWTEK ELECTRICALS
L.V. SWITCHBOARD- DRAWOUT / FIXED TYPE (PCC / PMCC / MCC / MLDB / MPDB / MOVDB / APFC)	ABB / ALPHA NIPPON / C & S / CGL / ELEMBCA / ELEMTECH / INDUSTRIAL CONTROLS / L&T POSITRONICS / POWER & INSTRUMENTATION (0) LTD. / SCHNEIDER / SIEMENS / SUN AUTOMAT / SWATI SWITCH- GEAR/HIGH VOLT / SAMUDRA POWER / SHIV SHAKTI / NUTRAL POWERTECH
Note No.-1: Any LT Panel Manufacturer meeting / possessing the following requirements as a minimum shall also be qualified as an approved vendor for supply of LT Panels: 1. Should have obtained approval from CPRI / ERDA and obtained type test certificate for LT Panel with rated voltage of 415V (3-Ph. + N), 50Hz rated frequency and min. 3200A rated current and having short circuit withstanding strength of min. 65kA for one sec. 2. Should have obtained approval from CPRI / ERDA and obtained type test certificate for Degree of Protection Class IP-55 or above for LT Panel with rated voltage of 415V (3-Ph. + N), 50Hz rated frequency and certificates must have validation for current year.. 3. Shall have In-house panel fabrication facility. 4. The company should be in existence for min. 5years and shall have GST Registration Certificate. 5. Shall be ISO 9001:2015 or latest amended up to date certified 6. The panel manufacturer should have min. average turnover of 3 Crores for similar panel manufacturing in last Two (2) financial year (Trading or contracting turnover shall not be considered), duly certified by chartered accountant. Necessary supporting documents / copy of certificates duly notarized shall be submitted along with the technical bid along with self-attested undertaking for manufacturing facilities on panel manufacturer's letter head (by bidder submitting bid as a panel manufacturer or by the bidder who is proposing to supply	

anel or carry out panel related work from such manufacturer including submission of back-up guarantee

as per tender). Client reserves to inspect the works facility of such panel vendor at any stage of bid / execution to assess the facility and verifying the requirements as specified above (The cost of such visit by Client officials of up to two persons including travel, lodging, boarding, local conveyance, etc. shall be borne by bidder). Further bidder and vendor (LT Panel manufacturer) to note that at any stage if it is observed that the LT panel vendor details submitted are incorrect or fake or forged, Client reserves right to initiate action against such bidder / vendor including keeping their registration with Client in abeyance for up to 3 years or as decided by the concerned authority of Client.	
AIR CIRCUIT BREAKERS	ABB / L&T / SCHNEIDER / SIEMENS /LEGRAND/C&S
MCCB'S	ABB / SIEMENS / L&T / SCHNEIDER / LEGRAND/C&S
SWITCH DISCONNECTOR FUSE UNIT (SDF) AND SWITCH DISCONNECTOR ISOLATOR	ABB / L&T / SCHNEIDER / SIEMENS/INDOASIAN
CHANGE-OVER SWITCH	BCH / C&S / GE POWER / HAYELLS / HPL / KRAUS & NAIMER / L&T / SCHNEIDER / SIEMENS
SOFT STARTER (MICROPROCESSOR BASED)	ABB / CG POWER (EMOTRON) / DANFOSS / L&T / ROCKWELL / SCHNEIDER / SIEMENS
VVVF DRIVES (VFD)	ABB / CG POWER (EMOTRON) / DANFOSS / L&T / ROCKWELL / SCHNEIDER / SIEMENS
MV CAPACITORS	ABB / EPCOS / SHREEM / UNIVERSAL/ VISHAY
LV CAPACITORS / POWER CAPACITOR	ABB / EPCOS / HAVELLS / KHATAU JUNKER / MADHAV / MALDE / NEPTUNE / SCHNEIDER / UNIVERSALISHREEMIPRABODHAN/POWER MATRIX / SIEMENSMSHAY
7% DETUNED SERIES REACTORS WITH temperature micro switch (Harmonic Filter reactor)	EPCOS / WHEPL / YESHAINEPTUNEI VISHAY/ L&T
Dynamic Power Factor correction Thyristor Module	EPCOS/ SCHNEIDER/NEPTUNE/ L&T
APFCPANEL	ABB / DATAR / EPCOS /L&T / NEPTUNE / SCHNEIDER / ALL APPROVED VENDORS FOR LT PANEL/EASUN/ ALSTOM / CSPC / SIEMENS
APFCRELAY/CONTROLLER	ABB / DATAR / ENERCON / EPCOS / L & T / SCHNEIDER / SIEMENS / SYNTEL / TRINITY/ NEPTUNE
CAPACITOR DUTY CONTACTOR	ABB / EPCOS / L & T / SCHNEIDER / SIEMENS / C&S
MICROPORCESSOR BASED MOTOR PROTECTION RELAY WITH RS 485	C&S/ ABB / L & T / SCHNEIDER / SIEMENS
AC / DC POWER & AUXILLARY CONTACTOR	ABB / BCH / C & S / GE / L&T / SCHNEIDER / SIEMENS / INDOASIAN
BI-METAL /ELECTRONIC / MICROPROCESSOR BASED OVERLOAD RELAY	ABB / C&S / GE / L&T / SCHNEIDER / SIEMENS / CSPC / ALSTOM / CG / INDOASIAN
THERMISTER RELAY	ALSTOM / INSTA CONTROLS / MINILEC
SINGLE PHASING PREVENTER WITH UV/OV PROTECTION	ABB / C&S / GE / L&T / MINILEC / SCHNEIDER / SIEMENS
TIME SWITCH	GIC / LEGRAND / SCHNEIDER / SIEMENS / THEBEN
TIMERS / TIME DELAY RELAY	BCH / EAPL / L&T / LEGRAND / MINILEC / OMRON / PLA / SCHNEIDER / SIEMENS / TEKNIC / THEBEN / ELICO / INDOASIAN
MOTORS	ABB / BBL / BHEL / CG POWER / NOTI / KEC / MARATHON / SIEMENS / L & T
BATTERY CHARGER & DCDB	AMARA RAJA / AMCO POWER / AUTOMATIC
	ELECTRIC / CALDYNE AUTOMATICS / CHHABI

	ELECTRICALS / EXIDE / HBL POWER SYSTEMS / HIREL-HITACHI / MASS-TECH CONTROLS / UNIVERSAL INSTRUMENTS
LIGHT FIXTURES	BAJAJ / C & S / CGL / HAVELLS / PHILIPS / SURYA / WIPRO
CABLES H.V. - XLPE INSULATED	HAVELLS / KEI / POLYCAB / RR KABEL
LT POWER & CONTROL CABLES / EARTHING CABLES	AS ABOVE
FLEXIBLES FRLS(ALL TYPES)	AVOCAB / FINOLEX / KEI / L&T / LAPP / POLYCAB / RR KABEL / NIVERSAL/ANCHORIHAVELLS/ATLAS
LIGHTING / SMALL POWER DISTRIBUTION BOARDS / ENCLOSURES	ABB / BCH / C&S / ELDON / ENCLOTEK / HENSEL / INDO ASIAN / L&T / LEGRAND / RITTAL / SCHNEIDER / SIEMENS / HAVELLS / STANDARD ELECTRIC / ALL LV PANEL VENDORS
MCB, RCCB, RCBO / MCB ISOLATORS	ABB / C&S / INDO ASIAN / L&T / LEGRAND / MOELLER / SCHNEIDER / SIEMENS / GEC / HAVELLS / S&S / INDOASIAN
MPCB	ABB / C&S / L&T / SCHNEIDER / SIEMENS/ INDOASIAN
ALARM ANNUNCIATORS (SOLID STATE TYPE WITH LED ILLUMINATION) /FACIA ANNUNCIATOR	ALSTOM / DIGICONT / ICA / IICP / MINILEC / PROCON INST. (P) LTD / PROTON ELECTRONICS / APLAB
DECORATIVE/MODULARSWITCH & SOCKET	ABB / ANCHOR / CLIPSAL / CRABTREE / L&T / SIEMENS/SCHNEIDERI INDOASIAN
CEILING / WALL MOUNTING / EXHAUST FANS	ALMONARD / BAJAJ / CGL / HAVELLS / KHAITAN / ORIENT / USHA
CABLE TERMINATION / JOINTING KITS	3M / ABB KABELDON / M SEAL / RAYCHEMIXICOM/CCI
CONTROL/SELECTORSWITCH	ABB / ALSTOM / BCH / GE POWER CONTROLS / HAVELLS / KAYCEE / L&T / SCHNEIDER / SIEMENSIRECOM/ SULZER/ EEIJYOTI
INDICATING LAMPS	BCH / L & T / SCHNEIDER / SIEMENS / TEKNIC CONTROLS IVAISHNO/
TERMINAL BLOCK / CONNECTORS	CONNECTWEL L / ELMEX / PHEONIX / TELEMECHANIQUE / W AGO
CONSTANT VOLTAGE TRANSFORMER/ CONTROL TRANSFORMER	AE / ASHMORE / G&M / INDCOIL / NEC / PRAGATI / PRECISE / SILKAANS
SEMICONDUCTOR FUSE	BUSSMANN / FERRAZ / GE / SIEMENS
HRC FUSE (POWER & CONTROL)	ABB / C&S / L & T / SCHNEIDER / SIEMENS / TECHNOELECTRIC/INDOASIAN
PUSHBUTTONS	BCH / L & T / RASS / SCHNEIDER / SIEMENS / TEKNIC /VAISHNO
PUSH BUTTON STATIONS / JUNCTION BOX (CAST ALUMINITJM\	BALIGA / BCH / CEAG / EXPROTECTA / FCG / FLEXPRO / HANSU / HENSEL / PUSTRON / SCHNEIDER / SIEMENS / SUDHIRIEXCEL
NON METALLIC ENCLOSURES INCLUDING INDUSTRIAL RECEPTACLES)	BCH / HENSEL / LEGRAND / PUSTRON / RITTAL / SCHNEIDER / SIEMENS / SINTEX
DIGITAL AMMETERNOLTMETERPOWER	AE / KRYKARD / L & T / MASIBUS / RISHABH / SCHNEIDER / SECURE / SIEMENSIIMP/MECO/

FACTOR METER	CONZERVINEWTEK ELECTRICALS/ABB
KWH / LOAD MANAGER / MULTI FUNCTION METER	ABB / KRYKAR D / L&T / SCHNEIDER / RISHABH / SECURE / IMP/ MECO / CONZERV/ ENERCONINEWTECH/ABB
IOCHANNELTEMPERATURE SCANNER WITH RS 485 MODBUS COMMUNICATION	MASIBUS/NIVAMINISHKO/ELECTRONET/REDIX
ELECTROMECHANICAL METERS- AMMETER & VOLTMETER	AE/IMP/MECO/RISHABH
CABLE LUGS	3D / COMET / CONNE CTWELL / DOWELLS / JAINSON/3M
CABLE GLANDS (SINGLE / DOUBLE COMPRESSION, NI- PLATTED BRASS)	BALIGA / BRACO / COMET / ELECTRO MEC / EX- PROTECTA / FCG / HMI / JAINSON / SIEMENS / SUDHIR
CABLE GLANDS-POLYAMIDE	FIBOX / GEWISS / HENSEL / LAPP
LIGHTNING ARRESTORS	CGL / ELPRO / JAYSHREE / OBLUM / WS / BIRLA NGK INSULATORS
SURGE SUPPRESSORS	ABB / EMERSON / ERICO / MTL / OBLUM / PEPPERL+FUCHS / PHOENIX / SCHNEIDER / SIEMENS / WEID MULLER
UNINTERRUPTED POWER SUPPLY (UPS)	ABB / EMERSON / FUJI / IDTACHI / INVENSYS / SCHNEIDER / SOCOMEC
GI CABLE TRAYS	GLOBE / INDIANA / JACINTH / LEGRAND / M.M. ENGINEERING / SHARDA / SILVERLINE POWER / VATCO/SUPER ELECTRO
UPVC CONDUIT & ACCESSORIES	AKG / CLIPSAL / L&T / POLYCAB / PRECISION / SALZER
MS / GI CONDUIT & PIPES	BEC INDUSTRIES / TINDAL / JK TUBE / SAIL / TATA STEEL / ZENITH
SMF /VRLA/Ni-CD/LEADACID LANTE/TUBULAR)BATTERY	AMARA RAJA BATTERIES LTD./ AMCO / EXIDE / HBL POWER SYSTEMS LTD./AUTOMATIC ELECTRIC
MS / GI LIGHTING POLES & BRACKETRS	AMBICA ENGINEERING / BAI AI / BOMBAY TUBES AND POLES / GAYATRI ELECTRICALS / INDIA ELECTRIC POLES / RIDDID POLES / SHAKTI POLES / SURYA
HIGH MAST LIGHTING SYSTEM	BAI AI / CGL / PIDLIPS / SURYA/ANALMONT
SANDWICH BUS TRUNKING	C&S/ SCHNEIDER/SIEMENS/ GODREJIL&T
NON PHASE SEGREGATED TYPE BUSDUCT(CONVENTIONAL)	ABB / C&S / L&T / SCHNEIDER / SIEMENS / STARDRIVE/ALLTPANELVENDORS
DIESEL ENGINES	ASHOK LEYLAND / CATERPILLAR / CUMMINS / KOEL / MAIDNDRA POWEROL / MITSUBISID / PERKINS /VOLVO /WARTSILA
ALTERNATORS FOR DG SETS	BHEL / CGL / JYOTI / KEC / KOEL / LEROY SOMER / NGEF / STAMFORD
AMF RELAY, SYNCHRONIZING RELAY (WITH RS 485)	DEAP SEA/ C&S/WOODWARD//DEIF
HANDHELD DIGITAL MULTIMETER / CLIP-ON METER / MEGGER	FLUKE / IMP / MECO / MOTWANE / RISHABH
BATIERY BACKED POWER PACK	ALAN/G'LEC/BHARANI/GOGATE
ALUMINIUM BUSBAR MATERIAL	BANCO/IIINDALCO/JINDAL
PANEL CRCA/MS/GI PLATES & SHEET	ESSAR/TATA/JINDAL/SAIL
CHEMICAL TYPE EARTHING INCLUDING COPPER BONDED ELECTRODE & BACK FILL COMPOUND	ASHLOK / CURSP / ECO TECHNOLOGY & PROFFICTSIENNOV INFRA / ERICOISG GLOBAL / PRAGATI ELECTROCOM/SAARA EARTHING/ EQUI. REPUTED MAKE SUBFFICT TO CLIENT APPROVAL
ACTIVE HARMONIC FILTER	ABB/DANFOSS/SCHNEIDER/AMTECH/EPCOS/

SOLUTION / PANEL	CONSULE NEOWATT / SCHNEFFER/ AD LIFASA
PVC CONDUITS & ACCESSORIES	PRECISION / CLIPSAL / L&T
MODULETYPEPLUGSOCKET	ANCHOR / HAYELLS / CLIPSAL / TOYAMA / MDS

The contractor shall distinctly understand that it will not be their prerogative to insist on a particular brand from the list, and final selection will be done with the approval of Engineer in charge.

SECTION - 6

FORM OF BID

• **FORM OF BID**

Bidders are required to fill up all blank spaces in this Bid Form.

The Executive Engineer,
AUDA,

Dear Sir,

Sub: " BID DOCUMENTS FOR "CONSTRUCTION OF SEWER NETWORK UNDER TP SCHEMES NOS. 412A, 412B, 243, 109, 413 & 411 AND CONSTRUCTION OF 3 NOS.PUMPING STATIONS (MPS 01- 11.98 MLD, MPS-2 12.24 MLD & MPS-3 20.55 MLD) AND SEWERAGE TREATMENT PLANT OF 30 MLD CAPACITY WITHIN AUDA TP SCHEME AREAS".

Having visited the site and examined the Bid Documents, Drawings, Conditions of Contract, Specifications, Schedules, Annexure, Preamble to Price Schedules, Price Schedules etc. including Addenda/Amendments to the above, for the execution of the above Contract, we the undersigned offer to design, engineering, procurement, installation, construction, complete, testing & commission, operate and maintain the whole of the said Works for **5 Years** from the date of successful commissioning including defects liability period for Three(3) Year as mentioned in Conditions of Contract and in conformity with the Drawings, Conditions of Contract, Specifications, Preamble to Price Schedules, Price Schedules, Annexure, Bidding Documents, including Addenda Nos. _____ (insert numbers) for a price of Rs. _____ (Rupees _____) for Design & Construction including 3 months trial run and Rs. _____ (Rupees _____) for Operation and Maintenance for a period of **5 Years** including defects liability period of Three (3) Years or such other sum as may be ascertained/adjusted in accordance with the Tender Conditions

1. I / We agree that
 - a. If we fail to provide required facilities to the Employer's representative or any other person/agency by the employer to perform on his behalf for carrying out the inspection and testing of materials and workmanship
Or
 - a) If we incorporate into the Works, materials before they are tested and approved by the Engineer's representative
Or
- 1.1 If we fail to deliver treated sewage quality according to the conditions/ stipulations of the Contract, the Employer will have rights to impose any penalties/liquidated damages according to the conditions of the contract and/or reject the work including termination of Contract.
2. We undertake, if our Bid is accepted, to complete and deliver the Works in accordance with the Contract as per tender conditions.
3. We agree to abide by this bid for a period of 180 days from the last date of submission of bid and it shall remain binding upon us and may be accepted at any time before the expiry of that period. In the event of our Bid being accepted, we agree to enter into a formal Contract Agreement with you incorporating the conditions of Contract thereto annexed but until such agreement is prepared, this Bid together with your written acceptance thereof shall constitute a binding Contract between us.
4. We agree, if our Bid is accepted, to furnish Performance Bond/Security in the forms and of value specified as per Volume-II(A), General Conditions of Contract, Clause No. 1 "Security Deposit".
5. We have independently considered the amounts of liquidated damages stipulated by you in

this bid document and agree that they represent a fair estimate of the damages likely to be suffered by you in the event of the Work not being completed by us in time.

6. We understand that you are not bound to accept the lowest or any bid you may receive.
Dated this _____ day of _____ 2026.

(Signature)

(Name of the person)

(In the capacity of)

Company Seal

(Name of firm)

Duly authorized to sign Bid for and on behalf of (Fill in block capitals)

Witness

Signature _____
Name _____
Address _____

SECTION - 7

BILL OF QUANTITIES

BILL OF QUANTITIES

Details of BOQ is Provide in Separate Sheet

PREAMBLE TO PRICE SCHEDULES

- 1. Name of work: Bid documents for " Construction of Sewer network under TP Schemes Nos. 412A, 412B, 243, 109, 413 & 411 and construction of 3 Nos.Pumping Stations (MPS 01- 11.98 MLD, MPS-2 12.24 MLD & MPS-3 20.55 MLD) and Sewerage Treatment Plant of 30 MLD Capacity within AUDA TP Scheme areas "**

The bidder shall quote his firm and fixed price under this Contract, defined in more details in various sections of this bid document.

2) It will be entirely at the discretion of the Employer to accept or reject the bidder's proposal, without giving any reason whatsoever and the bidder shall not be permitted to withdraw his bid on this account.

3) Deleted.

4) Deleted.

5) In BOQ the bidder should quote online the percentage above/below/at par with respect to amount put to tender in schedule B for percentage rate tender.

6) In BOQ , bidder shall quote his price for entire work. Prices quoted in BOQ only will be considered for price evaluation & shall form a part of the Contract Agreement.

7) The percentage above/ below/at par with respect to amount put to tender shall be submitted in the electronic formats given by n-procure. The percentage (%) above/ below or at par received in any other formats will be rejected and the Bids will be disqualified.

8) Wherever for a particular item the quantities have been specified payment shall be on unit rate basis and unit variation in quantity will be paid with pro rata basis.

9) Deleted.

10) Deleted.

11) "Schedule-D" gives the basis of interim payment for construction of works.

12) For the purpose of information, bidders shall furnish the details as per Part D 'List of Recommended spares, tools & tackles', Part E 'Manpower during operation and maintenance of STP' and Part-F ' Breakup of requirement of employer during construction phase'. The rates shall be quoted in INR in the given Performa.

13) The rates and prices shall be submitted in the electronic formats given by n-procure. Rates and prices received in any other formats will be rejected and the Bids will be disqualified.

14) The prices shall allow for all the works covered under the bid including digitized asset mapping and all liabilities and contractual obligations whether separately specified or not. Items against which no prices are quoted shall not be separately paid for and the bidder shall be deemed to have covered the cost of execution of such items (according to the requirements of the bid document) in the prices quoted for other items.

15) Items not specifically listed in Price Schedule, but required to be executed for satisfactory working of the system as specified, will not be separately paid for by the Employer when executed and shall be deemed to be already covered by other items and rates listed in the price sheets and total price quoted in 'Summary of Price'. No extra payment shall be given for any item which is required for successful completion and commissioning of the project.

17) For the purpose of information, bidders shall furnish the details as per Part D of "Minimum requirements of the Employer during construction phase and these items shall be handed over to the employer at the end of the construction period". The rates shall be quoted in INR in the given Performa.

18) The quoted price by the bidder shall be evaluated as per Clause 5 'Evaluation of Price Bid' under this volume. While Part B, shall form the basis to work out schedule of Interim payments during construction period & Part C shall form the basis to work out schedule of Interim payments during Operation & maintenance period with the successful bidder.

19) The bidder should acquaint himself with all the site conditions including but not limited to the access to Work site, HFL, High/ low Tide Level as etc. The successful bidder shall have to make suitable access to work sites at his own cost. These accesses may be permitted for the use of the other contractors working for AUDA as per instruction of Engineer-in-charge.

20) The bidder shall be deemed to have allowed in his bid proposal for all miscellaneous provisions, maintenance cost of equipment and establishments with final removal of all temporary works of whatsoever nature required for construction including temporary bunds, diverting water, pumping, de-watering etc. for the proper execution of works. The rates shall also be deemed to have included any works and setting out that may be required to be carried out for laying of pipeline and construction of structures of all the works involved.

21) The Price Schedules are to be read in conjunction with the Conditions of Contract, the Specifications and other sections of these bid documents and these documents are to be taken as mutually explanatory of one another.

22) Prices quoted by the bidder shall be firm for the entire period of Contract including O&M period without any escalation in accordance with the Conditions of Contract. The

drawings attached with this tender are only for the reference, bidder shall visit the site and collect relevant data before quoting. The successful bidder shall perform all the relevant surveys and design and approvals before execution on site and no escalation or extra claim shall be entertained based on the attached drawings.

23) The bidder shall obtain data on survey work, soil investigation work and any other data required for his proposal at his own cost.

24) The prices quoted shall also include the cost of materials utilized for testing.

25) The item descriptions in price schedule are for subject matter guidance only and the prices shall include all the equipment / materials / accessories and services required as per the specifications. The bidder shall fill in the price schedule furnished.

26) 1% of the value of work will be deducted from the Running bill amount against labor cess and it shall be non-refundable.

27) Third Party Inspection (TPI) / PMC agency will be deployed by AUDA and charges of the same will be borne by AUDA. If contractor gives misleading information about their readiness for inspection, cost of such futile inspection/ visit of third-party agency due to misinformation shall be recovered from the Contractor.

28) Payment against taxes and duties shall be as per stated in this tender document.

29) Liquidated Damages under as per stated in this tender document shall be read together in conjunction to Mode of Payment.

30) The rate quoted shall be exclusive of GST, but inclusive of all other taxes and cess or levies or duties which shall not be paid extra. While GST will be paid for admissible part of actual work done at the approved tender rates and tender conditions of price variations. GST shall be paid as per prevailing rates at the time of payment. The TDS shall be deducted at source as per provision of IT rules.

31) The rates should be quoted exclusive of GST but inclusive of all other taxes as per stated in this tender document.

32) The bidder shall be deemed to have taken full account of all requirements and obligations whether expressed or implied, covered by all parts of this Contract and to have priced the items herein accordingly. The rates and sum shall therefore be included for all incidental and contingent expenses and risks of every kind necessary to construct, complete and maintain the whole of works in accordance with the Contract. No additional claim whatsoever shall be entertained by AUDA.

33) The PMC / PIU certified report of successful flow test including leakages / hydro test for the components covered under the respective running bill / final bill must be attached for payment

34) All water, electricity, fuel (For running of DG, Diesel pumps etc. for construction purpose) charges during construction and Test & Trial Run shall be borne by the Contractor.

35) The contractor shall comply with all the requirements for purchase and use of electric power. Power sourcing from concerned DISCOM source shall be in the scope of the contractor and shall be reimbursed at actual rate by AUDA on submission of proper fees receipt/challans and other relevant documents. All necessary Liaisoning and statutory approval from concerned DISCOM is in bidder's scope.

36) The prices quoted shall also include the cost of Temporary/Permanent plugging and blocking of restoration of infrastructures like Kharkuwa. Electrical Line, Telephone cables all types. water lines. gas line. septic tanks. etc. sewer line, branch connections and diversion of flows and removal of all plugs, etc.

37) For any Underground and Over Head Utility, the contractor has to confirm it during site visit (as scheduled), the shifting or getting it shifted from the concern dept. (i.e. Liaisoning, follow -up and approval) required will be in contractor's scope. No extra cost will be given to contractor for any type of utilities shifting. All statutory fees/charges shall be paid by AUDA on submission of proper fees receipt/challans and other relevant documents.

38) The price bid submitted by the bidder rates shall be inclusive for;

a. Removing of Existing Pipeline including removal of specials, valves jointing material including carting and stacking of removed material from site of work to the department store as directed excl. Excavation and refilling Pipes/ Pre Stressed Concrete Pipe.

b. Labour charges for repairing leakage in CI/DI pipeline of following diameter at different places including necessary excavation manually or by machinery, removing of mud, dewatering, cleaning of pipe, cutting of pipe, Jointing & repairing using CID joints including CID joints, rubber rings, nut bolts, hiring excavator, Hydra/ Crane, dewatering machine fuel, operator etc. complete (including cost of jointing material and cost of pipe) CI/DI Pipelines.

c. Labour charges for repairing of leakage in PVC pipeline of following dia meter at different places including necessary excavation manually or by mechanized excavation, dewatering removing of mud, cleaning of pipe and leakage portion, cutting the pipeline & removing piece of pipe from trench with inclusive of mechanical devices JCB, Hydra/Crain if necessary & labours required with providing material such couplers, solution etc. comp. (incl. all material but Excluding cost of pipe)

d. Labour charges for repairing of leakage in HDPE pipeline of following diameter at different places including necessary excavation manually or by machinery, dewatering, removing of mud, cleaning of pipe and leakage portion, cutting the pipeline, Jointing & repairing using CID joint inclusive of using all required machinery, labour, D G Set, fuel, operator, CID joints, rubber rings, nut bolts etc. complete (but excluding cost of Pipe).

e. Contractor Providing and erecting 2.00-meter-high temporary barricading at site; each panel of size 2.50mx2.00m made of 40x40x6mm angle iron or 50x50x3mm hollow MS tube posts/horizontal members/bracings covered with 1.63mm thick MS sheet. The sheet shall be fixed with 30x5mm MS flat by suitable welding/riveting. The

panels shall be made so that gap of 50cm above the ground is available making overall height as 2.5m. MS channel ISLC 75 @ 5.70 kg/m, 50cm long shall be provided at the bottom having oval shaped holes of size 50x25mm at both ends with 50cm long MS angle 40x40x6mm bracing. Suitable arrangement shall be made to fix the barricading to avoid from overturning by providing 250mm long expansion fasteners at both ends.

The work shall be executed as per drawing/direction of Engineer-in-Charge which includes writing and painting, arrangement for traffic diversion such as traffic signals during construction at site for day and night, glow lamps, reflective signs, marking, flags, caution tape as directed by the Engineer-in- Charge. The barricading provided shall be retained in position at site continuously i/c shifting of barricading from one location to another location as many times as required during the execution of the entire work till its completion. Rate include its maintenance for damages, painting, all incidentals, labour materials, equipments and works required to execute the job. The barricading shall not be removed without prior approval of Engineering- Charge. (Note: - The barricading provided shall remain to be the property of the contractor on completion of the work).

f. Tracing of existing manholes using all required tools, labours complete.

B PREAMBLE

1. As mentioned in the Conditions of contract, the Contract being a lump sum type turnkey Contract on EPC basis, the provision of measurement will be applicable only for the assessment of value of work done for inclusion in any interim certificate for part payment to the Contractor.
2. The Schedule specifies the procedure for all such assessment of the items specified in Schedule B.
3. Each item of Schedule-B has been divided into broad components. The Employer's Representative shall assess the value of each component as indicated in paragraph 6 herein below.
4. Percentages are indicated against each component of each item specified in Schedule B, based on the Employer's best appreciation of the value of the component as related to the total costs of the concerned item as whole. A head titled (any other item(s)) is included in each breakdown of schedule and the tenderer shall at the time of tendering indicate any additional items which he considers necessary but cannot be covered by any of the heads indicated in the breakup.
5. The percentage breakup as indicated in the Schedule may differ from that corresponding to the tenderer's scheme and design and he should take this into account while quoting his lump sum prices for the items specified in Schedule-B.
6. The contractor shall, after approval of his detailed designs and drawings furnish to the Employer's Representative an initial bill of quantities to all major items, to be reviewed and updated periodically with the Employer's Representative. This bill of quantities will be used for assessment of percentage progress of the component at any stage. By measurement jointly taken by the Employer's Representative and the Contractor, mutually agreed and entered in the measurement books in the form and by the method approved by the Employer's Representative, and signed jointly by both the parties.
7. Priority of work shall be decided in consultation with officials of Municipality and PMC before starting /planning of work and the same shall be followed.

SCHEDULE - D

BREAK UP FOR INTERIM PAYMENTS **(CIVIL, MECHANICAL, INSTRUMENTATION & ELECTRICALWORKS)**

Item	Description of Items	Percentage Payment to be released
1	GRAVITY MAIN AND PUMPING MAINS	
A	PIPELINE	
a	On receipt of materials at project site (The bidder shall be permitted to retain unlaid pipes up to a maximum length of 10 km.)	65 % of Quoted rate
b	On Excavation, Lowering, laying and Jointing	20 % of Quoted rate
c	On Hydraulic/Flow test including leakage	5 % of Quoted rate
d	On refilling and disposal of surplus stuff	5 % of Quoted rate
e	After commissioning	5 % of Quoted rate
2	VALVES	
a	On receipt of materials on site	65 % of Quoted rate
b	On erection	25 % of Quoted rate
c	On Hydraulic testing	5 % of Quoted rate
d	After commissioning	5 % of Quoted rate
3	VALVE CHAMBERS	
a	On completion works as per approved drawings	95% of Quoted rate
b	After commission of system	5% of Quoted rate
4	MANHOLES & PUMPING STATION CIVIL WORKS	
A	On running bill as per actual work done	85% of Quoted rate
B	After Satisfactory Hydraulic / Flow test including leakage.	5% of Quoted rate
C	On completion & commissioning of the section in all aspects, and handing over to department / ULB.	10% of Quoted rate
5	MECHANICAL, ELECTRICAL AND INSTRUMENTAL WORKS	
A	On supply of material at work site in good condition	65% of Quoted rate

Item	Description of Items	Percentage Payment to be released
b	On erection of Equipment	25% of Quoted rate
c	On completion of Testing & Commissioning of Equipment	5% of Quoted rate
d	Satisfactory running of system.	5% of Quoted rate
6	Road Restoration	
a	On completion of 25% of road restoration work	22.5 % of Quoted rate
b	On completion of 50% of road restoration work	22.5 % of Quoted rate
c	On completion of 75% of road restoration work	22.5 % of Quoted rate
d	On completion of 100% of road restoration work	22.5 % of Quoted rate
e	Satisfactory running of system.	10 % of Quoted rate
7	House Connection	
a	On supply of material, Installing, Testing & Commissioning of House Connection at work site in good condition	100% of Quoted rate
	Total	100%
8	Property Connection	
a	On supply of material, Installing, Testing & Commissioning of House Connection at work site in good condition	100% of Quoted rate
	Total	100%
9	Civil work for Sewer Pumping Station/ Auxiliary Sewage Pumping Stations / Renovation of Existing Sewage Pumping Station	
	On completion of 25% of work	22.5 % of Quoted rate
	On completion of 50% of work	22.5 % of Quoted rate
	On completion of 75% of work	22.5 % of Quoted rate
	On completion of 100% of work	22.5 % of Quoted rate
	Satisfactory running of system.	10 % of Quoted rate
10	Miscellaneous work	
a	All other items such as encasing, columns support for culvert, pipe bridges for Canal /Drain/Khadi crossing, internal roads, railway/highway crossing, Anchor/thrust blocks, steel bridge for pipe crossing, etc.	80% of quoted rate on completion of works on prorata basis
b	On commissioning of the system	20% of quoted rate

11	For STP	
Sr. No.	Items	Release of Payments
1.0	Approval of Drawings and Documentation	Shall not exceed 2% of the Total Contract Value (Excluding O & M)
A	Approval of Basic Engineering Drawings	30%
B	Approval of Detailed Engineering Drawings	50%
C	Operation and Maintenance Manuals, As-built Drawings etc.	20%
	Total of 1.0 (Maximum 2% of the Total Contract Value excluding O&M price)	100%
2.0	Civil Works	Shall not exceed 45% of the Total Contract Value (Excluding O & M)
A	Primary Treatment Units (Stilling Chamber, Fine Screen Channel, Grit Chamber, Distribution Chamber, Primary Clarifiers, Sludge Sumps. etc. (Shall not exceed 15 % of the Total Civil Works)	
1	On Completion of bottom raft on pro-rata basis against monthly Running bills	30%
2	Walls	
	a) On completion of Side wall up to half of the height on pro-rata basis against monthly running bills	25%
	b) On completion of Side wall up to full height on pro-rata basis against monthly running bills	20%
3	Platform, Handrail and other Miscellaneous works	15%
4	On Completion and successful testing	3%
5	On successful commissioning of that particular unit complete in all respect	7%
	Total of A	100%
B	Biological Treatment Units, Chlorination Tank, Secondary Sludge Sump & Pump house (Shall not exceed 50 % of the Total Civil Works)	
1	On Completion of bottom raft on pro-rata basis against monthly Running bills	30%
2	Walls	
	a) On completion of Side wall up to half of the height on pro-rata basis against monthly running bills	25%

12	For STP	
Sr. No.	Items	Release of Payments
	b) On completion of side wall up to full height on pro-rata basis against monthly running Bills	20%
3	Platform, Handrail and other Miscellaneous works	15%
4	On Completion and successful Testing	3%
5	On Successful Commissioning of that particular unit complete in all respect	7%
	Total of B	100%
C	Buildings (Chlorine Building, Dewatering Building, Administrative, Process Air Building, MCC cum Panel building, Guard Room etc. (Shall not exceed 35 % of the Total Civil Works) Ground Floor – Blower Room – As per Approved Drawing	
1	RCC Work up to Bottom Slab / Basement	25%
2	Up to Roof Slab	25%
3	Brickwork, Internal & External Plastering	15%
4	Flooring, Painting, Waterproofing, Internal Lighting, Plumbing, Sanitary works, Landscaping, Site Development works and misc required works	15%
5	Landscaping, Site Development Works, Compound Wall etc.	10%
6	On Successful Testing	3%
7	On Successful Commissioning of that particular unit complete in all respect	7%
	Total of C	100%
	Total of 2.0 Civil Works (A+B+C) (Maximum 45% of the total contract value excluding O&M price.)	100%
3.0	Mechanical Works	Shall not exceed 30% of the Total Contract Value (Excluding O&M)
1	On supply of Machinery / Equipment on pro-rata basis against monthly running bills at Site	50%
2	On completion of Erection Works	25%
3	On completion of Testing and Commissioning of Equipment	15%
4	On completion of Commissioning of the Plant and issuance of taking over Certificate	10%
	Total of 3	100%

	Total of 3.0 Mechanical Works (Maximum 30% of the total contract value excluding O&M price)	100%
4.0	Electrical and Instrumentation Works	Shall not exceed 13% of the Total Contract value (Excluding O&M)
A	Procurement & Supply at Delivery site of Electrical & Instrumentation items like cables, earthing materials, Power Transformer, HT Substation and allied works, Switch gear including PCC, MCC, Lighting protection, system Instrumentation, PLC/SCADA system etc. as per the tender.	
1	On supply of Machinery /Equipment on pro-rata basis against monthly running bulls at Site	50%
2	On completion of Erection Works	25%
3	On Completion of Testing and Commissioning of equipment	15%
4	On completion of commissioning of the Plant and issuance of taking over certificate	10%
	Total of 4	100%
	Total of 4.0 Electrical & Instrumentation works (Maximum 13% of the total contract value excluding O&M price)	100%
5.0	After Commissioning and Trial Run	Shall not exceed 10% of the Total Contract value OF STP (Excluding O&M)
Detail Percentage Wise Cost Break of the Mechanical Items of STP (Shall not exceed 30% of the Total Contract Value (Excluding O&M))		
Sr. No.	Items	Release of Payments
A	PRIMARY UNITS	20%
	Mechanical & Manual Fine Screens with Conveyer Belt System and Grit Mechanism, Primary Clarifiers Mechanism, Sludge Pumps etc	
B	BIOLOGICAL TREATMENT UNITS AND RELATED MACHINERIES	40%
	Biological Process Units, air blowers and Grid system, secondary sludge pumps, etc.	
C	TERTIARY TREATMENT AND MISC. ITEMS (IF REQUIRED)	15%

12	For STP	
Sr. No.	Items	Release of Payments
	Coagulation flocculation, Coagulant Dosing System, Settling Tank (or Clari-flocculator), Filtration System, Chlorination System, Piping & Valves for the entire plant, Cranes, Misc Items which are necessary for smooth and efficient operation of the plant	
D	SLUDGE HANDLING UNITS	25%
	Thickener Mechanism, Sludge transfer pumps, Polyelectrolyte dosing pumps, Dewatering unit etc.	
	Total	100%

MILESTONE PAYMENT BREAK-UP FOR SEWER NETWORK (Part C)

Sr. No	Items	Release of Payments
1	Operation and Maintenance as per <u>Part C</u>	
	Every month in equal installment based on quoted prices of O & M	

5.0 METHODOLOGY FOR FINANCIAL BID EVALUATION

AUDA Will first open the technical bid of all the bidders as per schedule given in the instruction to the Bidders in the presence of the bidders or their authorized representatives who choose to attend on the prescribed place, date and time in the bid for bid opening. After opening of the technical bid, AUDA Will First evaluate bids for qualification requirement stipulated in the bid document.

Prior to the detailed technical evaluation, the Employer will carry out a preliminary examination to determine whether they are complete, whether the required EMD have been furnished, whether the documents have been properly signed, and whether the Tenders are generally in order and whether Qualification criteria to the requirement of the bidding document are met.

The detailed technical bid evaluation of those bids, who are meeting the qualification requirement, will be carried out. The Price bid of the bidders who are not qualified for the bid, will not be opened and returned to the bidder on award of the contract.

Price-Bid will not be opened by AUDA until evaluation of Technical-bids submitted by the bidders is completed and any conclusion is made. In the evaluation of Technical-bid, all the drawings, details etc., submitted by the bidders will be scrutinized before opening of price bid.

In the process of evaluation of Technical-bid, if there are queries regarding the details, data, drawings etc., submitted by the bidders with their Technical-bid then the same will be raised to the bidders and the bidders will have to give the answers / submit more details etc. accordingly. AUDA may appoint a consultant or expert in the field for the evaluation of details, data & drawings etc. submitted by the bidders with their Technical-bids.

After complete evaluation of Technical-bids submitted by all the bidders and after any conclusion is made by AUDA to its' own discretion, the price bid of technically responsive bidders will be opened.

During the financial bid evaluation, the bids shall be evaluated as per below formula to decide the lowest evaluated bid.

Note:

- ~~1. The bidder shall choose Process/Technology considering the available land area stated above duly justified in the Layout Plan as per Part E.~~
2. L1 Bidder shall be the preferred bidder.

G. SCHEDULE FOR TESTING OF MATERIALS

For ensuring quality control and workmanship, various tests prescribed below for materials shall Be taken at periodical intervals as stipulated below.

Sr. No.	Brief Description of Materials to be tested	Qty. of Materials	Prescription of test which shall be carried	Frequency @ which test shall be carried out	Total No. of Test 'to Be taken.
1	25 to 90 H. B.Metal 40 to 63 H. B.Metal 40 to 50 M. C.Metal 20 to 50 M. C.Metal Kapachi		- Gradation Test - Impact Value - Flakiness Index - Water absorption test - Sp. gravity	1 to 100 Cmt. - 1 Test 100 to 500 Cmt. - 3 Test 500 to 1500 Cmt. - 5 Test 1500 to 5000 Cmt. - 7 Test	
2	Grit		- Stripping Value, gradation, Water absorption, Sp. Gravity	One test per work	
3	Murrum		- P. I. Value - C.B.R.	One test per work	
4	Quarry spall		- C.B.R. - Gradation	One test per work	
5	Asphalt		- Penetration Test as per Specification	Tanker Test 1 1 2to15 2 16to50 3	
6	Tack Coat		- Binder temperature for application - Rate of spread of binder	Irregular close in intervals Two test per day.	
7	Carpet & Seal coat mix		- Grading - temperature of binder in boiler, aggregates in the dryer and mix at the time of laying and rolling (Binder content vide 45 IMD 2172) Rate of Spreaded mix materials.	One test on individual constituents and mixed aggregates from the dryer for each 100 tons of mix subject to minimum of Two tests per plant per day. One Test for each 100tons of mix subjects to mini. of Two per dayplant. Regular control through checks on layer thickness.	
8	Bricks		- Water absorption - Effloresce - Size - Compressive Strength	1 Test @ 50,000 Bricks	
9	Cement		Consistency - Compressive Strength - Initial & Final setting - Fineness - Soundness - Specific Gravity - Chemical analysis	1 Test / 50 M.T. 2 Tests / 100 M.T. 3 Tests / 200 M.T. 4 Tests / 400 M.T. 5 Tests / 500 M.T. 6 Tests / 600 M.T.	
10	Steel (TMT / M.S.)		- Tensile strength - Yield Stress - Elongation - Size - Bend	1 Test / 40 M.T. 1 Test/ 40 M.T. 1 Test / 40 M.T. 1 Test / 40 M.T. 1 Test / 20 M.T.	

Sr. No.	Brief Description of Materials to be tested	Qty. of Materials	Prescription of test which shall be carried	Frequency @ which test shall be carried out	Total No. of Test 'to Be taken.
			- Rebend	1 Test / 20 M.T.	
11	C.C. Cube in M-150 M-200, M-250, M-300, M-350 Grade		- Compressive Strength	1 to 5 C.mt. - 1 Set 6 to 15 C.mt. 2 Sets 16 to 20 C.mt. - 3 Sets 20 to 50 C.mt. - 4 Sets 51 above - 4 One additional sample for each 100 C.mt. / or.	
12	Coarse Sand		C.B.R., silt content, sieve analysis	One Test per work	
13	Sand (For concrete work)		- Specific Gravity - Alkali Reactivity - Petrography Exa. - Gradation - Silt Content - Water absorption test	2 Tests per season or change of river	
14	Crushed stone Aggregate (For concrete work)		- Gradation - Water absorption - Impact Value - Abrasion Value - Soundness Test	1 Sample / 150 Cum. or 2 Sample / Season each source.	
15	Water for all item pertaining to water		- Portability - Salinity - Chemical analysis	One sample for each source of supply	
16	Earthwork for Embankment		- Sand content - Atterberg's limit - Density test - Moisture content - C.B.R.	2 Test / 8000 Cum 2 Test / 8000 Cum 2 Test / 8000 Cum 1 Test / 250 Cum. 1 Test / work	
17	Cement concrete		- Mix design	One time test for each concrete grade beyond M-200	
18	Geotechnical Investigation		- Soil Bearing Capacity	One test for Structure Design Up to 10mtr. Depth	

LIST OF REGISTERS TO BE MAINTAINED AT SITE

FOLLOWING DOCUMENTS/REGISTERS TO BE MAINTAINED AT SITE FOR ENSURING PROPER QUALITY CONTROL OF WORK IN PROGRESS.

1. A complete set of Contract Documents
2. A Complete set of drawings (tender drawings and Good for Execution Drawings)
3. A complete set of change in specification or scope if any and approval thereof.
4. Master Test Register for
Material for field Test.
 - i) Lab Report
 - ii) Lab/Field Test.
5. Register for bricks testing. Lab/Field
6. Concrete Pouring Card
7. Bitumen Test Register
8. Paint Register
- A. Empty Bags of Cement Shall Be Deposited on Monthly Basis at Store of
A.U.D.A And Same Shall Be Recorded in Store Register for Cement.
10. Register for approval of samples for various materials.
11. Site Order Book.
12. Register showing defects noticed during execution of work and compliance reports.
13. Hindrance Register

Vendor List for Tender work

SCHEDULE OF APPROVED MAKES/MANUFACTURER'S OF MATERIALS:

The following guidelines are to be noted regarding use of materials in the work:

1. As far as possible, materials bearing "Standard Mark (ISI)" from Bureau of Indian Standard (BIS) shall be used in the work.
2. Wherever, materials bearing Standard Mark (ISI) are used in the work, the following shall be ensured:
 - i) The supplier has a valid license form BIS during the period the material is being used in the work.
 - ii) The Contractor should maintain furnish necessary documents and proof of payments made for the procurement of materials bearing Standard Mark (ISI).
3. Mandatory Tests shall be conducted at the specified frequency specified in the Contract. In case, frequency of testing is not stipulated in the contract then standard specification (CPWD, ISI etc.) may be considered for frequency at which materials are to be tested.
4. Before bulk purchase of quantities of materials, it is the responsibility of the Contractor to get the samples of materials approved from consultant and EIC. EIC reserves the right to engage Third Party Consultant for verify the material and QAP standards.
5. All cost towards the testing shall be borne by the contractor.
6. The latest approved Vendor list for the Civil/Mechanical/Electrical/Instrumentation and other equipment mentioned in AUDA/ GWSSB is applicable for this contract. Approval of any other make of the same material or additional items shall be put up for approval by tendering authority.

Reference: official website assist <http://www.gwssb.gujarat.gov.in>.

SECTION - 8

SECURITIES AND OTHER FORMS

• **BID SECURITY (BANK GUARANTEE)**

WHEREAS, ----- (name of Bidder) (hereinafter called the “The Bidder”) has submitted his bid Dated ----- (Date) for the construction of ----- (Name of Contractor hereinafter called “the Bid”)

KNOW ALL PEOPLE by these presents that We ----- (name of Bank) of ----- (name of country) having our registered office at ----- (hereinafter called “the bank”) are bound unto ----- (name of Employer) (hereinafter called “The Employer”) in the sum of ----- * for which payment well and truly to be made to the said Employer the Bank itself, his successors and assigns by these presents.

SEALED with the Common Seal of the said Bank this ----- day of ----- 20

THE CONDITIONS of these obligations are:

(1) If after Bid opening the Bidder withdraws his bid during the period of Bid validity specified in the Form of Bid;

• **Or**

(2) If the Bidder has been notified of the acceptance of his bid by the Employer during the period of Bid Validity:

A Fails or refuses to execute the Form of Agreement in accordance with the Instructions to Bidders, if required; or

B. Fails or refuse to furnish the Performance Security, in accordance with the Instructions to Bidders; or

C. does not accept the correction of the Bid Price pursuant to Clause 27 (Correction of Errors)

We undertake to pay to the Employer up to the above amount upon receipt of his first written demand, without the employer having to substantiate his demand, provided that in his demand the Employer will note that the amount claimed by him is due to him owing to the occurrence of one or any of the three conditions, specifying the occurred conditions or conditions.

This Guarantee will remain in force up to and including the date ----- **
days after the deadline for submission of Bids as such the deadline is stated in the
Instructions to Bidders or as it may be extended by the Employer, notice of which
extension (s) to the Bank is hereby waived. Any demand in respect of this
guarantee should reach the Bank not later than the above date

DATE -----

SIGNATURE-----

WITNESS -----

SEAL -----

(Signature, name and address)

* The Bidder should insert the amount of the guarantee in words and figures
denominated in Indian Rupees. This figure should be the same as shown in
Clause 16.1(Bid Security) of the Instructions to Bidders.

****45 days** after the **end of the validity period** of the Bid. Date should be
inserted by the Employer before the Bidding documents are issued.

• **PERFORMANCE SECURITY**

TO,

----- (Name of Employer)

----- (Address of Employer)

WHEREAS ----- (name and address of contractor) (hereafter called "the Contractor") has undertaken, in pursuance of Contracts No. ----- dates ----- to execute ----- (name of Contract and brief description of Works) (hereinafter called "The Contract")

AND WHEREAS it has been stipulated by you in the said Contract that the Contractor shall furnish you with a Bank Guarantee by a recognized bank for the sum specified therein as security for compliance with his obligation in accordance with the Contract.

AND WHEREAS we have agreed to give the Contractors such a bank Guarantee:

NOW THEREFORE we hereby affirm that we are the Guarantor and responsible to you on behalf of the Contractor, up to a total of ----- (amount of guarantee)* ----- (in words), such sum being payable in types and proportions of currencies in which the Contract prices is payable, and we undertake to pay you, upon your first written demand and without cavil or argument, any sum or sums within the limits of ----- (amount of guarantee) as aforesaid without your needing to prove or to show grounds or reasons for your demand for the sum specified therein.

We hereby waive the necessity of your demanding the said debt from the contractor before presenting is with the demand.

We further agree that no change or addition to or other modification of the terms of the Contract to of the Works to be performed thereunder or of any of the Contract documents which may be made between your and the Contractor shall in any way release us from any liability under this guarantee, and we hereby waive notice of any such charge, addition or modifications.

This guarantee shall be valid until 60 days from the date of expiring of the Defect Liabilities period.

Signature and Seal of the guarantor -----

Name of Bank -----

Address -----

Date -----

*An amount shall be inserted by the Guarantor, representing the percentage the Contract price specified in the Contract denominated in Indian Rupees.

• **ADDITIONAL PERFORMANCE SECURITY**

[Clause 34.1. (A)]

TO,

----- (Name of Employer)

----- (Address of Employer)

WHEREAS ----- (Name and address of contractor) (hereafter called "The Contractor") has undertaken, in pursuance of Contracts No. ----- dates ----- to execute ----- (Name of Contract and brief description of Works) (hereinafter called "The Contract")

AND WHEREAS it has been stipulated by you in the said Contract that the Contractor shall furnish you with a Bank Guarantee by a recognized bank for the sum specified therein as security for compliance with his obligation in accordance with the Contract.

AND WHEREAS we have agreed to give the Contractors such a bank Guarantee:

NOW THEREFORE we hereby affirm that we are the Guarantor and responsible to you on behalf of the Contractor, up to a total of ----- (amount of guarantee) ----- (in words), such sum being payable in types and proportions of currencies in which the Contract prices is payable, and we undertake to pay you, upon your first written demand and without cavil or argument, any sum or sums within the limits of ----- (amount of guarantee) as aforesaid without your needing to prove or to show grounds or reasons for your demand for the sum specified therein.

We hereby waive the necessity of your demanding the said debt from the contractor before presenting is with the demand

We further agree that no change or addition to or other modification of the terms of the Contract to of the Works to be performed thereunder or of any of the Contract documents which may be made between your and the Contractor shall in any way release us from any liability under this guarantee, and we hereby waive notice of any such charge, addition or modifications.

This guarantee shall be valid until **28 days** from the project completion date.

Signature and Seal of the guarantor -----

Name of Bank -----

Address -----

Date -----

• **BANK GUARANTEE FOR ADVANCE PAYMENT**

TO,

----- (Name of Employer)

----- (Address of Employer)

----- (Name of Contractor)

Gentlemen:

In accordance with the provisions of the Conditions of Contract, sub-clause

51.1 ("Advance Payment") of the above mentioned Contract, -----

----- (name and address of Contractor) (hereinafter called "the Contractor") shall deposit with----- (name of Employer) a bank guarantee his proper and faithful performance under the said Clause of the Contract in an amount of----- (amount of Guarantee)* -
-----in words).

We, the----- (bank of financial institution), as instructed by the Contractor, agree unconditionally and irrevocably to guarantee as primary obligator and not as Surety merely, the payment to ----- (name of Employer) on his first demand without whatsoever right of obligation on our part and without his first claim to the Contractor, in the amount not exceeding ---
----- (amount of guarantee)*----- (in words)

We further agree that no change or addition to or other modifications of the terms of the Contractor or Works to be performed thereunder or of any of the Contract documents which may be made between ----- (name of Employer) and the Contractor, shall in any way release us from any liability under this guarantee, and we hereby waive notice of any such change, addition or modifications.

This guarantee shall remain valid and in full effect from the date of the advance payment under the Contract until ----- (name of employer) receives full repayment of the same amount from the contractor.

YOUR'S TRULY

Signature and Seal _____
Name of Bank/ Financial Institution _____
Address _____
Date _____

* An amount shall be inserted by that Bank or Financial Institution representing the amount of the Advance Payment, and denominated in Indian Rupees.

- **Letter of Acceptance**

(Letter head paper of the Employer)

_____ (date)
To,
_____ (Name and address of the Contractor)

Dear Sirs,

This is to notify you that your Bid dated _____ for execution of the _____ (Name of the contract and identification number, as given in the Instructions to Bidders) for the Contract Price of Rupees _____ (_____) (amount in words and figures) as corrected and modified in accordance with the Instructions to Bidders* is hereby accepted by our agency.

You are requested to furnish performance security, in the form detailed in para 34.1 of ITB for an amount equivalent to Rs. _____ within **10 days** of the receipt of this letter of acceptance up to beyond **60 days** from the date of expiry of defects Liability period i.e. up to _____ and the Additional Performance Security for an amount equivalent to Rs. _____ shall be valid beyond 28 (twenty-eight) days of Project Completion Date i.e. up to _____ and sign the contract, failing which action as stated in Para 34.3 of ITB will be taken.

Yours Faithfully

Authorized Signature
Name and title of Signatory
Name of Employer

* Delete "Corrected and" or and modified if only one of these actions applies. Delete as corrected and modified in accordance with the Instructions to Bidders, if corrections or modifications have not been affected.

- **Issue of Notice to proceed with the work**

(Letterhead of the Employer)

----- (date)

To,

_____ (Name and address of the Contractor)

Dear Sirs,

Pursuant to your furnishing the requisite security in ITB Clause 34.1 and signing of the Contract for the construction of _____

_____ at a bid Price of Rs.

_____.

You are hereby instructed to proceed with the execution of the said works in accordance with the contract documents.

Yours faithfully

(Signature, name and title of signatory authorized
To sign on behalf of Employer)

• **AGREEMENT FORM**

This agreement, made on the _____ day of _____ between _____ (name and address of Employer) (Hereinafter called “the Employer) and _____ (name and address of contractor) hereinafter called “the Contractor” of the other part.

Whereas the Employer is desirous that the Contractor execute

Name and identification number of contract (hereinafter called “the works”) and the employer has accepted the Bid by the Contractor for the execution and completion of such works and the remedying of any defects therein, at a cost of Rs.

NOW THIS AGREEMENT WITNESSETH AS FOLLOWS

1. In this Agreement, words and expression shall have the same meanings as are respectively assigned to them in the conditions of contract hereinafter referred to and they shall be deemed to form and be read construed as part of this Agreement.
2. In Consideration of the payment to be made by the Employer to the contractor as hereinafter mentioned, the Contractor hereby covenants with the Employer to executive and complete the works and remedy any defects therein in conformity in all aspects with the provisions of the contracts.
3. The employer hereby covenants to pay the Contractor in consideration of the execution and completion of the works and the remedying the defects wherein 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.
4. The Following documents shall be deemed to form and be ready and construed as part of this Agreement viz
 - i) letter of Acceptance
 - ii) Notice to proceed with the works:
 - iii) Contractor’s Bid

- iv) Conditions of contract: General and Special
- v) Contract Data
- vi) Additional conditions
- vii) Drawings
- viii) Bill of Quantities and
- ix) Any other documents listed in the Contract
data as forming part of the Contract.

In witness whereof the parties there to have caused this Agreement to be
executed the day and year first before written

The Common seal of _____
Was hereunto affixed in the presence of :

Signed, sealed and Delivered by the said _____

In the presence of

Binding signature of Employer _____

Binding Signature of Contractor _____

UNDERTAKING (For Investment)

I, the undersigned do hereby undertake that our firm M/s would invest a minimum cash up to **25%** of the value of the work during implementation of the contract.

(Signed by an Authorized officer of the firm)

Title of officer _____

Name of firm _____

DATE _____

UNDERTAKING (For Validity)

I, the undersigned do hereby undertake that our firm M/s
..... agree to abide by this bid for a period..... days
for date fixed for receiving the same and it shall be binding on us and may be accepted at
any time before the expiration of that period.

(Signed by an Authorized officer of the firm)

Title of officer

Name of firm

DATE

SECTION - 9

DRAWINGS

Attached Separately

SECTION - 10

DOCUMENTS TO BE FURNISHED BY BIDDER

**QUALIFICATION DATA SHEET
TO BE FILLED UP BY THE BIDDER**

The qualification questionnaire contains the following forms:

SL. NO.	FORM NO.	DESCRIPTION OF PROFORMA
1	Form-0	List and order of Submittals
2	-	Proforma for "Letter for submission of tender".
3	Form-1	Details of organization structure of the bidder
4	Form-2	Details of Personnel
5	Form-3	Details of Machinery Equipments and work Plan
6	Form-4	Information relating to Financial Criteria
7	Form-5	Financial data
8	Form-6	List of works already completed by the Bidder
9	Form-7	Details of works on hand with Bidder
10	Form-8	Details of experience of completed work (similar nature)
11	Form-9	Additional Information and Litigation History / Debarment / Blacklisting
12	Form-10	Information for tenders submitted but not awarded
13	Form-11	Certificate for experience of work
14	Form-12	Joint Venture data
15	Form-13	Personnel/ staff proposed for the project
16	Form-14	Curriculum Vitae of Project Manager and all key Technical Staff
17	Form-15	Proposed site organization and Management
18	Form-16	Details of experience for physical qualification criteria
19	Form-17	Approach & Methodology with conceptual design & supporting calculations of the system.
20	Form-18	Form-H (Declaration)
21	Form-19	Proforma for Bank Guarantee (EMD)
22	Form-20	Work wise details of work completed/ in progress by the contractor.
23	Form-21	Proforma for Performance bond/ Performance guarantee Proforma for bid security
24	Form-22	Proforma for Joint Venture Agreement
25	Form-23	"Assured Pipe Supply Declaration" (MOU with Manufacturer of DI pipe)
26	Form-24	Proforma for memorandum of understanding (MOU) with pipeline supplier (If Applicable)
27	-	Site visit certificate - To be submitted on company's letter head duly

SL. NO.	FORM NO.	DESCRIPTION OF PROFORMA
		sealed and signed by PoA.
28	-	MoU for engagement of Agency for specialized work to be included in the Tender Form (if applicable)

Note:

1. If necessary, additional sheets may be added to the forms. Each page of each form should be clearly marked in the right top corner as follows: Form-0, page 1; Form I, page 2, etc.
2. Some of the forms will require attachments. Such attachments should be clearly marked as follows: Attachment 1 to Form I, Attachment 2 to Form I, etc.

FORM-0
**Sr.
No.**
LIST AND ORDER OF SUBMITTALS

1.	Covering Letter	Letter for submission of tender (Scanned Copy)
2.	Tender Fee	Scanned copy of Account payee Demand Draft for Tender Fee in accordance with relevant clause of Tender Notice, and also in physical form shall also be submitted by RPAD/Speed Post
3.	Earnest Money Deposit	Scanned copy of E.M.D. in accordance with relevant clause in "Tender Notice" of tender notice and the original shall also be submitted in physical form by RPAD/Speed Post
4.	Joint Venture Agreement	Bidder (individual or any member in case of JV/ consortium) shall not have suffered bankruptcy/ insolvency during the last 5 years. For this Certificate of CA appointed by the bidder must be produced along with a self affidavit on non-judicial stamp paper of ₹300/- duly notarized
5.	Company Establishment Details	Letter of Incorporation of the company (Individual or any member in case of JV/ consortium)
6.	Certificate of Registration	Certificate of registration of contractor as per Registration requirement mentioned in Volume I, Section II, Clause 1.
7.	Permanent Account Number (PAN) And Latest Income Tax Return Certificate	Copy of the latest Income Tax Return with permanent account number (PAN), Latest Income Tax Return Certificate (Scanned copy) .
8.	Goods and Services Tax Identification Number (GSTIN) Details	Copy of Goods and Services Tax Identification Number (GSTIN) . (Scanned copy) .
9.	Solvency Certificate	Scanned Copy of the Solvency Certificate from Bank of required amount as per Tender Notice.
10.	Power of Attorney	Power of attorney on ₹300/- Non-Judicial stamp paper duly notarised, if power is delegated for signing the bid to other persons by bidder. (Scanned Copy)
11.	Power of Attorney for Lead Member	Power of Attorney on the name of lead partner in JV Agreement on non-judicial stamp paper of ₹300/- duly notarized

FORM-0		
Sr. No.	LIST AND ORDER OF SUBMITTALS	
12.	Undertaking Regarding Document Submitted, Are True.	The bidder should submit undertaking on non-judicial stamp paper of ₹300/- duly notarized regarding document submitted, are true.
13.	Bidder Past Performance	The bidder, whose contracts are earlier terminated on account of poor performance in AUDA/GWSSB / GWIL works, will not be eligible. For this tender Self Declaration by bidders is required
14.	Supporting Document	Form 0 to Form 24
15.	Information relating to Financial Criteria	Certificate from chartered accountant verifying the Turnover of last 5 financial years
16.	Information relating to Financial Criteria	Audited Balance sheet certified by Chartered Accountant and duly notarized for the last 5 financial year
17.	List Of Work On Hand And Work Completed	A scanned copy of declaration showing the details of all works completed and works on hand with the contractor and the value of works that remain to be executed. (List of Work on hand to be supported with non-judicial stamp paper of ₹300/ duly notarized).
18.	MOU To Be Submitted on Non Judicial Stamp Paper Of ₹300/- Duly Notarized along with Proposed Technology Details	1- With Qualified technology provider (If Applicable) 2- Experience of designing and execution of Proposed Technology 3- Control Philosophy and design credentials of Proposed STP
19.	Other Documents	Schedule of construction method
		Work plan
		Schedule of Major items of equipment's
		Schedule of key personnel

Note: All submittals shall be numbered chronically, and reference of page nos. shall be mentioned in “**FORM-0**”. The same is to be uploaded online and submitted in physical form as well

LETTER FOR SUBMISSION OF TENDER

To
EXECUTIVE ENGINEER
AUDA

.Sub: SUBMISSION OF TENDER APPLICATION FOR (NAME OF WORK)

Sir,

- Having examined the details given in the invitation to Bidder for qualification and brief note, the condition of contract, Specification, Drawings and bill of quantities and Nos. for the execution of above named work, we the undersigned, offer to execute and complete such works and remedy any defects therein in conformity with the conditions of contract, Specifications, Drawings, Bill of Quantities and quoted amount in accordance with the said conditions.
- We hereby certify that all the statements made and information supplied in the enclosed forms and accompanying statements are true and correct.
- We have furnished all information and details necessary for qualification and have no further pertinent information to supply.
- We submit the certified solvency certificate of Rs. _____ Crore and authorize the AUDA to approach the Bank issuing the solvency certificate to verify the correctness thereof. We also authorize, AUDA to approach individuals, employers, firms and Corporation to verify our competency and general reputation.
- We hereby apply for qualification for (Name of work).
- We undertake, if our Tender is accepted, to commence the works immediately after the receipt of the Engineer's notice to commence, and to complete the whole of the works comprised in the contract within the time stated in the Appendix to tender.
- We agree to abide by this Tender for the period of 180 days from the last date fixed for receiving the same and it shall remain binding upon us and may be accepted at any time before the expiration of that period.
- We enclose here with fixed Deposit receipt / Deposit at call receipt / cross demand draft / Bank Guarantee amounting to Rs. Towards Earnest Money Deposit which is to be absolutely forfeited by AUDA should we not Deposit the amount of Security Deposit specified in the Clause 1, General Conditions of Contract, Volume-IB
- We enclose..... DD in favor of Field officer's designation & office name (as applicable) amounting to Rs. _____ towards tender fees.
- Unless and until a formal Agreement is prepared and executed this Tender, together with your written acceptance thereof, shall constitute a binding contract between us.
- We also submit a general description on the approach to the construction methods, technologies proposed etc. and the detailed Work Plan proposed for execution.
- We submit the following certificates in support of our suitability, technical know-how and capability for having successfully completed the following works.

Sr. No.	Works	Client / owner
---------	-------	----------------

- We hereby confirm that there are no deviations to the terms & conditions of the contract and we are liable for execution of this contract in accordance with the stipulated conditions of the contract.
- We understand that you are not bound to accept the lowest or any tender you may Receive. Dated this _____ day of _____ (Year) Signature _____ in the capacity of _____ Duly authorized to sign tender for and on behalf of _____
- We are enclosing herewith "Form H"
- Irrespective of whatsoever has been stated to the contrary anywhere else in our offer no technical deviations have been taken and the entire work shall be performed as per your specifications and Tender documents.

Signature of Applicant.

(NAME IN BLOCK CAPITALS)

Address _____

Seal of Applicant

Date of submission

Witness _____

Address _____

Occupation _____

Enclosures:

FORM - 1**DETAILS OF ORGANIZATION STRUCTURE OF THE BIDDER**

1.	Name of Bidder	
2.	Nationality of Bidder	
3.	Office address Telegraphic Address Telephone Number Fax Number E-mail address.	
4.	Year of Establishment	
5.	Location of Establishment	
6	Bid is submitted as a) An individual b) A proprietary firm c) A firm in partnership d) A limited Company or Corporation e) A Group of Firms / Joint Venture (if applicant is of category "f" give complete information in respect of each other). f) A Group of Companies	
7.	Attach the Organization chart showing the structure of the organization including the names of the Directors and Position of officers	
8.	Number of years of experience a) as a prime contractor (Contractor shouldering main responsibility) i) in own country ii) other countries (Specify countries) b) in a joint venture i) in own country ii) other countries (Specify countries)	
9.	For how many years has your organization been in business of Civil Engineering works under its present name? What were your fields when your organization was established?	
	Whether any new fields have been added in your organization? and if so, when?	
10	Whether you were required to suspend construction for a period of more than six months continuously after the work was started? If so, give the name of project and reasons thereof.	
11	Have you ever left the work awarded to you incomplete? (If so, give name of project and reasons for not completing work)	
12	In how many of your project's penalties were imposed for delays? (Please give details)	

13	In which fields of civil engineering construction do you claim specialization and interest?	
14	Give details of experience in water supply & sewerage projects, pipe laying works, installation of large capacity of pumps etc- with modern technology and quality control.	
15	Give details of experience for construction of large water supply and sewerage projects.	
16	Give details of experience in using heavy earth moving machinery, machineries for pipe laying and installation of pumping machinery	
17	Give details of testing laboratory, if any.	
18	In how many of your works cases of litigations have arisen?	
19	If the applicant intends to enter into a Joint Venture for the project, please give the following information otherwise state.	
	Name and Address of Joint Venture Name of Lead Firm Name and address of each of the partner/ member of JV Indicating the responsibility of planning, construction equipments and execution of the work of each of the JV partner. Name and address of the bankers to the JV Details regarding financial responsibility and participation (percentage share in the total) of each firm in the JV. Attach a certified copy of the JV (in prescribed Proforma)	
20	Whether the sole bidder/lead partner is technology provider? and if no, provide the details of MoU with technology provider? a) Name and address of technology provider b) Name of the technology c) Maximum Capacity of STP (In MLD) executed by the technology provider	

Note: In case of joint venture the above form shall be filled by the JV members separately.

FORM – 2
DETAILS OF PERSONNEL

Give details of key Technical and Administrative Personnel who could be assigned the work in the following Proforma.

A)	1)	Details of the Board of Directors Name of the Director Address Organization of the Board of Director			
B)	2)	Key Technical and administrative Personnel and Consultants Individual's Name Professional Qualification Present position in the firm Professional experience and details of works carried out No. of years worked with the applicant. Languages known Additional information			
(C)	Key Technical, Administrative Personnel				
	Sr. No.	Key Personnel	Nos.	Professional Experience	Qualification
	1.	Project Manager			
	2.	Process Engineer			
	3.	Civil Engineer			
	4.	Mechanical Engineer			
	5.	Electrical Engineer			
	6.	Instrumentation Engineer			
	7.	Construction Engineers			
	8.	Supervisors			
	9.	Technical Assistant			
(D)		Skilled and other labor (indicate number category wise) 1) Skilled labor 2) Other labor			

Note:

1. In case of joint venture, the above form shall be filled by the JV members separately.

SIGNATURE OF BIDDER

FORM – 3**DETAILS OF MACHINERY EQUIPMENTS AND WORK PLAN**

- Plant & Equipments Owned & Proposed for the Project

Name of Applicant:

The Applicant will provide adequate information to demonstrate clearly that it has the capability to meet the requirements for each and all items of equipment listed in the Employers requirements. A separate Form-3 will be prepared for each item of equipment proposed by the Bidder. For each item of equipment, the applicant should attach a copy of ownership certificate or lease agreement.

Name of Equipment		
Equipment information	1. Name of manufacturer	2. Model and power rating
	3. Capacity	4. Year of manufacture
Current status	5. Current location	
	6. Details of current commitments	
Source	7. Indicate source of the equipment ☐ Owned ☐ Rented ☐ Leased ☐ Specially manufactured	

Owner	8. Name of owner	
	9. Address of owner	
	Telephone	Contact name and title
	Facsimile	Telex
Agreements	Details of rental / lease / manufacture agreements specific to the Project	

Note: In case of joint venture the above form shall be filled by the JV members separately

FORM - 4

INFORMATION RELATING TO FINANCIAL CRITERIA

Name of Bidder or partner of a joint venture: All individual firms and all partners of a joint venture are requested to complete the information in this form. The information supplied should be the annual turnover of the Bidder (or each member of a joint venture), in terms of contract receipt of works (in all classes of Civil Engineering construction works only) for each year.

Use a separate sheet for each partner of a joint venture.

Bidders should not enclose testimonials, certificates, and publicity material with their applications; they will not be taken into account in the evaluation of qualifications.

Annual turnover data for the last Five financial years i.e. FY2020-21 to FY2025-26 (Rs. In lacs)

Year	Turnover (Gross)	Annual income from contracting (Engineering Works)	Annual income from other sources
A) Lead Partner			
2020-21			
2021-22			
2022-23			
2023-24			
2025-25			
B) Joint Venture Partner:			
2020-21			
2022-23			
2023-24			
2025-25			

Note: The declared figures as mentioned above shall be supported with balance sheet certified by Chartered Accountant and duly notarized for the respective financial year.

FORM - 5**16.38.2 FINANCIAL DATA**

(Give details separately for each member in case of a joint Venture.)

1)	Name of Firm		
2)	Name of Partner / Director		
3)	Capital 1. Authorized 2. Issued and paid up		
4)	Furnish Balance sheet and profit and loss statement with Auditor's Reports and Income Tax assessment orders for last Five (5) financial years. It should, interlaid include the following information 9. Working Capital 10. Foreign Investment 11. Turnover for the last Five (5) financial year, the contract receipts for Civil Engineering works (Furnish reference page number to balance sheet attached)		
Sr. No.	Year	Turnover (Rs in Crores) (Engineering Works)	Reference page No. to balance sheet or other documents
a	2020-21		
b	2021-22		
c	2022-23		
d	2023-24		
e	2025-25		
GROSS INCOME IN THE LAST Five (5) FINANCIAL YEAR			
Sr. No.	Year	Gross Income (Rs in Crores)	Reference page No. to balance sheet or other documents
a	2020-21		
b	2021-22		
c	2022-23		
d	2023-24		
e	2025-25		
5.	What is the maximum cost of the project that has been handled? (Please give details)		
6.	Have you ever been denied tendering facilities by any AUDA / GWIL /GWSSB/ Government Undertaking Organizations / Public sector undertaking etc.? (If Yes,		

	please give details)	
7.	List your sources of finance	
8.	Amount of financial soundness certified by Bank. (Attach copy of certificate)	
9	Name and address of Bank from whom reference can be obtained	
10.	Have you ever been declared bankrupt? (If yes, please give details)	

Note:

- 1 Firms owned by individuals, and partnerships, may submit their balance sheets certified by a registered accountant, and supported by copies of tax returns. Attach Certificate(s) issued by any Bank or Financial Institution for available credit to the Lead partner and joint venture partner.
- 2 The above-mentioned statement shall be signed and certified by the Chartered Accountant.
- 3 The turnover mentioned in the above statement shall be considered for the value of "A" as indicated in the qualifying requirement of "Available Bid Capacity" vide Volume-I, Section-III, Clause no. 4.2.3.
- 4 The turnover figure shall be considered only for the contract receipt of civil engineering works for which the Chartered Accountant certificate shall be attached.
- 5 In case of joint venture, the above form shall be filled by the JV members separately.

•

SIGNATURE OF BIDDER

FORM-6

List of works already completed by the bidder during last 7 financial years i.e. From year 2016-17 to year 2022-23 & up to one month prior to last date of submission of the bid in the following Proforma. (Separate form for each work)

No.	Name of work	Place/ Dist. / State	Tendered amount Rs. In Lac	Cost on completion Rs. In lac	Date of starting	Original time limit in months	Extended time limit in months	Time taken in month to complete the work	Actual date of completion	Reason for delay in completion	Remarks
1.	2.	2a.	3.	4	5a	5b.	5c.	5d.	5e	6	7

Note: Necessary completion certificate showing the year wise breakup of amount of work done from concerned officers shall be attached with the tender.

In case of joint venture, the above form shall be filled by the JV members separately.

Date:

Signature of the Bidder.

FORM-7

DETAILS OF WORKS ON HAND WITH BIDDER

- Work performance and Value of the existing commitments (Work on Hand) as on the date of bid submission for works (complete or partial) to be completed in the next Months (As Mentioned in Tender Notice Sr no 7) (In separate form for each work)
- The bidder should submit the abstract of details submitted on Form-7 on ₹300/- non judicial stamp paper duly notarized.
- (Give details separately for each member in case of a joint Venture.)

1)	Name of Work	
2)	Agreement No. & Date	
3)	Country and Location	
4)	Client's Name and Address	
5)	Tendered Cost of work (Rs. in Lacs)	
6)	Brief description of works including principal features and quantity of main items.	
7)	Details of work on hand • Date of Starting • Percentage of Physical completion • Amount billed for the work completed • Cost of work remaining to be executed • Stipulated date of completion vi) Anticipated date of completion.	
8)	Name of Applicant's Engineer - in - Charge with Professional Qualification.	
9)	Explain for non-completion of work within stipulated time limit if so.	
10)	Whether any Penalties / Fine / Stop notice / Compensation/ Liquidated Damages imposed? (Yes or No), (If Yes, give amount and explanation)	
11)	Details of Litigation / Arbitration cases, if any pertaining to ongoing works.	
12)	Attach Client's certificate for the details furnished in the Form-3A/ Form-11 (Not below the rank of Executive Engineer or equivalent).	

SIGNATURE OF BIDDER

Note: Necessary certificates showing the year wise breakup of amount of work done from the officer concerned shall be attached with the tender.

FORM – 8

DETAILS OF EXPERIENCE OF COMPLETED WORKS (SIMILAR NATURE)

Give details of the similar type of work completed during last Five (5) financial year from i.e. year 2020-21 to year 2025-26 & up to one month prior to last date of submission of the bid in the following Proforma. (Separate form for each work)

1)	Name of Work	
2)	Agreement No. & Date	
3)	Country and location	
4)	Client's Name and Address	
5)	Total Tendered cost of work (Rs. in Lac)	
6)	Cost of completed work	
7)	Brief description of works including principal features and quantity of main items.	
8)	Annual achievement (duly supported by certificate from Engineer In -Charge) ■ Of key quantities, total physical output of last Five(7) financial year (Separately for each item) (For EPC contract for Drainage/ Sewerage Projects) ■ Financial Output in Rupees (Cost of Work) (Including cost of materials supplied by the client)	
9)	Period of completion • Originally stipulated time limit. • Date of starting • Stipulated date of completion • Extended time limit if any, Actual time taken to complete the work. Reasons for non-completion of work in stipulated time limit / extended time limit if so. • Actual Cost of Work Done	
10)	Name of applicant's Engineer - in -charge of the work and his educational qualification	
11)	Were there any Penalties/ Fines / Stop notice / Compensation / Liquidated Damage imposed? (Yes or No. If yes, give case wise	

	details)	
12)	Give the details of Annual Financial Performance and your experience in execution in mobilizing in drainage Pipeline Project	
13)	Details of Litigation / Arbitration cases, if any pertaining to work completed.	
14)	Attach Client's certificate in Form-3A (Not below the rank of Executive Engineer or equivalent)	

- **Note:**

2. In case of joint venture, the above form shall be filled by the JV members separately.

- **The Bidder should furnish the information about financial capability (similar nature of work) in Form-8 (To satisfy Financial Criteria). Bidders are required to substantiate the information by submission of appropriate client certificates (Form-11).**

SIGNATURE OF BIDDER

- (*) **If the information is hidden or misleading by the bidder, he shall be disqualified for the Tender and debarred for three financial years.**

FORM - 9

ADDITIONAL INFORMATION AND LITIGATION HISTORY / DEBARMENT / BLACKLISTING

Name of Bidder:

1. PLEASE DESCRIBE:

Company's history of litigation or arbitration / Debarment / Blacklisting from contract executed in the last ten years or currently under execution. Please indicate for each case the year, name of employer, cause, matter in dispute, disputed amount, and whether the award was for or against the company.

2. Please add any further information that you consider to be relevant to the evaluation of your application. If you wish to attach other documents, please list below:

Note: In case of joint venture the above form shall be filled by the JV members separately.

SIGNATURE OF BIDDER

FORM – 10

INFORMATION FOR TENDERS SUBMITTED BUT NOT AWARDED

- 1 Please add any further information which the applicant considers relevant in regard to his capabilities.
- 2 Please give a brief note indicating by applicant considers himself eligible for qualification for the work.
- 3 List of works for which tender have already submitted to the client but not awarded

Sr. No	Name of Work	Estimated amount (In Crores Rs.)	Date of Submission of Offer	Name of Client	Likely date of award	Position with ref. to lowest bid.

Note: Giving additional information as per (a) and (b) shall not automatically lead to prequalification.
In case of joint venture the above form shall be filled by the JV members separately.

SIGNATURE OF BIDDER

FORM – 11

Name of Office:-

Date:

CERTIFICATE FOR EXPERIENCE OF WORK

This is to Certify that M/s_____ was awarded the work of _____(Agreement / contract No. & Year_____). As individual / in a Joint Venture with _____ other details of the work are as under.

1(a)	Name of Joint Venture (If applicable)	
1(b)	-Office address. -Name of state - Telegraphic address -Telephone number with STD code -Fax number. - E-mail address.	
2)	Percentage of share of the agency as per Joint Venture agreement (If applicable)	
3)	Tendered amount Rs. in Lac.	
4)	Actual cost of work completed, including price escalation	
5)	Time Limit in months	
6)	(A) Actual date of starting. (B) Stipulated date of completion	
7)	Actual / expected date of completion	
8)	Whether any fine imposed for not carrying the work as per stipulated time Schedule? (If Yes please give details)	
9)	Execution of pipe line work, type of pipe, diameter in mm & length in kms	
10)	Design and execution details of similar work	

Note:

- (a)The agency has carried out the work timely/ late and satisfactorily/ unsatisfactorily.
 (b)Details of quantities of main items of similar nature of work shall be given in the respective column.
 (c)In case of joint venture, the above form shall be filled by the JV members separately.

This form 11 shall be read in conjunction with Form 16, if Technology Provider is not a bidder or a member of JV, then for the experience of Technology provider, this form shall be filled by him separately.

SIGNATURE OF ACCOUNTANT**NAME OF ACCOUNTANT****DATE:****PLACE:****SIGNATURE OF ENGINEER-IN-CHARGE****NAME AND SEAL OF ENGINEER-IN-CHARGE****DATE:****PLACE:**

FORM – 12

JOINT VENTURE DATA- (NOT APPLICABLE)

A copy of the joint venture agreement must be attached to Form 4. In case the joint venture agreement is not acceptable to Gujarat Urban Development Company, the joint venture may be requested to modify the agreement accordingly. Failure to submit a modified Joint venture agreement within twenty-one days upon receipt by the applicant of the request for modification will disqualify the applicant for further consideration.

Names of the joint venture as mentioned in JV agreement:				
Partners	Name of Firm	Name of Contact Person with Telephone Number	Correspondence Address	Financial Stake in JV (In Percentage)
Lead Partner				
Partner				

Note: The above form shall be supported with Joint Venture Agreement as per proforma mentioned in Tender document.

• _____ **SIGNATURE OF BIDDER**

FORM - 13

•

• **PERSONNEL/STAFF PROPOSED
FOR THE PROJECT**

Name of Applicant or partner of a joint venture

For specific positions essential to contract implementation, applicants should provide the names of at least two candidates qualified to meet the specified requirements stated for each position. The data on their experience should be supplied in separate sheets using one Form-14 for each candidate.

1.	Title of position: Project Manager
	Name of prime candidate:
	Name of alternate candidate:
2.	Title of position: Civil Engineer
	Name of prime candidate
	Name of alternate candidate
3.	Title of position: Process and Mechanical Engineer (separately)
	Name of prime candidate
	Name of alternate candidate
4.	Title of position: Construction Engineer
	Name of prime candidate
	Name of alternate candidate
5	Title of position: Supervisor
	Name of prime candidate
	Name of alternate candidate
6	Title of position: Technical Assistant
	Name of prime candidate
	Name of alternate candidate

Note: Attach **Manning (Personnel) Schedule** stating each personnel's roles and responsibility for work to be carried out for the project.

Note

- (i) If sufficient staff does not exist at the time of bidding, an undertaking for employing the necessary staff shall be given by the Bidder
- (ii) Successful Bidder shall deploy minimum key Personnel's mentioned above during execution of work at site

FORM - 14

• **CURRICULUM VITAE OF PROJECT
MANAGER & ALL KEY TECHNICAL
PERSONNEL's**

Name of Applicant or partner of a joint venture

Proposed Position:		Candidate ☐ Prime ☐ Alternate	
<i>Candidate information</i>	1. Name of candidate	2. Date of birth	
	3. Professional qualifications:		
<i>Present employment</i>	4. Name of employer		
	Address of employer:		
	Telephone:	Contact (manager / personnel officer):	
	Facsimile:	Telex:	
	Job title of candidate:	Years with present employer:	

Summarize professional experience over the last ____ years, in reverse chronological order.

Indicate particular technical and managerial experience relevant to this Project.

From	To	Company / Project / Position / Description of relevant technical & managerial project specific experience

FORM - 15

-
- **PROPOSED SITE ORGANIZATION & MANAGEMENT**

Name of Applicant or partner of a joint venture

- a. Preliminary Site Organization Chart at HO level & at field level:
- b. Narrative Description of Site Organization & Project Management Chart
- c. Description of Relationship between Head Office and Site Management¹
- d. Description of Approach & Methodology to carried out work of this project.

Note: Indicate clearly which responsibility and what authority will be delegated to site management.

FORM – 16**DETAILS OF EXPERIENCE FOR PHYSICAL QUALIFICATION CRITERIA**

Sr. No	Name of work	Cost of work in Rs. Lakhs	Work completed/ in progress	Particulars of item	Unit	Qty in tender	Executed Quantity
1				Non-Metallic Pipe			
2				Pumping Machinery			
3				Operation & Maintenance			

Note: For each experience criteria Form-11 shall be submitted by the contractor duly signed by the employer

- a) In case the bidder has executed the works mentioned above in Joint Venture, he shall mention their financial stake in the works executed. The client certificate along with copy of joint venture agreement mentioning the JV stake shall also be attached.
- b) For each experience criteria Form-11/Form-3A shall be submitted by the contractor duly signed by the employer not below the rank of Executive Engineer or equivalent.
- c) The Bidder should furnish the information about Physical capability (to satisfy Physical Criteria) in Form-16. Bidders are required to substantiate the information by submission of appropriate client certificates as mentioned at Sr. No. (b) above.

SIGNATURE OF BIDDER

FORM – 17

Approach and Methodology with Conceptual Design and Supporting Calculations of the System

Bidder may submit their work plan, detail methodology with Conceptual Design and Supporting Calculations of the System to be adopted for this work.

SIGNATURE OF THE BIDDER

FORM-18

PROFORMA FOR LETTER OF UNDERTAKING (FORM-H)

(TO BE EXECUTED ON NON-JUDICIAL STAMP PAPER OF ₹300/- AND SUBMITTED BY THE TENDERER ALONGWITH HIS TENDER IN A SEPARATE COVER)

To

(Executive Engineer)

(Office address of AUDA)

Dear Sir,

- a) I/We hereby declare that I/We have visited the site and fully acquainted myself / ourselves with local situations regarding materials, labor and other factors pertaining to the work before submitting this tender.
- b) I/We hereby declare that I/We have read the Tender Documents published on website <https://tender.nprocure.com> and accordingly submitted online price Bid for the work of -----

- c) I/We hereby declare that I/We have carefully studied the conditions of contract and specifications and other documents of this work and agree to execute the same accordingly.
- d) I/We hereby declare that my/our near relatives are not working in this division or in its sub-divisions as an Engineer of any category, Divisional Accountant, Store Keeper, and in the Circle Office as a Superintending Engineer as on today.
- e) I/we hereby declare that I/we are not declared ineligibility for corrupt or fraudulent practices issued by the central/state govt. In accordance with **Sub Clause No. 41 Corrupt or Fraudulent Practices** or not in the list of black listed contractors announced by AUDA/GWSSB/ GWIL / Govt. of Gujarat or its Public Sector Undertakings, Government of India, Other states Government or Public Sector Units.
- f) I/ We hereby submit our tender and undertake to keep our tender valid for a period of 180 days from the date of opening of tenders i.e. up-to ----- I/We shall not vary/ alter or revoke my/ our tender during the validity period of tender. This undertaking is in consideration of **AUDA** agreeing to open my/ our tender, consider and evaluate the same for the purpose of award in terms of provisions of tender documents. Should this tender be accepted, I/ We also agree to abide by fulfill and comply with all the terms and conditions and provisions of the above-mentioned tender documents.
- g) I/We also declare that the bid duly filled in online and digitally signed and the required Earnest Money Deposit, Tender Fee and other required documents (scanned copy submitted online) will be handed over in physical form to " **EXECUTIVE ENGINEER, AUDA , Gujarat (Address as Sr No 27 of tender notice)** " by RPAD/Speed Post only.

- h) I/we say the details and particulars given by are true and correct, state and declare that the said has not concealed any fact, details or particulars and all the said..... are true and correct and complete.
- i) I/we say that if any particulars found to be incorrect or incomplete or misleading in any matter, the **AUDA** shall have full authority to cancel the tender at any point of time and theshall be liable for all the consequences that may arise out of the action of the **AUDA** .
- j) I/we say that I/we are aware that making wrong statement on affidavit is a punishable offence.

If this declaration is found to be incorrect then without prejudice to any other action that may be taken, my/our security deposit may be forfeited by AUDA in full & the tender, if any, to the extent accepted, may be cancelled.

Signature along with seal of the Company

(Duly authorised to sign the tender on
behalf of the Bidder)

Name:

Designation:

Name of Company (BLOCK LETTERS)

• **WITNESS :**

Signature:

Date:

Date:

Postal Address :

Name & Address:

Telephone/Fax No.

Note: In case of Joint Venture, the above declaration/letter of submission shall be jointly signed by all of the JV partners.

SIGNATURE OF THE BIDDER

Form-19
FORM OF BANK GUARANTEE
(Earnest Money Deposit)

Whereas M/s..... (herein after called the Tenderer) is desirous and prepared to tender for work in accordance with Terms & Conditions of Tender Notice of (financial year) dated and whereas We, Bank; agree to give the Tenderer a guarantee for the Earnest Money Deposit.

- i) Therefore, we hereby affirm that we are Guarantors on behalf of the Tenderer upto a total of Rupees(i.e. Rs.....) and we undertake to pay the AUDA, , upon his first written demand and without demur, without delay and without necessity of previous notice of individual or administrative procedure and without necessity to prove the bank the defects or shortcomings or debit of the contractor any sum within the limit of Rupees.....
- ii) We further agree that the guarantee here in contained shall remain in full force and effective during the period that would be taken for the acceptance of the tender. However, unless a demand or claim under this guarantee is made only in writing on or before the We shall be discharged from all liabilities under the guarantee thereafter.
- iii) We undertake not to revoke the guarantee during its currency except with the previous consent of the AUDA, , in writing.
- iv) We lastly undertake not to remove the guarantee for any change in constitution of the Tenderer or the Bank.

Signature and Seal of the Guarantor

Bank:

Address:

Date:

Form-20 (Form-3A)

WORK WISE DETAILS OF WORK COMPLETED/ IN PROGRESS BY THE CONTRACTOR

- a) Name of Contractor :
b) Name of Work :
c) Estimated Cost of Work Put To Tender :
d) Tendered Amount :
e) Date of starting of the work :
f) Date of completion of the work :
(As per contract agreement)
g) Actual Date of Completion of Work :
h) Amount of work done upto :
i) Brief history of the work :

Sl. No.	Particulars		

- 10 State whether details as above given by the contractor correct, if not as to what is the correct information. :

- 11 State whether the contractor has executed the work in progress satisfactory as per specification/ has completed the work, satisfaction, if any give the correct position of the work. :

Note: In case of joint venture the above form shall be filled by the JV members separately

Form-21

PERFORMANCE GUARANTEE PROFORMA

(See clause No. 1)

(The date of this bond must not be prior to the date of the instrument in connection with which it is given)_____

Principal (Contractor) _____

Surety (Scheduled or Nationalized Bank) _____

Sum of bond (express in words and figures) _____

Contract No. and date of contract _____

KNOW ALL MEN BY THESE PRESENTS THAT WE, THE PRINCIPALS AND SURETY above named are held and firmly bound up-to the _____ hereinafter called the Employer in the amount stated for payment of which' sum, well and truly to be made, we bind ourselves, our heirs, executors, administrators and successors jointly and severally, firmly by these presents subject to the provisions of which the aforesaid Contractor on demand and without demand on a claim being made by the Employer.

THE CONDITION OF THIS OBLIGATION IS SUCH that whereas the principals have entered in to a contract with the Employer numbered and 'dates as shown above and hereto attached for the execution of work _____

NOWTHEREFORE, if the Principal shall well and truly perform and fulfil all the undertakings, covenants, terms, conditions of agreement of said contract during the original terms of the said Contract and any extensions thereof that may be granted by the Employer with or without notice to the surety and during the life or any guarantee required under the contract and shall also well and truly perform and fulfil all the Undertakings, covenants, terms, conditions of agreement of any all duty and unduly authorized modifications of said Contract that may hereafter be made, notice of which modifications to the surety being hereby waived or shall pay over, make good and reimburse to the Employer all loss and damages which the employer may sustain by reason of failure or default on the part of said Principal so to do.

We _____ further agree that the guarantee herein Contained shall remain in full force and effect during the period that would be taken for the validity of the said Contract, and that it shall continue to be enforceable till all the dues of the employer under or by virtue of the Contract have been fully paid and its claims satisfied or discharged or till the Employer certifies that the terms and conditions of the Contract have been fully and properly carried out and work is completed by all means by the said Contractor and accordingly discharges the guarantee. Failing which Employer is at liberty to forfeit the performance Security and recover the amount by way of invocation/encasement. Unless a demand or claim under this guarantee is made on us in writing on or before the _____ we shall be discharged from all liability under this guarantee thereafter.

IN WITNESS WHERE OF, the above bounded parties have executed this instrument under their several seals on the date indicated above the name and corporate seal, of each corporate party being hereto affixed and these presents duly signed by is undersigned representatives, pursuant to authority

of its governing body.

In the presence of witness

individual

Principal

1. _____ as to _____ (seal)

2. _____ as to _____ (seal)

3. _____ as to _____ (seal)

4. _____ as to _____ (seal)

By _____ affix Corporate Seal

Attested

Corporate Surety

Business address

Affix by _____ Corporate Seal

Title _____

For and on behalf of the Employer

Form-22

JOINT VENTURE AGREEMENT – NOT APPLICABLE

(To be notarized on Rs. 300/- non judicial stamp paper)

(1) The Joint Venture agreement made and entered into at _____ (place) on _____ day of _____ (YEAR) by and between.

(a) a. Firm A (Name with address of the registered office)
(b) b. Firm B (Name with address of the registered office)

(2) **Definitions:** In this deed the following words and expressions shall have the meaning set out below.

- a. "The Employer" shall mean Gujarat Urban Development Company.
- b. "The Works" shall mean _____ (Name of work) which is more particularly described in the pre-qualification and tender documents issued thereof by the Employer.
- c. "The Tender" shall mean the Tender to be submitted by Joint Venture to the Employer for the work /works.
- d. "The Contract" shall mean the contract entered /to be entered into between the Joint Venture and the Employer for the works.

(3) **Joint Venture (J.V):**

The Parties hereto declare that they have agreed to form a Joint Venture for the purpose of submitting the pre-qualification Application/ tender document initially and then tender and if successful for the execution of the works as an integrated Joint Venture. The parties are not under this agreement entering into any permanent partnership of Joint Venture to tender or undertake any contract other than the subject works. Nothing herein contained shall be considered to constitute the parties of partners to constitute either Party the agent of the other.

(4) **Witnesses :** Whereas Gujarat Urban Development Company as Board employer has invited tenders from intending bidders and the Board has permitted a group of firms (not exceeding two) forming a Joint Venture to eligible to be a bidder. And
whereas _____ party of the first part and _____ party of the Second part/third part(if applicable) are desirous to enter into a Joint Venture in the nature of partnership engaged in the joint undertaking for the specific purpose of execution of the work of constructing _____ and whereas Parties of the first and Second part /third part(if applicable) reached understanding to submit pre-qualified/ tender, if pre-qualification, and to execute the contract if awarded;

~~This agreement witness as follows.~~

- (a) ~~The parties do not enter into an agreement of any permanent partnership of Joint Venture to tender or undertake any Contract other than the specified above;~~
- (b) ~~That the operation of this Joint Venture firm concerns and is confined to the work of _____ of AUDA~~
- (c) ~~The name of the Joint Venture firm for convenience and continuity shall be.....~~
- (d) ~~The Address of Joint Venture for communication shall be as under.....~~
- (e) ~~The Joint Venture shall jointly submit pre-qualification application on the above name according to all terms and conditions stated in the relevant instructions contained in the bid documents.~~
- (f) ~~That this Joint Venture shall regulate the relations between the parties thereto and shall include without being limited to them the following conditions.~~
- (1) ~~_____ firm shall be the lead company in charge of the Joint Venture for all intents and purpose.~~
- (2) ~~In case, the said work is awarded to the Joint Venture, the partners of the Joint Venture will nominate a person with duly notarized power of Attorney on stamp paper, who will represent the Joint Venture with the authority to incur liabilities, receive instructions and payments, sign and execute the contract for an on behalf of the Joint Venture,~~
- (i) ~~All the (Maximum Two) parties agree to make financial participation and to place at disposal of Joint Venture the benefits of its individual experience, technical knowledge, skill and shall in all respect bear its share as regards planning and execution of the work and responsibilities including the provision of information, advice and other assistance required in the Joint Venture and participation shall be in proportion of, Firm – A.....% Firm – B.....%~~
- (ii) ~~All rights, interests, liabilities, obligations work experience and risks (and all net profits or net losses) arising out of the contract shall be borne by the parties in proportion to their shares. Each of the parties shall furnish its proportionate share in any bonds, guarantees, sureties required for the works as well as its proportionate share in connection with the works. The share and participation of the two partners in working capital and other financial requirements shall be in ratio as mentioned above.~~
- (5) Internal responsibilities and liabilities:**
- (a) ~~The division of individual scope of work may be worked out mutually by the parties but the party shall be jointly and severally liable to the employer for the whole work.~~
- (b) ~~The parties specifically undertake to carry out their separate works in full compliance with the~~

contract with the employer. Each party shall be responsible jointly and severally for consequences if any arising out of defective or delayed execution of works which falls within the individual's party's area of responsibility and/ or it has been caused due to acts and /or omission of the concerned party.

(c) The parties jointly and severally agree to replace modify or repair any defect in their respective portions of works in accordance with the terms and condition of the contract with the employer.

(d) The parties jointly and severally shall indemnify and hold harmless to each other against any claim made by the employer or any other third party for injury, damage, loss or expenses is attributed to the breach /non performance of his responsibilities by the indemnifying party in accordance with the agreements and /or contract with the employer.

(e) None of parties have joined in any other Joint Venture for the said works.

(6) Responsibilities and liabilities of Joint Venture towards the employer:-

(1) Parties hereto shall be jointly and severally liable and responsible for the acts, deeds and things done or omitted to be done in respect of the execution of the contract and for any financial liability arising there from.

(2) Parties hereto shall be jointly and severally responsible to the Employer for the execution of the works in accordance with the contract conditions;

(3) Parties hereto shall be jointly and severally indemnify to the Employer against any claim made against the employer or any other third party for any injury, damage or loss which may be attributed to the breach of the obligations under the contract pursuant to the contract.

(7) Site management:-

(a) The execution of the work on the site will be managed by a Project Manager appointed by the Joint Venture and who will report to the _____ (J.V.) the project manager shall be authorized to represent the Joint Venture on site in respect of matters arising under the contract.

(b) The _____ (Name of the J.V.) shall be jointly and severally liable to the employer for the execution of the contract commitment in respect of the works in accordance with contract conditions.

(8) Termination of the Agreement:-

This agreement shall be terminated in the following circumstances.

(a) The employer awards the contract for the work to the other Bidder.

(b) The employer cancels the work to award the contract.

(c) On completion of the defect liability period as stipulated in the contract agreement of the works and all the liabilities thereof are liquidated.

(9) No partner has right to assign any benefits, obligation of liability under the agreement to any third party without prior written consent of the other partner as well as Board

(10) Financial matter:-

(a) Bank Account in the name of the Joint Venture will be opened with any scheduled or nationalized Bank to be operated by an individual signatory as decided mutually by the Joint

Venture partners.

(b) All the partners shall be responsible to maintain or cause to maintain proper Books of accounts balance sheet and profit and loss account as to the state of affairs of the firm as at the end of the financial year and as to the profit and loss made or incurred by the firm for the year ended on that date, respectively shall be prepared and the same shall subject to audit by a Chartered Accountant.

(c) None of the party shall be entitled to make any borrowing on behalf of the Joint Venture without express prior written consent of the other party.

(d) Bank guarantee for the application /execution of the work shall be provided jointly from a bank acceptable to the employer.

(11) Negotiation : Any negotiation of agreement between the parties hereto and the employer subsequent to the submission of the tender and prior to award, shall take place only with consent of each of the parties who shall be represented at the such negotiation by one or more representative(s) duly empowered to make such negotiation or agreement.

(12) Legal jurisdiction: All questions relating to validity interpretation of this agreement shall be governed by the law of India and shall be subject to jurisdiction of High court at AHMEDABAD.

(13) Settlement of disputes: Any dispute in interpretation of any condition mentioned herein shall be referred to an arbitrator/tribunal by mutual consent of the partners and such proceedings shall be governed by Gujarat Public Works contract disputes tribunal act of 1992 and as amended from time to time. The award of arbitrator shall be final and binding on the party hereto. Neither the obligation of each party here to the performance of contract nor the execution of work shall stop during the course of arbitration proceeding or as a result thereof.

(14) Insurance:

(a) The Joint Venture through the parties individually shall take such insurance in connection with the work in accordance with the tender condition as acceptable to the employer.

(b) The cost of the insurance premium paid by the Joint Venture shall be borne and paid by the parties in proportion to the respective shares of work. Other insurance taken individually by the parties shall be fully borne by the respective parties.

(15) No change shall be made in this agreement without prior written consent of the employer and other party. However if the employer directs the parties to make changes in the agreement so as to fulfill tender conditions the parties discuss with employer and mutually agreed such changes required to be made in the agreement.

(16) Default and withdrawals from the Joint Venture. : In case that either party fails to observe the provision stipulated in this agreement withdrawal from the Joint Venture, Loss and/or expenses incurred by other party due to such default and /or withdrawals shall be fully compensated by the party who has defaulted.

~~(17) All matter relating to or arising due to this agreement shall be treated as confidential and shall not be disclosed to any other party. In witness whereof the parties have caused their duly authorized representatives to sign below.~~

~~Witness:-~~

~~a) Signed for and on behalf of firm A
b) Date Seal~~

~~Witness:-~~

~~1 Signed for and on behalf of firm B
2 Date Seal~~

~~Witness:-~~

~~a. Signed for and on behalf of firm C
b. Date Seal~~

Form- 23 (if Applicable)

“Assured Pipe Supply Declaration” (MOU with Manufacturer of DI/MS/RCC/ DWC pipe)

In the interest of timely completion of the Project, after discussions and getting assurance from the manufacturer, the following schedule is proposed in order to meet the milestones and desire target of the Projects.

Name of the Pipe Supply Firm	Location of Manufacturing Unit	Size of Pipe			Quantity (In MT)	Assured date of delivery at site (zero date starts from date of work order)
		Diameter (In mm) (FID)	Length (In Km)			

Total number of days for supply of pipe shall be 120 days from the date of work order. We hereby declare that the supply of pipes for the Project will be ensured by us (within 120 days) as per the above-mentioned schedule. We are aware, that, in case the above schedule is not met with by us, we shall be liable for paying the Liquidated damages as prescribed in the tender documents for non-fulfillment of assured supply of pipes.

Authorised Signatory of the Contractor

Authorised Signatory of the Manufacturer.

FORM- 24 (if Applicable)

MEMORANDUM OF UNDERSTANDING (MOU)

This MEMORANDUM OF UNDERSTANDING hereinafter referred to as MoU made on__ Day _____(month and year) at _____ by and between.

(Name and Pipe Manufacturer with address) _____, represented by _____ Authorized Signatory, which expression shall unless repugnant to the subject or context include its administrators, Successors and assigns.

(Name of Bidder with Address) _____, represented by _____ (Authorized Signatory), which expression shall unless repugnant to the subject or context includes its administrator, successor and assigns

Hereinafter referred to as "Parties" in the collective sense and each of which is referred to as "_____(Name of Pipe Manufacturer)" & "_____(Name of Bidder)" in the individual sense.

WHEREAS AUDAL (hereinafter referred to as Employer) has invited tender (hereinafter referred to as the ("project")) for the following work:

Name of Project: _____

WHEREAS if the said project is awarded to "_____"(Name of Bidder) to execute the said project and it would also need _____ pipes and we the "_____"(Name of Bidder) hereby enter into this MoU with "_____(Name of Pipe Manufacturer)_____" for timely execution of _____ pipe line work and supply of pipes as per "Form 23 - Assured pipe Supply Declaration" attached herewith and as per the tender conditions and further we mutually agree to execute the said project jointly and both the parties would be jointly and severally responsible for execution of the said projects as per the Bidding Documents.

IN WITNESS WHEREOF all the parties mentioned herein above have signed this MOU on the day, month and year first above mentioned.

No change shall be made in this agreement without prior consent of Employer and other party. However, If the Employer direct the parties to make changes in MOU agreement so as to fulfil the tender condition / requirement, the parties shall discuss with the employer and shall mutually agree for such changes as may be required to be made in the agreement.

In the interest of timely completion of the project, after discussion and getting assurance from manufacture of _____ pipe, the following schedule for _____ pipe supply is proposed in order to meet the milestones and desired target of the projects.

Total number of days for supply of pipe shall be _____ days from the date of work order.

We hereby declare that the supply of pipes for the Project will be ensured by us (within _____ days) as per the above-mentioned schedule. We are aware that, in case the above schedule is not met with by us, we shall be liable for paying the Liquidated damages as prescribed in the tender documents for non-fulfilment of assured supply of pipes.

For, (Name of Bidder)

For, (Name of Pipe Manufacturer)

Authorised Signatory

Authorised Signatory

Encl.: Form 23 - Assured Pipe Supply Declaration

SECTION - 11

EXTENT OF WORK

DETAILED PROJECT EXTEND OF WORK (SCOPE OF WORK)

Project Title: Construction of Sewer network under TP Schemes Nos. 412A, 412B, 243, 109, 413 & 411 and construction of 3 Nos. Pumping Stations (MPS 01- 11.98 MLD, MPS-2 12.24 MLD & MPS-3 20.55 MLD) and Sewerage Treatment Plant of 30 MLD Capacity within AUDA TP Scheme areas.

1.0 Executive Summary

This project pertains to the **construction of a comprehensive sewerage system within AUDA Town Planning (TP) Scheme areas**, covering TP Schemes Nos. 412A, 412B, 243, 109, 413, and 411. The scope of work includes the **design, supply, construction, installation, testing, and commissioning of sewer network infrastructure**, along with **three (3) sewage pumping stations** and a **30 MLD capacity Sewerage Treatment Plant (STP)**, to be executed on a **turnkey basis**.

The project comprises the **construction of gravity sewer networks, house and property connections, rising mains, and three pumping stations**, namely **MPS-01 (11.98 MLD), MPS-02 (12.24 MLD), and MPS-03 (20.55 MLD)**, including all associated civil, mechanical, electrical, and instrumentation works. The scope further includes the **design and construction of a 30 MLD STP**, complete with inlet works, treatment units, sludge handling systems, treated effluent disposal arrangements, and all appurtenant structures.

In addition, the project includes **area development works, internal roads, compound walls, utility buildings, road resurfacing, and ancillary infrastructure**, as well as **comprehensive operation and maintenance (O&M) of civil and electro-mechanical systems for the specified period**.

All works shall be executed **strictly in accordance with AUDA specifications, approved drawings, applicable statutory provisions, and the directions issued from time to time by AUDA's Executive Engineer-in-Charge or his authorized representative**.

The project aims to provide a **robust, efficient, and environmentally compliant sewerage system** for the designated AUDA TP Scheme areas, ensuring **safe collection, conveyance, treatment, and disposal of sewage**, thereby supporting planned urban development and improving overall sanitation infrastructure, **to the satisfaction of AUDA's Executive Engineer-in-Charge**.

2.0 Major Project Components

The project is divided into the following key segments:

1. Gravity Sewer Network

Contractor have to do Topographical Survey , Geotechnical Investigation , Detail Design , supply, laying, jointing, testing, and commissioning of underground gravity sewer network comprising RCC/DI/HDPE sewer pipes of various diameters, manholes, inspection chambers, drop manholes, and all associated appurtenances including excavation, shoring, bedding, backfilling, road cutting, restoration, hydraulic testing, and commissioning, complete as directed and approved by AUDA's Executive Engineer-in-Charge.

2. House & Property Connections

Providing and connecting individual house/property sewer connections from property line to nearest sewer manhole including UPVC/SWR pipes, saddles, inspection chambers, surface restoration, testing, and integration with the gravity sewer system, complete to the satisfaction of AUDA's Executive Engineer-in-Charge.

3. Rising Main (Pressure Sewer Main)

Contractor have to do Topographical Survey , Geotechnical Investigation , Detail Design , Design, supply,

laying, jointing, testing, and commissioning of pressure sewer mains using DI/HDPE pipes including thrust blocks, air valves, scour valves, valve chambers, crossings, pressure testing, and commissioning, complete as per instructions of AUDA's Executive Engineer-in-Charge.

4. Pumping Stations (MPS / IPS – Multiple Locations)

Contractor have to do Topographical Survey , Geotechnical Investigation , Detail Design , Construction of sewage pumping stations including wet well, valve chambers, RCC superstructure, internal roads, drainage, sump, finishes, safety provisions, and all allied civil works, complete as approved by AUDA's Executive Engineer-in-Charge.

5. Sewage Treatment Plant (STP – 30 MLD)

Contractor have to do Topographical Survey , Geotechnical Investigation , Detail Design, construction, testing, commissioning, and performance guarantee of **30 MLD STP** including inlet works, treatment units, clarifiers, sludge handling system, treated effluent disposal, and all appurtenant civil structures, complete as per approved design and directions of AUDA's Executive Engineer-in-Charge.

6. Mechanical Works

Supply, installation, testing, and commissioning of all mechanical equipment including pumps, blowers, mixers, screens, gates, valves, sludge handling equipment, piping, platforms, ladders, and protective systems at STP and pumping stations, complete to the satisfaction of AUDA's Executive Engineer-in-Charge.

7. Instrumentation Works

Supply, installation, calibration, testing, and commissioning of complete instrumentation and automation systems including flow meters, level sensors, analyzers, PLC, SCADA, communication network, and integration of all units, complete as per approval of AUDA's Executive Engineer-in-Charge.

8. Electrical Works

Design, supply, installation, testing, and commissioning of HT/LT electrical systems including transformers, panels, MCCs, cabling, earthing, lightning protection, DG sets, and lighting systems, complete as directed by AUDA's Executive Engineer-in-Charge.

9. Area Development – Compound Wall

Contractor have to do Topographical Survey , Geotechnical Investigation , Detail Design , Construction of compound wall including RCC foundation, masonry/screen wall, gates, finishes, and drainage around premises, complete as per drawings approved by AUDA's Executive Engineer-in-Charge.

10. Area Development – Paver Block Works

Contractor have to do Topographical Survey , Geotechnical Investigation , Detail Design , Providing and laying interlocking paver blocks for internal roads and walkways including sub-base preparation, edge restraints, slope and drainage, complete to the satisfaction of AUDA's Executive Engineer-in-Charge.

11. Area Development – Toilet Block Works (3 Nos.)

Contractor have to do Topographical Survey , Geotechnical Investigation , Detail Design , Construction of toilet blocks including civil, plumbing, sanitary, electrical works, water supply, sewer connection, ventilation, and finishes, complete as approved by AUDA's Executive Engineer-in-Charge.

12. High Tension (HT) Panel Room at MPS (3 Nos.)

Contractor have to do Topographical Survey , Geotechnical Investigation , Detail Design , Construction of HT panel rooms including RCC structure, ventilation, fire safety provisions, cable trenches, flooring, and statutory clearances, complete as per instructions of AUDA's Executive Engineer-in-Charge.

13. Low Tension (LT) Panel Room at MPS (3 Nos.)

Contractor have to do Topographical Survey , Geotechnical Investigation , Detail Design , Construction of LT panel rooms including RCC/masonry works, flooring, cable trenches, ventilation, fire safety provisions, and operational clearances, complete as approved by AUDA's Executive Engineer-in-Charge.

14. Steel Truss Bridge

Contractor have to do Topographical Survey , Geotechnical Investigation , Detail Design, fabrication, erection, testing, and commissioning of steel truss bridge including foundations, deck system, railings, protective painting, and load testing, complete as per approved drawings and directions of AUDA's Executive Engineer-in-Charge.

15. Road Resurfacing & Approach Road

Restoration and resurfacing of roads affected during execution including bituminous/concrete layers, shoulders, markings, drainage, and approach roads, complete as directed by AUDA's Executive Engineer-in-Charge.

16. Other Gravity Network for Storm with Ancillary Works

Design, supply, laying, jointing, testing, and commissioning of underground gravity sewer network comprising RCC/DI/HDPE sewer pipes of various diameters, manholes, inspection chambers, drop manholes, and all associated appurtenances including excavation, shoring, bedding, backfilling, road cutting, restoration, hydraulic testing, and commissioning, complete as directed and approved by AUDA's Executive Engineer-in-Charge.

17. O&M – Civil Works @ 0.5% of Capex per Year (For 5 Years)

Operation and maintenance of all civil assets including sewer network, structures, buildings, roads, drains, compound walls, and repairs for 5 years, complete under the supervision of AUDA's Executive Engineer-in-Charge.

18. O&M – Electro-Mechanical Works @ 1.5% of Capex per Year (For 5 Years)

Operation, preventive and breakdown maintenance of all electro-mechanical systems including pumps, motors, panels, instrumentation, and cabling for 5 years, complete as per directions of AUDA's Executive Engineer-in-Charge.

19. O&M of Civil and Electro-Mechanical Works of STP (For 5 Years)

Comprehensive O&M of STP including manpower, routine maintenance, performance monitoring, effluent quality compliance, statutory reporting, and handover after O&M period, complete to the satisfaction of AUDA's Executive Engineer-in-Charge.

20. The Contractor shall be solely and entirely responsible for obtaining all statutory approvals, permissions, No Objection Certificates (NOCs), licenses, consents, and clearances as may be required for execution of the Works from all concerned Government, Semi-Government, Local Bodies, Statutory Authorities, and Non-Government agencies.

This shall include, but not be limited to, approvals from Sardar Sarovar Narmada Nigam Limited (SSNL), Highway Authorities, Gas Pipeline Authorities, Railways, Irrigation Departments, Utility-owning agencies, and any other authority having jurisdiction over the site or the Works, for matters such as crossings, right-of-way (ROW), road cutting permissions, utility shifting, protection works, and execution within their respective limits.

The Contractor shall deploy and maintain, at its own cost, a dedicated Liaison Officer/team for continuous coordination with all such authorities to ensure timely submission, follow-up, compliance, and procurement of required approvals and permissions.

All liaisoning activities, documentation, submissions, drawings, compliance requirements, modifications as required by statutory authorities, and related follow-up actions shall be entirely within the scope of the Contractor. No claim for extension of time (EOT) shall be entertained on account of delay in obtaining such approvals, permissions, or clearances.

However, statutory fees and official charges payable directly to the concerned authority, wherever required

in the name of AUDA, shall be borne by AUDA upon submission of proper documentary evidence by the Contractor.

21. The Contractor shall be required to install, commission, and maintain a fully functional Ready Mix Concrete (RMC) Plant of minimum 30 cubic meters per hour production capacity within the project limits. The RMC Plant shall be established exclusively for this project and shall remain operational for the entire duration of the work to ensure continuous, timely, and quality-controlled concrete supply conforming to relevant IS standards and approved mix designs.

3.0 Contractor's Responsibilities

The successful bidder will be responsible for:

- Topographical Survey , Geotechnical Investigation , Detail Design and engineering of all components.
- Procurement, supply, and transportation of all materials and equipment.
- Construction, installation, and integration of all civil and M&E works.
- Testing, commissioning, and performance demonstration of the entire system.
- Obtaining all necessary permits, approvals, and NOCs from relevant authorities.
- Providing comprehensive "as-built" drawings and operation & maintenance manuals.
- Training client personnel on system operation and maintenance.
- Providing O&M services for 5 years.

4.0 Standards and Compliance

All materials, equipment, and workmanship shall conform to the latest relevant Indian Standards (IS), International Electrotechnical Commission (IEC) standards, Central Public Health and Environmental Engineering Organisation (CPHEEO) manual guidelines, and specifications detailed in the tender document

SECTION - 12

DATA SHEETS

PREAMBLE TO DATA SHEET

- (c) The Levels given in the Appendix to Bid and drawings are as per the Data available with authority. As the Working survey is included in scope of the work of contractor, agency shall carry out working survey along the route.
- (d) The Agency shall have to confirm both the levels and line out of the pipeline network as per the requirement of the inter-related actual pipeline route/any structure and design accordingly. No Extra payment shall be made by the Department to the Agency for the extra excavation or for the raised structure above Ground Level.
- (e) The levels given in the documents are tentative as per the selected site presently surveyed. In case of change in pipeline route/any structure is to be necessary due to any reason, the Agency shall be bound to carry out all the works as per the new pipeline route/any structure and the design is to be carried out accordingly without any extra claims.
- (f) The sizes of the panel room given in the Price Bid are as per the Departmental Type Design of authority. The above-mentioned work should be constructed accordingly and any changes in size shall be measured and the payment will be made as per schedule of Payment. Agency shall be bound to carry out the work as per the re-designed structures.
- (g) All the civil structure like panel room given should be designed in relevant manner with given flow diagram, and the layout shall get approved before the detailed designing from the EIC.
- (h) For Construction of Civil Structures all the data are to be obtained by the agency and accordingly the structural design shall be prepared & to be got approved by authority.

Signature of Bidder

**EXECUTIVE ENGINEER
AUDA**

1.0 SUBMERSIBLE NON-CLOG VERTICAL PUMP

SR. NO.	PARTICULAR	DESCRIPTION	DATA TO FILL BY BIDDER
1.0	LIQUID DATA		
1.1	Liquid handled	Sewage	
1.2	Specific gravity	1.02	
1.3	Temperature	Amb. temp. - 50 Deg. C	
1.4	Suc. Pre.@ rated capacity-m	Atmospheric	
2.0	PUMP DATA		
2.1	Make	Please furnish	
2.2	Pump type	Sub.NC with dry type motor	
2.3	Pump Model	Please furnish	
2.4	Number of pumps	nos.	
2.5	Type of duty	Continuous	
2.6	Design capacity-m ³ /hr.	Please furnish	
2.7	Total Rated Head-m	Please furnish	
2.8	Pump Efficiency at duty point-%	Please furnish	
2.9	Motor Effi. at Duty Point-kW	Please furnish	
2.10	Guaranteed Overall efficiency of Pump set-%	Min. 78 % w/o -ve Tolerance	
2.11	Motor input at rated duty-kW	Please furnish	
2.12	Rated Speed of pump-RPM	Please furnish FLS of motor	
2.13	Max. BkW for Rated Impeller-W	Please furnish	
2.14	Recommended motor rating- kW	Please furnish	
2.15	Min. Submergence Required-m	Please furnish	
2.16	Shut off head -m	Please furnish	
2.17	Min. permissible solid size-mm	100	
2.18	Length of pair of cable offered with Pump (Power & Control)-m	Please furnish	
2.19	Location	Submerged	
3.0	CONSTRUCTIONAL FEATURE		
3.1	No. of stage	Single	
3.2	Casing	Volute type	
3.3	Impeller	Single suction Enclosed/Semi-open	
3.4	Impeller dia.-mm	Rated Max. / Min.	
3.5	Shaft / Drive Transmission	Direct Unit-built	
3.6	Shaft sealing	Double Mechanical Seal	
3.7	-Type & size of Mech. Seal -Faces Pump side Motor Side:	Pl. furnish detail of faces Pl. furnish detail of faces Pl. furnish detail of faces	
3.8	Nozzle orientation & size in mm		
	Suction	Bottom	___ mm / Bottom
	Discharge	Side	___ mm / Side
	Mounting Orientation	Vertical	

SR. NO.	PARTICULAR	DESCRIPTION	DATA TO FILL BY BIDDER
	Flange drilling	As per IS 1538, FF with off center bolt holes	
	Direction of rotation	CW when viewed from DE	
	Type of Starter	Soft Starter	
	MOTOR DATA		
	Motor Rating in KW	Pl. furnish	
	Voltage / Phase / Frequency & % variation	Pl. furnish	
	Combined Voltage & Frequency variation	Pl. furnish	
	Amb. Temp. / Temp. Rise °C	Pl. furnish	
	Insulation Class	Pl. furnish	
	Duty	Continuous	
	Full Load Speed-RPM	Pl. furnish	
	Full load Torque(FLT)-kg.m	Pl. furnish	
	Starting torque as % of FLT	Pl. furnish	
	Full load current(FLC)-A	Pl. furnish	
	Locked rotor current-A	Pl. furnish	
	Starting Current as % of FLC	Pl. furnish	
	Break down or POT - % of FLT	Pl. furnish	
	Starting time at 80% V / 100% V (Sec.) with load coupled	Pl. furnish	
	No load starting time	Pl. furnish	
	Locked rotor withstand time Hot/cold (Sec)	Pl. furnish	
	Overload capacity-%	Pl. furnish	
	Permissible cold / hot starts-Nos	Pl. furnish	
	Power factor @ 50% @ 75% @ 100% load	Pl. furnish	
	Efficiency @ 50% @ 75% @ 100% load	Pl. furnish	
	Guaranteed efficiency w/o tolerances	Pl. furnish	
	Starting Power Factor	Pl. furnish	
	Provision of Thermistors	Pl. furnish	
	Bearing Type/Number, DE/ NDE	Pl. furnish	
	Cable Type / Size	Pl. furnish	
	Control & Signal Cable:	Pl. furnish	
	Power Cable :	Pl. furnish	
	Protection Class	IP-68	
5.0	MATERIAL OF CONSTRUCTION		
5.1	Pump Casing & Casing cover	CI; IS 210 GR FG 260 with 2 % Ni	
5.2	Impeller & Impeller Nut (M)	CF 8 M	

SR. NO.	PARTICULAR	DESCRIPTION	DATA TO FILL BY BIDDER
5.3	Wear Plate / suction Cover (M)	CI; IS 210 GR FG 260 with to 2 % Ni	
5.4	Shaft (M)	AISI 410	
5.5	Shaft Sleeve(M)	AISI 410	
5.6	Motor housing/Oil chamber (M)*	CI: IS 210 Gr FG 260 with 2 % Ni	
5.7	Motor Jacket / Strainer	Not required	Not required
5.8	Motor Rotor	Copper Bar base / Aluminum Die Cast	
5.9	Hardware in contact with liquid	SS 304	
5.10	Guide pipe	SS 304	
5.11	Painting	Pl. furnish	
5.12	Auto Coupling unit with del. Bend	CI/DI epoxy painted	
6.0	ACCESSORIES & SERVICES REQUIRED		
6.1	Auto Coupling unit	YES	
6.2	Strainer	NO	NO
6.3	SS Double Guide pipe with support	YES	
6.4	SS304 Lifting Chain	YES	
6.5	Set of foundation bolts & Nuts	YES	
6.6	Control Panel	NO	NO
6.7	Nonstandard/special maint. tools	YES	
7.0	WEIGHT		
7.1	Weight of pump set-kg	Pl. furnish	
7.2	Reco. crane capacity-Ton	Pl. furnish	
8.0	DRAWINGS		
8.1	ISO Performance curve	Pl furnish	
8.2	GAD drg. of Pump set	Pl furnish	
8.3	C/S drg. of pump set with part list	Pl furnish	
8.4	Catalogue of products	Pl furnish	
8.5	QAP of products	Pl furnish	
9.0	TESTING		
9.1	Hydrostatic test	Certificate required	
9.2	Performance test	Witness	
9.3	Static and dynamic balancing test	Certificate required	
9.4	Visual inspection check	Witness	

Note: 01. Manufacturer / supplier shall submit separate data sheet for each duty.
For components (Marked-M) material certificates shall be furnished.
(*) Motor housing / Oil chamber not forming a part of casing in can be offered in CI.

2.0 DATA SHEET FOR BUTTERFLY VALVES

SR. NO.	PARTICULARS	DETAILS	DATA TO BE FILLED BY THE BIDDER
1.0	CONSTRUCTIONAL FEATURES		
1.1	Make	Pl. furnish detail	
1.2	Standard	IS 13095 or BS 5155	
1.3	Size in mm/ Qty.	As per SOQ	
1.4	Location	Indoor	
1.5	Fluid	Sewage	
1.6	Sp. Gravity	1.02	
1.7	Pressure Rating	PN 1.0	
1.8	Ends	Flanged, as per IS-1538 T- IV & VI	
1.9	Disc.	Duo eccentric	
1.9.1	Eccentricity-1 in mm	Pl. furnish detail	
1.9.2	Eccentricity-2 in mm	Pl. furnish detail	
1.10	Operation	Manually gear box operated	
1.11	Other requirements	Valves shall be with hand wheel	
1.12	Stem/Shaft Orientation	Horizontal	
2.0	MATERIAL OF CONSTRUCTION		
2.1	Body	C.I. IS 210 GR 260 (M)	
2.2	Disc	C.I. IS 210 GR 260 (M)	
2.3	Stem	S.S. AISI - 410 (M)	
2.4	Body seat (Renewable)	S.S. AISI - 410 (M)	
2.5	Disc seal	EPDM Rubber	
2.6	Clamping ring	S.S AISI -304	
2.7	Bolts, studs & nuts	CS, IS :1367 Class 4.6 / 4 galvanized	
3.0	ACCESSORIES		
3.1	Gear Box	Required (150 mm above)	
3.2	By-Pass Arrangement	Required (600 mm above)	Not required
3.3	Support foot	Required (900 mm above)	Not required
4.0	Details applicable require for Electrically Operated Valve		
4.1	Actuator make / model	Pl. furnish detail	N.A
4.2	Actuator Torque capacity	Pl. furnish detail	N.A
4.3	Power supply	3 Phase, 415 V, AC, 50 Hz.	N.A
4.4	Valve opening/closing time	Vendor to specify	N.A
4.5	Electric Actuator Requirements	Fwd. & reverse integral starter for local & remote mode & cable up to actuator motor with all accessories as per specifications as applicable	N.A
4.6	Actuator make / model	Pl. furnish detail	N.A
4.7	Actuator motor rating-kW	Pl. furnish detail	N.A
5.0	DRAWINGS		
5.1	General outline dimensional drg.	Pl. furnish detail	
5.2	C.S. drawing with parts	Pl. furnish detail	
5.3	QA plan	Pl. furnish detail	
6.0	TESTING		
6.1	Shell test	To be witnessed	15 Kg / Cm ²
6.2	Seat test	To be witnessed	10 Kg / Cm ²

3.0 DATA SHEET FOR NON-RETURN VALVES

SR. NO.	PARTICULAR	DESCRIPTION	DATA TO BE FILLED BY BIDDER
1.0	CONSTRUCTIONAL FEATURES		
1.1	Make	Pl. furnish detail	
1.2	Mfg. Standard	IS 5312- PART II	
1.3	Size & Quantity	Pl. furnish detail	
1.4	Pressure Rating	PN : 1.0	
1.5	Fluid	Sewage	
1.6	Sp Gravity	1.02	
1.7	Type	Pl. furnish detail	
	No of Doors	Pl. furnish detail	
1.8	Ends	Flanged. Flat faced and conforming to IS 1538-part IV& VI having off center bolt holes	
1.9	Seat	Body: Renewable Disc :Renewable	
2.0	MATERIAL OF CONSTRUCTION		
2.1	Body -Inlet & Outlet shell	C.I. IS 210 GR 260(M)	
2.2	Diaphragm & Hinges	C.I. IS 210 GR 260(M)	
2.3	Doors	C.I. IS 210 GR 260 (M)	
2.4	Seat rings	S.S AISI 316 (M)	
2.5	Hinge Pin	S.S BS 970 Gr 431 S29 (M)	
2.6	Internal Bolts, Studs & Nuts	SS 304	
3.0	ACCESSORIES		
3.1	By-Pass Arrangement	Required	Not Required
3.2	Drain Plug	Required	
3.3	Support foot	Required	
4.0	DRAWINGS		
4.1	General outline dimensional drg.	Pl. furnish detail	
4.2	C.S. drawing with parts	Pl. furnish detail	
4.3	QA plan	Pl. furnish detail	
5.0	TESTING		
5.1	Shell test	To be witnessed	15 Kg / Cm ²
5.2	Seat test	To be witnessed	10 Kg / Cm ²

4.0 DATA SHEET FOR SLUICE GATES

SR. NO.	PARTICULARS	DESCRIPTION	DATA TO FILL BY BIDDER
1.0	Make	Pl. furnish detail	
2.0	Manufacturing Standard	AWWA C 501 or IS: 13349/1992 CI-1	
3.0	Size of shutter & No. of Units	As per SOQ	
4.0	Type	Wall Thimble mounted	
5.0	Unseating head in m	App.5.0 m max.	
6.0	Wedging Device provided at	Side / Top / Bottom (Vendor to specify provision as per design)	
7.0	MATERIAL OF CONSTRUCTION:		
7.1	Wall thimble	CI IS 210 GR 200	
7.2	Frame and slide	CI IS 210 GR 200	
7.3	Seating faces	ASTM A 240 type 304	
7.4	Wedges	CI IS 210 FG 200	
7.5	Stem and stem extrn.	ASTM A 276 type 304	
7.6	Stem nut	ASTM A 276 type 304	
7.7	Stem coupling	ASTM A 276 type 304	
7.8	Fasteners, anchor bolts & nuts	SS ASTM A 276 304	
7.9	Lifting Mechanism, pedestal, gear house, cover and stem guide	CI IS 210 GR 200	
7.10	Lift nut	Bronze: ASTM B 148 (CA 952, 954 or 958)	
7.11	Flush bottom seal	EPDM Rubber	
7.12	Spindle height	As per SOQ / Specs.	
7.13	Type of Operation	Gear box & Hand wheel	
7.14	Spindle Dia.-mm	Pl. furnish detail	
7.15	Net Weight of unit in Kg.	Pl. furnish detail	
8.0	Details applicable require for Electrically Operated Valve		
8.1	Sluice Gate torque requirement	Pl. furnish detail- kgm	
8.2	Power supply	3 Phase, 415 V, AC, 50 Hz.	
8.3	Valve opening/closing time	Vendor to specify	
8.4	Electric Actuator Requirements	Fwd. & reverse integral starter for local & remote mode & cable up to actuator motor with all accessories as per specifications as applicable	
8.5	Max. Output torque of Actuator	Pl. furnish detail-kgm	
8.6	Actuator Motor rating-kW	Pl. furnish detail-kW	
9.0	TESTING		
9.1	Seat Test	0..75 kg /cm ²	

TECHNICAL DATA SHEET
(ELECTRICAL & INSTRUMENTATION WORKS)

SECTION- 3:

TECHNICAL SCHEDULE: ELECTRICAL INSTRUMENTATION WORKS

TABLE OF CONTENTS

Sr. No.	Description
1.0	ELECTRICAL EQUIPMENT
1.1	LV Metal Enclosed Switchgear (PCC/ MCC/ PDB/ SDB)
1.2	LV APFC Panel
1.3	Power, Control & Instrumentation Cables
1.4	Earthing & Lightning Protection Systems
1.5	Lighting & Receptacle System
1.6	Relays, Switchgears & Instruments
2.0	INSTRUMENTATION & CONTROL EQUIPMENT
2.1	Full Bore Electromagnetic Flow Transmitter
2.2	Pressure Gauge
2.3	Pressure Transmitter
2.4	Ultrasonic Level Transmitter
2.5	Float & Board Type Level Indicator
Note:	Technical data sheets/ schedules cover only salient features of equipment offered by the Contractor. The Contractor shall certify that the system requirements as covered in tender specifications are fully complied with, except those specifically brought out in Schedule of Deviations from Technical Specification.

Bidder to provide completely filled data sheets for the equipments mentioned below. As applicable, separate data sheets needs to be filled for each equipment/ system covered under the scope.

1.0 DATA SHEET FOR ELECTRICAL EQUIPMENT:

1.1 LT METAL ENCLOSED SWITCHGEARS:

SR. NO.	PARTICULAR	DETAILS	CONFIRM/ DATA TO BE FILLED BY
1.0	SITE CONDITION		
1.1	Type / Make	Indoor / As per tender	
1.2	Mounting	Floor	
1.3	Ambient Temperature	50° C	
1.4	Atmosphere	Corrosive, Humid and Dusty	
2.0	CONSTRUCTION		
2.1	Housing	2.0 mm thick CRCA sheet for body and all partitions	
2.2	Protection Class	IP-5X	
2.3	Doors	1.6 mm thick CRCA sheet with Hinges	
2.4	Base channel	75 x 40 mm C Channel	
3.0	OPERATIVE CONDITION		
3.1	Voltage	415 V $\pm$ 10%	
3.2	No. of phase	3	
3.3	System	3 phase, 4 wire	
3.4	Frequency	50 Hz, +5% / -5%	
3.5	Fault Current	25 kA / 50kA as per SLD	
3.6	Neutral Grounding	Solid	
4.0	CONTROL SYSTEM		
4.1	Voltage		
	For Indication	230 V A.C.	
	For Metering	230 V A.C.	
	For Protection	230 V A.C.	
4.2	Control Supply Through	230 V A.C. for MCC & APFC only	
4.3	Control Wiring	1.5 / 2.5 mm ² FRLS Cu. Wire	
5.0	BUSBAR		
5.2	Neutral Bus bar Material	Same as Phase Bus bar.	
5.3	Earth Bus bar Material	As per SLD	
6.0	PLC Based System	As per SLD / BOQ.	
7.0	Electronic Motor Protection Relay (with RS-485 port)	Microprocessor based	
7.1	Type	As per tender	
7.2	Make	As per tender	
7.3	Protection	PL. furnish	

SR. NO.	PARTICULAR	DETAILS	CONFIRM/ DATA TO BE FILLED BY
	1 over current 2 single phasing 3 phase reverse 4 Current unbalance 5 under current (dry run) 6 stall (bearing broken) locked rotor 7 Restart Inhibition 8 Ground/Earth fault (CBCT)		
8.0	PAINTING		
8.1	Sheet should be 7 tank processed, Oven Baked at 310 °C with powder coating.	Required	
8.2	Colour	RAL 7035	
8.4	Shade : Exterior & Interior	RAL 7035	
9.0	PANEL TEMPERATURE RISE		
9.1	Max. temperature rise inside the panel (°C)	35 °C above ambient	
10.0	Control Wiring		
10.1	Wire Size	1 C X 2.5 Mm ² / 1 C X 1.5 Mm ² Cu.	
11.0	Hardware (Zinc Plated)	YES	
12.0	Space Heater	230 V A.C. with thermostat	
13.0	Pocket For Drawings at door	YES	
14.0	Annunciator Window (Free standing to be mounted at convenient location with required cabling, required contacts should have separate terminal block in cable alley)	Indication for each Pump : 1. Pump Trip (Red)-Through starter 2. High level in sump 3. Low and very low level in sump 4. High and low discharge pressure 5. Valve Motor Trip	
15.0	Instrumentation compartment	Separate compartment for energy meter, Hr meter, level controller, etc. with necessary internal wiring	
16.0	Panel Internal Lighting	Auto NO contact/switch with Panel door and CFL 18 W for Panel Internal Lighting	

1.2 LV APFC PANEL:

Sr. No	Description	Unit	Particulars	To be filled By Bidder
1	Capacitor Bank Panel Particulars			
1.1	Make		As per approved make list	
1.2	Applicable Standards		As per Tender Specification	
1.3	Quantity		As per BOQ	
1.4	Rated Capacity	kVAR	* Bidder to furnish as per design requirement.	
1.5	Capacitor losses (a) For complete bank (b) For individual units	watts watts	0.5W/ kVAR 0.2W/ kVAR	
1.6	Rated voltage	V	415	
1.7	Rated frequency and phases		50 Hz, 3 Phase	
1.8	Ambient temperature	deg.C	50	
1.9	Cable gland required		Yes	
1.10	Size of cable		As per design Requirements	
1.11	Cable entry		Bottom	
2	Unit Capacitors			
2.1	Rated voltage	V	415V	
2.2	Standard Rated Output per bank at 415V	kVAR	5 / 10 / 15 / 25 / 50 / 100 KVAR	
2.3	Maximum over voltage the unit capacitor is capable of withstanding continuously	%	As per IS 13585	
2.4	Type		Double Layer APP	
3	Constructional Requirement			
3.1	Overall dimensions of Capacitor control panel (Length x Depth x Height)	mm	Pl. Furnish	
3.2	Thickness of sheet steel a) Frame, Frame enclosures, doors covers and partition	mm	CRCA - 2.0 Partition-1.6 Gland plate -3	
3.3	Degree of protection		IP 42	
3.4	Color finish shade (Interior/ Exterior)		RAL 7032/ Light grey semi glossy Shade 631 of IS-5	
3.5	Earthing bus - material - size		GI Suitable for max.sc rating for 1 sec)	
a)	Earthing conductor (main grid) - material Size		GI Suitable for max.sc rating for 1 sec)	
4	Design Requirements			
4.1	Insulation level	kV (rms)	2.5	
4.2	Capacitor bank connection		Delta	

Sr. No	Description	Unit	Particulars	To be filled By Bidder
4.3	Short circuit withstand for busbars Short time (1 sec)	kA (rms)	*	
4.4	Type of switching		Automatic switching responsive to power factor through power factor sensing relay	
4.5	Switching steps	Min. 8	As per requirements	
4.6	Rating of contactor		AC 6b Duty - To suit KVAR unit	
4.7	Incomer switch current rating	150% of rated	* As per requirements	
4.8	Busbars		Al	

1.3 POWER, CONTROL & INSTRUMENTATION CABLES:

Sr. No.	Description	Unit	Particulars	To be filled By Bidder
1	11 kV (UE), multi strand, Al, XLPE insulated, inner & outer extruded PVC sheathed, GI armoured power cable (as required)	LS	As per IS 7098 Part -II	
1.1	Make		As per approved list	
1.2	Applicable Standards		As per tender specification	
2	1.1 kV, multi strand Cu/ Al, XLPE insulated, inner & outer extruded PVC sheathed, GI armoured power/submersible cable (Cu conductor cable & GI round wire armoring for sizes up to 6 sq mm & below, for balance all, above 6 sq. mm conductor size- Al conductor & GI flat strip armoring) (Cu conductor, double PVC sheathed, water tight, flexible cable for submersible pump application)	LS	As per IS 7098-Part -I	
2.1	Make		As per approved list	
2.2	Applicable Standards		As per tender specification	
3	1.1 kV, multi-strand Cu, XLPE insulated, inner & outer extruded PVC sheathed, GI armoured control cables	LS	As per IS 7098	
3.1	Make		As per approved list	

Sr. No.	Description	Unit	Particulars	To be filled By Bidder
3.2	Applicable Standards		As per tender specification	
4.	General			
4.1	Type of Cable Gland (Suitable for Cable Size as per requirement)		Double compression brass type	
4.2	Type of Cable Lugs (Suitable for Cable Size & material or bimetallic - as per requirement)		Crimping type	
4.3	All Cable accessories as per specification requirements to be provided.		Yes/ No	

1.4 EARTHING AND LIGHTNING PROTECTION SYSTEM:

Sr. No.	Description	Unit	Particulars	To be filled By Bidder
1	Main Earthing Grid		To suite as per maximum SC rating & design Criteria	
2	Conductor leads to equipment		(Minimum 2 distinct earthing leads for equip. having > 125V & 1 earthing lead for equip. with < 125V)	
3	Other Items			
3.1	Main lighting D.B, Control panels and sub-lighting distribution boards	Mtr.	GI, 25x6mm	
3.2	Hand Rails	Mtr.	GI, 25x3	
3.3	Cable trays	Mtr.	GI, 25x3	
3.4	Tanks	Mtr.	GI, 25x3	
3.5	Street lighting, flood lighting poles and junctions boxes,	Mtr.	GI wire, 8 SWG	
3.6	Lighting fixtures, single phase receptacles, lighting conduits,	Mtr.	GI wire, 12 SWG	
3.6	Push button stations, limit switches,	Mtr.	GI wire, 12 SWG	
3.7	Crane rail,	Mtr.	GI, 25x3 mm	
3.8	Metallic noncurrent carrying structures,	Mtr.	GI, 25x3 mm	
4	Lightning Conductors	Mtr.		
4.1	Lightning protection down comers for building,	Mtr.	GI, 25x6 mm	
4.2	Lightning protection horizontal roof conductor for building	Mtr.	GI, 25x6 mm	
5	Electrodes			

Sr. No.	Description	Unit	Particulars	To be filled By Bidder
5.1	Pipe electrode	Nos.	Heavy duty GI pipe 3000 mm long, 40NB (Quantity to achieve ≤ 1 Ohm earth resistance based on 100 ohm-m or higher resistivity on the basis of actual measurement whichever is higher)	
5.2	Plate Electrode	Nos	Minimum 2 Nos. of 600mm x 600mm x 3.15 mm Cu for each transformer neutral - Minimum 2 Nos. of 600mm x 600mm x 6 mm GI for each transformer body/ other system	
6	Earthing Resistance to be achieved		As per IS 3043	
6.1	For safety earthing	Ohm	≤ 1	

1.5 LIGHTING & RECEPTACLE SYSTEM AND EQUIPMENT:

Sr. No.	Description	Unit	Particulars	To be filled By Bidder
1	System Particular			
1.1	Voltage			
a)	3 Phase, 4 wire 50 Hz system			
i)	Nominal	V	415	
ii)	Maximum	V	476	
b)	D.C. system			
i)	Rated	V	24/ 110	
c)	One minute withstand voltage		2000 V AC.	
d)	System short-circuit level			
i)	At 415 V, A.C.	kA (rms)	10	
ii)	At 110 V.D.C.	kA (D.C.)	6	
e)	Reference ambient temperature		450 C	
2	Distribution Board/ Panels			
2.1	Make		As per approved list	
2.2	Applicable Standards		As per Tender Specification	
2.3	Main, floor mounted distribution boards			
a)	Main LDB (A.C.)		As per requirement	
i)	Bus bars		Al/ Cu	

Sr. No.	Description	Unit	Particulars	To be filled By Bidder
ii)	Bus bar current rating	A	As per requirement	
	Incoming		As per requirement	
	Outgoing		As per requirement (With Minimum 2 spare feeders)	
iii)	Cable entry		Bottom	
iv)	Earthing terminals		50x8 mm GI flat	
b)	Emergency lighting panel		As per requirement	
i)	Bus bars		Copper	
ii)	Bus bar current rating	A	As per Requirement	
	Incoming and outgoing feeders		As per requirements (With Minimum 2 spare feeders)	
iii)	Cable entry		Bottom	
iv)	Earthing terminals		50x6 mm GI flat	
2.4	Sub DBs, wall/ structure mounting panels			
a)	SLDB for indoor area		As per requirement	
i)	Bus bars		Copper	
ii)	Bus bar current rating	A	As per requirement	
	Incoming and outgoing feeders		1 No. Incoming TPN MCB * (Minimum 32A) with ELCB As per requirement Outgoing 10/16A MCB SPN and DP ELCB per phase with PPI (With Minimum 2 spare feeder circuits; a single circuit consists of SPN MCBs for R,Y, B phase)	
iv)	Cable entry		Bottom/Top	
b)	SLDB for outdoor area		As per requirement	
i)	Bus bars		Copper	
ii)	Bus bar current rating	A	As per requirement	
	Incoming		1No.-Incoming * A TPN MCB (Minimum 32A) with ELCB- with timer (0-24 hours)	
	Outgoing		As per requirement Outgoing 10/16 A SPN MCB with switch contactors. (With Minimum 2 spare feeder circuits; a single circuit consists of SPN MCBs for R,Y, B	

Sr. No.	Description	Unit	Particulars	To be filled By Bidder
			phase)	
iii)	Cable entry		Bottom/Top	
2.5	Paint Finish			
a)	Color shade (Interior/ Exterior)		As per industry standard	
b)	Epoxy paint required		Yes.	
2.6	Earthing terminals suitable for conductor			
a)	Size	mm x mm	25x3 flat	
b)	Material		G.I.	
3	Receptacle Units			
3.1	Make			
3.2	Decorative (complete with flush/surface mounted boxes/cover plates etc.)			
a)	3 pin 1-ph & N with switch and plug tops	A	5/15 A, Indoor Type	
(b)	Industrial (complete with surface mounted, pre-fabricated CRCA boxes)			
i)	3 Pin, 230V AC		As per required	
	With ELCB(30mA) & plug	A	15A, Indoor Type	
ii)	5 pin, 3 Ph., 415V		As per required	
	With ELCB(30mA) & plug	A	63A, Outdoor type	
	With ELCB(30mA) & plug	A	32A, Indoor type	
4	Lighting Wires			
4.1	Make		As per approved list	
4.2	Conductor		Stranded Copper	
a)	Size (sizes mentioned are minimum & size to be decided on circuit load & voltage drop criteria) 1100V, PVC insulated FRLS	Core x mm ²	Lighting 2x1Cx1.5 mm ² Receptacle / Sockets Decorative 2x1Cx1.5mm ² Industrial 1ph - 2x1Cx4 mm ² 3ph - 4Cx 6 /16 mm ²	
5	Conduits			
5.1	Make			
5.2	Material		Galvanized steel	
5.3	Size	mm	20	
6	Street light poles and flood light poles			
6.1	Make		As per Approved list	
6.2	Street Light Pole			
a)	Typical drawing (if any)		-	
b)	Total Height:	M	8.5/10/12	
c)	Quantity:	Nos.	As per requirement	
6.3	Junction Box with Pole			
a)	Typical drawing (if any)		-	

Sr. No.	Description	Unit	Particulars	To be filled By Bidder
b)	No. of cable entries:	Nos.	Two	
c)	Cable entry suitable for :		4Cx16 mm ² Al. Conductor, PVC insulated, armoured cable	
d)	Earthing terminal suitable for		8 SWG/ 25x3 mm GS Flat	
6.4	Floodlight Light Pole			
a)	Total height	Mtr.	8.5/10/12/High Mast	
b)	No. of floodlights to be fixed per pole	No.	Minimum One/as required	
c)	Painted		Yes	
d)	Earthing terminal suitable for	mm x mm	8 SWG/ 25x3 mm GS Flat	
e)	Quantity :	Nos.	As per requirement	
7	Luminaire (Lighting fixture complete with prewired control gear terminal block & suitable lamps)	LS	As per specification requirement	
8	Note			
Supply of conduits, wires/cables, all fixing hardware, terminal connectors, cable termination kits and associated accessories for -lighting, receptacles, earthing, cabling & wiring works, required civil works etc. shall be included in Contractor's scope. All ELCBs for lighting circuit shall be with 100mA sensitivity. All ELCBs for receptacle circuit shall be with 30mA sensitivity.				

1.6 RELAYS/ SWITCHGEARS/ INSTRUMENTS DETAILS:

Sr. No.	Description	To be filled by bidder	
1	Relay	Make & Model No.	Yes/ No
1.1	Instantaneous Over Current & Earth Fault Protections (50 & 50N) (Element Of Numerical Relay)		
1.2	IDMT Over Current & Earth Fault Protections (51 & 51N) (Element Of Numerical Relay)		
1.3	Master Trip / Lock Out Relay (86) (Separate Relay)		
1.4	Stand By Earth Fault Relay (51NS) (Separate Relay)		
1.5	Under Voltage/ Over Voltage (27/ 59)		
1.6	Trip Circuit Supervision Relay (95)		
1.7	Auxiliary Relay (Separate Relays Based On Requirements, With At Least One Spare Element)		
1.8	Automatic Voltage Regulator (Separate Device)		
1.9	Microprocessor Based Battery Charger Controller		
1.10	Motor Protection Relay (98) (Comprehensive Motor Protection Relay for Motor Ratings 132 KW & above)		

Sr. No.	Description		To be filled by bidder			
2	Switchgear	Application	Make & Model No.	Rating / Release Type		Yes / No
2.1	ACB	Above 630A	As per approved make	Minimum as per BOQ & specification requirements		
2.2	MCCB	Up to 630 A				
2.3	MCB					
2.4	Fuse					
3	Starters (Including All Components for Type-2 Co-Ordination)	Application (Provide Feeder Range For Which It Is Applicable)	Make	Type -2 Co-Ordination (With MCCB) Ensured - Yes/ No		Yes
3.1	D.O.L.	As per BOQ		Yes		
3.2	FCMA Soft starter	As per BOQ		Yes		
4	Meters	Application	Make & Model No.	Type	Size	
4.1	Ammeter	Minimum As Per SLD & Specification Requirements	As Per Approved Make List			
4.2	Voltmeter					
4.3	MFM		As Per Approved Make List			
4.4	TVM/ Tariff Meter		(As Per GEB Requirements)			
5	Annunciators - Required		Quantity	Make & Model No.		Indication Lamp Type
5.1	8 Window					
5.2	16 Window					
6	Whether detailed literature for all the above (item 1 to 5) items enclosed with tender (Yes/ No)					

2.0 DATA SHEET FOR INSTRUMENTATION & CONTROL EQUIPMENT:

2.1 FULL BORE ELECTROMAGNETIC FLOW TRANSMITTER:

Sr. No.	Description	Particulars	To be filled by Bidder
1	General		
1.1	Make	As per approved vendor list	
1.2	Item	Full Bore Electromagnetic Flow Meter	
1.3	Service	Common Header of Pump Discharge	
1.4	Fluid	Raw Water/ Treated Water	
1.5	Area Classification	Non Hazardous	
2	Flow Sensor		
2.1	Type	DC pulsed	
2.2	Electrode / Sensor	SS 316	

Sr. No.	Description	Particulars	To be filled by Bidder
	MOC		
2.3	Flow Tube MOC	SS304	
2.4	Coil Housing MOC	SS 304	
2.5	Grounding Ring MOC	SS 304	
2.6	Liner MOC	Neoprene/ polyurethane	
2.7	Process Connection	Flanged	
2.8	Flange MOC	CS	
2.9	Housing Protection	IP 68	
2.10	Pressure Rating	16 Kg/cm ²	
2.11	Temperature	50° C Ambient	
2.12	Size(mm)	To suit mains flow parameters, with pipe reducer/ expander provided as necessary	
3	Flow Indicator and Transmitter		
3.1	Type	Microprocessor Based, Remote Mounted	
3.2	Power Supply	230 VAC (UPS)	
3.3	Accuracy	± 0.5 % of measured value	
3.4	Repeatability	± 0.1%	
3.5	Transmitter Protection	IP67	
3.6	Transmitter MOC	Dia-cast Aluminium with PU finish/ Polycarbonate	
3.7	Output	One Current - 4 to 20 mA (isolated) proportional to flow rate Hart (version 6 or above) One Scalable Pulse One Status Output	
3.8	Communication	Modbus RS485	
3.9	Display	2 Line Backlit LCD, Programmable	
3.10	Maximum Digit Display	8 Digit	
3.11	Indication on Display	2 Actual Flow Rate/ Instantaneous Flow Rate 3 Cumulative Forward Flow 4 Cumulative Reverse Flow 5 Cumulative Flow/ Sum/ Totalizers 6 Alarm	
		7 Five (5) digit backlit/ Normal LCD, for flow rate in m ³ /hr. 8 Eight (8) digit backlit/ Normal LCD for totalized flow in ML	

Sr. No.	Description	Particulars	To be filled by Bidder
		Display with 8 digits for main information. Index, menu and status symbols for dedicated information	
		Key for toggling through the information and reset customer totalizers and call-up function	
		Selectable default information and accessible menus: 9 Operator 10 Meter 11 Service 12 Data Logger	
3.12	Zero and Span adjustment	Factory set Password protection of all parameters and hardware protection of calibration and revenue parameters.	
3.13	Facility for on line diagnosis	Required as following:	
		Diagnostic: Continuous self test shall include 13Coil current to drive the magnetic field 14Signal input circuit 15Data calculation, handling and storing	
		Features 16Alarm statistics and logging for fault analyzing 17Electrode impedance to check actual media contact 18Flow simulation to check pulse and communication signal chain for correct scaling 19Number of sensor measurements (excitations) 20Transmitter temperature 21Low impedance alarm for change in media 22Flow alarm when defined high flow exceeds 23Verification mode for fast measure performance check 24Statistic flow and consumption data	
3.14	Cable Gland	Required	
3.15	Cable Length (sensor to transmitter)	10 Meter minimum or suit to site	
3.16	Data Protection:	25 All data shall be stored in an EEPROM. 26 Totalized statistic shall be backed up every 10 min	

Sr. No.	Description	Particulars	To be filled by Bidder
		27 Power consumption and temperature Measurement statistic at every 4 hour 28 Minimum 30 days of data shall be stored in EEPROM. 29 Password protection of all parameters and hardware protection of calibration and revenue parameters.	
3.17	Power Supply in case of Raw power is not available (Remote Area)	Battery power	

2.2 PRESSURE GAUGE:

Sr. No.	Description	Particulars	To be filled by bidder
1	General		
1.1	Make	As per approved vendor list	
1.2	Item	Pressure Gauge	
1.3	Service	Pump/Blower Discharge, Pump/Blower Discharge Common Header	
1.4	Fluid	Raw Water, Treated Water, Air	
1.5	Area Classification	Non Hazardous	
2	Pressure Gauge		
2.1	Type	Bourdon	
2.2	Sensor and other wetted parts M.O.C	SS 316	
2.3	Process connection	½" NPT (M)	
2.4	Dial size	150 mm	
2.5	Material of dial	Aluminium with white back ground and black numerals	
2.6	Glass	Shatterproof	
2.7	Housing material	Die cast aluminium with epoxy coating	
2.8	Accuracy	±1% of full scale or better	
2.9	Over range protection	125% of maximum pressure	
2.10	Gauge Protection	IP65	
2.11	Temperature	50° C Ambient	
2.12	Range	As per pump design (Range to be finalised during detailed engineering without any cost implication)	

Sr. No.	Description	Particulars	To be filled by bidder
2.13	Accessories	6 Snubber 7 3-way isolation valve 8 Impulse tubing, fittings 9 All other installation hardware	
2.14	Diaphragm Seal M.O.C	SS316	
2.15	3 Way Isolation Valve M.O.C	SS316	
2.16	Impulse Tube Fitting M.O.C	SS316	

2.3 PRESSURE TRANSMITTER:

Sr. No.	Description	Particulars	To be filled by Bidder
1	General		
1.1	Make	As per approved vendor list	
1.2	Item	Pressure Transmitter	
1.3	Service	Pump/ Blower Discharge Common Header	
1.4	Fluid	Raw Water/ Treated Water	
1.5	Area Classification	Non Hazardous	
2	Pressure Sensor		
2.1	Type	Diaphragm/ piezoelectric	
2.2	Sensor and other wetted parts M.O.C	SS 316	
2.3	Process connection	½" NPT (F)	
2.4	Sensor Fill Fluid	Silicon Oil	
2.5	Temperature	50° C Ambient	
2.6	Range	As per pump design (Range to be finalised during detailed engineering without any cost implication)	
3.	Pressure Transmitter		
3.1	Type	SMART Type/ Microprocessor Based, Head Mounted	
3.2	Power Supply	230 VAC Line Power/ 24 VDC	
3.3	Accuracy	± 0.1 % of measured value	
3.4	Response Time	100 ms	
3.5	Transmitter Protection	IP67	
3.6	Transmitter MOC	SS316 / Diacast Aluminium with PU finish	
3.7	Output	One Current - 4 to 20 mA (isolated) proposanal to	

Sr. No.	Description	Particulars	To be filled by Bidder
		pressure Hart (version 6 or above)	
3.8	Display	Alphanumeric LCD Type, Programmable	
3.9	Over range protection	125% of maximum pressure	
3.10	Zero and span adjustment	Required	
3.11	Cable Gland	Required	
3.12	Accessories	10 Snubber 11 3 way isolation valve 12 Impulse tubing, fittings 13 Mounting Bracket 14 Tag Plate 15 All other installation hardware	
3.13	Diaphragm Seal M.O.C	SS316	
3.14	3 Way Isolation Valve M.O.C	SS316	
3.15	Impulse Tube Fitting M.O.C	SS316	

2.4 ULTRASONIC LEVEL TRANSMITTER:

Sr. No.	Description	Particulars	To be filled by bidder
1	General		
1.1	Make	As per approved vendor list	
1.2	Item	Level Transmitter	
1.3	Service	Sump/ Tank	
1.4	Fluid	Raw Water / Treated Water, Chemical Water	
1.5	Area Classification	Non Hazardous	
2	Level Sensor		
2.1	Type	Ultrasonic	
2.2	Sensor MOC	PP/ PVDF	
2.3	Seal MOC	EPDM	
2.4	Sensor Housing MOC	Diacast Aluminium with PU finish/ Polycarbonate	
2.5	Process Connection	Flanged	
2.6	Flange MOC	PP/ CS	
2.7	Housing Protection	IP 68	
2.8	Temperature compensation	Required	
2.9	Swirling arm arrangement for	Required for access during maintenance	

Sr. No.	Description	Particulars	To be filled by bidder
	mounting of sensor		
2.10	Size(mm)	To suit Sump/ Tank Height	
2.11	Pressure Rating (Kg/cm ²)	Atmospheric	
2.12	Temperature	50 °C Ambient	
3	Level Transmitter		
3.1	Type	Microprocessor Based, Remote Mounted	
3.2	Power Supply	230 VAC Line Power	
3.3	Accuracy	± 0.1% of measured value	
3.4	Repeatability	± 0.1%	
3.5	Transmitter Protection	IP67	
3.6	Transmitter MOC	Diacast Aluminium with PU finish/ Polycarbonate	
3.7	Output	One Current - 4 to 20 mA (isolated) proportional to Level Hart (version 6 or above)	
3.8	Display	2 Line Backlit LCD, Programmable	
3.9	Maximum Digit Display	8 Digit	
3.10	Indication on Display	Actual Sump/ Tank Level Alarm	
3.11	Zero and Span adjustment	Factory set Password protection of all parameters and hardware protection of calibration and revenue parameters.	
3.12	Cable Gland	Required	
3.13	Cable Length (sensor to transmitter)	10 Meter minimum or suit to site	

2.5 FLOAT & BOARD TYPE LEVEL INDICATOR:

Sr. No.	Description	Particulars	To be filled by Bidder
1	General		
1.1	Make	As per approved vendor list	
1.2	Item	Level Indicator	
1.3	Service	Sump/ Tank	
1.4	Fluid	Raw Water/ Treated Water	
1.5	Area Classification	Non Hazardous	
2	Level Indicator		
2.1	Type	Float and Board	

Sr. No.	Description	Particulars	To be filled by Bidder
2.2	Construction	Guided	
2.3	Measuring Range	To Suit Sump / Tank Height	
2.4	Travel	Full Range	
2.5	Float	SS316	
2.6	Float / Guide wire Rope	SS316	
2.7	Calibrated Gauge Board	6" wide x aluminium powder coating with black graduations and numerical	
2.8	Pointer	Red, powder coated steel with measuring rope holder	
2.9	Protection Conduit	Vertical and Horizontal limb in galvanized steel	
2.10	Elbow pulley	Cadmium plated steel or PP pulley with PTFE bush and SS shaft housed in weather proof aluminium or PP enclosure	
2.11	Tensioner	Cadmium plated steel spring housed in CS or PP enclosure	
2.12	Anchor	SS316 plate (25mm x 6mm thick plate to be welded at bottom of sump / tank at site)	
2.13	Rope Fastener	SS316	
2.14	Gauge Brackets	Powder Coated Steel	
2.15	Counter weight for rope type probe to keep it straight	Required	
2.16	Spacers between the probes to avoid entangling with each other	Required	